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DRAFT WORLD-WIDE STUDY OF THE PETROCHEMICAL INDUSTRY 1975–2000

(APPENDICES)

PREPARED BY THE

INTERNATIONAL CENTRE FOR INDUSTRIAL STUDIES

id. 78-5919

DRAFT WORLD-WIDE STUDY
OF THE
PETROCHEMICAL INDUSTRY
1975–2000

(APPENDICES)

PREPARED BY THE

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Table of Contents

Appendix A

DETAILED PRODUCTION CAPACITIES

TABLE A.1.

PRODUCTION CAPACITY

PRODUCT: Ethylene

	10^3 t/year	
	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	500	450
France	2 465	225
F.R.G.	3 780	610
Italy	2 020	505
Netherlands	2 340	450
Spain	670	325
United Kingdom	1 735	850
Others	655 (1)	1 450 (2)
TOTAL	14 165	4 865
EASTERN EUROPE		
Bulgaria	375	250
Czechoslovakia	305	590
G.D.R.	550	-
Hungary	275	-
Poland	140	340
Romania	360	220
U.S.S.R	700 (3)	450
Yugoslavia	250	100
TOTAL	2 955	1 950
NORTH AMERICA		
Canada	670	1 000
U.S.A.	13 780	4 400
TOTAL	14 450	5 400

(1) *of which 340 in Sweden*

(2) *of which 500 in Sweden*
300 in Portugal
360 in Sweden

(3) *estimated from plastics production*

PRODUCT : Ethylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	60	120
Colombia	20	-
Ecuador	-	-
Peru	5	-
Venezuela	150	400
Sub-total	235	520
Argentina	55	150
Brazil	730	350
Mexico	435	680
Others	-	-
TOTAL	1 455	1 700
AFRICA		
North Africa		
Algeria	120	-
Egypt	-	300
Libyan Arab Jamahiriya	-	300
Morocco	-	-
Tunisia	-	-
Sub-total	120	600
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	200	400
TOTAL	320	1 000

PRODUCT: Ethylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	150
Israel	130	155
Kuwait	-	-
Lebanon	-	-
Qatar	-	300
Saudi Arabia	-	-
Turkey	60	300
United Arab Emirates	-	-
Sub-total	*190*	*905*
South Asia		
India	180	130
Iran	12	300
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*192*	*430*
East Asia		
China	40	465
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	100	400
Others	340	300
Sub-total	*480*	*1 165*
Japan	4 510	1 600
TOTAL	5 372	4 100
PACIFIC AREA		
Australia	290	300
New Zealand	-	-
TOTAL	290	300
WORLD TOTAL	39 007	19 315

TABLE A.2.

PRODUCTION CAPACITY

PRODUCT : Propylene

	10^3 t/year	
	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	230	135
France	1 320	110
F.R.G.	2 150	345
Italy	1 200	280
Netherlands	1 305	200
Spain	305	130
United Kingdom	1 160	425
Others	350 (1)	600
TOTAL	8 020	2 225
EASTERN EUROPE		
Bulgaria	175	-
Czechoslovakia	145	220
G.D.R.	150	-
Hungary	150	-
Poland	93	320
Romania	200	120
U.S.S.R	510	-
Yugoslavia	110	50
TOTAL	1 533	710
NORTH AMERICA		
Canada	-	225
U.S.A.	7 100	2 200
TOTAL	7 100	2 425

(1) *of which 180 in Sweden*

PRODUCT : Propylene

	10³ t/year	
	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	40	-
Colombia	10	-
Ecuador	-	-
Peru	-	-
Venezuela	90	170
Sub-total	*140*	*170*
Argentina	-	115
Brazil	278	350
Mexico	-	130
Others	-	-
TOTAL	418	765
AFRICA		
North Africa		
Algeria	-	-
Egypt	-	150
Libyan Arab Jamahiriya	-	-
Morocco	-	-
Tunisia	-	-
Sub-total	-	*150*
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	150

PRODUCT: Propylene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
<u>ASIA</u>		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	40	
Qatar	-	-
Saudi Arabia	-	-
Turkey	-	-
United Arab Emirates	-	-
Sub-total	*40*	-
South Asia		
India	100	-
Iran	-	120
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*100*	*120*
East Asia		
China	15	200
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	60	180
Others	140	130
Sub-total	*215*	*510*
Japan	2 800	800
TOTAL	3 155	1 430
<u>PACIFIC AREA</u>		
Australia	80	-
New Zealand	-	-
TOTAL	80	-
<u>WORLD TOTAL</u>	20 306	7 705

TABLE A.3.

PRODUCTION CAPACITY

PRODUCT : Butadiene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	160	-
France	313	-
F.R.G.	615	160
Italy	280	100
Netherlands	370	30
Spain	95	68
United Kingdom	300	90
Others	20 (1)	-
TOTAL	2 153	448
EASTERN EUROPE		
Bulgaria	10	90
Czechoslovakia	35	60
G.D.R.	80	-
Hungary	40	-
Poland	85	50
Romania	-	-
U.S.S.R	90	45
Yugoslavia	-	-
TOTAL	340	245
NORTH AMERICA		
Canada	n.a	
U.S.A.	2 270	90
TOTAL	2 270	90

(1) *In Finland*

PRODUCT : Butadiene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	35	32
Brazil	115	52
Mexico	55	30
Others	-	-
TOTAL	205	114
AFRICA		
North Africa		
Algeria	-	-
Egypt	-	49
Libyan Arab Jamahiriya	-	-
Morocco	-	-
Tunisia	-	-
Sub-total	-	49
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	20	-
TOTAL	20	49

PRODUCT: Butadiene

	10³ t/year EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	33	-
United Arab Emirates	-	-
Sub-total	33	-
South Asia		
India	36	22
Iran	-	30
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	36	52
East Asia		
China	12	45
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	20	70
Others	45	100
Sub-total	77	215
Japan	872	60
TOTAL	1 018	327
PACIFIC AREA		
Australia	34	-
New Zealand	-	-
TOTAL	34	-
WORLD TOTAL	6 040	1 273

TABLE A.4.

PRODUCTION CAPACITY

PRODUCT : Benzene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	159	-
France	702	170
F.R.G.	1 300	680
Italy	986	620
Netherlands	915	415
Spain	320	497
United Kingdom	1 400	250
Others	20(1)	-
TOTAL	5 802	2 632
EASTERN EUROPE		
Bulgaria	122	240
Czechoslovakia	234	-
G.D.R.	280	-
Hungary	80	-
Poland	174	230
Romania	200	-
U.S.S.R	2 200	880
Yugoslavia	170	180
TOTAL	3 460	1 530
NORTH AMERICA		
Canada	400	200
U.S.A.	6 000	100
TOTAL	6 400	300

(1) *of which 15 in Austria*

PRODUCT : Benzene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	-	-
Colombia	43	-
Ecuador	-	-
Peru	-	-
Venezuela	-	-
Sub-total	43	-
Argentina	60	80
Brazil	130	120
Mexico	116	410
Others	-	-
TOTAL	349	610
AFRICA		
North Africa		
Algeria	-	-
Egypt	-	155
Libyan Arab Jamahiriya	-	-
Morocco	-	-
Tunisia	-	-
Sub-total	-	155
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	155

10³ t/year

PRODUCT: Benzene

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	-	120
United Arab Emirates	-	-
Sub-total	-	*120*
South Asia		
India	69	-
Iran	-	330
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*69*	*330*
East Asia		
China	-	100
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	100	-
Others	34	32
Sub-total	*134*	*132*
Japan	2 550	635
TOTAL	2 753	1 217
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	18 764	6 444

TABLE A.5.

PRODUCTION CAPACITY

PRODUCT : P-Xylene

	10^3 t/year	
	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	-	-
France	114	-
F.R.G.	308	80
Italy	280	118
Netherlands	70	-
Spain	25	-
United Kingdom	423	-
Others	-	94 (1)
TOTAL	1 220	292
EASTERN EUROPE		
Bulgaria	12	-
Czechoslovakia	40	-
G.D.R.	30	-
Hungary	-	-
Poland	54	50
Romania	30	-
U.S.S.R	161	-
Yugoslavia	-	-
TOTAL	327	50
NORTH AMERICA		
Canada	-	-
U.S.A.	1 908	1 200
TOTAL	1 908	1 200

(1) *in Portugal*

PRODUCT : P-Xylene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	-	-
Colombia	-	17
Ecuador	-	-
Peru	-	-
Venezuela	-	-
Sub-total	-	17
Argentina	40	-
Brazil	-	160
Mexico	60	220
Others	-	-
TOTAL	100	397
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa		
TOTAL	-	-

10³ t/year

PRODUCT: P-Xylene

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	-	74
United Arab Emirates	-	-
Sub-total	-	*74*
South Asia		
India	17	24
Iran	-	100
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*17*	*124*
East Asia		
China	17	123
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	-	100
Others	25	200
Sub-total	*42*	*423*
Japan	636	360
TOTAL	695	981
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	4 250	2 920

TABLE A.6.

PRODUCTION CAPACITY

PRODUCT : O-Xylene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	-	-
France	140	-
F.R.G.	270	65
Italy	220	-
Netherlands	55	-
Spain	23	80
United Kingdom	140	-
Others	-	30 (1)
TOTAL	848	175
EASTERN EUROPE		
Bulgaria	24	-
Czechoslovakia	24	30
G.D.R.	10	-
Hungary	15	-
Poland	10	-
Romania	44	-
U.S.S.R	140	660
Yugoslavia	18	-
TOTAL	285	690
NORTH AMERICA		
Canada	27	-
U.S.A.	576	-
TOTAL	603	-

(1) *in Portugal*

PRODUCT : O-Xylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	-	-
Colombia	8	-
Ecuador	-	-
Peru	-	-
Venezuela	-	-
Sub-total	8	-
Argentina	20	-
Brazil	30	80
Mexico	17	55
Others	-	-
TOTAL	75	135
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa		
TOTAL	-	-

10^3 t/year

PRODUCT: O-Xylene

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		
Israel		
Kuwait		
Lebanon		
Qatar		
Saudi Arabia		
Turkey		
United Arab Emirates		
Sub-total	-	-
South Asia		
India	-	21
Iran	-	20
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others		
Sub-total	-	41
East Asia		
China	-	-
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	-	60
Others		
Sub-total	-	60
Japan	315	
TOTAL	315	101
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	2 126	1 101

TABLE A.7.

PRODUCTION CAPACITY

PRODUCT : Methanol

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	-	-
France	385	-
F.R.G.	1 610	-
Italy	460	-
Netherlands	410	330
Spain	200	-
United Kingdom	695	-
Others	160 (1)	-
TOTAL	3 920	330
EASTERN EUROPE		
Bulgaria	23	100
Czechoslovakia	150	-
G.D.R.	260	-
Hungary	-	70
Poland	160	-
Romania	220	-
U.S.S.R	1 700	1 650
Yugoslavia	-	180
TOTAL	2 513	2 000
NORTH AMERICA		
Canada	420	420
U.S.A.	4 204	930
TOTAL	4 624	1 350

(1) *of which 70 in Austria*
60 in Norway

PRODUCT : Methanol

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	34	80
Brazil	58	60
Mexico	172	150
Others	-	-
TOTAL	264	290
AFRICA		
North Africa		
Algeria	110	-
Egypt	-	-
Libyan Arab Jamahiriya	-	330
Morocco	-	-
Tunisia	-	-
Sub-total	110	330
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	17	-
TOTAL	127	330

PRODUCT: Methanol

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	54	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	-	-
United Arab Emirates	-	-
Sub-total	54	-
South Asia		
India	33	44
Iran	-	540
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	33	584
East Asia		
China	150	100
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	390	-
Others	45	-
Sub-total	585	100
Japan	1 164	300
TOTAL	1 836	984
PACIFIC AREA		
Australia	33	-
New Zealand		
TOTAL	33	-
WORLD TOTAL	13 317	5 284

TABLE A.8.

PRODUCTION CAPACITY

PRODUCT : Ethylene Oxide

	10^3 t/year	
	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	310	100
France	270	-
F.R.G.	410	170
Italy	140	160
Netherlands	310	-
Spain	20	80
United Kingdom	225	-
Others	45 (1)	40 (2)
TOTAL	1 730	550
EASTERN EUROPE		
Bulgaria	12	40
Czechoslovakia	24	40
G.D.R.	100	100
Hungary	-	-
Poland	30	60
Romania	52	-
U.S.S.R	60	400
Yugoslavia	24	40
TOTAL	302	680
NORTH AMERICA		
Canada	115	-
U.S.A.	2 335	235
TOTAL	2 450	235

(1) *of which 40 in Sweden*

(2) *in Sweden*

PRODUCT: Ethylene Oxide

	EXISTING CAPACITY (10^3 t/year)	ADDITIONAL CAPACITY (start-up before 1980) (10^3 t/year)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	-	20
Brazil	35	40
Mexico	30	100
Others	-	-
TOTAL	65	160
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa		
TOTAL	-	-

PRODUCT: Ethylene Oxide

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	-	55
United Arab Emirates	-	-
Sub-total	-	55
South Asia		
India	12	-
Iran	-	-
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	12	-
East Asia		
China	-	35
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	-	-
Others	-	-
Sub-total	-	35
Japan	490	150
TOTAL	502	240
PACIFIC AREA		
Australia	15	-
New Zealand	-	-
TOTAL	15	-
WORLD TOTAL	5 064	1 865

TABLE A.9.

PRODUCTION CAPACITY

PRODUCT : Vinyl chloride

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
	10^3 t/year	
WESTERN EUROPE		
Belgium	540	270
France	850	800
F.R.G.	1 250	730
Italy	960	230
Netherlands	300	450
Spain	220	410
United Kingdom	550	-
Others	190	450
TOTAL	4 860	3 340
EASTERN EUROPE		
Bulgaria	18	150
Czechoslovakia	200	-
G.D.R.	60	200
Hungary	33	160
Poland	-	205
Romania	244	-
U.S.S.R	600	270
Yugoslavia	40	100
TOTAL	1 195	1 085
NORTH AMERICA		
Canada	60	300
U.S.A.	3 040	n.a
TOTAL	3 100	300

PRODUCT : Vinyl chloride

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	15	-
Chile	29	-
Colombia	-	-
Ecuador	9	-
Peru	-	-
Venezuela	-	56
Sub-total	53	56
Argentina	36	130
Brazil	178	110
Mexico	90	200
Others	-	-
TOTAL	357	496
AFRICA		
North Africa		
Algeria		40
Egypt		-
Libyan Arab Jamahiriya		-
Morocco		-
Tunisia		-
Sub-total	-	40
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	42	190
TOTAL	42	230

PRODUCT: Vinyl Chloride 10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	60
Israel	14	30
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	55	105
United Arab Emirates	-	-
Sub-total	69	195
South Asia		
India	80	-
Iran	60	150
Indonesia	15	24
Malaysia	-	-
Pakistan	6	-
Philippines	10	-
Singapore	-	-
Thailand	20	-
Viet Nam	-	-
Others	-	-
Sub-total	191	174
East Asia		
China	-	-
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Reoublic of Korea	60	150
Others	106	240
Sub-total	166	390
Japan	2 290	n.a
TOTAL	2 716	759
PACIFIC AREA		
Australia	47	-
New Zealand	-	-
TOTAL	47	-
WORLD TOTAL	12 317	6 210

TABLE A.10.

PRODUCTION CAPACITY

PRODUCT : Styrene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	-	275
France	345	145
F.R.G.	1 080	-
Italy	460	300
Netherlands	500	500
Spain	80	340
United Kingdom	480	-
Others	-	-
TOTAL	2 945	1 560
EASTERN EUROPE		
Bulgaria	20	-
Czechoslovakia	50	-
G.D.R.	-	-
Hungary	-	-
Poland	40	-
Romania	40	35
U.S.S.R	-	300 (1)
Yugoslavia	14	-
TOTAL	164	335
NORTH AMERICA		
Canada	190	260
U.S.A.	3 390	700
TOTAL	3 580	960

(1) *including existing capacity*

PRODUCT : Styrene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	50	25
Brazil	60	160
Mexico	40	100
Others	-	-
TOTAL	150	285
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	18	-
TOTAL	18	-

PRODUCT: Styrene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	25	-
United Arab Emirates	-	-
Sub-total	25	-
South Asia		
India	30	-
Iran	-	100
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	30	100
East Asia		
China	-	-
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	-	60
Others	100	-
Sub-total	100	60
Japan	1 535	-
TOTAL	1 690	160
PACIFIC AREA		
Australia	30	100
New Zealand	-	-
TOTAL	30	100
WORLD TOTAL	8 577	3 400

TABLE A.11.

PRODUCTION CAPACITY

PRODUCT : Caprolactam

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	200	30
France	-	-
F.R.G.	200	-
Italy	175	80
Netherlands	160	-
Spain	20	5
United Kingdom	30	75
Others	15 (1)	-
TOTAL	800	190
EASTERN EUROPE		
Bulgaria	15	15
Czechoslovakia	32	-
G.D.R.	60	-
Hungary	27	-
Poland	70	-
Romania	35	-
U.S.S.R	180	-
Yugoslavia	-	-
TOTAL	419	15
NORTH AMERICA		
Canada	-	60
U.S.A.	430	60
TOTAL	430	120

(1) *in Switzerland*

PRODUCT: Caprolactam

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
	10^3 t/year	
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	-	-
Colombia	34	-
Ecuador	-	-
Peru	-	-
Venezuela	-	-
Sub-total	34	-
Argentina	-	60
Brazil	-	35
Mexico	40	-
Others	-	-
TOTAL	74	95
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	-

PRODUCT: Caprolactam

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		
Israel		
Kuwait		
Lebanon		
Qatar		
Saudi Arabia		
Turkey		
United Arab Emirates		
Sub-total	-	-
South Asia		
India	20	-
Iran	-	100
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*20*	*100*
East Asia		
China	-	-
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	30	30
Others	50	50
Sub-total	*80*	*80*
Japan	460	-
TOTAL	560	180
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	2 283	600

TABLE A.12.

PRODUCTION CAPACITY

PROOUCT : Acrylonitrile

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	-	-
France	130	45
F.R.G.	370	-
Italy	235	140
Netherlands	120	-
Spain	40	245
United Kingdom	190	320
Others	25	75
TOTAL	1 110	825
EASTERN EUROPE		
Bulgaria	70	-
Czechoslovakia	-	-
G.D.R.	20	-
Hungary	-	-
Poland	10	-
Romania	45	50
U.S.S.R	125	175
Yugoslavia	5	10
TOTAL	275	235
NORTH AMERICA		
Canada	20	-
U.S.A.	725	240
TOTAL	745	240

PRODUCT : Acrylonitrile

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	-	-
Brazil	-	-
Mexico	24	50
Others	-	-
TOTAL	24	50
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa		
TOTAL	-	-

PRODUCT: Acrylonitrile

	EXISTING CAPACITY (10³ t/year)	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		
Israel		
Kuwait		
Lebanon		
Qatar		
Saudi Arabia		
Turkey		
United Arab Emirates		
Sub-total	-	-
South Asia		
India		
Iran		
Indonesia		
Malaysia		
Pakistan		
Philippines		
Singapore		
Thailand		
Viet Nam		
Others		
Sub-total	-	-
East Asia		
China	10	50
Hong Kong	-	24
Democratic People's Republic of Korea	-	-
Republic of Korea	26	-
Others	66	66
Sub-total	102	140
Japan	675	50
TOTAL	777	190
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	2 931	1 540

TABLE A.13.

PRODUCTION CAPACITY

PRODUCT : D M T

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	65	-
France	120	-
F.R.G.	500	120
Italy	75	140
Netherlands	330	105
Spain	90	10
United Kingdom	40	-
Others	-	-
TOTAL	1 220	375
EASTERN EUROPE		
Bulgaria	24	-
Czechoslovakia	18	-
G.D.R.	45	-
Hungary	-	-
Poland	84	70
Romania	64	-
U.S.S.R	432	-
Yugoslavia	-	-
TOTAL	667	70
NORTH AMERICA		
Canada	-	-
U.S.A.	1 923	740
TOTAL	1 923	740

PRODUCT : D M T

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	-	-
Colombia	-	25
Ecuador	-	-
Peru	-	-
Venezuela	-	-
Sub-total	-	25
Argentina	14	14
Brazil	-	60
Mexico	135	135
Others	-	-
TOTAL	149	234
AFRICA		
North Africa		
Algeria	-	-
Egypt	-	25
Libyan Arab Jamahiriya	-	-
Morocco	-	-
Tunisia	-	-
Sub-total	-	25
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	25

PRODUCT: DMT

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	-	60
United Arab Emirates	-	-
Sub-total	-	*60*
South Asia		
India	24	-
Iran	-	90
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*24*	*90*
East Asia		
China	25	88
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	-	220
Others	52	100
Sub-total	*77*	*408*
Japan	740	-
TOTAL	841	558
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	4 800	2 002

TABLE A.14.

PRODUCTION CAPACITY

PRODUCT : T P A

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	105	-
France	50	-
F.R.G.	-	-
Italy	120	30
Netherlands	-	-
Spain	30	-
United Kingdom	210	-
Others	-	-
TOTAL	515	30
EASTERN EUROPE		
Bulgaria	-	-
Czechoslovakia	-	-
G.D.R.	45	-
Hungary	-	-
Poland	-	-
Romania	-	-
U.S.S.R	-	-
Yugoslavia	-	-
TOTAL	45	-
NORTH AMERICA		
Canada	-	-
U.S.A.	890	454
TOTAL	890	454

PRODUCT : T P A

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	-	-
Brazil	-	45
Mexico	55	135
Others	-	-
TOTAL	55	180
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa		
TOTAL	-	-

PRODUCT: T P A

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		
Israel		
Kuwait		
Lebanon		
Qatar		
Saudi Arabia		
Turkey		
United Arab Emirates		
Sub-total	-	-
South Asia		
India		
Iran		
Indonesia		
Malaysia		
Pakistan		
Philippines		
Singapore		
Thailand		
Viet Nam		
Others		
Sub-total	-	-
East Asia		
China	-	-
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	-	100
Others	-	150
Sub-total	-	250
Japan	750	470
TOTAL	750	720
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	2 255	1 384

TABLE A.15.

PRODUCTION CAPACITY

PRODUCT : Adipic Acid

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	30	
France	320	100
F.R.G.	200	100
Italy	40	60
Netherlands	-	-
Spain	-	-
United Kingdom	250	50
Others	-	-
TOTAL	840	310
EASTERN EUROPE		
Bulgaria	-	
Czechoslovakia	-	
G.D.R.	-	
Hungary	-	
Poland	-	
Romania	6	
U.S.S.R	3	
Yugoslavia	n.a	
TOTAL	9	-
NORTH AMERICA		
Canada	80	
U.S.A.	715	200
TOTAL	795	200

PRODUCT : Adipic Acid

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	-	
Brazil	32	
Mexico	-	
Others	-	
TOTAL	32	-
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	-

PRODUCT: Adipic Acid

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		
Israel		
Kuwait		
Lebanon		
Qatar		
Saudi Arabia		
Turkey		
United Arab Emirates		
Sub-total	-	-
South Asia		
India		
Iran		
Indonesia		
Malaysia		
Pakistan		
Philippines		
Singapore		
Thailand		
Viet Nam		
Others		
Sub-total	-	-
East Asia		
China	-	55
Hong Kong		
Democratic People's Republic of Korea		
Republic of Korea		
Others		
Sub-total	-	55
Japan	30	-
TOTAL	30	55
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	1 706	55

TABLE A.16.

PRODUCTION CAPACITY

PRODUCT : Hexamathylene Diamine

	10^3 t/year	
	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	4	-
France	100	102
F.R.G.	36	-
Italy	15	-
Netherlands	-	-
Spain	-	-
United Kingdom	100	-
Others	-	-
TOTAL	255	102
EASTERN EUROPE		
Bulgaria		
Czechoslovakia		
G.D.R.		
Hungary		
Poland		
Romania		
U.S.S.R	n.a	
Yugoslavia		
TOTAL	-	-
NORTH AMERICA		
Canada	20	
U.S.A.	450	
TOTAL	470	-

PRODUCT: Hexamethylene Diamine

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	-	
Brazil	12	
Mexico	-	
Others	-	
TOTAL	12	-
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	-

PRODUCT: Hexamethylene Diamine

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		
Israel		
Kuwait		
Lebanon		
Qatar		
Saudi Arabia		
Turkey		
United Arab Emirates		
Sub-total	-	-
South Asia		
India		
Iran		
Indonesia		
Malaysia		
Pakistan		
Philippines		
Singapore		
Thailand		
Viet Nam		
Others		
Sub-total	-	-
East Asia		
China		22
Hong Kong		
Democratic People's Republic of Korea		
Republic of Korea		
Others		
Sub-total	-	22
Japan	5	
TOTAL	5	22
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	742	124

TABLE A.17.

PRODUCTION CAPACITY

PRODUCT : Low-density Polyethylene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	430	240
France	910	170
F.R.G.	1 020	60
Italy	755	40
Netherlands	595	100
Spain	240	130
United Kingdom	470	180
Others	500(1)	430(2)
TOTAL	4 920	1 350
EASTERN EUROPE		
Bulgaria	50	50
Czechoslovakia	70	80
G.D.R.	50	-
Hungary	25	-
Poland	65	100
Romania	70	80
U.S.S.R	360	270
Yugoslavia	35	95
TOTAL	725	675
NORTH AMERICA		
Canada	260	230
U.S.A.	3 465	580
TOTAL	3 725	810

(1) *of which 160 in Sweden*
140 in Finland
100 in Austria

(2) *of which 130 in Austria*
100 in Norway
100 in Portugal

PRODUCT : Low-density Polyethylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	30	-
Colombia	25	-
Ecuador	-	-
Peru	-	-
Venezuela	50	50
Sub-total	*105*	*50*
Argentina	75	55
Brazil	170	200
Mexico	90	80
Others	-	-
TOTAL	440	385
AFRICA		
North Africa		
Algeria		50
Egypt		-
Libyan Arab Jamahiriya		-
Morocco		-
Tunisia		-
Sub-total	-	50
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	70	-
TOTAL	70	50

PRODUCT: Low-density Polyethylene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	60
Israel	30	60
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	25	150
United Arab Emirates	-	
Sub-total	55	270
South Asia		
India	50	80
Iran	-	100
Indonesia	-	-
Malaysia	-	-
Pakistan	5	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	55	180
East Asia		
China	60	240
Hong Kong	-	-
Democratic People's Republic of Korea	-	25
Republic of Korea	50	100
Others	35	160
Sub-total	245	525
Japan	1 300	105
TOTAL	1 655	1 080
PACIFIC AREA		
Australia	100	100
New Zealand	-	-
TOTAL	100	100
WORLD TOTAL	11 635	4 450

TABLE A.18.

PRODUCTION CAPACITY

PRODUCT : High-density Polyethylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	200	-
France	240	-
F.R.G.	975	40
Italy	300	20
Netherlands	80	-
Spain	90	100
United Kingdom	80	90
Others	90(1)	180 (2)
TOTAL	2 055	430
EASTERN EUROPE		
Bulgaria	10	-
Czechoslovakia	70	-
G.D.R.	20	10
Hungary	-	-
Poland	-	-
Romania	40	-
U.S.S.R	60	400
Yugoslavia	50	50
TOTAL	250	460
NORTH AMERICA		
Canada	85	150
U.S.A.	1 490	680
TOTAL	1 575	830

(1) *of which 60 in Sweden*

(2) *of which 60 in Sweden*
50 in Portugal
40 in Norway

PRODUCT: High-density polyethylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	-	20
Brazil	30	105
Mexico	-	100
Others	-	-
TOTAL	30	225
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	50	-
TOTAL	50	-

PRODUCT: High-density Polyethylene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		30
Israel		-
Kuwait		-
Lebanon		-
Qatar		-
Saudi Arabia		-
Turkey		40
United Arab Emirates		-
Sub-total	-	70
South Asia		
India	30	-
Iran	-	60
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	30	60
East Asia		
China	-	35
Hong Kong	-	-
Democratic People's Republic of Korea	-	105
Republic of Korea	-	-
Others	-	25
Sub-total	-	165
Japan	630	185
TOTAL	660	480
PACIFIC AREA		
Australia	70	10
New Zealand	-	-
TOTAL	70	10
WORLD TOTAL	4 690	2 435

TABLE A.19.

PRODUCTION CAPACITY

PRODUCT : P V C

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	250	230
France	785	625
F.R.G.	1 335	40
Italy	905	495
Netherlands	280	210
Spain	258	425
United Kingdom	575	195
Others	330 (1)	-
TOTAL	4 718	2 220
EASTERN EUROPE		
Bulgaria	135	120
Czechoslovakia	229	-
G.D.R.	120	100
Hungary	30	120
Poland	220	195
Romania	77	140
U.S.S.R	600	250
Yugoslavia	100	40
TOTAL	1 511	965
NORTH AMERICA		
Canada	100	180
U.S.A.	3 135	80
TOTAL	3 235	260

(1) *of which 70 in Austria*
70 in Norway
60 in Sweden

PRODUCT : P V C

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	-
Chile	15	-
Colombia	48	2
Ecuador	-	-
Peru	7.5	3.5
Venezuela	-	54
Sub-total	70.5	59.5
Argentina	33	60
Brazil	125	200
Mexico	105	30
Others	-	-
TOTAL	333.5	349.5
AFRICA		
North Africa		
Algeria	-	35
Egypt	-	-
Libyan Arab Jamahiriya	-	-
Morocco	-	25
Tunisia	-	-
Sub-total	-	60
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	40	140
TOTAL	40	200

PRODUCT: P V C

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	60
Israel	25	30
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	52	100
United Arab Emirates	-	-
Sub-total	*77*	*190*
South Asia		
India	80	10
Iran	60	-
Indonesia	12	-
Malaysia	-	-
Pakistan	5	-
Philippines	29	-
Singapore	10	-
Thailand	20	-
Viet Nam	-	-
Others	-	-
Sub-total	*216*	*10*
East Asia		
China	-	
Hong Kong	-	
Democratic People's Republic of Korea	-	
Republic of Korea	50	
Others	140	
Sub-total	*190*	-
Japan	1 833	600
TOTAL	2 316	800
PACIFIC AREA		
Australia	47	
New Zealand	-	
TOTAL	47	-
WORLD TOTAL	12 200.5	4 794.5

TABLE A.20.

PRODUCTION CAPACITY

PRODUCT : Polypropylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	-	370
France	100	295
F.R.G.	184	320
Italy	210	185
Netherlands	70	130
Spain	28	190
United Kingdom	270	190
Others	30	-
TOTAL	892	1 640
EASTERN EUROPE		
Bulgaria	15	40
Czechoslovakia	110	30
G.D.R.	-	-
Hungary	-	40
Poland	30	-
Romania	15	-
U.S.S.R	30	100
Yugoslavia	-	-
TOTAL	200	210
NORTH AMERICA		
Canada	70	90
U.S.A.	1 360	630
TOTAL	1 430	720

PRODUCT: Polypropylene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina		30
Brazil		100
Mexico		54
Others		-
TOTAL	-	184
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	22	50
TOTAL	22	50

PRODUCT: Polypropylene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		50
Israel		-
Kuwait		-
Lebanon		-
Qatar		-
Saudi Arabia		-
Turkey		60
United Arab Emirates		-
Sub-total	-	*110*
South Asia		
India	-	30
Iran	-	100
Indonesia	20	-
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*20*	*130*
East Asia		
China	-	115
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	30	95
Others	-	-
Sub-total	*30*	*215*
Japan	960	280
TOTAL	1 010	735
PACIFIC AREA		
Australia	28	25
New Zealand	-	-
TOTAL	28	25
WORLD TOTAL	3 582	3 564

TABLE A.21.

PRODUCTION CAPACITY

PRODUCT : Polystyrene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	265	80
France	500	125
F.R.G.	827	200
Italy	480	165
Netherlands	265	65
Spain	112.5	10
United Kingdom	334	20
Others	48	10
TOTAL	2 831.5	675
EASTERN EUROPE		
Bulgaria	12	-
Czechoslovakia	42	-
G.D.R.	50	-
Hungary	-	-
Poland	50	10
Romania	10	-
U.S.S.R	280	300
Yugoslavia	40	-
TOTAL	484	310
NORTH AMERICA		
Canada	110	35
U.S.A.	2 190	266
TOTAL	2 300	301

PRODUCT: Polystyrene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	7
Chile	5	-
Colombia	16	-
Ecuador	-	-
Peru	-	36
Venezuela	40	-
Sub-total	61	43
Argentina	56	-
Brazil	97	45
Mexico	44	16
Others	-	-
TOTAL	258	104
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	7	-
TOTAL	7	-

PRODUCT: Polystyrene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	16	45
Kuwait	-	-
Lebanon	-	10
Qatar	-	-
Saudi Arabia	-	-
Turkey	15	-
United Arab Emirates	-	-
Sub-total	31	55
South Asia		
India	62	17
Iran	-	-
Indonesia	-	-
Malaysia	7	-
Pakistan	-	-
Philippines	13	-
Singapore	-	-
Thailand	-	15
Viet Nam	-	-
Others	-	-
Sub-total	82	32
East Asia		
China	6	-
Hong Kong	68	-
Democratic People's Republic of Korea	-	-
Republic of Korea	3	-
Others	9	4
Sub-total	86	4
Japan	900	37
TOTAL	1 099	128
PACIFIC AREA		
Australia	55	-
New Zealand	-	-
TOTAL	55	-
WORLD TOTAL	7 0345	1 518

TABLE A.22.

PRODUCTION CAPACITY

PRODUCT : Styrene Butadiene Rubber

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	55	35
France	278	-
F.R.G.	310	-
Italy	292	55
Netherlands	165	-
Spain	94	66
United Kingdom	317	10
Others	-	-
TOTAL	1 511	166
EASTERN EUROPE		
Bulgaria	17	10
Czechoslovakia	50	30
G.D.R.	100	-
Hungary	-	-
Poland	60	-
Romania	100	-
U.S.S.R	750	-
Yugoslavia	20	-
TOTAL	1 097	40
NORTH AMERICA		
Canada	190	
U.S.A.	1 884	
TOTAL	2 074	-

PRODUCT: Styrene Butadiene Rubber 10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		-
Chile		-
Colombia		-
Ecuador		-
Peru		-
Venezuela		20
Sub-total	-	20
Argentina	55	
Brazil	172	10
Mexico	84	
Others	-	
TOTAL	321	30
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	30	-
TOTAL	30	-

PRODUCT: Styrene Butadiene Rubber

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	-	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	32	20
United Arab Emirates	-	-
Sub-total	32	20
South Asia		
India	30	
Iran	-	
Indonesia	-	
Malaysia	-	
Pakistan	-	
Philippines	-	
Singapore	-	
Thailand	-	
Viet Nam	-	
Others	-	
Sub-total	30	-
East Asia		
China	23	
Hong Kong	-	
Democratic People's Republic of Korea	-	
Republic of Korea	25	
Others	100	50
Sub-total	148	50
Japan	649	125
TOTAL	859	195
PACIFIC AREA		
Australia	50	-
New Zealand	-	-
TOTAL	50	-
WORLD TOTAL	6 152	431

TABLE A.23.

PRODUCTION CAPACITY

PRODUCT : Polybutadiene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	20	-
France	146	-
F.R.G.	68	-
Italy	76	10
Netherlands	-	-
Spain	8	7
United Kingdom	55	-
Others	-	-
TOTAL	373	17
EASTERN EUROPE		
Bulgaria	10	
Czechoslovakia	15	
G.D.R.	30	
Hungary	-	
Poland	30	
Romania	25	
U.S.S.R	200	
Yugoslavia	-	
TOTAL	310	-
NORTH AMERICA		
Canada	30	
U.S.A.	375	
TOTAL	405	-

PRODUCT: Polybutadiene

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina	-	20
Brazil	28	50
Mexico	30	-
Others	-	-
TOTAL	58	70
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	-

PRODUCT: Polybutadiene

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	
Israel	-	
Kuwait	-	
Lebanon	-	
Qatar	-	
Saudi Arabia	-	
Turkey	13.5	
United Arab Emirates	-	
Sub-total	13.5	-
South Asia		
India		20
Iran		
Indonesia		
Malaysia		
Pakistan		
Philippines		
Singapore		
Thailand		
Viet Nam		
Others		
Sub-total	-	20
East Asia		
China		
Hong Kong		
Democratic People's Republic of Korea		
Republic of Korea		
Others		
Sub-total	-	-
Japan	300	50
TOTAL	313.5	70
PACIFIC AREA		
Australia	20	-
New Zealand	-	-
TOTAL	20	-
WORLD TOTAL	1 479.5	157

TABLE A.24.

PRODUCTION CAPACITY

PRODUCT : Alkylbenzenes (linear included)

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	15	
France	150	
F.R.G.	150	
Italy	210	
Netherlands	13	
Spain	95	
United Kingdom	100	
Others	-	
TOTAL	733	-
EASTERN EUROPE		
Bulgaria		
Czechoslovakia		
G.D.R.		
Hungary		
Poland		
Romania	15	
U.S.S.R		
Yugoslavia		
TOTAL	15	-
NORTH AMERICA		
Canada	n.a	
U.S.A.	400	
TOTAL	400	-

PRODUCT : Alkylbenzenes (linear included)

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	
Chile	-	
Colombia	15	
Ecuador	-	
Peru	-	
Venezuela	18.5	
Sub-total	33.5	
Argentina	-	40
Brazil	27	35
Mexico	n.a	-
Others	-	-
TOTAL	60.5	75
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	-

PRODUCT: Alkylbenzenes (linear included) 10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	
Israel	-	
Kuwait	-	
Lebanon	-	
Qatar	-	
Saudi Arabia	-	
Turkey	10	
United Arab Emirates	-	
Sub-total	*10*	
South Asia		
India	n.a	-
Iran	12	30
Indonesia	-	-
Malaysia	-	-
Pakistan	-	-
Philippines	15	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*27*	*30*
East Asia		
China	-	50
Hong Kong	-	-
Democratic People's Republic of Korea	-	-
Republic of Korea	13	-
Others	-	20
Sub-total	*13*	*70*
Japan	180	-
TOTAL	230	100
PACIFIC AREA		
Australia	7	-
New Zealand	-	-
TOTAL	7	-
WORLD TOTAL	1 445.5	175

TABLE A.25.

PRODUCTION CAPACITY

PRODUCT : Detergent-range Alcohols

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	4	
France	16.5	
F.R.G.	190	
Italy	50	
Netherlands	5	
Spain	1	
United Kingdom	110	
Others	5	
TOTAL	381.5	-
EASTERN EUROPE		
Bulgaria	-	
Czechoslovakia	-	
G.D.R.	20	
Hungary	3	
Poland	9	
Romania	5	
U.S.S.R	n.a	
Yugoslavia		
TOTAL	37	-
NORTH AMERICA		
Canada	5	
U.S.A.	350	
TOTAL	355	

PRODUCT : Detergent-range Alcohols

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia		
Chile		
Colombia		
Ecuador		
Peru		
Venezuela		
Sub-total	-	-
Argentina		
Brazil		
Mexico	n.a	
Others		
TOTAL	-	-
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	-

PRODUCT: Detergent-range Alcohols

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq		
Israel		
Kuwait		
Lebanon		
Qatar		
Saudi Arabia		
Turkey		
United Arab Emirates		
Sub-total	-	-
South Asia		
India	-	
Iran	-	
Indonesia	-	
Malaysia	-	
Pakistan	-	
Philippines	4	
Singapore	-	
Thailand	-	
Viet Nam	-	
Others	-	
Sub-total	4	-
East Asia		
China		
Hong Kong		
Democratic People's Republic of Korea		
Republic of Korea		
Others		
Sub-total	-	-
Japan	150	-
TOTAL	154	-
PACIFIC AREA		
Australia	-	-
New Zealand	-	-
TOTAL	-	-
WORLD TOTAL	927.5	-

TABLE A.26.

PRODUCTION CAPACITY

PRODUCT : Polyester fibres

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	37	
France	120	
F.R.G.	532	
Italy	153	
Netherlands	70	
Spain	81	
United Kingdom	160	
Others	130(1)	
TOTAL	1 283	-
EASTERN EUROPE		
Bulgaria	31	
Czechoslovakia	26	
G.D.R.	47	
Hungary	-	
Poland	71	
Romania	68	
U.S.S.R	165	
Yugoslavia	21	
TOTAL	429	-
NORTH AMERICA		
Canada	60	
U.S.A.	2 220	
TOTAL	2 280	-

(1) *of which 60 in Switzerland*

PRODUCT : Polyester fibres

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	
Chile	8	
Colombia	33	
Ecuador	2	
Peru	13	
Venezuela	20	
Sub-total	76	-
Argentina	38	
Brazil	119	
Mexico	172	
Others	13	
TOTAL	418	-
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast	-	
Kenya	-	
Nigeria	5	
Others		
Sub-total	5	-
South Africa		
Republic of South Africa	36	
TOTAL	41	-

PRODUCT: Polyester Fibres

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	
Israel	-	
Kuwait	-	
Lebanon	-	
Qatar	-	
Saudi Arabia	-	
Turkey	69	
United Arab Emirates	-	
Sub-total	69	-
South Asia		
India	34	
Iran	-	
Indonesia	39	
Malaysia	-	
Pakistan	-	
Philippines	26	
Singapore	28 (1)	
Thailand	77	
Viet Nam	-	
Others	-	
Sub-total	204	-
East Asia		
China	n.a	
Hong Kong	-	
Democratic People's Republic of Korea	n.a	
Republic of Korea	171	
Others	353	
Sub-total	524	-
Japan	525	-
TOTAL	1 322	
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	5 773	-

(1) *including Malaysia*

TABLE A.27.

PRODUCTION CAPACITY

PRODUCT : Polyamide fibres

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	34	10
France	119	-
F.R.G.	304	-
Italy	205	-
Netherlands	50	-
Spain	50	-
United Kingdom	217	-
Others	100	-
TOTAL	1 079	10
EASTERN EUROPE		
Bulgaria	15	-
Czechoslovakia	30	-
G.D.R.	35	-
Hungary	5	6
Poland	72	8
Romania	15	-
U.S.S.R	250	-
Yugoslavia	4	-
TOTAL	426	14
NORTH AMERICA		
Canada	60	20
U.S.A.	1 243	150
TOTAL	1 303	170

PRODUCT : Polyamide fibres

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	
Chile	7	
Colombia	30	
Ecuador	3	
Peru	10	
Venezuela	15	
Sub-total	65	-
Argentina	45	
Brazil	55	
Mexico	27	
Others	2	
TOTAL	194	-
AFRICA		
North Africa		
Algeria	-	
Egypt	3	
Libyan Arab Jamahiriya	-	
Morocco	-	
Tunisia	-	
Sub-total	3	-
East and West Africa		
Ivory Coast		-
Kenya		2
Nigeria		-
Others		-
Sub-total	-	2
South Africa		
Republic of South Africa	15	-
TOTAL	18	2

PRODUCT: Polyamide fibres 10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	-
Israel	8	-
Kuwait	-	-
Lebanon	-	-
Qatar	-	-
Saudi Arabia	-	-
Turkey	23	5
United Arab Emirates	-	-
Sub-total	31	5
South Asia		
India	20	6
Iran	10	28
Indonesia	4.5	-
Malaysia	-	-
Pakistan	5	-
Philippines	7.5	-
Singapore	8	-
Thailand	10	-
Viet Nam	-	-
Others	-	-
Sub-total	65	34
East Asia		
China	-	64
Hong Kong	6	-
Democratic People's Republic of Korea	-	-
Republic of Korea	44	5
Others	120	
Sub-total	170	69
Japan	350	5
TOTAL	616	113
PACIFIC AREA		
Australia	29	-
New Zealand	3	-
TOTAL	32	-
WORLD TOTAL	3 668	309

TABLE A.28.

PRODUCTION CAPACITY

PRODUCT : Acrylic fibres

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
WESTERN EUROPE		
Belgium	24	6
France	128	36
F.R.G.	270	-
Italy	234	25
Netherlands	30	-
Spain	90	-
United Kingdom	194	-
Others	60	-
TOTAL	1 030	67
EASTERN EUROPE		
Bulgaria	12	
Czechoslovakia	5	
G.D.R.	30	
Hungary	11	
Poland	15	
Romania	38	
U.S.S.R	77	
Yugoslavia	15	
TOTAL	203	-
NORTH AMERICA		
Canada	11	
U.S.A.	376	
TOTAL	387	-

PRODUCT: Acrylic fibres

10³ t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
LATIN AMERICA		
Andean Group Countries		
Bolivia	-	
Chile	-	
Colombia	-	
Ecuador	-	
Peru	18	
Venezuela	-	
Sub-total	18	-
Argentina	7	-
Brazil	16	40
Mexico	34	-
Others	-	-
TOTAL	75	40
AFRICA		
North Africa		
Algeria		
Egypt		
Libyan Arab Jamahiriya		
Morocco		
Tunisia		
Sub-total	-	-
East and West Africa		
Ivory Coast		
Kenya		
Nigeria		
Others		
Sub-total	-	-
South Africa		
Republic of South Africa	-	-
TOTAL	-	-

PRODUCT: Acrylic fibres

10^3 t/year

	EXISTING CAPACITY	ADDITIONAL CAPACITY (start-up before 1980)
ASIA		
Middle East Countries		
Iraq	-	2
Israel	5	
Kuwait	-	
Lebanon	-	
Qatar	-	
Saudi Arabia	-	
Turkey	26	
United Arab Emirates	-	
Sub-total	*31*	*2*
South Asia		
India	1	20
Iran	-	30
Indonesia	-	10
Malaysia	-	-
Pakistan	-	-
Philippines	-	-
Singapore	-	-
Thailand	-	-
Viet Nam	-	-
Others	-	-
Sub-total	*1*	*60*
East Asia		
China	20	
Hong Kong	-	
Democratic People's Republic of Korea	8	
Republic of Korea	75	
Others	70	
Sub-total	*173*	-
Japan	370	30
TOTAL	575	92
PACIFIC AREA		
Australia		
New Zealand		
TOTAL	-	-
WORLD TOTAL	2 270	199

Appendix B

DETAILED CONSUMPTION DATA

TABLE B.1. PLASTICS, WORLD DEMAND BY REGION, 1965/1976

Unit: 1000 tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
WESTERN EUROPE	4 800	7 200	8 650	9 770	10 700	12 220	14 660	15 430	12 330	
FRANCE	680	1 038	1 290	1 454	1 693	2 021	2 242	2 407	1 904	2 500
F.R.G.	1 440	2 178	2 646	2 962	3 247	3 662	4 161	4 348	3 546	
ITALY	635	1 037	1 250	1 446	1 507	1 762	2 045	2 051	1 559	
SPAIN							747	769	600	
UNITED KINGDOM	830	1 110	1 232	1 395	1 462	1 628	1 825	1 921	1 519	
E.E.C.										
EASTERN EUROPE						3 802			5 150	
U.S.A.	5 500	7 620	8 975	8 750	9 600	11 800	13 152	12 932	10 325	
JAPAN	1 520	3 174	3 615	4 354	4 442	4 748	5 600	5 800	4 470	

TABLE B.1. PLASTICS, WORLD DEMAND BY REGION, 1965/1976 (Continued)

Unit: 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL	350	600	750	921	1 127.5	1 348.5	1 634	1 923	1 905.5	
. Argentina				146.5	177	204	213.5	241	261.5	
. Brazil				319	420	500	669.5	829.5	755.5	
. Mexico				191.5	218.5	282	323	384.5	391.5	
. Andean countries				179	204	247.5	303	323	348.5	
. Others : Caribbean, . Central America	30	50	65	85	108	115	125	145	148.5	
AFRICA : TOTAL 1/	111	164.5	218	251	288	334.5	632.5	724	810	
NORTH AFRICA	43	59	90	103	113	147	199.5	220	240	
of which :										
. Algeria	10	21	34	35.5	36	50	95	104		
. Egypt	16	11.5	16.5	19	22	23	17	29		
. Morocco	11	18	27	31	34	46	52	42		
. Tunisia	2	4.5	5.5	7	9	12.5	15	19	23	
WEST AFRICA	21.5	34	44	53	65	61	81.5	102	115	
of which :										
. Ivory Coast	4	7	8	10	14	13	17.5	19.5		
. Nigeria	11	14.5	21	25	33	28	35	52		
EAST AFRICA	28	48	58	66	76	86	99	108	120	
CENTRAL AFRICA	18.5	23.5	26	29	34	40.5	52.5	64	75	
of which :										
. Angola	10	10.5	10.5	11	13.5	17	26	31		
SOUTH AFRICA							200	230	260	
PACIFIC AREA							550	600	650	

1/ Figures for 1965-1972 do not include South Africa

Table B.1. PLASTICS, WORLD DEMAND BY REGION, 1965/1976 (Continued)

Unit :1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL	2 116	3 969	4 608	5 488	5 706	6 237	7 450	7 554	6 429	
(excluding **China**)										
EAST ASIA	1 825	3 445	3 945	4 705	4 840	5 202	6 183	6 376	5 129	
. Hong-Kong	75	145	165	150	160	155	180	145	165	
. **Others**	125 } 25	270 } 60	330 } 80	350 } 100	400 } 110	452 } 120	583 } 150	576 } 170	659 } 210	
. **Republic of Korea**	25	65	85	100	130	177	253	261	284	
. Japan	1 700	3 175	3 615	4 355	4 440	4 750	5 600	5 800	4 470	
SOUTH ASIA	199	343	461	540	628.5	724.5	877	773	855	
of which :										
. India	55	86	95.5	110	115.5	127.5	138.5	141	150	
. Iran	50	70	85	100	120	140	160	180	200	
. Pakistan	6	9	9	20	36	33	60	55	60	
. Indonesia	11	32	65	65	67	101	143	125	145	
. Philippines	37	61	82	100	125	123	146	117	125	
. Singapore	10	20	25	25	30	45	60	50	60	
. Thailand	20	50	80	95	110	125	140	80	90	
MIDDLE EAST	92	181	202	243	237	310	390	405	445	
of which :										
. Iraq	6.5	9	8	11	14	17	18	22	25	
. Lebanon	10	15	15	15.5	20.5	29	42	40	30	
. Israel	35	75	83	96	80	83	110	125	140	
. Turkey	30	65	75	95	105	135	160	165	180	
. Syria	4	7	9	11.5	13.5	35.5	29	14	20	

TABLE B.2.

DEMAND FOR PLASTICS IN SOME INDUSTRIALIZED COUNTRIES

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	14 663	15 490	12 333
of which :			
. Belgium	517.7	636.3	482.5
. France	2 241.9	2 406.8	1 904.1
. F.R.G.	4 160.5	4 348.3	3 545.5
. Italy	2 044.7	2 051.0	1 558.6
. Netherlands	545.4	608.0	523.9
. Spain	746.9	769.1	[illegible]00.0
. United Kingdom	1 825.9	1 921.0	1 516.5
. Others	2 580.0	2 750.0	2 200.0
EASTERN EUROPE : TOTAL	* 3 797		5 150
. Bulgaria	* 146.9		
. Czechoslovakia	* 309.0		
. G.D.R.	* 386.0		
. Hungary	* 173.0		
. Poland	* 315.0		
. Romania	* 278.0		
. U.S.S.R.	* 1 999.0	2 227	2 384
. Yugoslavia	* 190.0		
NORTH AMERICA : TOTAL	14 036	13 872	11 185
. Canada	884	940	860
. U.S.A.	13 152	12 932	10 325

* 1972

TABLE B.3.

WORLD DEMAND FOR LOW-DENSITY POLYETHYLENE BY REGION

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	3 115	3 303	2 318
of which :			
. Belgium	120	183	88
. France	462.7	557.5	333.1
. F.R.G.	789	757	587.5
. Italy	504	474	374
. Netherlands	104	108	75
. Spain	210.5	193	140
. United Kingdom	395	446	310
. Others	550	585	410
EASTERN EUROPE : TOTAL			750
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	2 688	2 779.7	2 169
. Canada	214	232.7	200
. U.S.A.	2 474	2 547	1 969

* 1972 - Including HD polyethylene

TABLE B.3. LOW-DENSITY POLYETHYLENE - WORLD DEMAND BY REGION - 1965-1976 (Continued) Unit: 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL (excluding China)							1 398	1 336	1 258	
EAST ASIA							1 057	1 017	908	
. Hong-Kong . Others . Republic of Korea							157	155	177	
. Japan							900	862	731	
SOUTH ASIA							236	209	230	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							105	110	120	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

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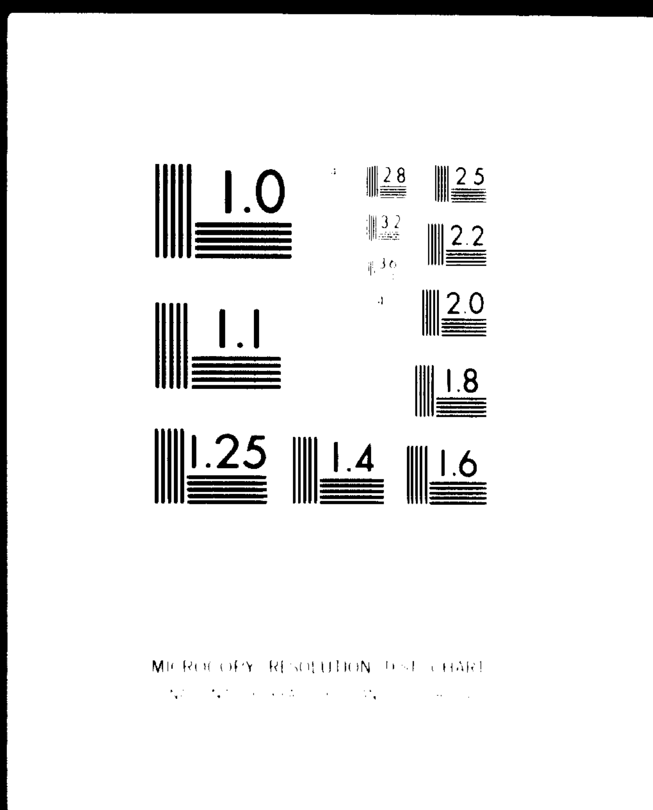

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TABLE B.3. LOW-DENSITY POLYETHYLENE - WORLD DEMAND BY REGION - 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				264	264	320	410	500	472	
. Argentina				34.1	40.3	42.7	56.1	60.9	70.2	
. Brazil				93.6	86.4	113.4	141.2	201.0	159.9	
. Mexico				51.2	56.4	75.6	90.2	109.2	105.2	
. Andean countries				60.3	54.3	60.8	92.3	89.7	99.2	
. Others : Caribbean										
. Central America										
AFRICA : TOTAL							175	200	223	
NORTH AFRICA							60	66	72	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							25	31	35	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							30	33	36	
CENTRAL AFRICA							16	19	23	
of which :										
. Angola										
SOUTH AFRICA							44	51	57	
PACIFIC AREA							110	132	142	

TABLE 8.4.

WORLD DEMAND FOR HIGH-DENSITY POLYETHYLENE

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	977	1 234	843
of which :			
. Belgium	43	49.3	37
. France	143.6	183.4	131.3
. F.R.G.	299	432.5	250
. Italy	113	122	92
. Netherlands	38.5	43.9	34
. Spain	75	85.1	80
. United Kingdom	92	100	90
. Others	173	218	149
EASTERN EUROPE : TOTAL			150
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	1 209.1	1 207.8	1 017
. Canada	84.1	86.8	80
. U.S.A.	1 125	1 121	937

TABLE B.4. HIGH-DENSITY POLYETHYLENE - WORLD DEMAND BY REGION - 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				46	75	94	134	135	147	
. Argentina				4.6	5.4	5.6	7.2	9.0	10.0	
. Brazil				8.5	25.2	28.6	41.1	51.9	46.6	
. Mexico				14.7	19.7	25.9	40.2	27.8	36.2	
. Andean countries				13.6	16.9	25.7	35.3	35.8	42.7	
. Others : Caribbean, Central America				4.6	7.8	8.2	10.2	10.5	11.5	
AFRICA : TOTAL							58	66	74	
NORTH AFRICA							19	21	23	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							8	10	11	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							10	11	12	
CENTRAL AFRICA							5	6	7	
of which :										
. Angola										
SOUTH AFRICA							16	18	21	
PACIFIC AREA							44	48	52	

TABLE B.4. HIGH-DENSITY POLYETHYLENE - WORLD DEMAND BY REGION - 1965-1976 (Continued) **Unit: 1000 metric tons**

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL (excluding **China**)							617	561	484	
EAST ASIA							504	457	369	
. Hong-Kong										
. **Others**							} 53	} 52	} 60	
. **Republic of Korea**										
. Japan							451	405	309	
SOUTH ASIA							79	70	77	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							34	34	38	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.5.

WORLD DEMAND FOR POLYPROPYLENE

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	576	692	543
of which :			
. Belgium	5.1	11.5	14.2
. France	61.2	83	65.9
. F.R.G.	125	149	110
. Italy	95	110	72
. Netherlands	18.5	26	12
. Spain	21.9	25.1	18
. United Kingdom	147	165	155
. Others	102	122	98
EASTERN EUROPE : TOTAL	* 131.3		200
. Bulgaria	* 20		
. Czechoslovakia	* 10		
. G.D.R.	* 27.1		
. Hungary	* 6		
. Poland	* 25		
. Romania	* 9.2		
. U.S.S.R.	* 24.5		
. Yugoslavia	* 9.5		
NORTH AMERICA : TOTAL	927.8	960.3	823
. Canada	53.8	59.3	55
. U.S.A.	874	901	768

* 1972

TABLE B.5. POLYPROPYLENE - WORLD DEMAND BY REGION - 1965-1976 (Continued)

Unit: 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				25	37	55	75	95	107	
. Argentina				4.8	5.4	9.4	9.0	10.7	12.1	
. Brazil				3.6	7.6	11.4	24.8	31.9	33.4	
. Mexico				8.9	12.1	16.4	16.7	23.3	26.4	
. Andean countries				5.6	8.6	13.4	18.2	21.8	26.8	
. Others : Caribbean / . Central America				2.1	3.3	4.4	6.3	7.3	8.3	
AFRICA : TOTAL							27.5	32	36	
NORTH AFRICA							8	9	10	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							3.5	4.5	5	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							4	4.5	5	
CENTRAL AFRICA							2	2.5	3	
of which :										
. Angola										
SOUTH AFRICA							10	11.5	13	
PACIFIC AREA							27	30	33	

TABLE B.5. POLYPROPYLENE - WORLD DEMAND BY REGION - 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL							742	772	705	
(excluding China)										
EAST ASIA							634	674	596	
. Hong-Kong										
. Others							58	58	66	
. Republic of Korea										
. Japan							576	616	530	
SOUTH ASIA							88	77	86	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							20	21	23	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.6.

WORLD DEMAND FOR P.V.C.

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	3 474	3 492	2 828
of which :			
. Belgium	97	113	90.5
. France	622	628	525
. F.R.G.	991	933	792
. Italy	445	445	331
. Netherlands	160	182	148
. Spain	129.2	153.8	110
. United Kingdom	415	417	331
. Others	615	620	500
EASTERN EUROPE : TOTAL			930
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	2 213.9	2 149.6	1 763
. Canada	128.9	143.6	130
. U.S.A.	2 085	2 006	1 633

*1972

TABLE B.6. PVC, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				187	254	280	306	403	371	
. Argentina				30.8	35.2	41.4	41.3	42.6	51.3	
. Brazil				67.8	109.9	106.6	129.9	177.1	159.4	
. Mexico				35.8	40.9	56.1	53.1	83.1	60.0	
. Andean countries				34.2	43.5	50.3	57.5	70.2	71.0	
. Others : Caribbean . Central America				18.4	24.5	25.6	24.2	30.0	29.3	
AFRICA : TOTAL							172	197	220	
NORTH AFRICA							58	64	70	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							24	30	33	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							29	31	35	
CENTRAL AFRICA							15	19	22	
of which :										
. Angola										
SOUTH AFRICA							46	53	60	
PACIFIC AREA							126	137	150	

TABLE B.6. PVC, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL (excluding **China**)							1 984	1 597	1 657	
EAST ASIA							1 661	1 294	1 322	
. Hong-Kong . **Others** . **Republic of Korea**							140	138	158	
. Japan							1 521	1 156	1 164	
SOUTH ASIA							210	186	206	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							113	117	129	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.7.

WORLD DEMAND FOR POLYSTYRENE

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	1 528	1 701	1 338
of which :			
. Belgium	52	58	51
. France	230	240	203
. F.R.G.	410	500	415
. Italy	235	242	180
. Netherlands	50	58	57
. Spain	89.5	98	70
. United Kingdom	191	205	126.5
. Others	270	300	235
EASTERN EUROPE : TOTAL			310
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	1 869.6	1 796.3	1 603
. Canada	93.6	107.3	100
. U.S.A.	1 776	1 689	1 503

* 1972

TABLE B.7. POLYSTYRENE, WORLD DEMAND BY REGION, 1965–1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				86	112	130	154	187	160	
. Argentina				16.4	22.3	23.8	20.3	32.7	31.5	
. Brazil				24.7	37.5	42.1	58.6	78.9	48.0	
. Mexico				17.8	19.2	26.9	31.7	30.7	39.2	
. Andean countries				18.8	22.0	25.9	30.7	29.4	28.5	
. Others : Caribbean, . Central America				8.3	11	11.3	12.7	15.3	12.8	
AFRICA : TOTAL							59.5	68	76	
NORTH AFRICA							18	20	22	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							7.5	9	10	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							9	10	11	
CENTRAL AFRICA							5	6	7	
of which :										
. Angola										
SOUTH AFRICA							20	23	26	
PACIFIC AREA							55	60	65	

TABLE B.7. POLYSTYRENES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL (excluding **China**)							538	509	503	
EAST ASIA							422	402	384	
. Hong-Kong							}	}	}	
. **Others**							52	52	59	
. **Republic of Korea**							}	}	}	
. Japan							370	350	325	
SOUTH ASIA							79	69	77	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							37	38	42	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE 8.8.

WORLD DEMAND FOR ABS AND SAN RESINS

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	293	300	266
of which :			
. Belgium	5	8	6
. France	34	38	33
. F.R.G.	95	95	90
. Italy	54	56	53
. Netherlands	6	6	6
. Spain	6.2	6.5	5
. United Kingdom	41	37	26
. Others	52	53	47
EASTERN EUROPE : TOTAL			65
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	502	449.2	300
. Canada	43	43.2	44
. U.S.A.	459	406	256

* 1972

TABLE B.8. ABS, SAN RESINS, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				9	13	17	22	24	25	
. Argentina				2.8	3.3	5.5	6.3	6.3	6.8	
. Brazil				1.0	1.8	2.2	4.7	6.0	4.8	
. Mexico				3.0	4.0	5.0	6.0	7.0	8.0	
. Andean countries				1.2	2.0	2.3	2.6	2.9	3.5	
. Others : Caribbean . Central America				1.0	1.9	2.0	2.4	1.8	1.9	
AFRICA : TOTAL							6	7	9	
NORTH AFRICA							1	1	1.5	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							0.5	0.5	1	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							0.5	0.5	1	
CENTRAL AFRICA							-	0.5	0.5	
of which :										
. Angola										
SOUTH AFRICA							4	4.5	5	
PACIFIC AREA							11	12	13	

TABLE B.8. ABS, SAN RESINS, WORLD DEMAND BY REGION, 1965-1975 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL (excluding China)							244	258	221	
EAST ASIA							231	246	207	
. Hong-Kong										
. Others							6	6	7	
. Republic of Korea										
. Japan							225	240	200	
SOUTH ASIA							9	8	9	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							4	4	5	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.9.

STRUCTURE OF DEMAND FOR PLASTICS

Percentage

REGION	1973	1974	1975	1976	1980	1985
JAPAN						
Polyethylene ld	16.1	14.9	16.4			
Polyethylene hd	8.0	7.0	6.9			
Polypropylene	10.3	10.6	11.9			
PVC	27.2	19.9	26.0			
Polystyrene	6.6	6.0	7.3			
ABS	4.0	9.1	4.5			
TOTAL	72.2	67.5	73.0			
WESTERN EUROPE						
Polyethylene ld	21.2	21.4	18.8			
Polyethylene hd	6.7	8.0	6.8			
Polypropylene	3.9	4.5	4.4			
PVC	23.7	22.6	22.9			
Polystyrene	10.4	11.0	10.8			
ABS	2.0	1.9	2.1			
TOTAL	67.9	69.4	65.8			
EASTERN EUROPE						
Polyethylene ld			14.6			
Polyethylene hd			2.9			
Polypropylene			3.9			
PVC			18.1			
Polystyrene			6.0			
ABS			1.2			
TOTAL			46.7			
U.S.A.						
Polyethylene ld	18.8	19.7	19.1			
Polyethylene hd	8.6	8.7	9.1			
Polypropylene	6.6	7.0	7.4			
PVC	15.8	15.5	15.8			
Polystyrene	13.5	13.1	14.5			
ABS	3.5	3.1	2.5			
TOTAL	66.8	67.1	68.4			

TABLE B. 9. (CONTINUED)

STRUCTURE OF DEMAND FOR PLASTICS

Percentage

REGION	1973	1974	1975	1976	1980	1985
LATIN AMERICA						
Polyethylene ld	25.1	26.0	24.7			
Polyethylene hd	8.2	7.0	7.7			
Polypropylene	4.6	4.9	5.6			
PVC	18.7	21.0	19.5			
Polystyrene	9.4	9.7	8.4			
ABS	1.3	1.2	1.3			
TOTAL	67.3	69.8	67.2			
ASIA						
CHINA						
Polyethylene ld						
Polyethylene hd						
Polypropylene						
PVC						
Polystyrene						
ABS						
TOTAL						
EAST ASIA						
Polyethylene ld	26.9	26.9	26.8			
Polyethylene hd	9.1	9.0	9.1			
Polypropylene	9.9	10.1	10.0			
PVC	24.0	23.9	24.0			
Polystyrene	8.9	9.0	8.9			
ABS	1.0	1.0	1.1			
TOTAL	79.8	79.9	79.9			
SOUTH ASIA						
Polyethylene ld	26.9	27.0	26.8			
Polyethylene hd	9.0	9.0	9.0			
Polypropylene	10.0	9.9	10.0			
PVC	23.9	24.1	24.1			
Polystyrene	9.0	8.9	9.0			
ABS	1.0	1.0	1.0			
TOTAL	79.8	79.9	79.9			

TABLE 8.9. (CONTINUED)

STRUCTURE OF DEMAND FOR PLASTICS

Percentage

REGION	1973	1974	1975	1976	1980	1985
ASIA (continued)						
MIDDLE EAST						
Polyethylene ld	26.9	27.1	26.7			
Polyethylene hd	8.7	8.4	8.5			
Polypropylene	5.1	5.2	5.5			
PVC	29.0	28.9	29.0			
Polystyrene	9.5	9.4	9.4			
ABS	1.0	1.0	1.1			
TOTAL	80.2	80.0	80.2			
PACIFIC AREA						
Polyethylene ld	20.0	22.0	21.8			
Polyethylene hd	8.0	8.0	8.0			
Polypropylene	4.9	5.0	5.1			
PVC	22.9	22.8	23.1			
Polystyrene	10.0	10.0	10.0			
ABS	2.0	1.8	2.0			
TOTAL	67.8	69.6	70.0			
AFRICA						
NORTH AFRICA						
Polyethylene ld	30.1	30.0	30.0			
Polyethylene hd	9.5	9.5	9.6			
Polypropylene	4.0	4.1	4.2			
PVC	29.1	29.1	29.2			
Polystyrene	9.0	9.1	9.2			
ABS	0.5	0.4	0.6			
TOTAL	82.2	82.2	82.8			
WEST AFRICA						
Polyethylene ld	30.7	30.4	30.4			
Polyethylene hd	9.8	9.8	9.6			
Polypropylene	4.3	4.4	4.3			
PVC	29.4	29.4	28.7			
Polystyrene	9.2	8.8	8.7			
ABS	0.8	0.5	0.9			
TOTAL	84.0	83.3	82.6			

TABLE B.9. (CONTINUED)

STRUCTURE OF DEMAND FOR PLASTICS

Percentage

REGION	1973	1974	1975	1976	1980	1985
AFRICA (continued)						
EAST AFRICA						
Polyethylene ld	30.3	30.5	30.0			
Polyethylene hd	10.1	10.2	10.0			
Polypropylene	4.0	4.2	4.2			
PVC	29.3	28.7	29.2			
Polystyrene	9.1	9.2	9.2			
ABS	5.0	0.5	0.8			
TOTAL	87.8	83.3	83.4			
CENTRAL AFRICA						
Polyethylene ld	30.5	29.7	30.7			
Polyethylene hd	9.5	9.4	9.3			
Polypropylene	3.8	3.9	4.0			
PVC	28.6	29.7	29.3			
Polystyrene	9.5	9.4	9.3			
ABS	-	0.8	0.7			
TOTAL	81.9	82.9	83.3			
SOUTH AFRICA						
Polyethylene ld	22.0	22.2	21.9			
Polyethylene hd	8.0	7.8	8.1			
Polypropylene	5.0	5.0	5.0			
PVC	23.0	23.0	23.1			
Polystyrene	10.0	10.0	10.0			
ABS	2.0	2.0	2.0			
TOTAL	70.0	70.0	70.1			

TABLE 8.9. (CONTINUED)

STRUCTURE OF DEMAND FOR PLASTICS

Percentage

REGION	1973	1974	1975	1976	1980	1985
NORTH AMERICA						
Polyethylene ld	18.3	20.0	19.4			
Polyethylene hd	8.6	8.7	9.1			
Polypropylene	6.6	6.9	7.3			
PVC	15.8	15.5	15.8			
Polystyrene	13.3	12.9	14.3			
ABS	3.6	3.2	2.7			
TOTAL	66.2	67.2	68.6			
WORLD TOTAL	*	*				
Polyethylene ld	19.7	20.2	19.0			
Polyethylene hd	7.1	8.1	7.1			
Polypropylene	5.9	6.4	6.4			
PVC	22.0	19.9	22.1			
Polystyrene	10.5	10.7	10.5			
ABS	2.6	2.6	2.3			
TOTAL	67.8	67.9	67.4			

* Excluding Eastern Europe

TABLE B.10. MAN-MADE FIBRES, WORLD DEMAND

Unit : 1000 tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
WESTERN EUROPE	1 431	1 825	2 136	2 168	2 251	2 403	2 790	2 570	2 231	
FRANCE	167	212	259	276	289	316	363	247	195	
F.R.G.	373	447	526	488	550	538	588	558	452	
ITALY	173	231	314	320	314	355	434	338	284	
SPAIN	74	104	130	145	151	196	227	218	205	
UNITED KINGDOM	338	439	436	447	467	466	552	499	485	
E.E.C.										
Others E.E.C.										
EASTERN EUROPE	950	1 190	1 290	1 380	1 450	1 629	1 700	1 850	1 900	
U.S.A.	1 501	2 219	2 311	2 247	2 494	2 927	3 166	2 946	2 665	
JAPAN	466.5	624.8	643.9	732.2	678.6	566.7	1 064.3	931.5	855.0	

TABLE B.10. MAN-MADE FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL	206.5	270.0	295.9	344.7	406.1	493.8	593.1	651.0	628.9	
. Argentina	34.6	29.9	33.2	34.4	44.9	53.0	60.0	64.4	60.8	
. Brazil	56.7	89.0	88.2	106.3	117.2	139.4	184.2	209.7	188.4	
. Mexico	42.1	55.2	64.8	76.7	90.2	131.4	146.4	158.8	166.6	
. Andean countries	44.0	54.0	64.0	75.8	95.9	108.1	121.7	129.4	126.1	
. Others : Caribbean	16.4	23.0	26.9	30.2	30.5	31.4	32.7	32.9	34.0	
. Central America	12.7	18.9	18.8	21.3	27.4	30.5	48.1	55.8	53.0	
AFRICA : TOTAL	186.5	216.3	234.2	242.4	266.0	285.2	345.5	361.9	370	
NORTH AFRICA	52.7	69.9	83.4	87.7	88.7	102.6	116.5	114.1	125	
of which :										
. Algeria	3.1	17.4	27.6	30.6	31.3	40.4	33.3	31.8		
. Egypt	(11.0)	12.7	11.7	13.2	12.2	11.5	9.7	11.6		
. Morocco	20.3	27.9	31.0	29.7	27.2	29.6	40.5	37.5		
. Tunisia										
WEST AFRICA	14.5	16.3	16.7	20.7	29.2	26.7	45.2	51.3	55	
of which :										
. Ivory Coast	1.3	3.6	4.2	3.2	4.0	3.8	2.6	2.5		
. Nigeria	5.4	6.3	5.7	9.7	16.2	13.0	33.7	35.3		
EAST AFRICA	38.3	45.5	34.4	34.8	36.8	36.8	43.5	46.8	50	
CENTRAL AFRICA	6.7	7.9	9.6	10.8	12.2	12.0	13.0	13.9	15	
of which :										
. Angola	2.1	3.4	3.5	4.0	4.2	3.0	4.1	4.5		
SOUTH AFRICA	74.3	76.7	90.1	88.4	99.1	107.1	127.3	135.8	125	
PACIFIC AREA	80.7	81.6	94.9	103.7	113.9	120.6	140.1	193.3		
of which Australia	65.3	66.7	76.8	85.4	95.4	102.3	117.4	166.9		

TABLE B.10. MAN-MADE FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL	934.1	1 276.3	1 350.8	1 527.9	1 590.7	1 599.2	2 370.7	2 306.7	2 410.0	
(including China)	83.8	80.3	85.5	122.1	166.6	245.7	362.3	282.1	350	
EAST ASIA excl. JAPAN	36.8	113	136.4	162	207	164.7	202	233	295	
. Hong-Kong	4.1	22.0	25.5	23.6	39.4	32.8	27.2	14.0	20.0	
. **Others**	14.1	32.3	43.9	60.0	80.0	90.0	110.0	130.0	150.0	
. **Republic of Korea**	18.6	57.8	67.0	78.3	87.6	41.9	64.5	88.9	125.0	
. Japan	466.5	624.8	643.9	732.2	678.6	566.7	1 064.3	931.5	885.0	
SOUTH ASIA	271.3	352.9	377.6	413.7	430.4	488.0	598.7	693.4	730	
of which :										
. India	85.9	124.8	125.7	140.3	144.8	154.2	138.3	154.4	155	
. Iran	49.0	66.6	50.2	79.4	74.8	83.9	89.0	106.6	115	
. Pakistan	17.1	11.2	16.2	17.5	15.1	17.3	22.6	27.8	26.5	
. Indonesia	22.9	17.9	16.0	17.0	15.1	19.4	78.7	101.2	100	
. Philippines	22.6	40.4	50.1	40.7	56.4	57.2	58.3	67.9	70	
. Singapore	(30.0)	(35.0)	(40.0)	42.0	50.0	44.0	(45.0)	(45.0)	45	
. Thailand	15.4	24.2	28.9	34.1	35.8	59.4	50.7	49.2	50	
MIDDLE EAST	75.7	105.3	107.4	97.9	108.1	134.1	143.4	166.7	150	
of which :										
. Iraq	15.0	22.5	21.7	19.4	16.7	16.4	15.9	27.1	25	
. Lebanon	5.7	9.4	10.5	9.0	12.0	13.7	15.6	15.3	15	
. Israel	9.8	14.2	12.7	11.2	15.0	24.7	12.4	13.7	15	
. Turkey	18.7	35.0	35.2	38.1	48.4	55.9	70.2	82.6	66	
. Syria										

TABLE B.11.

DEMAND FOR MAN-MADE FIBRES IN SOME INDUSTRIALIZED COUNTRIES

Unit : 1000 tons

	1972	1973	1974	1975
WESTERN EUROPE : TOTAL	2 403	2 900	2 570	2 231
of which :				
. Belgium	226	264	247	195
. France	316	363	336	267
. F.R.G.	538	588	558	452
. Italy	355	434	338	284
. Netherlands				
. Spain	196	337	218	205
. United Kingdom	466	552	499	485
. Others	306	362	374	343
EASTERN EUROPE : TOTAL	1 629	1 700	1 850	1 900
. Bulgaria	52			
. Czechoslovakia	119			
. G.D.R.	222			
. Hungary	48			
. Poland	204			
. Romania	106			
. U.S.S.R.	807			
. Yugoslavia	71			
NORTH AMERICA : TOTAL	3 101	3 363	3 128	2 839
. Canada	174	197	182	174
. U.S.A.	2 927	3 166	2 946	2 665

TABLE 6.12.

WORLD DEMAND FOR SYNTHETIC FIBRES

Unit : 1000 tons

	1972	1973	1974	1975
WESTERN EUROPE : TOTAL	1 610	1 930	1 770	1 640
of which :				
. Belgium	137	172	159	144
. France	183	245	226	187
. F.R.G.	374	424	409	340
. Italy	238	307	223	215
. Netherlands				
. Spain	140	164	150	154
. United Kingdom	316	400	368	339
. Others	222	218	235	261
EASTERN EUROPE : TOTAL	557	680	830	950
. Bulgaria	29			
. Czechoslovakia	41			
. G.D.R.	50			
. Hungary	16			
. Poland	83			
. Romania	33			
. U.S.S.R.	270			
. Yugoslavia	35			
NORTH AMERICA : TOTAL	2 429	2 734	2 591	2 475
. Canada	135	154	144	148
. U.S.A.	2 294	2 580	2 447	2 327

TABLE B.12. SYNTHETIC FIBRES, WORLD DEMAND BY REGION, 1965–1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL	65.3	124.9	153.1	206.0	255.3	341.9	428.9	497.0	485.7	
. Argentina	13.7	18.5	23.3	24.3	30.6	38.3	44.8	46.9	46.0	
. Brazil	15.1	35.5	38.8	56.1	61.2	86.4	124.7	153.7	138.6	
. Mexico	14.1	26.7	35.5	51.7	64.8	103.9	116.1	133.5	140.0	
. Andean countries	13.0	24.0	32.0	44.9	62.7	72.9	85.6	96.8	96.1	
. Others : Caribbean	4.8	8.3	11.4	13.7	15.2	16.6	16.6	17.9	65	
. Central America	4.6	11.9	12.1	15.3	20.8	23.8	41.1	48.2		
AFRICA : TOTAL	39.6	78.0	100.2	109.8	137.1	148.5	179.5	196.9	203	
NORTH AFRICA	3.9	19.7	28.9	30.2	38.2	47.0	46.3	50.6	57	
of which :										
. Algeria	-	7.5	12.6	14.5	19.6	26.5	18.8	19.4		
. Egypt	-	2.1	2.4	2.5	2.6	2.5	2.0	4.3		
. Morocco	2.5	7.8	10.4	9.0	10.5	12.2	18.7	17.8		
. Tunisia										
WEST AFRICA	3.8	6.2	8.2	10.7	19.3	18.5	25.4	29.3	33	
of which :										
. Ivory Coast	0.1	1.7	3.1	2.1	2.6	2.5	1.3	1.5		
. Nigeria		1.0	1.5	3.5	10.6	9.5	19.0	19.5		
EAST AFRICA	7.9	12.7	10.0	11.5	12.9	12.3	18.8	21.3	24	
CENTRAL AFRICA	2.2	4.7	5.0	6.6	8.3	8.8	8.7	9.4	11	
of which :										
. Angola	0.5	1.6	1.6	1.8	2.2	1.3	2.2	2.2		
SOUTH AFRICA	21.8	34.7	48.1	50.8	58.4	61.9	80.3	86.3	78	
PACIFIC AREA	45.0	47.4	58.4	68.1	77.0	86.9	109.7	155.4	140	

TABLE B. 12. SYNTHETIC FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL	330.7	608.1	688.5	880.5	943.7	904.4	1 542.0	1 497.8	1 485	
China	9.2	12.1	18.6	57.4	93.0	160.8	230.1	177.7	200	
EAST ASIA excl. JAPAN	20	71.5	99.3	124.4	162.3	112.5	148.9	185.6	230	
. Hong-Kong	2.0	8.3	12.6	12.1	23.3	19.8	15.6	4.1		
. **Others**	7.7	17.5	32.3	44.5	59.0	67.0	82.0	97.0	113	
. **Republic of Korea**	10.3	45.7	54.4	67.8	79.7	25.7	51.3	84.5		
. Japan	221.5	347.4	363.6	476.8	429.3	(321.7)	755.2	655.1	565	
SOUTH ASIA	62.4	128.0	154.0	165.1	194.5	226.2	319.2	362.7	380	
of which :										
. India	9.1	13.9	17.2	21.5	27.0	26.6	27.9	25.5		
. Iran	2.3	19.8	17.6	27.3	23.5	36.1	45.3	52.3	55	
. Pakistan	2.8	0.7	4.1	6.2	6.3	7.0	8.8	14.4		
. Indonesia	0.1	11.2	10.2	11.6	10.7	14.0	75.2	95.7		
. Philippines	6.5	18.1	24.2	20.5	32.8	34.0	38.3	46.2		
. Singapore	(30.0)	(32.0)	(35.0)	37.0	44.0	40.0	(42.0)	(42.0)		
. Thailand	7.0	20.1	25.3	23.6	27.2	44.6	50.5	47.9		
MIDDLE EAST	17.6	49.1	53.0	56.8	64.6	83.2	88.6	116.7	110	
of which :										
. Iraq	-	4.0	6.9	8.1	3.6	3.1	4.7	12.1		
. Lebanon	1.7	4.6	5.3	5.7	9.4	11.7	14.0	13.3		
. Israel	4.5	10.5	8.9	7.8	11.3	21.5	11.2	12.1		
. Turkey	8.7	23.0	21.4	26.4	33.1	36.8	49.4	62.6		
. Syria										

TABLE B.13 .

WORLD DEMAND FOR POLYESTER FIBRES

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	695	645	590
of which :			
. Belgium			
. France			
. **F.R.G.**			
. Italy			
. Netherlands			
. Spain			
. United Kingdom			
. Others			
EASTERN EUROPE : TOTAL	205	300	350
. Bulgaria			
. Czechoslovakia			
. **G.D.R.**			
. Hungary			
. Poland			
. **Romania**			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	1 365	1 345	1 375
. Canada			
. U.S.A.			

TABLE B.13. POLYESTER FIBRES, WORLD DEMAND BY REGION, 1965–1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				70.0	100.0	166	214	245	245	
. Argentina				6.1	7.2	10.7	14.0	15.7	15.2	
. Brazil				20.6	26.9	42.7	62.9	76.2	72.0	
. Mexico				18.5	31.2	64.0	71.6	76.6	82.5	
. Andean countries				14.7	20.8	28.5	36.6	43.6	42.1	
. Others : Caribbean . Central America				10.1	13.9	20.1	28.9	32.9	33.2	
AFRICA : TOTAL							83.5	93.5	102	
NORTH AFRICA							23	25	29	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							13	15	18	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							9.5	11	13	
CENTRAL AFRICA							4.5	5	6	
of which :										
. Angola										
SOUTH AFRICA							33.5	37.5	36	
PACIFIC AREA							45.5	67.5	64.5	

TABLE B.13. POLYESTER FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL							619	671	702	
China							88	78	91	
EAST ASIA							354	368	367	
. Hong-Kong										
. **Others**							69	93	122	
. **Republic of Korea**										
. Japan							285	285	245	
SOUTH ASIA							144	178	197	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							33	47	47	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.14.

WORLD DEMAND FOR POLYAMIDE FIBRES

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	675	620	560
of which :			
. Belgium			
. France			
. F.R.G.			
. Italy			
. Netherlands			
. Spain			
. United Kingdom			
. Others			
EASTERN EUROPE : TOTAL	295	320	355
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	1 025	960	855
. Canada			
. U.S.A.			

TABLE B. 14. POLYAMIDE FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				104	115	131	155	161	147	
. Argentina				15.7	20.9	23.5	25.9	24.7	24.1	
. Brazil				30.8	29.6	35.0	49.4	50.6	42.3	
. Mexico				23.2	21.2	26.5	25.9	33.0	28.4	
. Andean countries				19.7	27.0	30.3	32.8	30.5	31.4	
. Others : Caribbean / . Central America				14.6	16.3	15.7	21.0	22.2	20.8	
AFRICA : TOTAL							66	70.5	69.5	
NORTH AFRICA							16.5	17.5	19.5	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							10	11	11.5	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							7.5	8.5	8.5	
CENTRAL AFRICA							3.5	3.5	4	
of which :										
. Angola										
SOUTH AFRICA							28.5	30	26	
PACIFIC AREA							39	54	47	

TABLE B.14. POLYAMIDE FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL							541	490	478	
China							100	69	75	
EAST ASIA							267	233	226	
. Hong-Kong							}	}	}	
. **Others**							} 57	} 63	} 71	
. **Republic of Korea**							}	}	}	
. Japan							210	170	155	
SOUTH ASIA							127	130	125	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							47	58	52	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.15.

WORLD DEMAND FOR ACRYLIC FIBRES

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	540	485	475
of which :			
. Belgium			
. France			
. F.R.G.			
. Italy			
. Netherlands			
. Spain			
. United Kingdom			
. Others			
EASTERN EUROPE : TOTAL	150	180	205
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	340	285	245
. Canada			
. U.S.A.			

TABLE B. 15. ACRYLIC FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				30	39	45	58	92	95	
. Argentina				1.1	2.5	4.1	4.9	6.5	6.7	
. Brazil				4.7	4.7	8.7	12.2	26.9	24.3	
. Mexico				10.0	12.4	13.4	18.6	23.9	29.1	
. Andean countries				10.0	13.7	13.6	15.0	21.7	21.8	
. Others : Caribbean . Central America				4.2	5.7	5.2	7.3	13.0	13.1	
AFRICA : TOTAL excluding South Africa							29.5	30.5	30.5	
NORTH AFRICA							7	7.5	8.5	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							2.5	3.0	3.5	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							2	2	2.5	
CENTRAL AFRICA							1	1	1	
of which :										
. Angola										
SOUTH AFRICA							17	17	15	
PACIFIC AREA							23	30	27	

TABLE B.15. ACRYLIC FIBRES, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL							328	287	274	
China							41	31	34	
EAST ASIA							230	190	172	
. Hong-Kong							}	}	}	
. **Others**							25	30	37	
. **Republic of Korea**							}	}	}	
. Japan							205	160	135	
SOUTH ASIA							48	54	57	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							9	12	11	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.16.

STRUCTURE OF THE DEMAND FOR SYNTHETIC FIBRES

Percentage

	1973	1974	1975	1980	1985
WORLD, TOTAL					
Acrylic	19.2	18.3	18.2		
Polyamide	36.5	35.3	33.9		
Polyester	43.3	44.4	46.3		
Other	1.0	2.0	1.6		
TOTAL	100	100	100		
WESTERN EUROPE					
Acrylic	28	27.5	29	27	25
Polyamide	35	35	34	30	28
Polyester	36	36.5	36	42	46
Other	1	1	1	1	1
TOTAL	100	100	100	100	100
EASTERN EUROPE					
Acrylic	22	21.5	21.5	20.5	20
Polyamide	43.5	38.5	37.5	34.5	32
Polyester	30.0	36	37	41	44
Other	4.5	4	4	4	4
TOTAL	100	100	100	100	100
U.S.A.					
Acrylic	12.5	11	10	10	10
Polyamide	37.5	37	34.5	32	29
Polyester	50	52	55.5	58	61
Other	-	-	-	-	-
TOTAL	100	100	100	100	100
JAPAN					
Acrylic	27	24.5	24	23	21
Polyamide	27.5	26	27.5	25	23
Polyester	38.0	41.5	43.5	47	51
Other	7.5	8	5	5	5
TOTAL	100	100	100	100	100

TABLE B.16. (CONTINUED)

STRUCTURE OF THE DEMAND FOR SYNTHETIC FIBRES (CONTINUED)

Percentage

	1973	1974	1975	1980	1985
LATIN AMERICA					
Acrylic	14	18.5	19.5	19	17
Polyamide	36	32.5	30		
Polyester	50	49	50.5	55	60
Other				1	2
TOTAL	100	100	100		
ASIA					
CHINA					
Acrylic	18	17.5	17		
Polyamide	43.5	38.5	37.5		
Polyester	38.5	44	45.5		
Other	-	-	-		
TOTAL	100	100	100		
EAST ASIA					
Acrylic	16	16	16		
Polyamide	38	34	31		
Polyester	46	50	53		
Other	-	-	-		
TOTAL	100	100	100		
SOUTH ASIA					
Acrylic	15	15	15		
Polyamide	40	36	33		
Polyester	45	49	52		
Other	-	-	-		
TOTAL	100	100	100		
MIDDLE EAST					
Acrylic	10	10	9.5	10.5	11
Polyamide	53	50	47.5	37	29.5
Polyester	37	40	42.5	51.5	57.5
Other	-	-	0.5	1.0	2.0
TOTAL	100	100	100	100	100

TABLE B.16. STRUCTURE OF THE DEMAND FOR SYNTHETIC FIBRES (Continued)

Percentage

	1973	1974	1975	1980	1985
AFRICA					
NORTH AFRICA					
Acrylic	15	15	15		
Polyamide	36	35	34		
Polyester	49	50	51		
Other	-	-	-		
TOTAL	100	100	100		
WEST AFRICA					
Acrylic	10	10	10		
Polyamide	40	38	35		
Polyester	50	52	55		
Other	-	-	-		
TOTAL	100	100	100		
EAST AFRICA					
Acrylic	10	10	10		
Polyamide	40	38	35		
Polyester	50	52	55		
Other	-	-	-		
TOTAL	100	100	100		
CENTRAL AFRICA					
Acrylic	10	10	10		
Polyamide	40	38	35		
Polyester	50	52	55		
Other	-	-	-		
TOTAL	100	100	100		
SOUTH AFRICA					
Acrylic	21	19.5	19		
Polyamide	35.5	35	33.5		
Polyester	41.5	43.5	46		
Other	2	2	1.5		
TOTAL	100	100	100		
PACIFIC AREA					
Acrylic	21	19.5	19		
Polyamide	35.5	35	35.5		
Polyester	41.5	43.5	44		
Other	2	2	1.5		
TOTAL	100	100	100		

TABLE B.17. TOTAL RUBBER DEMAND: INDUSTRIALIZED REGIONS

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
WESTERN EUROPE	1 582.5	1 912.5	2 152.5	2 357.5	2 442.5	2 507.5	2 730	2 650	2 467.5	2 657
FRANCE	277.0	324.8	380.3	419.2	442.7	458.0	467.0	470.8	433.9	452.9
F.R.G.	366.4	423.0	519.2	558.8	567.4	555.4	613.6	553.0	513.2	544.0
ITALY	200.0	260.0	280.0	310.0	327.5	338.0	360.0	380.0	338.0	410.0
SPAIN										
UNITED KINGDOM	369.4	438.7	454.4	472.7	459.6	452.2	517.1	446.5	437.5	492.8
E.E.C.	1 317.5	1 570.0	1 767.5	1 925.0	1 972.5	1 997.5	2 142.5	2 055.0	1 935.0	2 112.5
Others E.E.C.	265.0	342.5	385.0	432.5	470.0	510.0	587.5	595.0	532.5	545.0
EASTERN EUROPE	1 175.0	1 370.0	1 425.0	1 520.0	1 700.0	1 900.0	2 100.0	2 300.0	2 475.0	2 600.0
NORTH AMERICA	2 229.9	2 669.4	2 843.1	2 703.1	2 724.1	3 212.3	3 376.1	3 298.7	2 812.8	3 194.6
CANADA	142.2	151.6	178.7	186.1	210.3	233.2	246.6	244.6	251.6	288.6
U.S.A.	2 087.7	2 517.8	2 664.4	2 517	2 513.8	2 979.1	3 129.5	3 054.1	2 561.2	2 906
JAPAN	377.0	603.0	694.0	779	820	900	1 045	927.0	870	970

TABLE 3.17 RUBBER TOTAL (INCLUDING MATERIALS, ARTICLES), WORLD DEMAND BY REGION, 1965-1976 (Continued) **Unit: 1000 metric tons**

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL	837	1 228	1 366	1 504	1 610	1 732	1 979	1 913	1 591	2 165
China	170	225	245	265	270	275	280	285	290	310
EAST ASIA	407	648	754	849	900	980	1 155	1 032	985	1 095
. Hong-Kong										
. **Others**	30	45	60	70	80	80	110	105	115	125
. **Republic of Korea**										
. Japan	377	603	694	779	820	900	1 045	927	870	970
SOUTH ASIA	205	275	297	310	345	382	429	471	511	600
of which :										
. India	93.5	120	129	131	142	153	163	170	176	184
. Iran	10	15	17	20	32	40	52	56	70	
. Pakistan								20	25	
. Indonesia								100	110	120
. Philippines	22	33	35	37	38	39	45	55	59	
. Singapore								15	15	
. Thailand								35	35	
MIDDLE EAST	55	80	70	80	95	95	105	125	140	160
of which :										
. Iraq									7	
. Lebanon									18	
. Israel									25	
. Turkey									50	
. Syria										

TABLE B.17. RUBBER TOTAL (INCLUDING MATERIALS, ARTICLES) WORLD DEMAND BY REGION, 1965–1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL	210	310	320	353	393.5	418	500.5	550	562	
. Argentina				52	59	66.5	77	72	71	
. Brazil	64.5	109	106	122	139	158.5	200.5	224	235	
. Mexico				80	82.5	83.5	95.5	122.5	115	267
. Andean countries				67.5	77	77	88.5	93.5	101.5	130
. Others, Caribbean, Central America	22	27	29	32	36	34	39	38	40	
AFRICA : TOTAL	170.5	177.5	199.5	213	249	260	269	308	326	
NORTH AFRICA	46	56.5	63.5	67	68.5	77	72	78	90	
of which :										
. Algeria	23	23	25	26.5	24	27	28	29	30	
. Egypt	10	12	12	13	15	17	15	14	18	
. Morocco	5	8	8.5	8.5	8.5	9.5	9.5	12	13	
. Tunisia										
WEST AFRICA	56.5	42	50	55	87	72	62	79	73	
of which :										
. Ivory Coast										
. Nigeria	30.5	18.5	20.5	26.5	60	44	31.5	39.5	35.5	43
EAST AFRICA	30	35	40	38	41	53	67	69	75	
CENTRAL AFRICA	8	9	9	10	11	13	15	18	20	
of which :										
. Angola	3	4	4	4	4.5	4.5	5	6	7	
SOUTH AFRICA	30	35	37	43	41.5	45	53	64	68	
PACIFIC AREA	86	116	115	116	124	125	139	147	119	
of which :										
. New Zealand	16.5	18.5	22	22	23.5	21	21	23	19	
. Australia	79.5	97.5	93	94	100.5	104	118	124	100	

TABLE 8.18.

DEMAND FOR TOTAL RUBBER IN SOME INDUSTRIALIZED COUNTRIES

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	2 730	2 650	2 467
of which :			
. Belgium	90	90	95
. France	467	471	434
. F.R.G.	613.5	553	513
. Italy	360	380	338
. Netherlands	85	87	87.5
. Spain			
. United Kingdom	517	446.5	437.5
. Others	597.5	622.5	562
EASTERN EUROPE : TOTAL	2 100	2 300	2 450
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	3 375	3 299	2 813
. Canada	245.6	245	252
. U.S.A.	3 129.5	3 054	2 561

TABLE 8.19.

WORLD DEMAND FOR SYNTHETIC RUBBER

Unit : 1000 tons

	1973	1974	1975	1976
WESTERN EUROPE : TOTAL	1 795	1 720	1 560	1 732
of which :				
. Belgium	60	60	65	65
. France	305	308.5	277.5	286
. F.R.G.	408	359	316	338
. Italy	240	255	220	270
. Netherlands	61.5	62	63	63
. Spain	134	122.5	109.5	115
. United Kingdom	330.5	279	267	324.5
. Others	256	274	242	270.5
EASTERN EUROPE : TOTAL	1 610	1 800	2 000	2 125
. Bulgaria				
. Czechoslovakia				
. G.D.R.				
. Hungary				
. Poland				
. Romania				
. U.S.S.R.				
. Yugoslavia				
NORTH AMERICA : TOTAL	2 617	2 495	2 076	2 379
. Canada	186	181	179	204
. U.S.A.	2 431	2 314	1 897	2 175

TABLE B.19. SYNTHETIC RUBBER, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL	125	195	205	228	261.5	290	357.5	398	410	
. Argentina				38	44	53.5	62	59.5	54	
. Brazil				85.5	97.5	114.5	149.5	166	176.5	205
. Mexico				50	53.5	57	66.5	89	86	
. Andean countries				36.5	45	44	54.5	58	65	
. Others, Caribbean, Central America				18	21.5	21	25	25.5	28.5	
AFRICA : TOTAL	75	86	103	112	135	140	146	162	184	
NORTH AFRICA	25	34	38	42	44	50	48	51	58	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA	27	22	28	31	49	41	36	45	42	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA	14	18	22	22	24	31	39	39	43	
CENTRAL AFRICA	4	5	5	6	6	7	9	11	12	
of which :										
. Angola										
SOUTH AFRICA	5	7	10	11	12	11	14	16	29	
PACIFIC AREA	50	64	63	67	73	70	78	78	61	
of which :										
. New Zealand	8.5	11.5	11	11.5	10.5	10	10	11	12	
. Australia	40.5	53.5	51	54	60	58	66	64.5	50	

TABLE B.19. SYNTHETIC RUBBER, WORLD DEMAND BY REGION, 1965-1976 (Continued) Unit : (1000 metric tons)

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL	336.5	586	691	791	849.5	937	1 114.5	1 056	1 065	939
China	30	45	50	55	57.5	60	62.5	65	70	80
EAST ASIA	189.5	374	463	541	576	640	783	688	661	756
. Hong-Kong										
. **Others**	14	26	37	45	51	52	73	73	77	86
. **Republic of Korea**										
. Japan	175.5	348	426	496	525	588	710	615	584	670
SOUTH ASIA	87	120	135	145	155	175	200	220	245	
of which :										
. India	23	27	34	35	40.5	42	27	24	35	36.5
. Iran	3	6	7	8	10	15	30	40	50	
. Pakistan										
. Indonesia										
. Philippines	12	13	14	14	15	17	18	20	21	
. Singapore										
. Thailand										
MIDDLE EAST	30	47	43	50	61	62	69	83	89	103
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.20.

WORLD DEMAND FOR S.B.R.

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	1 085	1 040	945
of which :			
. Belgium	43.0	40.0	35.0
. France	199.0	194.0	137.0
. F.R.G.	269.0	238.0	233.0
. Italy	174.0	165.5	114.0
. Netherlands	60.0	65.0	56.0
. Spain	86	78	71
. United Kingdom	179.0	175.0	120.0
. Others	75.0	84.5	179.
EASTERN EUROPE : TOTAL	1 030	1 130	1 240
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	1 530	1 470	1 285
. Canada			
. U.S.A.			

TABLE B.20. S.B.R., WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				163	192	206	264	304	250	
. Argentina				23.3	29.8	34.6	44.9	40.1	38.7	
. Brazil				65.0	76.6	82.2	114.2	135.8	98.6	
. Mexico				35.1	36.2	40.9	44.7	64.2	45.8	
. Andean countries				26.5	33.7	33.4	41.1	44.0	49.6	
. Others : Caribbean . Central America				13.1	15.7	14.9	19.1	19.9	17.3	
AFRICA : TOTAL							113	124.5	138	
NORTH AFRICA							36.5	38.5	43	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							29	35.5	33	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							31	31	33.5	
CENTRAL AFRICA							7.5	9	9.5	
of which :										
. Angola										
SOUTH AFRICA							9	10.5	19	
PACIFIC AREA							51	51	40	

TABLE B.20. S.B.R., WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL							718	703.5	716	
China							47.5	49	52.5	59
EAST ASIA							473.5	425	413	469
. Hong-Kong										
. **Others**							55.5	55	58	64
. **Republic of Korea**										
. Japan							418	370	355	405
SOUTH ASIA							152	167	184	
of which :										
. India										
. Iran										
. Pakistan								6	8	
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							45	62.5	66.5	76
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.21.

WORLD DEMAND FOR POLYBUTADIENE RUBBER

Unit : 1000 tons

	1973	1974	1975
WESTERN EUROPE : TOTAL	242	232	211
of which :			
. Belgium	17.7	19.2	15.0
. France	45.0	44.0	29.7
. F.R.G.	67.0	60.0	29.7
. Italy	31.0	30.0	21.1
. Netherlands	4.8	3.3	3.5
. Spain	17	15	19
. United Kingdom	40.0	38.0	30.0
. Others	19.5	22.5	63.0
EASTERN EUROPE : TOTAL	103	114	124
. Bulgaria			
. Czechoslovakia			
. G.D.R.			
. Hungary			
. Poland			
. Romania			
. U.S.S.R.			
. Yugoslavia			
NORTH AMERICA : TOTAL	335	312	311
. Canada			
. U.S.A.			

TABLE B.21. POLYBUTADIENE, WORLD DEMAND BY REGION, 1965–1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL							141	138.5	144.5	
China							7.5	8	9	10.5
EAST ASIA							101	92.5	92	
. Hong-Kong										
. **Others**							9	9.5	10	11.5
. **Republic of Korea**										
. Japan							92	83	82	94
SOUTH ASIA							24	27.5	32	
of which :										
. India										
. Iran										
. Pakistan								1.5	3.5	
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST							8.5	10.5	11.5	13.5
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.21. POLYBUTADIENE, WORLD DEMAND BY REGION, 1965-1976 (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL				34	35.0	41	50.0	54	60	
. Argentina				5.0	4.6	6.4	6.8	7.0	6.6	
. Brazil				11.3	12.8	16.1	19.9	23.3	27.2	
. Mexico				6.6	6.8	8.2	10.3	11.2	12.1	
. Andean countries				7.6	7.6	7.0	9.4	8.1	9.3	
. Others : Caribbean . Central America				3.5	3.2	3.3	3.6	4.4	4.8	
AFRICA : TOTAL							14.5	17.0	22.0	
NORTH AFRICA							6	6.5	7.5	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA							3	4	4.5	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA							3	3.5	4.5	
CENTRAL AFRICA							1	1	1.5	
of which :										
. Angola										
SOUTH AFRICA							1.5	2.0	4.0	
PACIFIC AREA							9.5	10.0	8.5	

TABLE B.22. PERCENTAGE CONSUMPTION OF SYNTHETIC RUBBER (SYNTHETIC RUBBER/TOTAL RUBBER)

	1965	1970	1973	1974	1975	1976	1980	1985
WORLD, TOTAL	60.5	65.3	70	69.2	69	70	71.5	72.5
WESTERN EUROPE	53.5	61.5	66	65	63.5	65	66	67
EASTERN EUROPE	64	69.5	77.5	78.5	81.5	82	83	84
NORTH AMERICA	75	77	77.5	75.5	74	74.5	77	79
JAPAN	45.5	64	68	66.5	67	69	71	73
LATIN AMERICA	59.5	64.5	71.5	72.5	73		75	77
AFRICA	46.5	55.0	57.5	56	60.5			
NORTH AFRICA	54.5	60	66.5	65.5	64.5		68	71
WEST AFRICA	48	56.5	58	57	57		61	64
EAST AFRICA	46.5	58	58	57	57.5		61	64
CENTRAL AFRICA	50	60	60	61	63.5		66	68
SOUTH AFRICA	16.5	25.5	26.5	25	42.5		50	60
ASIA	40	52.5	58.5	55	55			
CHINA	17.5	21	22.5	23	24	26	32	37
EAST ASIA excl.JAPAN	47	65	66.5	69.5	67	69	72	74
SOUTH ASIA	42.5	47	47	47	48		65	68
MIDDLE EAST	54.5	62.5	66	66.5	63.5	64.5	69	72
PACIFIC AREA	52	57.5	56	53	51.5	54	59	65

TABLE B.22. SYNTHETIC RUBBER, PERCENTAGE CONSUMPTION (Continued)

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL	60	63	64	65	66.5	69.5	71.5	72.5	73	
. Argentina				73	74.5	80.5	80.5	82.5	76	
. Brazil	59			70	70	72	74.5	74	75	75.5
. Mexico				62.5	64.5	68	70	71.5	75	74.5
. Andean countries				56.5	63	60	64.5	67	71	
. Others : Caribbean										
. Central America										
AFRICA : TOTAL										
NORTH AFRICA										
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA										
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA										
CENTRAL AFRICA										
of which :										
. Angola										
SOUTH AFRICA										
PACIFIC AREA										

TABLE B.22. SYNTHETIC RUBBER, PERCENTAGE CONSUMPTION (Continued)

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL										
China	17.5	20	20.5	21	21.5	22	22.5	23	24	26
EAST ASIA										
. Hong-Kong										
. **Others**										
. **Republic of Korea**										
. Japan	46.5	58	61.5	63.5	64	65.5	68	66.5	67	69
SOUTH ASIA										
of which :										
. India	24	22.5	26	27	28	27.5	17.0	14	20	20
. Iran	30	40	42	40	32	38	57	71	71	
. Pakistan										
. Indonesia										
. Philippines	55	40	40	38	40	43	40	37	36	
. Singapore										
. Thailand										
MIDDLE EAST										
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.23.

STRUCTURE OF THE DEMAND FOR SYNTHETIC RUBBER

Percentage

	1973	1974	1975	1976	1980	1985
WORLD,TOTAL						
SBR	62.2	62.7	62.7		61.5	63
Polybutadiene	11.6	11.4	12.0		14	14
Others	26.2	25.9	25.3		24.5	23
TOTAL	100.0	100.0	100.0		100	100
WESTERN EUROPE						
SBR	60.5	60.5	60.5		59	58
Polybutadiene	13.5	13.5	13.5		14	14.5
Others	26	26	26		27	27.5
TOTAL	100	100	100		100	100
EASTERN EUROPE						
SBR	64	63	62		57	55
Polybutadiene	7	8	9		10	12
Others	29	29	29		33	33
TOTAL	100	100	100		100	100
U.S.A.						
SBR	58.5	58.8	61		57	56
Polybutadiene	12.8	12.5	15		16	16.5
Others	28.7	28.7	24		27	27.5
TOTAL	100	100	100		100	100
JAPAN						
SBR	59	60	61		60	58
Polybutadiene	13	13.5	14		15	16
Others	28	26.5	25		25	26
TOTAL	100	100	100		100	100

TABLE B.23. (CONTINUED)

STRUCTURE OF THE DEMAND FOR SYNTHETIC RUBBER (CONTINUED)

Percentage

	1973	1974	1975	1976	1980	1985
LATIN AMERICA						
SBR	74	76.5	(61.5)		70	67
Polybutadiene	14	13.5	14.5		15.5	16.5
Others	12	10	24		14.5	26.5
TOTAL	100	100	100		100	100
ASIA, excl. JAPAN						
SBR	76	75.5	75	74	71	68
Polybutadiene	12	12.5	13		14	15
Others	12	12	12		15	17
TOTAL	100	100	100		100	100
AFRICA, excl. S.AFRICA						
SBR	80	79	78		75	70
Polybutadiene	8	9	10		12	14
Others	12	12	12		13	16
TOTAL	100	100	100		100	100
SOUTH AFRICA						
SBR	71	70	69		65	63
Polybutadiene	10	11	12		14	15
Others	19	19	19		21	22
TOTAL	100	100	100		100	100
PACIFIC AREA						
SBR	66	65.5	65		64	63
Polybutadiene	12	13	14		15	16
Others	22	21.5	21		21	21
TOTAL	100	100	100		100	100

TABLE B.24.

SYNDETS - WORLD DEMAND BY REGION - ESTIMATE

Unit : 1000 t

	1973	1975
WESTERN EUROPE	4 000	3 300
of which E.E.C.	3 300	2 750
EASTERN EUROPE		1 500
NORTH AMERICA	3 000	2 700
of which U.S.A.	2 700	2 420

TABLE B.24. SYNDETS, WORLD DEMAND BY REGION, 1965-1976, ESTIMATE (Continued) Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
ASIA : TOTAL									1 100	
(excluding **China**)										
EAST ASIA									400	
. Hong-Kong										
. **Others**									100	
. **Republic of Korea**										
. Japan							900	850	850	950
SOUTH ASIA	80	160	200	250	280	340	400	500	550	
of which :										
. India										
. Iran										
. Pakistan										
. Indonesia										
. Philippines										
. Singapore										
. Thailand										
MIDDLE EAST	60	80	85	90	95	115	125	140	150	
of which :										
. Iraq										
. Lebanon										
. Israel										
. Turkey										
. Syria										

TABLE B.24. SYNDETS, WORLD DEMAND BY REGION, 1965-1976, ESTIMATE (Continued)

Unit : 1000 metric tons

	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
LATIN AMERICA : TOTAL	330	500	570	600	690	760	800	850	900	
. Argentina										
. Brazil										
. Mexico										
. Andean countries										
. Others : Caribbean									190	
. Central America									130	
AFRICA : TOTAL									250	
NORTH AFRICA	33	54	63	74	84	94	105	105	110	
of which :										
. Algeria										
. Egypt										
. Morocco										
. Tunisia										
WEST AFRICA									50	
of which :										
. Ivory Coast										
. Nigeria										
EAST AFRICA									40	
CENTRAL AFRICA									25	
of which :										
. Angola										
SOUTH AFRICA									25	
PACIFIC AREA	90	145	165	170	180	200	205	230	250	

TABLE B.25. WORLD DEMAND FOR SURFACTANTS BY TYPES, ESTIMATE

Unit : 1000 tons

	1 9 7 3				1 9 7 5			
	Cationic	Non ionic	Anionic	DDB incl. linear	Cationic	Non ionic	Anionic	DDB incl. linear
WESTERN EUROPE	80	300	730	420	75	265	505	270
of which E.E.C.	65	250	600	345	60	220	420	225
NORTH AMERICA	140	600	1 570	370	105	510	1 500	280
of which U.S.A.	125	540	1 420	330	95	460	1 360	250
JAPAN	24	150	160	170	22	137	172	130
INDUSTRIALIZED COUNTRIES					250	1 100	2 800	850
DEVELOPING COUNTRIES					25	100	1 000	350
WORLD TOTAL					275	1 200	3 800	1 200

Appendix C

INTERNATIONAL TRADE

TABLE C.1. ETHYLENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	503	-	-	5
OTHER W. EUROPE	120	-	-	-
EASTERN EUROPE	13	-	-	-
U.S.A.	-	-	-	-
CANADA	-	-	-	-
JAPAN	-	-	-	-
LATIN AMERICA	1	-	-	-
OTHER ASIA/OCEANIA	14	-	-	-
AFRICA	neg	-	-	-
TOTAL	651	-	-	5
TOTAL EXCLUDING INTERNAL TRADE	148			

TABLE C.2. PROPYLENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	472	-	-	30
OTHER W. EUROPE	18	-	-	-
EASTERN EUROPE	13	-	-	-
U.S.A.	7	-	-	-
CANADA	-	-	-	-
JAPAN	-	-	-	-
LATIN AMERICA	-	5	-	-
OTHER ASIA/OCEANIA	-	-	-	-
AFRICA	-	-	-	-
TOTAL	510	5	-	30
TOTAL EXCLUDING INTERNAL TRADE	38			

TABLE C.3. UNSATURATED C4'S INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	292	3	29	6
OTHER W. EUROPE	26	-	-	-
EASTERN EUROPE	32	-	-	-
U.S.A.	111	-	58	-
CANADA	2	6	-	-
JAPAN	-	-	-	-
LATIN AMERICA	11	23	-	-
OTHER ASIA/OCEANIA	-	-	n.a.	-
AFRICA	-	-	-	-
TOTAL	474	32	n.a.	6
TOTAL EXCLUDING INTERNAL TRADE	182			

TABLE C.4. BENZENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	476	76	-	170 (1)
OTHER W. EUROPE	2	-	2	-
EASTERN EUROPE	27	-	-	-
U.S.A.	37	-	45	108 (2)
CANADA	-	10	-	-
JAPAN	-	-	-	25
LATIN AMERICA	-	15		-
OTHER ASIA/OCEANIA	1	-	83	-
AFRICA	-	-		-
TOTAL	543	101	130	303
TOTAL EXCLUDING INTERNAL TRADE	67			

(1) Eastern Europe : 115
(2) Canada : 81

TABLE C.5. TOLUENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	201	210	-	78 (1)
OTHER W. EUROPE	59	5	-	2
EASTERN EUROPE	1	-	-	-
U.S.A.	35	-	128	164 (2)
CANADA	-	5	-	-
JAPAN	-	-	-	-
LATIN AMERICA	1	50	-	-
OTHER ASIA/OCEANIA	7	5	-	-
AFRICA	7	-	-	-
TOTAL	311	275	128	244
TOTAL EXCLUDING INTERNAL TRADE	110			

(1) Eastern Europe : 72
(2) Canada : 104, Latin America : 48

TABLE C.6. O.XYLENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	F.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	118	95	-	11 (1)
OTHER W. EUROPE	17	2	-	-
EASTERN EUROPE	2	-	-	-
U.S.A.	7	-	-	-
CANADA	-	-	-	-
JAPAN	-	8	-	-
LATIN AMERICA	-	45	n.a.	-
OTHER ASIA/OCEANIA	4	5	n.a.	-
AFRICA	-	1	-	-
TOTAL	148	156	n.a.	11
TOTAL EXCLUDING INTERNAL TRADF	30			

(1) Mainly Eastern Europe

TABLE C.7. P.XYLENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	131	14	-	21 (1)
OTHER W. EUROPE	-	-	-	-
EASTERN EUROPE	1	-	-	-
U.S.A.	63	-	-	-
CANADA	-	-	-	-
JAPAN	-	50	-	38 (2)
LATIN AMERICA	-	7	n.a.	-
OTHER ASIA/OCEANIA	-	-	n.a.	-
AFRICA	-	-	-	-
TOTAL	195	71	n.a.	59
TOTAL EXCLUDING INTERNAL TRADE	64			

(1) Other W.Europe : 12

(2) Mainly other Asia/Oceania

TABLE C.8. MIXED XYLENES INTERNATIONAL TRADE, 1973

Figures in 1000 t.

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	105	110	1	24 (1)
OTHER W. EUROPE	17	-	-	13 (2)
EASTERN EUROPE	6	-	-	-
U.S.A.	7	-	-	-
CANADA	-	4	-	-
JAPAN	-	4	-	115 (3)
LATIN AMERICA	neg	29		-
OTHER ASIA/OCEANIA	5	4	75	-
AFRICA	2	4		-
TOTAL	142	155	76 *	152
TOTAL EXCLUDING INTERNAL TRADE	37			

(1) Eastern Europe : 18 (2) Eastern Europe (3) Mainly other Asia/Oceania

* Total xylenes

TABLE C.9. METHANOL INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	258	153	neg	39 (1)
OTHER W. EUROPE	36	23	neg	54 (2)
EASTERN EUROPE	3	7	-	5
U.S.A.	-	-	-	-
CANADA	-	110	-	-
JAPAN	-	36	-	-
LATIN AMERICA	-	31	neg	-
OTHER ASIA/OCEANIA	10	29	49	-
AFRICA	-	2	-	-
TOTAL	307	391	49	98
TOTAL EXCLUDING INTERNAL TRADE	49			

(1) Eastern Europe : 31

(2) From Eastern Europe

TABLE C.10. VINYL CHLORIDE MONOMER (VCM) INTERNATIONAL TRADE, 1973 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	340	26	-	-
OTHER W. EUROPE	121	46	-	n.a.
EASTERN EUROPE	32	9	-	n.a.
U.S.A.	-	-	-	-
CANADA	-	2	-	-
JAPAN	6	-	-	-
LATIN AMERICA	-	89	}	-
OTHER ASIA/OCEANIA	13	15	} 120	-
AFRICA	neg	-	}	-
TOTAL	512	187	120	n.a.
TOTAL EXCLUDING INTERNAL TRADE	172			

TABLE C.11. STYRENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	267	120	neg.	2
OTHER W. EUROPE	43	11	-	-
EASTERN EUROPE	2	1	-	-
U.S.A.	-	-	-	-
CANADA	-	2	-	-
JAPAN	1	20	-	-
LATIN AMERICA	-	81	-	-
OTHER ASIA/OCEANIA	1	22	42	-
AFRICA	neg	5	2	-
TOTAL	314	262	44	2
TOTAL EXCLUDING INTERNAL TRADE	46			

TABLE C.12. ACRYLONITRILE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	127	7	17	4
OTHER W. EUROPE	3	4	-	-
EASTERN EUROPE	1	-	-	-
U.S.A.	-	-	-	-
CANADA	-	18	-	-
JAPAN	-	-	-	-
LATIN AMERICA	-	18	-	-
OTHER ASIA/OCEANIA	-	-	50	-
AFRICA	-	-	-	-
TOTAL	131	47	67	4
TOTAL EXCLUDING INTERNAL TRADE	4			

TABLE C.13. CYCLOHEXANE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	216	225	4	13 (1)
OTHER W. EUROPE	2	5	-	-
EASTERN EUROPE	3	-	-	-
U.S.A.	-	-	-	-
CANADA	-	1	-	-
JAPAN	-	2	-	-
LATIN AMERICA	-	1	} n.a.	-
OTHER ASIA/OCEANIA	-	-	} n.a.	-
AFRICA	neg	-	} n.a.	-
TOTAL	221	234	n.a.	13
TOTAL EXCLUDING INTERNAL TRADE	5			

(1) Latin America : 9

TABLE C.14. CAPROLACTAM INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	106	1	-	5
OTHER W. EUROPE	5	-	neg	2
EASTERN EUROPE	5	-	-	-
U.S.A.	15	-	-	-
CANADA	-	8	-	-
JAPAN	3	-	-	3
LATIN AMERICA	22	-	-	-
OTHER ASIA/OCEANIA	44	-	55	-
AFRICA	neg	-	-	-
TOTAL	200	9	55	10
TOTAL EXCLUDING INTERNATIONAL TRADE	94			

TABLE C.15 ADIPIC ACID INTERNATIONAL TRADE, 1973 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	32	-	-	-
OTHER W. EUROPE	3	-	-	-
EASTERN EUROPE	1	-	-	-
U.S.A.	2	-	-	-
CANADA	-	2	-	-
JAPAN	-	-	-	-
LATIN AMERICA	2	neg	-	-
OTHER ASIA/OCEANIA	-	-	-	-
AFRICA	-	-	-	-
TOTAL	40	2	-	-
TOTAL EXCLUDING INTERNAL TRADE	8			

TABLE C.16. HEXAMETHYLENEDIAMINE (HMDA) INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	177	4	-	-
OTHER W. EUROPE	-	-	-	-
EASTERN EUROPE	-	-	-	-
U.S.A.	-	-	-	-
CANADA	-	neg	-	-
JAPAN	neg	1	-	-
LATIN AMERICA	-	3	-	-
OTHER ASIA/OCEANIA	-	-	-	-
AFRICA	-	-	-	-
TOTAL	177	8	-	-
TOTAL EXCLUDING INTERNAL TRADE	-			

TABLE C.17. DIMETHYL TEREPHTALATE (DMT) INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	17	5	-	-
OTHER W. EUROPE	10	3	-	-
EASTERN EUROPE	30	-	-	-
U.S.A.	-	-	-	-
CANADA	-	15	-	-
JAPAN	-	-	-	-
LATIN AMERICA	5	38	} 85	-
OTHER ASIA/OCEANIA	neg	1		-
AFRICA	neg	-		-
TOTAL	62	62	85	-
TOTAL EXCLUDING INTERNAL TRADE	45			

TABLE C.18. TEREPHTALIC ACID (TPA) INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	41	neg	-	-
OTHER W. EUROPE	8	-	-	-
EASTERN EUROPE	14	-	-	-
U.S.A.	-	-	-	-
CANADA	6	1	-	-
JAPAN	-	-	-	-
LATIN AMERICA	15	-		-
OTHER ASIA/OCEANIA	4	-	24	-
AFRICA	-	-		-
TOTAL	88	1	24	-
TOTAL EXCLUDING INTERNAL TRADE	47			

TABLE C.19. DODECYLBENZENE (DDB), INCL. LINEAR, INTERNATIONAL TRADE, 1973 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	50	7	3	20 (1)
OTHER W. EUROPE	30	1	-	-
EASTERN EUROPE	8	-	-	-
U.S.A.	4	-	-	-
CANADA	-	4	-	-
JAPAN	-	-	-	-
LATIN AMERICA	20	34		-
OTHER ASIA/OCEANIA	23	23	n.a.	-
AFRICA	9	7		-
TOTAL	144	76	n.a.	20
TOTAL EXCLUDING INTERNAL TRADE	90			

(1) Other W. Europe : 20

TABLE C.20. ALKYLBENZENE, EXCL. DDB, INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	25	2	-	1
OTHER W. EUROPE	3	-	-	-
EASTERN EUROPE	1	-	-	-
U.S.A.	-	-	-	-
CANADA	-	15	-	-
JAPAN	-	neg	-	-
LATIN AMERICA	-	4	-	-
OTHER ASIA/OCEANIA	3	5	n.a.	-
AFRICA	-	1	-	-
TOTAL	32	27	n.a.	1
TOTAL EXCLUDING INTERNAL TRADE	7			

TABLE C.21. POLYVINYL CHLORIDE (PVC) INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	712	13	1	11 (1)
OTHER W. EUROPE	112	neg	neg	n.a.
EASTERN EUROPE	96	-	-	n.a.
U.S.A.	18	-	2	11 (2)
CANADA	6	22	-	n.a.
JAPAN	24	2	-	-
LATIN AMERICA	37	19		n.a.
OTHER ASIA/OCEANIA	94	15	148	n.a.
AFRICA	74	neg		n.a.
TOTAL	1 173	71	151	n.a.
TOTAL EXCLUDING INTERNAL TRADE	461			

(1) About 50 % W. Europe, 50 % Eastern Europe (2) Mainly other W.Europe and Canada

TABLE C.22. HIGH-DENSITY POLYETHYLENE (HDPE) INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	240	11	6	5
OTHER W. EUROPE	141	13	-	n.a.
EASTERN EUROPE	49	2	-	n.a.
U.S.A.	1	-	-	-
CANADA	3	20	-	-
JAPAN	2	2	-	-
LATIN AMERICA	37	48		-
OTHER ASIA/OCEANIA	47	31	144	-
AFRICA	40	-		-
TOTAL	560	127	150	n.a.
TOTAL EXCLUDING INTERNAL TRADE	320			

TABLE C.23. LOW-DENSITY POLYETHYLENE (LDPE) INTERNATIONAL TRADE, 1973 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	864	13	-	12 (1)
OTHER W. EUROPE	351	9	-	n.a.
EASTERN EUROPE	50	-	-	n.a.
U.S.A.	1	-	-	-
CANADA	neg	50	-	n.a.
JAPAN	4	6	-	-
LATIN AMERICA	52	53	}	n.a.
OTHER ASIA/OCEANIA	105	91	} 233	n.a.
AFRICA	79	2	}	n.a.
TOTAL	1 506	224	233	n.a.
TOTAL EXCLUDING INTERNAL TRADE	642			

(1) About 50 % other W.Europe, 50 % Eastern Europe.

TABLE C.24. POLYPROPYLENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	52	21	3	2
OTHER W. EUROPE	33	9	-	-
EASTERN EUROPE	18	-	-	-
U.S.A.	1	-	4	2
CANADA	-	38	-	-
JAPAN	neg	6	-	-
LATIN AMERICA	13	31	} 127	-
OTHER ASIA/OCEANIA	23	36		-
AFRICA	10	1		-
TOTAL	150	142	134	4
TOTAL EXCLUDING INTERNAL TRADE	98			

TABLE C.25. TOTAL THERMOPLASTICS/THERMOSETTINGS INTERNATIONAL TRADE, 1973 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	3 727	146	90	112 (1)
OTHER W. EUROPE	1 150	46	10	32 (2)
EASTERN EUROPE	397	3	40	67 (3)
U.S.A.	51	-	49	22 (4)
CANADA	21	222	7	5
JAPAN	46	56	-	2
LATIN AMERICA	206	205	57	7
OTHER ASIA/OCEANIA	319	236	710	49 (5)
AFRICA	294	11	30	20 (6)
TOTAL	6 211	925	993	316
TOTAL EXCLUDING INTERNAL TRADE	2 484			

(1) About 50 % from non-EEC Western Europe, 45 % from Eastern Europe
(2) From E. Europe
(3) From other W.Europe
(4) Mainly Canada
(5) Mainly O.W.Europe
(6) Mainly from O.W.Europe

TABLE C.26. POLYSTYRENE INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	341	2	neg	7
OTHER W. EUROPE	52	2	-	n.a.
EASTERN EUROPE	31	-	-	n.a.
U.S.A.	1	-	16	7
CANADA	neg	14	-	n.a.
JAPAN	2	11	-	-
LATIN AMERICA	7	11		n.a.
OTHER ASIA/OCEANIA	31	52	40 (Other Asia/Oceania and Africa combined)	n.a.
AFRICA	4	1		n.a.
TOTAL	469	93	56	n.a.
TOTAL EXCLUDING INTERNAL TRADE	128			

TABLE C.27. ACRYLIC FIBRES INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	109	10	neg	5
OTHER W. EUROPE	56	3	-	n.a.
EASTERN EUROPE	24	neg	-	n.a.
U.S.A.	26	-	6	-
CANADA	1	15	-	-
JAPAN	-	-	-	-
LATIN AMERICA	4	6		-
OTHER ASIA/OCEANIA	35	9	n.a.	n.a.
AFRICA	13	1		n.a.
TOTAL	268	44	n.a.	n.a.
TOTAL EXCLUDING INTERNAL TRADE	159			

TABLE C.28. POLYAMIDE FIBRES AND YARNS INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	358	23	neg	7
OTHER W. EUROPE	59	1	-	n.a.
EASTERN EUROPE	50	-	-	n.a.
U.S.A.	19	-	10	2
CANADA	3	20	-	-
JAPAN	2	3	-	-
LATIN AMERICA	6	4	}	-
OTHER ASIA/OCEANIA	60	10	} n.a.	n.a.
AFRICA	22	-	}	n.a.
TOTAL	579	61	n.a.	n.a.
TOTAL EXCLUDING INTERNAL TRADE	221			

TABLE C.29. POLYESTER FIBRES AND YARNS INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	191	6	neg	5
OTHER W. EUROPE	30	1	-	n.a.
EASTERN EUROPE	14	-	-	n.a.
U.S.A.	25	-	-	3
CANADA	4	13	-	-
JAPAN	-	1	-	-
LATIN AMERICA	3	5	}	-
OTHER ASIA/OCEANIA	22	32	} n.a.	n.a.
AFRICA	8	2	}	n.a.
TOTAL	297	60	n.a.	n.a.
TOTAL EXCLUDING INTERNAL TRADE	106			

TABLE C.30. TOTAL SYNTHETIC FIBRES INTERNATIONAL TRADE, 1973 *

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	719	46	1	17
OTHER W. EUROPE	166	5	-	1
EASTERN EUROPE	109	1	2	11
U.S.A.	91	-	20	9
CANADA	11	53	-	-
JAPAN	2	4	-	6
LATIN AMERICA	24	15		-
OTHER ASIA/OCEANIA	140	53	398 (Latin America, Other Asia/Oceania and Africa together)	7
AFRICA	48	4		1
TOTAL	1 310	181	421	52
TOTAL EXCLUDING INTERNAL TRADE	591			

* Including polyamide, polyester, acrylic, olefinic, chlorofibres and other synthetic fibres and yarns.

TABLE C.31. POLYBUTADIENE RUBBER INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	57	2	4	neg
OTHER W. EUROPE	12	neg	-	-
EASTERN EUROPE	2	-	-	-
U.S.A.	1	-	neg	-
CANADA	1	2	-	-
JAPAN	-	1	-	-
LATIN AMERICA	4	neg		-
OTHER ASIA/OCEANIA	2	-	64	-
AFRICA	5	neg		-
TOTAL	84	5	68	-
TOTAL EXCLUDING INTERNAL TRADE	27			

TABLE C.32. STYRENE - BUTADIENE RUBBER AND LATEX (SBR) INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	287	31	22	46 (1)
OTHER W. EUROPE	97	1	-	n.a.
EASTERN EUROPE	15	-	-	-
U.S.A.	5	-	neg	n.a.
CANADA	1	38	-	-
JAPAN	-	3	-	1
LATIN AMERICA	4	12		n.a.
OTHER ASIA/OCEANIA	14	12	134	n.a.
AFRICA	7	1		-
TOTAL	430	98	156	n.a.
TOTAL EXCLUDING INTERNAL TRADE	143			

(1) Eastern Europe : 36

TABLE C.33. SYNTHETIC RUBBER AND LATICES INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	636	97	38	69 (1)
OTHER W. EUROPE	148	8	14	25 (2)
EASTERN EUROPE	34	-	4	-
U.S.A.	9	-	43	64 (3)
CANADA	2	64	9	
JAPAN	2	15	-	4
LATIN AMERICA	18	56	21	15 (4)
OTHER ASIA/OCEANIA	21	34	131	14 (4)
AFRICA	17	5	8	-
TOTAL	887	279	268	191
TOTAL EXCLUDING INTERNAL TRADE	251			

(1) Eastern Europe : 40 (2) Mostly Eastern Europe (3) Mainly Canada (4) From Canada

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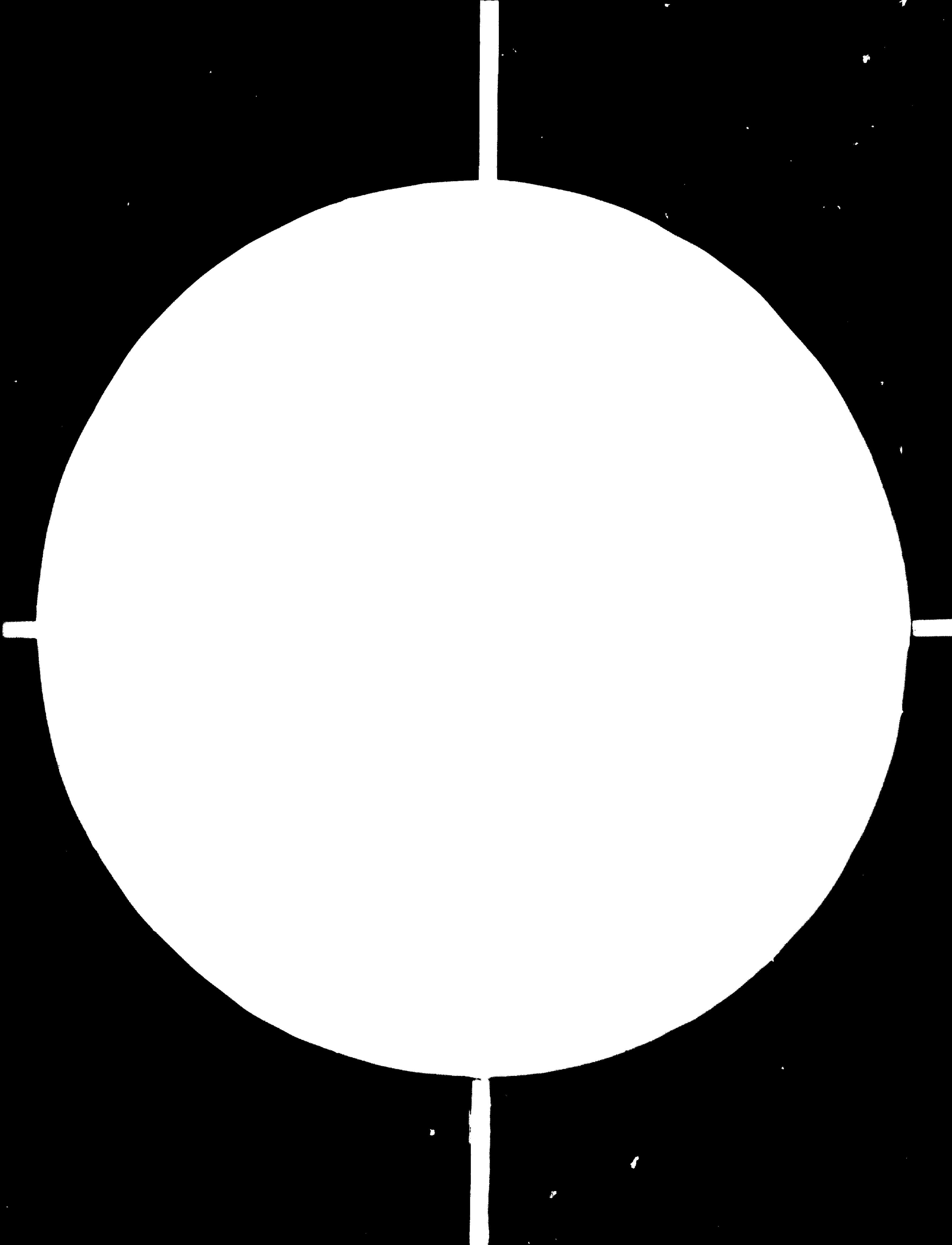

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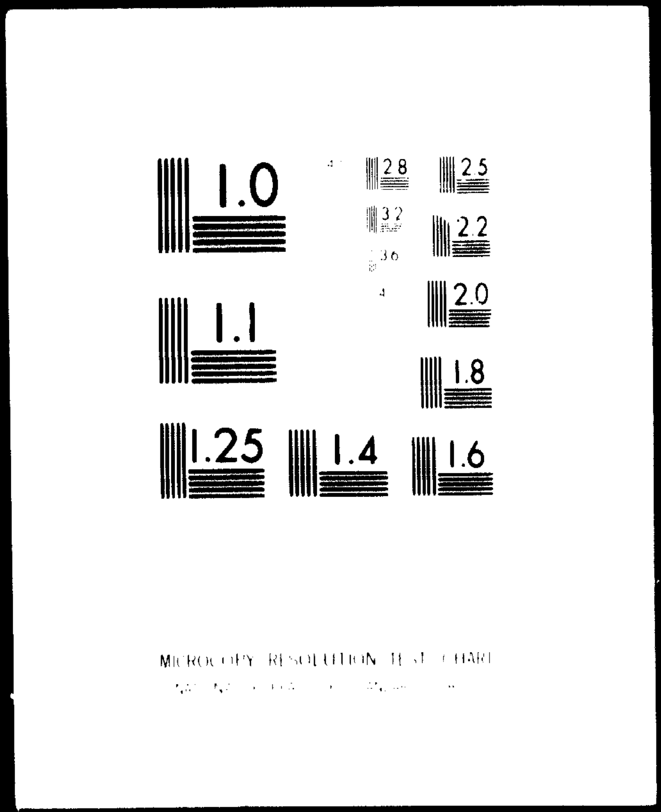

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TABLE C.34. ANIONIC ORGANIC DETERGENTS INTERNATIONAL TRADE, 1973

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	83	6	-	1
OTHER W. EUROPE	25	1	-	-
EASTERN EUROPE	13	-	-	-
U.S.A.	1	-	-	-
CANADA	neg	5	-	-
JAPAN	3	4	-	-
LATIN AMERICA	4	3	-	-
OTHER ASIA/OCEANIA	9	2	n.a.	-
AFRICA	3	neg	-	-
TOTAL	141	21	n.a.	1
TOTAL EXCLUDING INTERNAL TRADE	58			

TABLE C.35. NON-IONIC ORGANIC DETERGENTS INTERNATIONAL TRADE, 1973 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	37	10	neg	3
OTHER W. EUROPE	14	1	-	-
EASTERN EUROPE	8	neg	-	-
U.S.A.	1	-	-	-
CANADA	neg	6	-	-
JAPAN	1	2	-	-
LATIN AMERICA	10	3	-	-
OTHER ASIA/OCEANIA	10	3	n.a.	-
AFRICA	5	1	-	-
TOTAL	86	26	n.a.	3
TOTAL EXCLUDING INTERNAL TRADE	49			

TABLE C.36. CATIONIC ORGANIC DETERGENTS INTERNATIONAL TRADE, 1973

Figures in 1 000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	10	4	-	1
OTHER W. EUROPE	2	neg	-	-
EASTERN EUROPE	1	-	-	-
U.S.A.	neg	-	-	-
CANADA	neg	2	-	-
JAPAN	-	1	-	-
LATIN AMERICA	1	1	-	-
OTHER ASIA/OCEANIA	1	neg	n.a.	-
AFRICA	1	-	-	-
TOTAL	16	8	n.a.	1
TOTAL EXCLUDING INTERNAL TRADE	6			

TABLE C.37. TOTAL SYNTHETIC ORGANIC DETERGENTS AND WASHING PREPARATIONS INTERNATIONAL TRADE, 1973 **Figures in 1000 t**

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	384	39	-	17 (1)
OTHER W. EUROPE	70	5	1	1
EASTERN EUROPE	51	1	-	6
U.S.A.	3	–	-	18 (2)
CANADA	1	48	-	-
JAPAN	5	12	-	-
LATIN AMERICA	22	25	-	4
OTHER ASIA/OCEANIA	32	17	42	5
AFRICA	27	3	-	3
TOTAL	595	150	43	54
TOTAL EXCLUDING INTERNAL TRADE	211			

(1) Other W. Europe : 17

(2) Canada : 16

TABLE C.38. ETHYLENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	633	1	-	16
OTHER W. EUROPE	98	-	-	-
EASTERN EUROPE	10	-	-	-
U.S.A.	-	-	-	10 (1)
CANADA	-	neg	-	-
JAPAN	-	-	-	-
LATIN AMERICA	-	-	-	-
OTHER ASIA/OCEANIA	12	-	-	-
AFRICA	1	-	-	-
TOTAL	754	1	-	26
TOTAL EXCLUDING INTERNAL TRADE	121			

(1) Canada

TABLE C.39. PROPYLENE INTERNATIONAL TRADE, 1975

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	452	-	-	44
OTHER W. EUROPE	39	-	-	-
EASTERN EUROPE	19	-	-	-
U.S.A.	58	-	-	-
CANADA	-	neg	-	25 (1)
JAPAN	5	-	-	-
LATIN AMERICA	-	7	-	-
OTHER ASIA/OCEANIA	10	-	30	-
AFRICA	-	-	-	-
TOTAL	583	7	30	69
TOTAL EXCLUDING INTERNAL TRADE	131			

(1) Canada

TABLE C.40. UNSATURATED C4'S INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	214	6	-	-
OTHER W. EUROPE	9	-	-	-
EASTERN EUROPE	55	-	-	-
U.S.A.	159	-	68	32 (1)
CANADA	-	14	-	-
JAPAN	-	-	-	-
LATIN AMERICA	4	23	-	-
OTHER ASIA/OCEANIA	-	1	n.a.	-
AFRICA	-	-	-	-
TOTAL	441	44	n.a.	32
TOTAL EXCLUDING INTERNAL TRADE	227			

(1) From Canada

TABLE C.41. BENZENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	555	72	33	245 (1)
OTHER W. EUROPE	5	-	-	-
EASTERN EUROPE	24	-	-	-
U.S.A.	68	-	33	101 (2)
CANADA	-	60	-	-
JAPAN	-	-	-	-
LATIN AMERICA	-	-	-	-
OTHER ASIA/OCEANIA	15	3	68	-
AFRICA	-	-	-	-
TOTAL	668	135	134	346
TOTAL EXCLUDING INTERNAL TRADE	113			

(1) Eastern Europe : about 180
(2) Canada : 56 ; Latin America : 38

TABLE C.42. TOLUENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	156	292	-	183 (1)
OTHER W. EUROPE	42	2	-	1
EASTERN EUROPE	2	neg	-	-
U.S.A.	7	-	33	25 (2)
CANADA	-	neg	-	-
JAPAN	-	-	-	-
LATIN AMERICA	-	21	-	-
OTHER ASIA/OCEANIA	7	10	27	-
AFRICA	7	8	-	-
TOTAL	221	333	60	209
TOTAL EXCLUDING INTERNAL TRADE	65			

(1) Eastern Europe : 134 ; Latin America : 47 ;

(2) Canada :23 ;

TABLE C.43. O.XYLENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	173	89	-	18 (1)
OTHER W. EUROPE	14	1	-	-
EASTERN EUROPE	12	-	-	-
U.S.A.	7	-	-	-
CANADA	-	neg	-	-
JAPAN	3	6	-	-
LATIN AMERICA	1	21	n.a.	-
OTHER ASIA/OCEANIA	-	3	n.a.	-
AFRICA	-	3	-	-
TOTAL	210	123	n.a.	18
TOTAL EXCLUDING INTERNAL TRADE	37			

(1) Eastern Europe : 18

TABLE C.44 P.XYLENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	198	57	-	29 (1)
OTHER W. EUROPE	-	-	-	-
EASTERN EUROPE	3	-	-	-
U.S.A.	22	-	-	-
CANADA	-	-	-	-
JAPAN	4	50	-	10 (2)
LATIN AMERICA	-	2	n.a.	-
OTHER ASIA/OCEANIA	-	2	n.a.	-
AFRICA	-	-	-	-
TOTAL	227	111	n.a.	39
TOTAL EXCLUDING INTERNAL TRADE	29			

(1) Other Western Europe : 16 ; Eastern Europe : 13

(2) Mainly other Asia/Oceania.

TABLE C.45. MIXED XYLENES INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	68	161	-	42 (1)
OTHER W. EUROPE	6	-	-	6
EASTERN EUROPE	9	-	-	-
U.S.A.	4	-	-	-
CANADA	-	2	-	-
JAPAN	-	40	-	35
LATIN AMERICA	-	15	}	-
OTHER ASIA/OCEANIA	4	4	52	-
AFRICA	1	4	}	-
TOTAL	92	226	52 *	83
TOTAL EXCLUDING INTERNAL TRADE	24			

(1) Eastern Europe : 32 ;

* Total xylenes

TABLE C.46. METHANOL INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	232	44	5	71 (1)
OTHER W. EUROPE	156	26	-	-
EASTERN EUROPE	13	-	-	-
U.S.A.	6	-	-	6
CANADA	-	18	-	-
JAPAN	25	58	-	-
LATIN AMERICA	-	38	-	-
OTHER ASIA/OCEANIA	36	12	3	-
AFRICA	6	10	-	-
TOTAL	474	206	8	77
TOTAL EXCLUDING INTERNAL TRADE	242			

(1) Eastern Europe : 41 ; Other Asia/Oceania : 27

TABLE C.47. VINYL CHLORIDE MONOMER (VCM) INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	178	3	-	1
OTHER W. EUROPE	77	31	-	n.a.
EASTERN EUROPE	39	16	-	n.a.
U.S.A.	-	-	-	-
CANADA	-	-	-	-
JAPAN	-	-	-	-
LATIN AMERICA	7	92	-	-
OTHER ASIA/OCEANIA	15	45	64	-
AFRICA	2	-	-	-
TOTAL	318	187	64	n.a.
TOTAL EXCLUDING INTERNAL TRADE	140			

TABLE C.48. STYRENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	374	169	12	4
OTHER W. EUROPE	76	4	-	-
EASTERN EUROPE	19	-	-	-
U.S.A.	-	-	-	-
CANADA	-	1	-	-
JAPAN	-	-	-	-
LATIN AMERICA	4	71	-	-
OTHER ASIA/OCEANIA	3	12	59	-
AFRICA	-	1	2	-
TOTAL	476	258	73	4
TOTAL EXCLUDING INTERNAL TRADE	102			

TABLE C.49. ACRYLONITRILE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	88	27	10	4
OTHER W. EUROPE	7	-	-	-
EASTERN EUROPE	2	-	-	-
U.S.A.	-	-	-	-
CANADA	-	16	-	-
JAPAN	-	4	-	-
LATIN AMERICA	-	30	-	-
OTHER ASIA/OCEANIA	4	11	70	-
AFRICA	-	-	-	-
TOTAL	101	88	80	4
TOTAL EXCLUDING INTERNAL TRADE	13			

TABLE C.50. CYCLOHEXANE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	141	112	-	47 (1)
OTHER W. EUROPE	neg	-	-	-
EASTERN EUROPE	-	-	-	-
U.S.A.	-	-	-	-
CANADA	7	7	-	-
JAPAN	3	-	-	-
LATIN AMERICA	-	8	n.a.	-
OTHER ASIA/OCEANIA	1	-		-
AFRICA	-	-		-
TOTAL	152	127	n.a.	47
TOTAL EXCLUDING INTERNAL TRADE	11			

(1) Eastern Europe : 18 ; Latin America : 18 ; Other W. Europe : 11

TABLE C.51. CAPROLACTAM INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	80	1	1	5
OTHER W. EUROPE	10	-	-	2
EASTERN EUROPE	5	-	-	-
U.S.A.	neg	-	-	-
CANADA	-	6	-	-
JAPAN	neg	-	-	1
LATIN AMERICA	17	3	3	-
OTHER ASIA/OCEANIA	26	7	128	-
AFRICA	-	-	-	-
TOTAL	138	17	132	8
TOTAL EXCLUDING INTERNAL TRADE	58			

TABLE C.52. ADIPIC ACID INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	21	-	-	-
OTHER W. EUROPE	2	-	-	-
EASTERN EUROPE	2	-	-	-
U.S.A.	-	-	-	-
CANADA	neg	2	-	-
JAPAN	-	1	-	-
LATIN AMERICA	-	neg	-	-
OTHER ASIA/OCEANIA	-	neg	-	-
AFRICA	-	-	-	-
TOTAL	25	3	-	-
TOTAL EXCLUDING INTERNAL TRADE	4			

TABLE C.53. HEXAMETHYLENEDIAMINE (HMDA) INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	150	9	-	-
OTHER W. EUROPE	neg	-	-	-
EASTERN EUROPE	1	-	-	-
U.S.A.	-	-	-	-
CANADA	-	-	-	-
JAPAN	-	1	-	-
LATIN AMERICA	-	3	-	-
OTHER ASIA/OCEANIA	-	neg	-	-
AFRICA	-	-	-	-
TOTAL	151	13	-	-
TOTAL EXCLUDING INTERNAL TRADE	1			

TABLE C.54. DIMETHYL TEREPHTALATE (DMT) INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	35	3	-	-
OTHER W. EUROPE	14	1	-	-
EASTERN EUROPE	19	neg	-	-
U.S.A.	-	-	-	-
CANADA	-	8	-	-
JAPAN	-	1	-	-
LATIN AMERICA	1	55		-
OTHER ASIA/OCEANIA	1	25	142	-
AFRICA	-	-		-
TOTAL	70	93	142	-
TOTAL EXCLUDING INTERNAL TRADE	35			

TABLE C.55. TEREPHTALIC ACID (TPA) INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	16	1	1	-
OTHER W. EUROPE	8	-	-	-
EASTERN EUROPE	-	-	-	-
U.S.A.	4	-	-	-
CANADA	-	1	-	-
JAPAN	2	neg	-	-
LATIN AMERICA	30	-	}	-
OTHER ASIA/OCEANIA	45	-	} 64	-
AFRICA	-	-	}	-
TOTAL	105	2	65	-
TOTAL EXCLUDING INTERNAL TRADE	89	-	-	-

TABLE C.56. DODECYLBENZENE (DDB) INCL. LINEAR, INTERNATIONAL TRADE, 1975 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	49	11	-	19 (1)
OTHER W. EUROPE	18	2	-	-
EASTERN EUROPE	8	-	-	-
U.S.A.	-	-	-	-
CANADA	-	8	-	-
JAPAN	1	2	-	-
LATIN AMERICA	20	32	-	-
OTHER ASIA/OCEANIA	29	25	n.a.	-
AFRICA	15	6	-	-
TOTAL	140	86	n.a.	19
TOTAL EXCLUDING INTERNAL TRADE	91			

(1) Other Western Europe : 19

TABLE C.57. ALKYLBENZENES, EXCL. DDB, INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	28	3	-	1
OTHER W. EUROPE	2	1	-	-
EASTERN EUROPE	3	-	-	-
U.S.A.	-	-	-	-
CANADA	neg	10	-	-
JAPAN	-	-	-	-
LATIN AMERICA	-	-	-	-
OTHER ASIA/OCEANIA	4	-	n.a.	-
AFRICA	1	-	-	-
TOTAL	38	14	n.a.	1
TOTAL EXCLUDING INTERNAL TRADE	10			

TABLE C.58. POLYVINYLCHLORIDE (PVC) INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	632	10	-	47 (1)
OTHER W. EUROPE	100	2	-	n.a.
EASTERN EUROPE	78	1	-	n.a.
U.S.A.	5	-	3	5
CANADA	2	22	-	-
JAPAN	-	1	-	-
LATIN AMERICA	36	29	-	n.a.
OTHER ASIA/OCEANIA	66	11	128	n.a.
AFRICA	77	2	-	n.a.
TOTAL	996	78	131	n.a.
TOTAL EXCLUDING INTERNAL TRADE	364			

(1) Other Western Europe : 36 ; Eastern Europe : 11

TABLE C.59. HIGH-DENSITY POLYETHYLENE (HDPE) INTERNATIONAL TRADE, 1975 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	191	13	3	15 (1)
OTHER W. EUROPE	119	9	-	n.a.
EASTERN EUROPE	36	1	-	n.a.
U.S.A.	3	-	-	-
CANADA	3	15	-	-
JAPAN	-	neg	-	-
LATIN AMERICA	29	42	-	n.a.
OTHER ASIA/OCEANIA	34	13	137	n.a.
AFRICA	30	neg	-	n.a.
TOTAL	445	93	140	n.a.
TOTAL EXCLUDING INTERNAL TRADE	254			

(1) Other Western Europe : 13.

TABLE C.60. LOW-DENSITY POLYETHYLENE (LDPE) INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	789	24	2	65 (1)
OTHER W. EUROPE	253	2	-	n.a.
EASTERN EUROPE	94	neg	5	n.a.
U.S.A.	3	-	-	-
CANADA	5	29	-	-
JAPAN	70	1	10	n.a.
LATIN AMERICA	-	36	-	-
OTHER ASIA/OCEANIA	72	28	256	n.a.
AFRICA	66	1	-	n.a.
TOTAL	1 352	121	273	n.a.
TOTAL EXCLUDING INTERNAL TRADE	563			

(1) Other W.Europe : 57 ; Eastern Europe : 7

TABLE C.61. POLYPROPYLENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	95	24	5	7
OTHER W. EUROPE	35	10	-	n.a.
EASTERN EUROPE	26	neg	-	n.a.
U.S.A.	1	-	-	-
CANADA	1	48	-	-
JAPAN	neg	neg	-	-
LATIN AMERICA	32	42	-	n.a.
OTHER ASIA/OCEANIA	38	11	149	n.a.
AFRICA	9	neg	-	n.a.
TOTAL	237	135	154	n.a.
TOTAL EXCLUDING INTERNAL TRADE	142			

TABLE C.62. POLYSTYRENE INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	466	6	1	7
OTHER W. EUROPE	78	1	-	n.a.
EASTERN EUROPE	40	-	-	n.a.
U.S.A.	7	-	4	4
CANADA	-	11	-	-
JAPAN	neg	1	-	-
LATIN AMERICA	4	6	-	n.a.
OTHER ASIA/OCEANIA	38	26	61	n.a.
AFRICA	7	-	3	n.a.
TOTAL	640	51	69	n.a.
TOTAL EXCLUDING INTERNAL TRADE	174			

TABLE C.63. TOTAL THERMOPLASTICS/THERMOSETTINGS INTERNATIONAL TRADE, 1975* Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	3 673	184	39	256 (1)
OTHER W. EUROPE	953	33	-	n.a.
EASTERN EUROPE	425	6	5	n.a.
U.S.A.	28	-	22	19 (2)
CANADA	22	216	-	-
JAPAN	5	25	-	-
LATIN AMERICA	212	236	10	n.a.
OTHER ASIA/OCEANIA	390	128	895	n.a.
AFRICA	300	6	3	n.a.
TOTAL	6 008	834	974	n.a.
TOTAL EXCLUDING INTERNAL TRADE	2 335			

(1) Other W.Europe : 198 ; Eastern Europe : 54 (2) Canada : 10

* Including ion-exchange resins, polyamide, melamine-formaldehyde, urea-formaldehyde, phenolic, phenolic molding compounds, polyester, alkyd, silicone, epoxy, SAN, ABS, other styrene copolymers, PVA, acrylic and other polymer and copolymer resins

TABLE C.64. ACRYLIC FIBRES INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	113	7	1	3
OTHER W. EUROPE	49	2	-	n.a.
EASTERN EUROPE	55	neg	-	n.a.
U.S.A.	5	-	2	neg
CANADA	2	10	-	-
JAPAN	neg	-	-	-
LATIN AMERICA	20	7		-
OTHER ASIA/OCEANIA	35	7	n.a.	n.a.
AFRICA	16	1		n.a.
TOTAL	295	34	n.a.	n.a.
TOTAL EXCLUDING INTERNAL TRADE	182			

TABLE C.65. POLYAMIDE FIBRES AND YARNS INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	181	24	3	22 (1)
OTHER W. EUROPE	40	1	-	n.a.
EASTERN EUROPE	30	neg	-	n.a.
U.S.A.	13	-	12	1
CANADA	2	12	-	-
JAPAN	-	2	-	-
LATIN AMERICA	2	6		-
OTHER ASIA/OCEANIA	30	6	n.a.	n.a.
AFRICA	17	neg		n.a.
TOTAL	315	51	n.a.	n.a.
TOTAL EXCLUDING INTERNAL TRADE	134			

(1) Other Western Europe : 18

TABLE C.66. POLYESTER FIBRES AND YARNS INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	259	6	1	15 (1)
OTHER W. EUROPE	60	neg	-	n.a.
EASTERN EUROPE	40	-	-	n.a.
U.S.A.	12	-	3	2
CANADA	2	13	-	-
JAPAN	1	neg	-	-
LATIN AMERICA	5	10		-
OTHER ASIA/OCEANIA	25	21	n.a.	n.a.
AFRICA	16	1		n.a.
TOTAL	420	51	n.a.	n.a.
TOTAL EXCLUDING INTERNAL TRADE	161			

(1) Other Western Europe : 11.

TABLE C.67. TOTAL SYNTHETIC FIBRES INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	520	44	5	41 (1)
OTHER W. EUROPE	200	4	-	n.a.
EASTERN EUROPE	122	1	-	n.a.
U.S.A.	30	-	17	6
CANADA	14	40	-	-
JAPAN	1	3	-	-
LATIN AMERICA	20	23	}	-
OTHER ASIA/OCEANIA	105	35	} 400	n.a.
AFRICA	38	3	}	n.a.
TOTAL	1 050	153	422	n.a.
TOTAL EXCLUDING INTERNAL TRADE	530			

(1) Other Western Europe : 32 ;

\# including polyamide, polyester, acrylic, olefinic, chlorofibres, and other synthetic fibres and yarns.

TABLE C.68. POLYBUTADIENE RUBBER INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	56	5	6	-
OTHER W. EUROPE	14	1	2	-
EASTERN EUROPE	5	-	3	-
U.S.A.	1	-	neg	-
CANADA	3	3	-	-
JAPAN	-	-	-	-
LATIN AMERICA	6	2	4	-
OTHER ASIA/OCEANIA	3	neg	10	-
AFRICA	6	neg	-	-
TOTAL	94	11	25	-
TOTAL EXCLUDING INTERNAL TRADE	38			

TABLE C.69. STYRENE - BUTADIENE RUBBER AND LATEX (SBR) INTERNATIONAL TRADE, 1975 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	298	16	25	39 (1)
OTHER W. EUROPE	78	1	8	n.a.
EASTERN EUROPE	16	neg	8	n.a.
U.S.A.	neg	-	-	-
CANADA	-	34	-	-
JAPAN	1	neg	-	-
LATIN AMERICA	2	12	5	-
OTHER ASIA/OCEANIA	6	3	75	n.a.
AFRICA	4	1	2	-
TOTAL	405	67	123	n.a.
TOTAL EXCLUDING INTERNAL TRADE	107			

(1) Eastern Europe : 28 ; Canada : 9

TABLE C.70. TOTAL SYNTHETIC RUBBER AND LATICES INTERNATIONAL TRADE, 1975* Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	588	75	45	54 (1)
OTHER W. EUROPE	117	14	13	50 (2)
EASTERN EUROPE	51	neg	16	-
U.S.A.	24	-	18	52 (3)
CANADA	3	59	3	-
JAPAN	2	5	-	-
LATIN AMERICA	18	49	21	-
OTHER ASIA/OCEANIA	14	12	92	5
AFRICA	16	6	2	-
TOTAL	833	220	210	161
TOTAL EXCLUDING INTERNAL TRADE	245			

(1) Eastern Europe : 34 ; Canada : 13 (2) Mainly Eastern Europe (3) Canada : 52

* Including SBR, PB, butyl rubber, N-type rubber, polyisoprene, ethylene-propylene rubber, and other rubbers and latices.

TABLE C.71. ANIONIC ORGANIC DETERGENTS INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	65	6	-	2
OTHER W. EUROPE	26	neg	-	-
EASTERN EUROPE	19	-	-	-
U.S.A.	1	-	-	-
CANADA	1	5	-	-
JAPAN	2	1	-	-
LATIN AMERICA	5	3	-	-
OTHER ASIA/OCEANIA	11	1	n.a.	-
AFRICA	6	neg	-	-
TOTAL	136	16	n.a.	2
TOTAL EXCLUDING INTERNAL TRADE	71			

TABLE C.72. NON-IONIC ORGANIC DETERGENTS INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	41	4	-	5
OTHER W. EUROPE	13	1	-	-
EASTERN EUROPE	14	neg	-	-
U.S.A.	3	-	-	-
CANADA	neg	5	-	-
JAPAN	neg	1	-	-
LATIN AMERICA	5	2	-	-
OTHER ASIA/OCEANIA	4	1	n.a.	-
AFRICA	3	neg	-	-
TOTAL	83	14	n.a.	5
TOTAL EXCLUDING INTERNAL TRADE	42			

TABLE C.73. CATIONIC ORGANIC DETERGENTS INTERNATIONAL TRADE, 1975

Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	6	3	-	1
OTHER W. EUROPE	1	neg	-	-
EASTERN EUROPE	neg	-	-	-
U.S.A.	-	-	-	-
CANADA	-	3	-	-
JAPAN	-	neg	-	-
LATIN AMERICA	-	1	-	-
OTHER ASIA/OCEANIA	neg	neg	n.a.	-
AFRICA	neg	-	-	-
TOTAL	7	7	n.a.	1
TOTAL EXCLUDING INTERNAL TRADE	1			

TABLE C.74. TOTAL SYNTHETIC ORGANIC DETERGENTS AND WASHING PREPARATIONS INTERNATIONAL TRADE, 1975 Figures in 1000 t

FROM	E.E.C.	U.S.A.	JAPAN	OTHER COUNTRIES
TO				
E.E.C.	490	34	-	45 (1)
OTHER W. EUROPE	159	2	-	n.a.
EASTERN EUROPE	84	1	-	n.a.
U.S.A.	5	-	3	17 (2)
CANADA	2	53	-	-
JAPAN	4	14	-	-
LATIN AMERICA	37	26	-	n.a.
OTHER ASIA/OCEANIA	74	25	45	n.a.
AFRICA	64	2	-	n.a.
TOTAL	919	157	48	n.a.
TOTAL EXCLUDING INTERNAL TRADE	429			

(1) Other Western Europe : 45

(2) Canada : 14

PETROCHEMICAL TRADE, MAIN ASSUMPTIONS

CONCERNING TABLES 0.1. through 0.74.

THERMOPLASTICS/THERMOSETTINGS :

include ion-exchange resins, polyamide, melamine, formaldehyde, urea formaldehyde, phenolic and phenolic molding compounds, polyester, alkyd, silicone, epoxy, resins for adhesive and protective coatings, SAN, ABS, other styrene copolymers, PVA, acrylic and other polymer and copolymer resins.

SYNTHETIC FIBRES :

include polyamide, polyester, olefinic, acrylic, chlorofibres and other synthetic fibres and yarns.

SYNTHETIC ELASTOMERS :

include styrene-butadiene (rubber and latex), polybutadiene rubber, butyl rubber, polyisoprene rubber, nitrile rubber, ethylene-propylene rubber and other rubbers.

Appendix D

MAJOR TRENDS IN SECTORAL DEMAND FOR FINAL PRODUCTS

Plastics

General

The necessity for the plastics industry to develop its own processing techniques undoubtedly slowed down expansion in the initial phase corresponding to the first 10-15 years after the end of the Second World War.

As soon as the basic knowledge for injection moulding, extrusion and other specific processing possibilities had been developed, these new polymer materials with their self-created processing industry then expanded by means of substitution and innovation. In numerous cases, the diversity of new resins (including grades of large tonnage polymers) has meant new applications and vice versa.

The broad spectrum of conventional materials (such as metal, wood, ceramics, paper) offered the new-comer so many possibilities of substitution with new technologies, that all sectors concerned with plastics - including processing and machinery - enjoyed a period of extremely high growth from the middle of the fifties onwards. This expansion was also supported by the downward trend in plastics prices in real terms (up to 1973).

However, from the beginning of the seventies, it appeared that the period of constant growth - 15 per cent per annum on a worldwide scale - was coming to an end.

The slow-down in the expansion of the plastics market accelerated in the industrialized countries in 1974-1975, whereas other parts of the world showed a more favourable development in consumption (probably due to the large potential demand in those countries).

After the present period of making-up for the poor results registered in industrialized countries in 1974-1975, the future development of plastics has become more questionable in those countries. An inventory of the major outlets and trends in the plastic market would help to forecast the future of this sector.

As for developing countries, the development of markets and market structures to be observed in the more advanced countries offers, to a large extent, an indication of the demand for plastics.

Demand for plastics by sector

Despite the marked expansion of the demand for plastics registered over the two past decades, the penetration of these materials is still limited to sectors with large potential: construction and transportation.

In the United States, for example, with its relatively high level of demand, the construction of a new house requires only one ton of plastics, a small quantity when compared with the total volume of building materials needed for this construction. In the transportation sector, plastics account for a modest 3.5 per cent of materials used for the manufacture of a car, this percentage being close to that of aluminium (the current competitor of plastics in many applications).

On this basis, a further penetration of plastics in these two large areas of applications can still be expected as recently forecast for the transportation sector by International Research and Technology in a report to the Government. (See Table D1 below).

They estimated (conservatively) that the average car in 1980 will contain 6.7 per cent plastics and 6.3 per cent aluminium, and in 1990 9.2 per cent plastics and 11.9 per cent aluminium.

Mass production of car bodies has been under consideration for years but, contrary to expectations, no major developments have taken place.

The penetration of plastics into the medium-size market of packaging is generally deeper than for the above two sectors. In France, for instance, the volume of demand for plastics in this sector corresponds to about 15 per cent of that of paper and paper-board used in the same sector. In the United States market, this percentage is only 6 per cent. The above percentages depend to a large extent on relative prices and the availability of paper products. For the other sectors with a more limited potential (appliances and furniture) plastic materials have usually penetrated still deeper.

With respect to the United Statee market, the breakdown of the demand for plastics by major end-use sectors is as follows:

	1975	1976
	(Percentage)	
Packaging	43.0	42.0
Building and construction	33.0	35.0
Transportation	13.5	13.0
Furniture	6.5	6.0
Appliances	4.0	4.0

Tablee D1 through D6 below show the demand for individual plastics in the United States. For reasons of simplicity, only the large tonnage plastics dealt with in the preeent etudy have been presented in the tables. Theee have generally better prospects (in the developing countries as well) than many others such as thermosettings.

As shown in these tablee, large tonnage plaetics meet 93 per cent of the neede in packaging, 58 per cent in building, but only 28 per cent in transportation. The percentage amounts to 36 per cent in furniture and 59 per cent in applicances.

Demand for individual plastics

Structure of the demand for large tonnage plastics covered in the present study is indicated in Tables D7 through D11. All of them relate to Western Europe, but there are no large differences between the large consuming areas. At least, the trends are basically similar.

As can be seen from the tables, the changes in structure in the industrialized countriee are generally gradual, reflecting, to some extent, the maturation of the markete. As a general rule, there are one or two major outlets for these plastics, the share of the total remaining more or leee constant. For example, packaging film and sheeting in low-density polyethylene, and hollow articles or containers in high- density polyethylene.

More precisely, in the case of polyolefins (polyethylenss and polypropylene), generally the most promising class of large tonnage plastics, the future development of such plastics can bs seen as follows.

Low-density polyethylene (LDPE)

There is a definite trend towards ths production of plastic film. About two thirds of the total production are in the form of plastic film and sheets. A second production process is used to obtain various packaging materials such as bags, carrier-bags, and sacks.

The fast growing supply of pre-packed articles in supermarkets has rscently contributed greatly to the vast expansion of plastic film. However, this expansion is closely related to private consumption expenses. Apart from plastic films for packaging, considsrabls quantities of LDPE are used in the building, agriculture and horticulturs sectors.

In industrialized countries, all end-use areas are still growing at appreciable rates, and better than average growth is expectsd for garbage bags, agricultural films, pallet shrink wraps, stretoh film and other film paokaging uses.

In all other fields of applioation, ths oonsumption of LDPE has for some time been in favour of other thermoplastics (mainly high-density polyethylene and polypropylene).

High-density polyethylene (HDPE)

Blow-moulding has become the most dominant market for HDPE, following the development of all sorts of bottles of various sizes, cans, barrels and other large oontainers. The reoent signifioant progress in prooessing techniques has oontributed to this expansion.

In the large blow-moulding seotor, outstanding growth is seen for food and beverage containers. New processing technology oan unlook potential markets such as auto-fuel tanks and shipping material.

Injection-moulding applications are the second outlet for HDPE with the production of household articles (buckets, bowls, tanks, baskets) and various articles used in the packaging sector (boxes, containers, transportation and storage crates).

These injection-moulded articles, as well as pipes and profiles, have been continually losing their share in the total HDPE consumption or only just holding their position. As for the pipe sector, its share will increase in the future (large diameter pipes), while film is a modest but fast expanding market for HDPE. Whereas HDPE will continue to make future gains in paper and glass replacement, penetration of some traditionally secure HDPE markets by other plastics is expected (mainly polypropylene, but some others which have become competitive in specific end-use areas).

Polypropylene (PP)

Moulded parts for technical applications are still dominating the PP market. Polypropylene fibres have intruded heavily into the domain of jute, replacing jute fibres in carpet backing and shipping sacks. The trend towards a further increased share in fibre and film applications which was expected some years ago has been effectively realized (contrary to the situation observed in Japan which, however, has the most developed PP market).

For the future, higher market shares for fibres and related items, as well as for films and sheets, are foreseen in relation to their use in packaging.

Bottles, a modest polypropylene outlet, show great promise. As compared with other thermoplastics, market maturity of popypropylene is still a long way off. In addition, polypropylene now enjoys the advantage of being the lowest priced thermoplastic resin in the United States market. As for PVC and polystyrene, the salient features and trends of sectoral demand are as follows.

Polyvinyl chloride (PVC)

PVC applications usually fall into two categories:
Rigid PVC applications.
Soft PVC applications.

In the latter caee, PVC resins contain plastioizere (mainly phtalates) in various proportions: up to 50 per cent in a few oases.

The major outlet for rigid PVC is found in the manufacture of pipes and extruded profiles, mainly ueed in the building seotor. Other uses of rigid PVC include: film and sheets (paokaging sector), bottles (an applioation well developed in eome Weet European countries - France, for example). As a general rule, rigid uses have shown higher growth rates than flexible ones.

Flexible applicatione consiet of coated (leather-like) fabrics, film and sheets, flooring (tiles), wires and cablee. Shoes are etill an appreoiable outlet for flexible PVC in some developing countriee.

For the years to come, good growth is foreseen for rigid extrusion products, especially in the construction industry where pipe fittings already account for one third of produotion in the United States market. Flooring, window oomponent profiles, and siding are being promoted in the United States market as areas suitable for PVC applications. Applications in the automotive eector are expected to grow moderately as cars become smaller and competition from polyurethane for leather-like applications increases.

Some emaller end-uses, such ae recorde, apparel and sporting goods, are not expected to ehow signifioant growth.

In short, the predicted growth of the demand for PVC depends, to a large extent, on a development of the conetruction induetry tied to a healthy economy. A further penetration of PVC in thie seotor will certainly occur, since the PVC industry hae eolved many of the technioal and regulatory problems of recent years. On the other hand, aluminium is a severe competitor for rigid PVC in many applications of the building sector (eepecially profilee) as has already been seen in the caee of the automotive industry.

Polystyrene (PS)

Packaging is the main outlet and the most promising market for polystyrene. In this sector, polystyrene ie mainly used for the production of various oontainers. In this field, PS enjoys the properties of being rigid and capable of being processed into thin walle (for disposable wrapping).

TABLE D1

COMPOSITION OF MATERIALS IN AVERAGE AUTOMOBILE*

	1975	1980	1990
PLASTICS	3,5 %	6,7 %	9,2 %
ALUMINIUM	2,9	6,3	11,9
LOW-CARBON STEEL	55,2	50,4	46,3
HIGH-STRENGTH, LOW-ALLOY STEEL	6,0	8,5	7,9
CAST IRON	16,2	13,6	7,9

* Source : International Research and Technology

TABLE D2

PLASTICS IN PACKAGING

MATERIAL	1975	1976
	1000 metric tons	
COASTING (FOR PAPER, FILM, FOIL, METAL) :		
. POLYETHYLENE HIGH DENSITY	18	19
. POLYETHYLENE LOW DENSITY	184	214
. POLYPROPYLENE	3	4
. POLYVINYL ACETATE	17	18
. PVC	8	9
SUBTOTAL	230	264
OTHERS	75	77
TOTAL	305	341
CLOSURES :		
. POLYETHYLENE HIGH DENSITY	23	25
. POLYETHYLENE LOW DENSITY	9	10
. POLYPROPYLENE	25	35
. POLYSTYRENE	23	25
. PVC (GASKETS AND LINERS)	9	11
SUBTOTAL	89	106
OTHERS	10	12
TOTAL	99	118
CONTAINERS AND LIDS :		
. POLYETHYLENE HIGH DENSITY, BLOW MOLDED UP TO 2 GAL.	315	378
. POLYETHYLENE BLOW MOLDED 2 GAL. OR MORE	35	42
. POLYETHYLENE INJECTION MOLDED	90	93
. POLYETHYLENE THERMOFORMED	27	28
. POLYETHYLENE LOW DENSITY BLOW MOLDED	18	23
. POLYETHYLENE INJECTION MOLDED	70	72
. POLYPROPYLENE BLOW MOLDED	13	16
. POLYPROPYLENE EXTRUDED (DRINKING STRAWS)	13	14
. POLYPROPYLENE INJECTION MOLDED	25	34
. POLYPROPYLENE THERMOFORMED	7	10
. POLYSTYRENE BLOW MOLDED	12	14
. POLYSTYRENE MOLDED : CRYSTAL	52	55
FOAM	38	40
IMPACT	45	47
. POLYSTYRENE THERMOFORMED : FOAM	81	87
IMPACT	120	124
ORIENTED	68	70
OTHER	45	47
. ABS	16	18
. PVC : BLOW MOLDED	25	38
THERMOFORMED (INCL. BLISTER PACKS)	34	35
SUBTOTAL	1145	1261
OTHERS	60	86
TOTAL	1205	1347

TABLE D2 continued

MATERIAL	1975	1976
	1000 metric tons	
FILM :		
. POLYETHYLENE HIGH DENSITY	31	43
. POLYETHYLE LOW DENSITY	677	824
. POLYPROPYLENE	64	82
. PVC	55	60
. POLYSTYRENE	15	16
SUBTOTAL	842	1045
OTHERS	38	39
TOTAL	880	1084
GRAND SUBTOTAL	2308	2696
OTHERS	218	232
GRAND TOTAL	2524	2928

TABLE D3

PLASTICS IN BUILDING AND CONSTRUCTION

APPLICATION/MATERIAL	1975	1976
	1000 metric tons	
FLOORING : PVC	131	155
INSULATION : POLYSTYRENE FOAM	18	20
LIGHTING FIXTURES :		
. POLYSTYRENE	11	12
. PVC	8	16
PANELS AND SIDING : PVC	32	42
PIPE, FITTINGS AND CONDUIT :		
. ABS	91	114
. HDPE	70	113
. LDPE	10	15
. POLYPROPYLENE	5	7
. POLYSTYRENE	15	9
. PVC	460.	858
PROFILE EXTRUSIONS (INCL. WINDOWS RAINWATER SYSTEMS ETC...)		
. PVC (INCL. FOAM)	63	69
. POLYETHYLENE	2	3
VAPOR BARRIERS :		
. POLYETHYLENE	51	74
. PVC (INCL. SWIMMING POOL LINERS)	23	24
WALL COVERINGS AND WOOD SURFACING (INTERIOR) :		
. POLYSTYRENE	2	2
. PVC	45	47
SUBTOTAL	1035	1370
OTHERS	855	1009
TOTAL	1890	2379

TABLE D4

PLASTICS IN TRANSPORTATION

MATERIAL	1976, 1000 metric tons		1977, 1000 metric tons	
	Passenger car	Trucks, buses	Passenger car	Trucks, buses
ABS	68	1.5	70	2
POLYETHYLENE : high density	6	2	11	3
POLYPROPYLENE AND COPOLYMERS	130	6.8	140	7
POLYSTYRENE ; high impact	2	N	2	N
POLYVINYL CHLORIDE	120	10	130	11
SAN (STYRENE ACRYLONITRILE)	4	N	5	N
SUBTOTAL	330	20.3	358	23
OTHERS	398	56.7	457	65
TOTAL	728	77	815	88

TABLE D5

PLASTICS IN FURNITURE

MARKET	1975	1976
	1000 metric tons	
ABS	4	5
POLYETHYLENE	9	11
POLYPROPYLENE	11	13
POLYSTYRENE	28	34
POLYVINYL CHLORIDE	90	95
SUBTOTAL	142	158
OTHERS	237	281
TOTAL	379	439

TABLE D6

PLASTICS IN APPLIANCES

MATERIAL	1975	1976
	1000 metric tons	
POLYETHYLENE	2.0	2.2
POLYPROPYLENE	35.0	40.0
POLYVINYL CHLORIDE	20.0	20.0
STYRENICS :		
. POLYSTYRENE	55.0	70.0
. ABS	39.0	48.0
. SAN	5.0	8.0
SUBTOTAL	156.0	188.2
OTHERS	98.5	132.6
TOTAL	254.5	320.8

TABLE D7 W. EUROPE L.D. POLYETHYLENE PATTERN OF CONSUMPTION (PERCENTAGE)

Market \ Years	1971	1972	1973	1974	1975	1976
Film and Sheet (mainly packaging)	67.1	68.3	69.6	69.4	70.05	69.5
Injection Moulding (house hold, mechanical goods)	13.5	12.2	10.8	11.1	10.3	9.7
Extrusion Coating	4.5	5.0	5.5	5.3	5.05	5.1
Wire and Cable	3.6	3.8	4.0	4.0	4.7	4.4
Blow Moulding (hollow articles, containers)	5.2	5.1	2.5	2.5	3.1	2.95
Pipe and Conduit	2.7	2.7	3.6	3.7	3.9	3.95
Others	3.4	2.9	4.0	4.0	2.9	4.4
TOTAL, %	100.0	100.0	100.0	100.0	100.0	100.0

TABLE D8 W. EUROPE H.D. POLYETHYLENE PATTERN OF CONSUMPTION (PERCENTAGE)

Market / Years	1971	1972	1973	1974	1975	1976
Blow Moulding (hollow articles, containers)	40.1	41.3	42.7	41.0	45.2	46.0
Injection Moulding (packaging household, mechanical goods)	46.5	42.8	40.8	40.0	39.9	39.1
Pipe and conduit	4.5	5.9	4.9	5.2	4.3	4.5
Film and Sheet (packaging)	2.3	3.1	3.9	4.3	4.8	4.7
Wire and Cable	0.8	0.9	1.5	1.8	1.0	0.9
Other extruded Products*	4.4	4.0	4.9	5.5	4.3	4.2
Others	1.4	2.0	1.3	2.2	0.5	0.6
TOTAL, %	100.0	100.0	100.0	100.0	100.0	100.0

* Monofilament and slit film

TABLE D9 W. EUROPE POLYPROPYLENE PATTERN OF CONSUMPTION (PERCENTAGE)

Market / Years	1971	1972	1973	1974	1975	1976
Injection Moulding and extrusion	56.0	56.0	47.0	45.8	53.3	51.8
Film (packaging)	10.6	10.4	12.5	12.5	10.8	11.9
Flat Yarn (raffia etc ...)	21.4	21.4	23.3	23.6	25.0	25.8
Monofilament fibers	12.0	12.2	17.2	18.1	10.9	10.5
Others	-	-	-	-	-	-
TOTAL, %	100.0	100.0	100.0	100.0	100.0	100.0

TABLE D10 W. EUROPE PVC PATTERN OF CONSUMPTION (PERCENTAGE)

Market \ Years	1971	1972	1973	1974	1975	1976
Bottles	5.1	5.6	6.5	6.1	7.3	7.4
Film and Sheet	9.7	9.4	9.9	10.2	9.1	9.3
Injection Moulding	1.7	2.3	2.4	2.5	2.2	2.2
Pipe and conduit	18.4	23.5	24.6	25.1	23.2	23.6
Profile Extrusion	9.4	10.5	11.3	11.7	13.3	13.4
Records and Others	3.2	2.4	2.6	2.8	3.8	3.9
Total, Rigid	(47.5)	(53.7)	(57.3)	(58.4)	(58.9)	(59.8)
Leather (iseted fabrics)	8.5	9.0	8.6	7.9	6.8	6.8
Film and sheet	10.0	10.2	9.4	9.0	10.2	9.8
Flooring	7.0	6.8	6.0	6.5	6.2	6.1
Tubing (and profiles)	5.0	4.5	4.2	4.4	4.7	4.4
Wire and Cable	10.0	9.8	8.9	9.3	10.9	10.6
Others, Adhesives, Coating	12.0	6.0	5.6	5.5	2.2	2.5
Total, soft	(52.5)	(46.3)	(42.7)	(41.6)	(41.1)	(40.2)
TOTAL, %	100.0	100.0	100.0	100.0	100.0	100.0

TABLE D11 W. EUROPE POLYSTYRENE PATTERN OF CONSUMPTION (PERCENTAGE) EXCLUDING EXPANDABLE POLYSTYRENE (BUILDING, PACKAGING)

Market \ Years	1971	1972	1973	1974	1975	1976
Appliances		9.4	10.0	9.7	10.2	9.7
Housewares		11.6	12.0	12.0	13.3	13.7
Packaging		41.4	42.3	42.6	42.8	44.0
Refrigerators		8.9	9.2	9.2	8.2	8.4
Automotive		2.0	1.9	1.9	1.5	1.8
Toys		6.4	5.8	5.3	5.1	4.8
Others (including furniture, shoe heels)		20.3	18.8	19.3	18.9	17.6
TOTAL, %		100.0	100.0	100.0	100.0	100.0

Other polystyrene applications include: appliances, houseware, refrigerators and toys. A moderate but sustained growth is generally expected for these applications resulting from the competition of polypropylene.

There are practically only two fields of application for expandable polystyrene foam: building (insulation) and packaging. In Western Europe, the use in these two areas is 49 and 42 per cent, respectively. The expected growth of polystyrene foam market is no more than that of styrenic resins as a whole.

Synthetic fibres

General

In industrialized countries, apparel remains the major outlet for the textile industry: 51 per cent of total in Western Europe, 45 per cent in the United States.1/ However, its share in the textile market has been slightly decreasing over the past years to the benefit of both home furnishings (33.5 per cent of total in Western Europe, 30 per cent in the United States) and induetrial uses (15.5 per cent in Wetsern Europe, 23 per cent in the United States).

As for the typee of fibres used in the main sectors of the textile industry over the paet yeare, the following remarks can be made:

Western Europe

- The market share held by cotton in the textile market (28 per cent of total on an average) has been more or lese constant. However, a slight upswing has been registered from 1973 in relation to the recent development of polyester-cotton systems (blends used for apparel production). On the other hand, cotton has lost ground in percentage terms for both home furnishings and industrial uses.
- The share of wool in textiles (12 per cent on an average) has **slightly** decreased. The decline has been general, but more severe for carpets, an area of application where the percentage of wool remains higher than for the other textile applications.

1/ Most percentage figures cited come from International Rayon and Synthetic Fibres Committee and from Textile Organon.

- Similar to the evolution in the wool market, cellulosic fibres (16 per cent of the total on an average) have lost ground in every sector in both percentage and volume terms. The drop has been severe for carpets and for tyres (where the percentage still amounts to 67 per cent). The drop in the use of cellulosics for tyre manufacture is linked to the development of metallic carcasses. On the other hand, cellulosics have kept their market share for home furnishings, excluding carpets.
- Synthetic fibres (43.5 per cent of textile market on an average, as against 35 per cent at the beginning of the seventies) have gained ground in every sector.

In 1975, the penetration of synthetics by sector was as follows:

	Percentage of total fibres
Apparel	47.5
Carpets	70.0
Other furnishings	29.0
Tyres	27.0
Other industrial uses	31.0

Referring to the trends observed in Western Europe and to the situation observed in the United States (they are at a more advanced stage in terms of volume and market structure) a deeper penetration of synthetic material can still be expected for apparel and home furnishings, excluding carpets.

United States

- The share of the textile market held by cotton - 30 per cent of total on an average - has greatly decreased over the past years (40 per cent of the total in 1970). This drop in percentage has been general, but more severe for home furnishings and for industrial uses. However, from 1973 on, the set-back in percentage has been checked. It is to be noted that the percentage of cotton in textile exports has remained at a high level: 51 per cent of the total, reflecting the needs of the importing areas.
- Wool has kept only a modest share of the textile market: 1.3 per cent of the total.
- The share of cellulosics in the textile market has decreased to 7.5 per cent of the total (as against about 15 per cent in 1970). This fall has been observed in every end-use sector. A contributory factor to this decline has been the comparatively low cotton prices.
- Synthetic fibres (61 per cent of the textile market on an average as against 42 per cent in 1970) have gained ground in every sector of application although the percentage of synthetics was already high.

In 1975, the penetration of synthetics by sector was as follows:

	Percentage
Apparel	57.5
Home furnishings	65.5
Industrial and other consumer-type products	67.0
Domestic products for exports	36.5

Synthetic materials can be expected to penetrate further into the textile market. However, this penetration seems to be limited in the long-term, given the decrease in demand for wool and cellulosic fibres. On the other hand, cotton is expected to lose only a modest share of the market owing to its firm position in apparel as a component of polyester-cotton blend.

Basically, the structure of the demand for textiles by sector is not very different in the developing countries. In Brazil, for instance, apparel accounted for 51 per cent of the total demand some years ago, home furnishings and other consumer goods for 30 per cent, and industrial uses for 19 per cent. Of course, the market share held by apparel is probably larger in developing countries at a less advanced stage than Brazil.

However, the main differences between industrialized and developing countries lie in the degree of penetration by synthetic materials in the main end-use sectors.

By referring to the structural changes recently observed in industrialized countries, it is possible to obtain a fairly accurate picture of future demand in the developing countries.

Synthetic fibres by type

Of the main types of synthetic fibre, polyester fibre has gained the largest share of the synthetics market throughout the world. Polyester fibres still have a large potential growth in both 100 per cent synthetic fibre fabrics as well as in blends with natural fibres, especially cotton.

The apparel market is generally the largest market for polyester fibres where they enjoy equal acceptance by both men and women. For some apparel applications such as hosiery, polyester yarns can be textured, a feature that gives the finished fabric a more natural feel resembling that of fabric made from spun yarn, yet maintaining the economics of continuous filament yarns.

Polyester fibres are used by men for light-weight suits, sometimes alone, but more often blended with wool and likewise for slacks. They are also used for men's shirts when blended with cotton and for women's blouses, dresses, suits and slacks.

The main reason for this acceptance is the convenience. Polyester/natural fibre blends are the best for accepting the comparatively new permanent press and crease-resistant finishes.

Among household goods, polyester is well accepted for curtaining - again because of its convenience and comfort. When blended with cotton, there is a major market developing in sheets for bedding.

Industrial uses of polyester are a major market that has been developing, including reinforcement of rubber goods, cordage and webbing.

An important point to be noted is that the development of polyester fibres is, to a large extent, linked with the prices of these fibres relative to cotton. Assuming a price of 60 to 65 cents/pound for cotton (this is a price recently observed in the United States market) and allowing for a 14 per cent loss in making yarn and a 4 to 6 per cent shrinkage in converting, the cotton value in the finished cloth should be about 72-73 cents/pound. Deducting the higher cost of dyeing a polyester-based fabric, this is equivalent to a polyester staple price of 60 to 65 cents/pound. This figure could be used in justifying new fibre capacity in in ustrialized countries. According to Rumsey, it could only be achieved with large production units. On the other hand, a United States cotton price of 75-85 cents/pound has been foreseen in the long term.

In the apparel market, polyamide fibres continue to hold a share in women's lingerie, but they have been outpaced by other fibres in women's dresses and outerwear.

Carpets form the major outlet of polyamides in the household sector. There is fierce competition in this area among all fibres. Although polyamides are expected to hold a large share of the market, the real growth lies with other fibres, especially polypropylene.

Industrial uses for polyamides include: tyre cord (almost only for the replacement market in the United States), automotive upholstery, tenting, tarpaulins, nets, cordage and as reinforcement in hose belting and similar products. There are not very good prospects for these kinds of uses, especially for the first one listed.

This review of the main end-use sectors of polyamide shows that the long-term development will in any case be more limited than for other synthetic fibres.

The main outlet for acrylic fibres is to be found in sweaters, but also in dresses, suits and slacks, usually blended with wool. In suits and slacks, acrylics are feeling the pressure of polyester fibres. In household products, acrylics have made an excellent penetration into the markets for blankets as well as for rugs and carpets. There are only a few industrial outlets for acrylics, such as covers for paint rollers.

The following table summarizes the expected development of synthetics in their various end-uses.

Table D12 Development of various end-uses for synthetics
(in Western Europe)

Synthetic		End-use
Nylon	Increasing:	carpets, home furnishings, panty hose
	Decreasing:	tyres
	Constant :	warp knitting, power nets, linings, ropes, nets.
Polyesters	Increasing:	men's and women's outerwear, underwear, shirts, workclothing, bed linen, tyres, coated fabrics, carpets, carpet backing
	Decreasing:	-
	Constant :	rainwear, curtains, anoraks
Acrylics	Increasing:	knitted outerwear, draperies, upholstery fabrics, blankets, carpets
	Decreasing:	men's and women's outerwear
	Constant :	-

Source: Enka Glanzstoff.

Rubber

General

The main points to be noted from the above forecast estimates are the following:

- The slow-down in the growth rates of world rubber consumption,
- The increasing stability in the share of world demand between natural (NR) and synthetic rubber (SR).

Since the automotive sector is by far the greatest outlet for rubber (tyre and non-tyre products), the forecast of the demand for rubber has to be based on the expected development of car and car-related industries.

The recent economic crisis is not the only factor to have changed the market for rubber in industrialized countries. Saturation of the car market, the size of cars and development of tyre-building techniques are three main other factors.

It is generally anticipated that the saturation point is probably around 350 cars per 1,000 of population; the United States and Japan are most likely to be the first countries affected. However, the above figure has to be corrected taking into account economic, (purchase cost and running cost of cars) social and political factors. Pollution and urban congestion also have to be considered.

Although the growth of the small-car market in the United States has not developed as originally anticipated, there is a world-wide trend towards smaller and less powerful cars, particularly in the high potential growth areas of the centrally planned and developing countries. Thus, the average tyre size and the weight of rubber tyres will drop. In addition, smaller cars require smaller mechanical rubber components, such as belting and hose.

The most important development in tyre-building techniques in recent years has been the introduction of the radial tyre. Consumer pressure for higher mileage or longer life has brought changes from the bias tyre to the radial tyre (average mileage is about twice that of the former). In the long term, it will have an adverse effect on total consumption.

In addition, there is a trend towards increased use of retread tyres, based on the availability of quality of radial cases, which in turn will affect rubber consumption.

The radial tyre has been in use in Wetsern Europe much longer than in North America. Consequently, the full effect has yet to be felt there: slowdown in the development of demand for rubber, relative increase in the consumption of natural rubber.

According to International Synthetic Rubber, the future development of tyre production is likely to be concentrated on tyre engineering. The following points have to be considered:

- The trend towards low profile tyres with the use of more rubber in the tread and less in the side walls, to give a bigger footprint and longer life.
- Monoply construction, requiring less rubber and giving a smaller and lighter tyre.
- On a long-term basis, an everlasting tyre eliminating the spare wheel.
- And possibly, cast liquid rubber tyres (or even urethane moulded tyre) particularly for small cars.

However, it is unlikely that any significant change will arise commercially before the beginning of the eighties.

The predicted slow growth rate in industrialized countries could be, to some extent, compensated for by the increasing use of non-tyre products. This will be linked with increasing needs, in the field of safety, weight, comfort and noise control, resulting in a demand for materials containing rubber.

Competition between synthetic and natural rubber

As has been seen, the major outlet for rubber is the manufacture of tyre and tyre-products (about 60 per cent of the total in many industrialized countries). The share of tyres in the rubber market has varied over the past years (e.g. decreasing in the United Kingdom and the Federal Republic of Germany; increasing in France and Japan; stable in the United States and Brazil).

Referring to the situation observed ten years ago, penetration of synthetic materials into the tyre market has varied too. As a general rule, a deeper penetration of synthetics has been observed, although more moderate than that observed a few years ago. The deepest penetration is now observed in the United States, Brazil and, to a lesser extent, in Japan.

In some cases, such as the Federal Republic of Germany, there was even a set-back for synthetics in tyre manufacture, in percentage terms. This generally moderate penetration by synthetics reflects the recently improved competitiveness of natural rubber and the development of radial tyre production in some countries (since such a product requires relatively more natural rubber).

A point to be kept in mind is the limited potential for switching from synthetic rubber to natural rubber: the capability of switching is probably only in the order of 5 per cent (International Synthetic Rubber). In the tyre industry even a minor change requires modifications of plant and tyre-making equipment; a period of six months is required to adopt even a modest change.

Penetration of synthetic material in non-tyre production is, as a general rule, significantly deeper than for tyre production. Rates of penetration even exceed the level of 80 per cent in the United States and in Brazil; it is currently in the range of 75 per cent of the total in many industrialized countries. By contrast with the evolution observed for tyre production, percentages in this sector have kept growing over the last past years.

Taking into account the anticipated limited development of synthetics for radial tyre manufacture and, in addition, the currently high rate of penetration by synthetics into non-tyre production, the expansion of the synthetic rubber market will, in most cases, be more moderate than it has been up to the most recent past.

Furthermore, as indicated above, natural rubber is going to be able to resist better the challenge of synthetic rubber. The following technical innovations are increasingly applied in major producing areas (International Synthetic Rubber):

- Increased yields (fertilizers and Ethrel providing lower production cost).
- Production savings (improved latex collection techniques).
- Maximization of plantation potential (simultaneous production of other crops).
- Reduction of handling costs.
- Standardization of grades.
- Improved quality and new grades.

Of course, the potential development of the demand for natural rubber is relatively much higher in some countries, especially developing countries, where the percentage consumption of synthetic rubber is still at a low level (China 26 per cent, India 20 per cent).

Trends in mand for the major synthetic rubbers: SBR and polybutadiene

SBR is the leading synthetic rubber. By virtue of its low price (as compared with that of natural rubber), general versatility and rubber technologists' long standing experience, SBR has maintained its position in the tyre market and most non-tyre markets, essentially moulded goods, conveyor belting, carpet backing and footwear. However, in the latter market, it is under pressure from other materials such as PVC, polyurethanes and newer elastomers (e.g. EPDM).

In the United States market, SBR now accounts for 56 per cent of the synthetic rubber used for tyre manufacture, a percentage significantly lower than that observed ten years ago. As for non-tyre products, SBR accounts for 50 per cent of the synthetic rubber used for these applications (as against 59 per cent ten years ago).

The breakdown of SBR end-uses in the United States (1976) is a typical one. There are no large variations over the other consumer areas:

	Percentage
Tyres and tyre products	68
Moulded and extruded goods	13
Sponge	4
Footwear	3
Miscellaneous	12

SBR will continue to hold the largest share in rubber markets because there is nothing on the horizon that could replace it. However, the increased use of radial tyres which wear longer and the growing popularity of smaller automobiles, which will use smaller tyres, will continue to cut into sales. However, as prices of natural rubber (and the natural rubber substitute polyisoprene) rise, more SBR could be used in radial tyre manufacture.

As for small traditional markets such as battery cases and underlays, these have been eroded by competing materials, polypropylene and polyurethane.

Polybutadiene finds its major outlets in the tyre industry, most of the remainder being used as the impact improver for high impact polystyrene. Minor amounts are used in sponge-rubber carpet underlay and in mechanical goods such as belting.

The breakdown of polybutadiene end-uses in the United States market is as follows:

	Percentage
Auto and truck tyres	85
High impact resins	12
Others	3

Polybutadiene is primarily used in the formulation of tread stock to increase wear resistance. In the manufacture of passenger car tyres, polybutadiene is blended chiefly with SBR; in truck and bus tyre manufacture, it is blended mainly with natural rubber. In 1974, the polybutadiene content in the average passenger car tyre amounted to one kilogram, the figure for truck and bus tyre being 3.3 kilograms.

It is expected that the tyre market will continue to be the dominant use for polybutadiene. Growth in this end-use has basically stabilized and no new developments which would significantly increase domestic consumption of polybutadiene are anticipated.

In the long term, radial tyres which use less polybutadiene and last longer will cut into growth. On the other hand, a trend to substitute polybutadiene for natural rubber in sidewall components could give polybutadiene demand an unexpected boost.

Use of polybutadiene in rubber-modified high-impact polystyrene is expected to follow the resin's growth, and increase its market share.

Detergents

In industrialized countries, the slow-down in the growth of demand for synthetic detergents observed for some years correspond, to a great extent, to a deep penetration of these materials in the soap-detergent market. This penetration is expected to be achieved in the coming years.

In addition, since the beginning of the seventies, there have been basic changes in the behaviour of consumers and this has been significantly restricting demand such as consumer price resistance under the influence of consumer organizations (as observed in the United States) and saturation of the washing-machine market.

On the other hand, another factor will contribute to increasing the demand for syndets: this is the elimination of phosphate builders which complement the detergent action of surfactants (acting primarily as water softeners). Phosphate builders make up a large part (traditionally about 30 per cent) of formulations, but their use has been questioned since the early seventies because of the algae growth problems which the high nutrient value phosphate causes in waste water streams.

Phosphate builders have already been banned in some states in the United States, resulting in an increasing need for surfactants. Europeans have taken longer to consider the problem. However, the Federal Republic of Germany is already limiting phosphate contents and will enforce their replacement when alternatives are available. In some other European countries, the alternative approach has been taken: most municipal sewage plants are equipped to precipitate phosphate from all sources.

Even when taking into account this phosphate problem, the demand for syndets is not expected to grow by more than 1 to 2 per cent per annum in industrialized countries, considering the saturation of the market and the high level of consumption (26.3 kilograms per capita in the United States, 16.9 kilograms in Western Europe in 1974).[1/] The expected growth for alkyl benzene sulphonate-based detergents will be even lower - below 1.0 per cent per annum - reflecting the more favourable growth expected for other types of detergents.

With their far higher rates of growth, the same remarks apply to the developing countries.

Appendix E

MANPOWER AND TRAINING

The main task of this chapter is to estimate manpower training needs, educational and training capacities in developing countries, identify the main difficulties and problems in the manpower development and training fields and propose policy suggestions. Another objective is to estimate job generation opportunities in other industries owing to the petrochemical development. The main information sources used for the calculations are the manpower estimations for 1980 and 1985 by region and by occupation, the total number of labour force expected in petrochemicals by the year 2000 calculated from three sources - UNIDO, Leontief and Cavendish - relationships between investment and manpower in petrochemicals, number of coefficients, rates and other statistical materials obtained as a result of a number of case studies that were undertaken.

In our approach we proceed from the assumption that the further development of the petrochemical industry in developing countries will lead not only to increasing production output and capacities but to decreasing the technological gap and other differences in the manpower structure between developed and developing countries. This is a reasonable assumption because petrochemical industries have the characteristic of being highly capital- and science-intensive and highly automated. Even now there is too much in common in the petrochemical industry of the developed and developing countries comparing it to other types of manufacturing industries.

I. ESTIMATION OF THE MANPOWER QUANTITY AND STRUCTURE BY OCCUPATION AND REGION

Based on the investment pattern for the periods under consideration and on the rather strong correlations between investment and manpower[1], we have been able to estimate active manpower employed in the industry for 1976. This amounted to 32,000 persons for all developing countries.

The data and information about the manpower structure by region for the period 1930-1935 and also the assumption that there will not be any sharp fluctuations in manpower patterns in the petrochemical industry in the long-run (petrochemicals is a high skill-intensive industry and a long time is needed to prepare adequate manpower), enabled us to make a projection of manpower structure by region (Table No. 1).

Using data from Table No. 1 we calculated the manpower for different regions until 2000 under the three different scenarios (UNIDO, Cavendish and Leontief). Results of these calculations are shown in Table No. 2.

If we take the present employment as 100, the indices of manpower expected in the regional breakdown are as shown in Table No. 3.

The above table shows that the highest manpower growth rates are expected in the African countries which are only now starting to develop their petrochemical industry and the lesser manpower growth rates are in the Eastern Asian countries.

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[1] Much stronger than correlations between output and manpower.

The Latin American region, having an already comparatively highly developed petrochemical industry, expects to have approximately the same growth rates as in all developing countries.

These data give preliminary indications about the intensity of manpower training and development problems which could appear in different regions during this period.

More valuable information about the real manpower development problems expected could be derived from analysing the manpower requirements by occupation. These estimations were derived from studying the standard manpower structure of the petrochemical industry in developed countries and also a number of developing ones. The results of the calculations by region are shown in Tables Nos. 4-3.

Data obtained could be used as starting material for calculating real manpower training needs by region and by occupation and later on to define educational and training facilities required to maintain the required manpower level.

II. ESTIMATING THE MANPOWER EDUCATION AND TRAINING NEEDS

Methodology

Manpower education and training needs are a function of:

- increased employment level, $\Delta E = E_2 - E_1$ where E_1 and E_2 are employment levels for two different years;
- replacement of those retiring, going abroad, moving to other industries, etc., or leaving petrochemicals for different reasons (turnover - τ, as proportion of people who are leaving to the total manpower, in percentage);
- a gap between existing and standard job requirements for the skill and educational levels of manpower. This gap could be expressed through a quantity of

manpower requiring periodical retraining, say every five or more years. This number could be expressed as a certain proportion of all manpower in percentages (β).[1]

Then, manpower training needs for a certain period can be expressed as follows:

$$M = (E_2 - E_1) + \tau_{1,2} + \beta_{1,2} = \Delta E_{1,2} + \tau_{1,2} + \beta_{1,2}$$

These calculations could be made for all main occupational categories of manpower and regions.

The value of τ and β has been defined through a number of case studies, and by studying the manpower statistics both in developed and developing countries.

1. <u>Evaluation of the managers' and engineers' educational and training needs</u>

These calculations have been made using the assumption that all engineers and managers have to have a university education degree either in chemicals, engineering or other related industry specialities.

Results of the calculations of the total number of managers and engineers in petrochemicals related to the technical personnel by region are presented in Table No.9.

Quantitative evaluation of the turnover τ (about 10 per cent for engineers and managers in developing countries) and β (about 20 per cent, because every manager and engineer should go through refresher training courses at least once every five years) are shown in Tables Nos. 10 and 11.

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[1] There are some others less influential factors which have not been taken into consideration here because of a too long period of forecasting.

The increase of managers and engineers during each period ($E_1 - E_2 = \Delta E_{1,2}$) is shown in Table No. 12 and the total calculations of managers' and engineers' educational and training needs for the technical personnel ($\Delta E + \tau + \beta$) are presented in Table No. 13.

However, these data reflect education and training needs for technical personnel only.

Taking into consideration that both administrative and marketing staff are about 4 per cent (2 per cent + 2 per cent) of the total manpower, and all the above-mentioned assumptions would be the same for administrative and marketing managers, we can calculate educational and training needs for the administrative and marketing management. The total results of the calculations for managers' and engineers' educational and training needs for three main categories of personnel (technical, administrative and marketing) are shown in Table No. 14.

These data enable us later on to evaluate educational and training capacities which have to be developed to satisfy petrochemical industry's needs in these categories of manpower during the forecasting period.

2. Evaluation of foremen and technicians' educational and training needs

Using the same methodology as for the evaluation of educational and training needs for managers and engineers, we have obtained the following data, Table No.15.

3. Evaluation of administrative and marketing educational and training needs for the non-managerial personnel (clerks)

To calculate educational and training needs for this category of manpower, we used the above-mentioned methods and drew from them that the turnover of manpower is about 5 per cent, and that the proportion of the manpower which is going to be retrained yearly is about 10 per cent for this category of manpower.

The results of the calculations are shown in Table No.16.

4. Evaluation of skilled workmen's vocational training needs

In this case, using the results of the case studies we take $\tau = 7$ per cent and $\delta = 10$ per cent of this category of manpower.

Results of the calculations are presented in Table No. 17.

III. EVALUATION OF THE INSTITUTIONAL EDUCATIONAL AND TRAINING CAPACITIES REQUIRED

The above forecast of the future educational and training needs enables us to calculate total training capacities required to prepare the present and future labour force which is expected to be engaged in the petrochemical industry yearly during the forecast period.

Before doing this, we would like to describe a number of assumptions and limitations which have been used in our models (see fig. No.1).

It goes without saying that first of all we should split our task into the following three main dimensions:

- to make a distinction between formal educational and training capacities;
- to make a distinction between manpower hierarchical levels;
- to make distinctions between technical and other (administrative and marketing) manpower and, inside the technical category, between chemical and non-chemical specialists (mechanics, electricians and other maintenance staff).

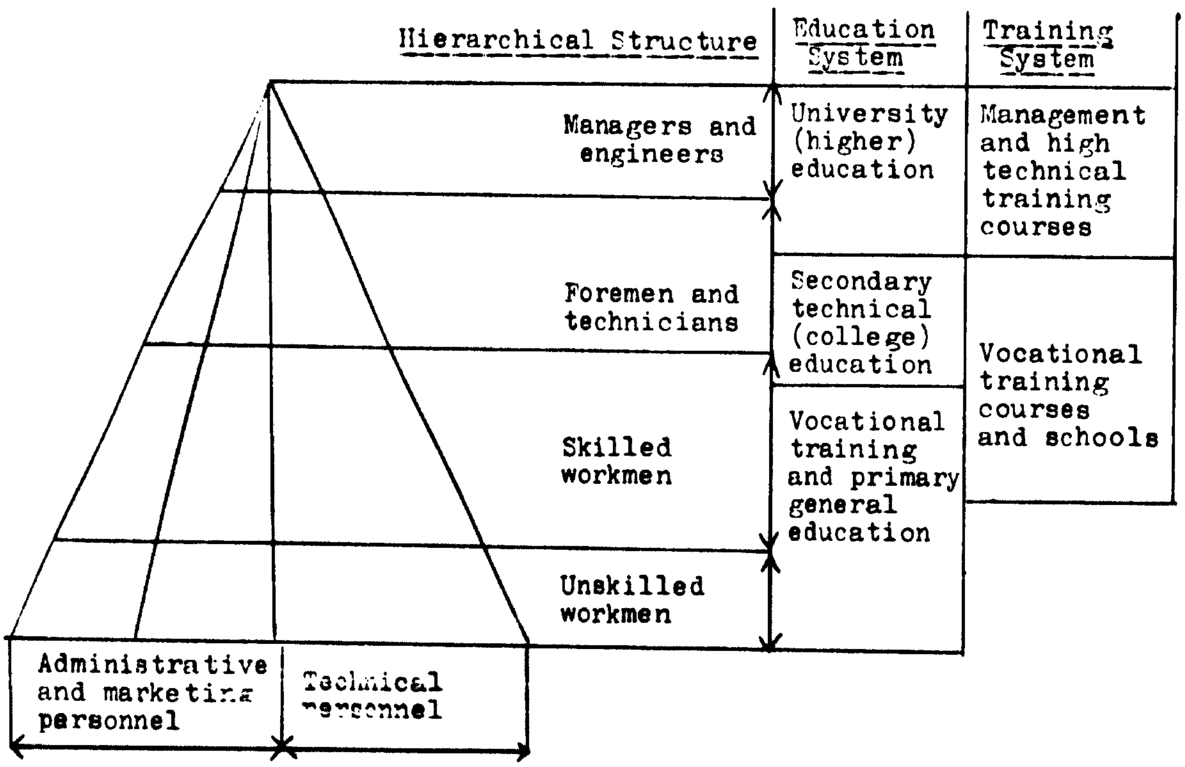

Fig. No.1: Relationships model between a hierarchical structure, the educational and training systems

Among other assumptions and limitations the following could be noted:

- All managers and engineers have a university degree. This is already the case for petrochemical companies in many developing countries;
- All graduate intake goes through special short-term initial training courses in order to adjust theoretical knowledge to the practical needs of the particular company;
- Approximately 20 per cent of all engineers, managers, foremen and technicians go through skills improvement (refresher) courses once every five years. For skilled workers this figure could be about 10 per cent.

- It is now a fact that the proportion of university and college graduates in petrochemical companies in developing countries is between 8-13 per cent of total manpower. The same proportion (7-13 per cent) is found in managerial, engineers, foremen and technicians staff in the total manpower.

This means that up till now there has been a very little gap in selected developing countries between requirements for university and college graduates and their supply by the existing educational system. Compared with the enormous growth rate of graduate specialists which most developing countries expect up until the year 2000, this little gap could be easily ignored without noticeable influence on future educational and training capacities needs and policy trends in these fields. For example, in certain developing countries there are plenty of unemployed chemical engineers, some of whom go abroad to the Middle East and even to developed countries to work as petrochemical and chemical engineers.

However, there is an essential structural disproportion between graduate supply and demand because of the lack of specialisation in chemical and mechanical engineering subjects. The typical graduate has a theoretical and practical background that is too general to be suitable for the specific requirements of the petrochemical industry. Results of case studies and other statistical material enable us to conclude that there are not more than 20-30 per cent of chemical departments at the university level which offer specialised courses in petrochemicals.

Another shortcoming of the educational system is that there is too high a proportion of graduates whose education has no relation either to the chemical or to the engineering and maintenance fields of activity. For example, among all the university graduates of the PERTAMINA (Indonesia), only about 30 per cent are chemical and maintenance engineers. In PETKIM (Turkey) this figure is about 20 per cent.

The next educational problem which has to be taken into consideration in the evaluation process is the relatively low level in many cases of the university and college graduates, both from the theoretical point of view and, even more, the practical capability to use the knowledge gained. One of the results of these shortcomings is that the level of performance of managers, engineers, foremen and technicians is well below the desired level.

An opinion survey of many local and western specialists indicates that a gap between actual and desired performance exists for all levels of manpower including top managerial staff.

1. Evaluation of the educational and training capacities required to prepare engineers and managers

Using the above assumptions and educational and training needs obtained for all categories of manpower, we can calculate yearly educational and training needs for engineers and managers of technical personnel $(\Delta E + \tau + \xi)$. The results are shown in Table No.18. Of this quantity, the university degree should fill only a part which is equal to $(\Delta E + \tau)$. The number of personnel in this category who should have a university educational level are shown in Table No.19.

As a matter of fact, not all these specialists required education and training in chemicals or chemical processing. Other engineers and managers, who specialised in mechanics, electrical and other maintenance fields, have to be prepared in other technological departments.

The established proportion of chemical to non-chemical graduates is 60 : 40. This rate enables us to split the above-mentioned figures in Table No. 19 into two sections - chemical and non-chemical graduates required.

Since non-chemical mechanical graduates could be educated in many kinds of technological universities, we will limit ourselves to considering only the educational capacities for preparing chemical specialists, which is going to be the main constraint in the future development of the petrochemical industry.[1]

The number of technical personnel with chemical university education required to join petrochemical companies yearly is shown in Table No.20, and the number of non-chemical (mechanical, electrical and other engineers) personnel is shown in Table No.21. These figures are well below university capacities. Experience shows that in many developing and developed countries only less than 50 per cent of all graduate chemical engineers go to the petrochemical industry after leaving university. Many of them go abroad; join non-petrochemical industries; or completely change specialisation by working in other fields. This is why university capacities for chemical graduates should be twice as much as the actual requirement. This is shown in Table No.22.

After evaluating the university capacities, it is important to evaluate the required training capacity of the petrochemical industry. Existing practice shows that almost 30 per cent of the new intake of engineers go through retraining courses since they have to become adjusted to real-life problems of petrochemical production and even to improve their theoretical knowledge.

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[1] It is not a difficult problem to supply the petrochemical industry with non-chemical specialists, since the proportion of manpower in petrochemicals is less than 2 per cent and sometimes less than 1 per cent of the total manufacturing sector of many developing countries.

Ideally this practice should also cover managerial training, because at present there is no special institutional training facility intended to train and retrain managers for petrochemicals. At the same time, almost all managers in the technical divisions are promoted from among the chemical and mechanical engineers.[1] This is why it is reasonable to consider separately the training capacities which are intended for engineers and for managers.

Apart from that about 30 per cent of the new yearly intake of engineers should go through special training systems (both on-job and off-job training), and 20 per cent of engineers already working should go through refresher courses (again, once every five years).

The proportion of managers to engineers among graduates in the petrochemical industry is 40 : 60. As we are going to consider management training capacities separately, we should take into account in the calculation of the training facilities for engineers that only 60 per cent of all university graduates actually work as functional engineers. In other words, the total training capacities required to train and retrain engineering staff have to be counted as follows: 0.3 X (intake) + 0.2 X 0.6 X (No. of working graduate engineers). The result of the calculation is presented in table No.23.

2. Evaluation of the managerial training capacities

We have already defined managerial educational needs (and capacities) assuming that both engineers and managers must have a university degree. Taking into consideration that there are no educational facilities to prepare managers for petrochemicals, it is understandable that there must be some kind of special management training courses for those who are promoted to managerial positions.

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[1] In PETKIM (Turkey), for example, there is only one manager who has a business administration university degree.

We already know about engineers' and managers' training needs, educational capacities, rates of τ and δ for this category of manpower, and proportions of engineers to managers (60 : 40) among graduates.

It is also clear that those who join managerial ranks for the first time should go through initial management training courses ($\Delta E + \tau$), and about 20 per cent of working managers should go to refresher courses yearly (δ).

Results of calculations of the management training capacities required, broken down as initial and refresher training, are shown in Table No.24. These figures will enable the authorities responsible for manpower planning and development to have very important basic data for planning engineers' and managerial educational and training facilities, using the standard requirements of educational level and skill, number of months/years required to give people certain kinds of knowledge and experience, to evaluate number of trainers, training equipment and other facilities.

3. Identifying the educational and training capacities for administrative and marketing managerial personnel

Evaluation of the educational and training capacities of the managerial staff for administrative and marketing personnel has been done using the same assumptions and methodology as for technical personnel. All these managers also require university degrees so that educational capacities must be equal to $\Delta E + \tau$. The only difference is that there is no assumption here that there must be overproduction of graduates in these specialities, as for chemical engineers, because administrative and marketing personnel normally obtain their university degree in the general higher educational system, and there is no particular need for them to specialise in petrochemicals during their studies. So, the requirement for these specialists is the same as educational capacities. The results of calculations are presented in Table No.25.

To identify training capacities, we again assume that all intake should go through short-term initial training courses and, in addition, every manager should have refresher courses at least once every five years. The results of calculations are shown in Table No.26.

4. Evaluation of the educational and training capacities for foremen and technicians

Consideration of educational needs for foremen and technicians has been based on the following assumptions:

- all foremen and technicians should have college or any other secondary technical education;
- the proportion of foremen to technicians is 40 : 60;
- the proportion of chemical to other specialists inside this category of manpower is 60 : 40.

In this case, educational capacities have to be equal to $\Delta E + \tau$ and training capacities are as follows:

initial training - $\Delta E + \tau$
refresher training - $0.2\ E$

assuming that everyone from this category should go through refresher courses at least once every five years.

The results of calculations of the annual educational (college) capacities to prepare technicians and foremen in the required quantity (see Table No.15) are shown in Table No.27.

Another part of graduates of this educational level have to be chemical specialists. In reality only about 50 per cent of all college chemical graduates join the petrochemical industry. So, the actual educational college capacities should be twice as much as the quantity of graduates expected to join petrochemicals.

The results of the calculations are presented in Table No. 28.

Capacities of the training facilities to ensure the training of foremen and technicians are shown in Table No. 29.

5. Evaluation of the educational and training capacities for skilled workers

Using data on total skilled workers needs, annual vocational training capacities have been calculated, assuming that every skilled worker should go through a special vocational training school or course.

The results are presented in Table No.30.

This is the total of vocational training capacities necessary to train all skilled workmen intake, plus periodical retraining of 10 per cent of workmen yearly.

Total capacities of the vocational training schools specialising in the preparation of skilled workers for petrochemicals have to be approximately 30 per cent more than the yearly intake $(\Delta E + \tau)\ 1.3$

The results of the calculations are shown in Table No.31.

The next task is to break down these vocational training capacities into two parts: the first, which trains chemical processing workers; and the second, which prepares the number of maintenance specialists (mechanics, electricians, welders, etc.).

Usually the ratio of these two groups of workers is 70 : 30.

The results of the calculations are presented in Table No.32.

6. Summary of results

In order to present educational and training facilities both by region and by level, and enable all those interested to be able to use the results more easily, all calculations and tables have been re-organised to give an integrated picture of educational and training facilities required to fulfil petrochemical industry development projections in developing countries (see Tables Nos. 33-39).

IV. THE MAIN DIFFICULTIES AND PROBLEMS

The main problem in achieving the targets of the rapid expansion of petrochemicals in developing countries is, and will be, the shortage of skilled manpower. Initially, there are essential structure disproportions between graduates supply-and-demand due to lack of sufficient specialisation of chemical and mechanical engineers, as well as graduates of secondary schools and vocational educational institutes. These disproportions have resulted in a shortage of technicians, craftsmen, electronic and mechanical engineers, supervisors and middle-managers, and all kinds of skilled manpower dealing with LNG processes.

At the same time, in almost all developing countries there is an essential overstaffing which could be evaluated between 130 and 180 per cent of the personnel really needed to operate various petrochemical plants. Usually this extra manpower is concentrated among the administrative and managerial staff, creating a number of unnecessary barriers to effective management. It is estimated that in one private middle-size petrochemical company roughly 40 per cent of all managerial staff are the real decision-makers.

Though there is some scarcity of skilled chemical engineers, the majority of developing countries involved in the petrochemical industry already have enough chemistry graduates to meet the countries' needs in quantitative terms. However, the specialisation, composition and the quality of these graduates are far from meeting the industry's demands. Many of the chemical engineers have no specialisation in petrochemicals, their theoretical background is too general, and they have no or little practical experience and understanding of the type of industrial problems that they will face.

It is, therefore, a common practice to put university graduates into positions of technicians or to retrain them for 6-12 months before they can work as chemical engineers.

One of the problems of the petrochemical industry in developing countries is a low managerial level and experience. It is a very difficult task to find a broad-minded manager who is at the same time a good technical specialist. This is particularly acute for middle-management positions in the industry. One of the weaknesses of the managers is the lack of general management knowledge, talent and capabilities.

Supervisors have a quite different problem - they are usually promoted from the workers' ranks, they are probably more able to identify with workers' problems, but they usually lack a systematic training that enables them to exercise their supervisory functions. Similarly they face difficulties in dealing with the complex equipment involved. There is a marked need for training in such managerial skills as planning and communications, apart from technical training.

Another problem is that there is still too high a proportion of graduates from the universities and colleges whose education has no relation either to chemical, petrochemical or maintenance fields of activities and who are employed in the petrochemical industry.

This leads to a situation where the petrochemical industry in developing countries usually retrains various kinds of specialists who joined the industry and who have received their training or education outside of the industry.

Four sources of industrial skills may be distinguished:

- general education;
- academic institutions for specific vocational training at secondary and tertiary levels, such as technical schools, colleges and universities;
- on-the-job training;
- training abroad (or using expatriate personnel as trainers).

There must be some kind of optimal balance between all these four sources of industrial skills. Unfortunately, the main emphasis in most developing countries has been placed on "on-the-job training" and on "training abroad". neglecting the first two.

There are some reasons which could explain this situation. First, the curriculum of engineering and technical colleges is to a large extent patterned after that of colleges in highly developed countries and thus fails to take into account the needs of local industry. Among the universities and colleges only few have chemical departments and fewer still have petrochemical specialisation. Similarly, the quality of education in certain institutes leaves much to be desired.

In addition, very few vocational training schools outside the petrochemical industry have chemical training curricula. In many developing countries dealing with petrochemicals there are no vocational training schools to prepare operatives, craftsmen and technicians and all training is usually undertaken at the plant.

A further observation is that these educational institutions and vocational training schools often lack laboratory equipment and other facilities required to provide practical training.

Finally, the technological infrastructure and environment, which plays a significant role in shaping industrial studies in developed countries, is often lacking in developing countries. Office work is often accorded a higher status than work in the plant.

It can, therefore, be seen that the main responsibility for training falls on the industry itself through on-the-job training methods. Certainly in-plant training alone cannot cope with this huge task due to many reasons. First, plant managers usually have little time to devote to trainees. Secondly, the varying nature of the petrochemical industry, which is composed of big public companies producing basic petrochemicals and smaller or middle-size private companies dealing with downstream products, makesit difficult for the latter to accumulate the necessary facilities and other resources needed for the training of their personnel, so that there is only short-time, in-plant, very narrow and specialised training.

An urgent problem for the petrochemical industry in developing countries is the lack of qualified trainers and adequate training programmes, insufficient finance, and a climate which favours "academic" study rather than vocational and technical training, and university professors have little contact with the industry.

Developing countries often receive overseas trainers, but the latter possess little knowledge of local conditions and culture and their effectiveness as trainers is lower than expected.

Training abroad is used very broadly in developing countries. It is indeed useful when there are no specialised facilities in a developing country either because of poor planning or because of cost reasons. However, one of the shortcomings of the training abroad is not only the high cost, but the brain drain of trainees, many of them during or after their overseas training.

One of the sources of training in the petrochemical industry is package contract with multinational companies. However, sometimes this type of training fails to take into consideration local training conditions, and in some cases stressing areas which are not particularly preoccupying in the country concerned.

One of the big problems of the petrochemical industry in developing countries is the lack of management training facilities. There are almost no specialised management courses connected with the specific problems of petrochemicals. Existing management training is more oriented to production management and pays little attention to the leadership talent, communications, or motivation. This training is usually given in the form of short courses.

National management development centres give little help to petrochemicals to train their managers or trainers. Very few managers from petrochemicals participate in the training programmes organised by these centres. Much could be done to pool the resources of the industry in a direction that would already create the needed infrastructure of trained manpower at various levels of the formal education levels and in co-operation with the concerned ministries.

V. JOB GENERATION OPPORTUNITIES OF PETROCHEMICALS

Closely related to the interaction between petrochemical industries and the rest of the economy are the employment implications of the inter-sectoral linkages. Because of the wide spread of these linkages over many sectors, substantial induced employment can be created as a result of the development of the industry.

The petrochemicals are outstanding among other industries in the importance of their contribution to industrialisation in the developing countries. For example, the contribution of petrochemicals by value added to total manufacturing now stands at about 15 per cent, and more than half of the petrochemical products are used by other sectors.

There are two kinds of linkages: backward and forward linkages with other industries. Forward linkages of petrochemical industries express the role of a sector as an input provider to other manufacturing sectors. It creates an opportunity for other sectors to increase their output through a growing supply of its input.

In this way, the value added through further processing stages can benefit the economy and provide additional employment and income. There is also scope for stimulating employment creation through import substitutions for inputs required by the petrochemical industries, including capital equipment and engineering services.

It has been observed, for example, that local production of food chemicals and additives has greatly stimulated the expansion of food processing industries; similar experiences can be quoted from the textile and pharmaceutical industries, stimulated through production of synthetic fibres and active ingredients respectively.

Another case is the rubber industry, which has strong forward linkages with the automobile industry and strong backward linkages with the basic petrochemicals (carbon black, synthetic rubber, intermediates, etc.). The chlorinecaustic industry provides essential inputs for a whole range of industries, such as solvents, insecticides, PVC plastics, paper, soap, textiles, etc., and thereby stimulate industrial diversification and employment generation.

An increase in petrochemical output requires a certain amount of extra imputs (backward linkages) which may be produced domestically.

In fact some people believe that through backward linkages, the induced employment could be more than twice the employment generated within the industry itself. There would be a still greater employment generation if an increasing share of domestic inputs for the petrochemical industry could substitute for imported ones.

The task of defining the approximate figures of the employment generated by the petrochemicals in a great number of sectors and for the more than 70 developing countries involved in the production of petrochemicals, remains a very problematic task, particularly from the methodological point of view and falls outside the scope of this study.

However, a number of estimates have already been made in this field. Using these quantitative results plus our qualitative analysis of the trends help us to draw a general picture which could be used both for the more detailed evaluation in the countries interested and for the evaluation of some of the planning decisions at the national level.

One such estimation has been computed by the ILO and is shown in the table below.[1]

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[1] "Manpower Aspects of Establishing Chemical Industries in Developing Countries", ILO, Geneva, 1976, p.14.

Major receiving sectors of chemical inputs[1]

	Chemi-cals	Agri-culture	Tex-tiles	Other comsump. goods	Mining	Capital goods	Construc-tion	Trans-port	Services
Mexico	.1159	.0343	.0752	.0305	.0179	.0534	.0217	.0346	.0451
Egypt	.1016	.2435	.0791	.1016	*	.0234	.0236	.0037	.0315
Turkey	.1346	.1217	.0577	.0159	.0040	.0467	.0332	.0796	.0235
Kenya	.0655	.0979	.0306	.0271	.0045	.0271	.0364	.0676	.0623
Republic of Korea	.0723	.0146	.0024	.0609	.0132	.0364	.0217	.0549	.0739
Argen-tina	.1472	.0203	.0444	.0572	.0027	.0662	.0119	.0494	.0232

[1] The ratio is $\frac{X\ ch.j}{Xj}$ where

X ch.j is the amount of chemical input going into production sector j

Xj is the output of sector j

* - negligible

Though this data is related only to the chemical industry, because of the high proportion of petrochemicals in the chemical industry in developing countries these figures give a good indication of the trends and scales of linkages.

One of the conclusions that could be made from this table is that the development of the chemical industry is not so much related to the strong expansion of one or a few sectors, but rather to the general growth of all sectors of the economy.

The sectors that benefit most from the indirect generation of employment by the petrochemical industry are agriculture, services, textiles, plastics, and other consumer goods industries, transport, commerce, and some of the mechanical industries (car. electronics, etc.)

Since these activities are in several cases labour-intensive in nature, an increase in the supply of chemicals can be a strong incentive for growth of these sectors and thus for generation of jobs.

In the case of agriculture, which is one of the major receivers of the petrochemical products in the forms of fertilisers and pesticides, these tend to lead to a more land-intensive type of cultivation, and make more land arable through enrichment. By extending the area under cultivation more jobs can become available and a higher yield obtained.

One of the new areas that is developing rapidly as a result of the fast chemical and petrochemical industry development, is the industry dealing with environmental protection. This has provided a stimulus for new employment opportunities.

Among activities falling in this area are the production of advanced instrumentation for monitoring of pollution and equipment, chemicals and catalysts for sewage treatment, solid waste disposal and combustion gas purification, recycling equipment, antifire means and the training of personnel involved in all these activities.

The manpower requirements for environmental protection are expected to increase sharply. Many petrochemical enterprises have already set up environmental units, staffed by qualified specialists, and training facilities are expanding to meet these needs.

The enforcement of environmental legislation also requires greatly expanded manpower in public agencies charged with this task.

It has been estimated that the potential manpower demand for environmental protection can account for approximately 9 per cent of the labour force in the chemical industries. The additional employment gained from anti-pollution products and services could amount to 2-6 per cent of the current labour force in the chemical industry.

Taking into account reduction of employment in the sectors affected by the diversion of capital from production to environmental protection (about 7-8 per cent), the net over-all gain is about 4-7 per cent of current employment in chemical industries.[1]

Until now we have reviewed the positive effects of petrochemicals development on jobs generation in other sectors. However, not all the effects go in the direction of employment growth. For example, development of synthetic fibre production competes with labour-intensive jute production in some developing countries whose exports revenue is heavily dependent on jute. This competition could decrease employment in this segment of the agriculture sector. The same could be said about substitution of the natural resin by synthetic ones. It is known, also, that the manufacturing of goods from plastics for the construction, electronics, and electrical industries is less labour intensive than from the metal substitutes.

Employment prospects may also be harmed by the increased risk connected with environmental constraints. Compliance with environmental legislation is necessary but sometimes can be a lengthy and often costly process, delaying new ventures or inhibiting growth.

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[1] See "Manpower Aspects of Establishing Chemical Industries in Developing Countries", ILO, Geneva, 1976, p.67.

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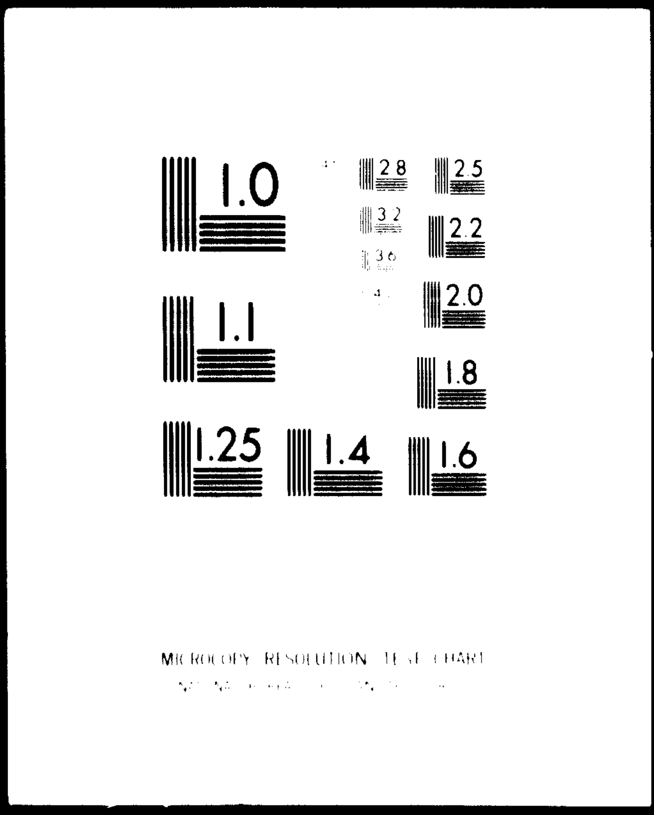

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It is perhaps important that the governments aiming at expanding the petrochemical industry should be fully aware of both the positive and negative implications in the field of job generation and induced employment.

However, taking into consideration positive and negative effects in job generation in developing countries as a whole, it must be stressed that the net employment creation effect of the petrochemical development is a positive one.

For example, Philippines' manpower specialists consider that in their country one new job in petrochemicals could create 5-6 jobs in other industries. In Mexico there is even a more optimistic view; there it is expected that this ratio can be as high as 1 to 14.. Most of the specialists both in developing and developed countries believe that on the average this ratio for the conditions in the developing countries could be 1 to 7. Thie is perhaps a more realistic estimation, and could be used to estimate the jobs to be generated by the development of petrochemicals until the year 2000.

The results of the calculations are presented in the table below.

An Approximate Estimation of
<u>Jobs Generation in Other Induetries</u>

	1976-1980	1980-1985	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
New jobs in petro-chemicals	54,000	149,230	1,155,100	675,100	325,100
New jobs expected to be generated in other induetries owing to development of petro-chemicals	378,000	1,044,610	8,035,700	4,725,700	2,275,700

The data about new jobs expected to be created in other industries should be considered only as approximate, yet it is valuable in the sense that it shows that a national policy putting an emphasis on petrochemicals development is in harmony with other priorities of the economic and social development of the developing countries as far as employment generation is concerned.

The following abstract from the Conclusions (No.53) concerning Manpower Aspects of Establishing Chemical Industries in Developing Countries could serve as a good guidance for government policy-making in the petrochemical development:

"While some branches of the chemical industries are, under given market conditions, relatively capital-intensive and will provide only limited employment opportunities for a given capital investment, other branches can generate substantial employment. Due consideration should therefore be given by development planners in governments and industry to selecting chemical products, plant locations and the size of production units with a view to optimising employment opportunities in chemical production.

.... In selecting particular products for expansion programmes, it is important to bear in mind their backward and/or forward linkages with other sectors of the economy, with a view to maximising productive employment throughout the economy." [1]

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1 Official Bulletin, ILO, Geneva, Vol.LIX, 1976, Series A, No.3, p.130.

VI. POLICY SUGGESTIONS

The main policies which could be helpful to meet growing requirements of the rapid petrochemical expansion in the developing countries on the manpower development side are in the following areas of activity:

(a) manpower planning;

(b) co-operation and co-ordination of activities between the petrochemical industry and the educational system;

(c) training policy and development of the institutional training;

(d) co-operation among developing countries in the manpower training field;

(e) assistance of the developed countries in the manpower development fields.

(a) Manpower planning

The importance of manpower planning cannot be over-emphasised. In the first stages of formulating a petrochemical expansion proposal, an assessment should be made of the manpower requirements and potential availability in the country. This assessment should include, inter alia, the adequacy of the infrastructure, maintenance and repair services, marketing and management.

This may well determine not only plant location, the design and choice of equipment, but also the manpower development programme that will be required. Such decisions will have to be taken at the planning stage, in order to undertake a recruitment and training programme geared to the particular capacity and type of operation. Careful manpower planning is also essential as part of the erection programme in order to ensure that a qualified staff is ready by the time the construction is completed.

Advanced planning methods, such as PERT and critical path planning, can be used for manpower planning, provided that training needs and duration can be assessed with sufficient accuracy.

The lines along which developing countries should identify their manpower requirements are known. First of all, the parameter of "human resources" should be included in the sectoral planning and even licensing procedures for the creation of a new petrochemical enterprise.

Most of the information should be forthcoming from feasibility studies of individual plants in every country and statistical bodies dealing with labour force statistics and projections in the particular country. In the long run the number, type and ratios of people employed in comparable plants elsewhere can be used as a yardstick provided that the occupations are uniformly defined and that account is taken of any difference in the level of industrialisation.

The next step is to identify existing manpower resources for which the country should undertake:

- occupational analysis of employees
- surveys of education and qualifications of employees
- statement of general skills required
- statement of skills required in key petrochemical occupations
- extent to which related skills in other industries can be used
- extent to which existing primary, secondary and higher level education facilities can provide the manpower required
- extent to which vocational training is provided by formal courses and on-the-job training.

The planning of skills has to be performed in the framework of a certain number of skill categories. The essence of planning industrial skills concerns, on the one hand, engineers and technicians, and on the other, the skilled workers. Because of the length of the relevant educational curricula, the planning of the labour force of engineers and technicians should be within the framework of long-term plans and that of skilled workers in medium-term plans.

The plan for qualified manpower has to be closely integrated into the over-all plans for economic and production development of the petrochemical sector.

The planning of the engineers, scientists and technicians training has to be worked out together because of the possibilities of substitution and the close interconnections among them.

The planning period is determined by:

(a) the duration of the educational curricula
(b) allowing for some years of practice after graduation in order that the specialists may be more fully trained, and
(c) the time (if any) necessary to establish new educational capacities.

Highly qualified technical manpower thus has to be planned about 10 to 15 years ahead.

While the number of engineers and technicians has to be planned on the long term, the planning of skilled worker manpower, because of the shorter period of instruction and training, can take place in the framework of medium-term plans.

(b) Co-operation and co-ordination of activities between the petrochemical industry and the educational system

One of the main problems of the educational and training policy is identifying the right proportions between university and college studies, secondary technical education, off-job and in-plant training and making decisions about their proper development. All these educational and training forms should be integrated into a united system in order to be used in a more effective way. In reality almost all these forms belong organisationally in different governmental bodies such as the Ministry of Education, the Ministry of Industry, the Labour Ministry, Planning, etc., in many cases with little co-ordination between them. There are also few links between the skill producing and consuming sectors. Instead, the petrochemical industries tend to rely on their own resources to solve their training problems. Training is totally separated from education, and whilst it may be true that employers are able to train effectively for their own short-term benefit, it does not follow that such training provides the best benefit for the trainees. Until the industry, the education and training institutions, and the school system co-ordinate their tasks, the industry will continue to provide job-oriented training, while vocational and training centres will provide candidates for such programmes.

Where petrochemicals constitute an important sector of economic activity it may be necessary to set up an organisation or a council which could co-ordinate the activities of the educational and training institutions with the industry demand, both from the point of view of quantity and specialisation compositions of enrollment and quality of education and curricula.

The general educational system should be reoriented, where necessary, to put greater emphasis on the natural sciences, technology and vocational knowledge and skills relevant to employment opportunities in petrochemicals. Particular attention should be given to the training of maintenance technicians and qualified chemical operators. In other words a shift in the emphasis of the secondary vocational training and education should be made to give it a more basic scientific and practical bias.

Bringing together industry and education could increase possibilities to expand colleges' and universities' facilities and programmes to train and retrain supervisory and managerial staff and high technical personnel. Many of the educational institutions could work on a shift system to avoid huge expenditures on the facilities expansion.

Some of the petrochemical industries in developing countries have already useful practice dealing with the universities and colleges. They have an agreement to put part of the chemical students on summer training courses in the petrochemical plants together with their university professors and enable them to have practical experience and to understand better industrial problems. After graduation from the universities these trainees become a useful source of recruitment. In other cases, petrochemical companies can give small projects to be done by the university professors and students.

Thus the main task of the co-ordination of the activities of the existing educational and training systems and industry is to avoid duplication and overlapping between them, strictly clarify their functions, to improve quality and to decrease costs and the time period of education, and to avoid the waste of human and financial resources nationwide.

(c) Training policy and development of institutional training

A very important step should be identifying a right training system and to institutionalise training, choosing the right mix between on-job and off-job (formal) training.

A particular aspect of training in petrochemicals is that the on-the-job training for many occupations is becoming less effective, more expensive and sometimes even dangerous. Even a small error made by an inexperienced trainee in the production process could be disastrous both for the plant and for the environment as well.

At the same time, on-the-job training in petrochemicals gives limited possibilities for practice in the maintenance, repair and adjustment of equipment because breakdowns do not occur very often and trainees usually are not permitted to touch equipment which is working properly during the production process.

Thus only special educational and training institutions, actively using simulation techniques, and followed up by in-plant training and skill improvement, offer the best means of training from the point of view of knowledge, experience in dealing with the equipment and training costs.

Simulators could be used to train operators in carrying out nearly all the operations of controlling the plant in conditions resembling reality and they can be given repeated practice in dealing with abnormal occurrences which can be foreseen - without risk to themselves or to the plant with a reasonably lifelike feedback from the instruments of the consequences of all their actions - right or wrong.

The apparent sophistication of these devices introduces a degree of novelty into off-the-job training situations which can be useful in arousing the interest of the trainee and free him for any decisions that need to be made during the training.

It would therefore be advantageous if training centres are equipped with pilot-plants and simulations for training purposes. It is evident that for beginners it is better to start working on the real pilot-plant, but for refresher courses the simulator is to be preferred.

Such training centres could be used to train manpower not only from big but also from the small and medium-size enterprises, which are often unable to organise their own in-plant training.

There is also a need for full-time widely based basic training courses for different skill areas at training centres, especially for technicians, in order to reduce the time spent on in-plant training.

Programmes for re-enforcing vocational training in vocational schools and training centres should be set up to meet the changing needs of the industry.

Generally speaking, the majority of the labour force should be already trained while the plant is being erected.

The setting up of training facilities and drawing up of educational programmes are being carried out on such a vast scale that many enterprises often find it more efficient to offer a contract to consortia which are able to provide the whole gamut of integrated services.

One of the important elements of any training policy in developing countries is management development. Until now, little use has been made of existing management development centres. The current practice of training managers overseas could be usefully reassessed in terms of alternative training forms, such as establishing specialised management institutions and expanding existing management training facilities. Governments and industry should combine forces to increase financial resources available for the development of the needed managerial infrastructure for the petrochemical industry.

Substantial technical manpower is required to accomplish the various tasks involved in introducing computer process control in the petrochemical industry. Sometimes the number of computer specialists (including managers, system analysts, programmers, process control engineers, technicians and computer control operators), could reach up to 10-15 pe. cent of all employees of a petrochemical plant. It is for this reason that the training of computer specialists for the petrochemical industry in developing countries should receive special attention.

Thus, a well co-ordinated manpower training policy can help to avoid, or at least reduce to a minimum, a possible inbalance resulting between demand and supply of various categories of manpower, waste of resources both human and financial, and brain-drain and migration, including the shift in work to other areas of economic activity.

(d) Co-operation among developing countries in the manpower training field

There are other problems that deserve closer attention. One is regional co-operation. Countries could save a considerable amount of scarce resources by pooling them to create common support services for the petrochemical industries, such as training institutions, research centres, marketing organisations, etc.

Countries which already have a petroleum industry possess an excellent basis for establishing such regional co-operation. Some of the developing countries fall in this category. The skills acquired can be readily applied in other developing countries through regional training and research centres and offer advantages over skill transfer from developed countries.

One way of co-operation among developing countries is the exchange of personnel for operations as well as the exchange of trainers. A prerequisite for such co-operation is the establishment of an inventory of available training capabilities and facilities available in the participating group of countries.

Regional and multicountry training centres could also promote standardisation of the training programmes and even establish standards of skills for each occupation. This type of training is often less costly than training overseas.

Finally, by pooling resources, regional training centres could afford to have expensive and modern training laboratory equipment, advanced training programmes for all categories of manpower, and the most qualified trainers both from the developing and developed countries. Economy of scale of these centres can improve the quantity and quality of output and reduce training costs.

(e) Assistance of the developed countries in training

There are three main forms of assistance the industrialised countries can provide in training. These are:

- overseas training
- expatriates activities as trainers in developing countries
- establishing training centres in the developing countries by multinationals or contracting foreign companies as part of a package contract.

Although more costly, training abroad is sometimes preferred, since it can enable a trainee to obtain direct working experience in an industry, improve his fluency in a second language at first hand, and sometimes equip him with a formally recognised academic achievement. Perhaps it is for these reasons that overseas training has been undertaken on a large scale by developing countries.

Nevertheless, there is a growing feeling that training could best be given in the developing country itself and that training in industrialised countries should be reserved for very special cases.

The advantages of training in a national environment are well known. But national institutions, at least many of them, may not have the necessary expertise and facilities for training in various "packages" related to petrochemicals. On the other hand, protracted overseas training for nationals from developing countries is often unsettling, and can contribute to the brain-drain. Therefore, short periods of overseas training with specific objectives might prove to be more beneficial, especially if they combine theoretical courses with practice. As the quality of local and regional training improves, dependance on overseas training is likely to decrease.

It is perhaps more effective to invite expatriate trainers and specialists for a limited period to conduct training courses in developing countries. The recruitment of expatriates was recognised as being essential while a petrochemical industry or a new production is being established. Such training should be geared to the local social and cultural environment.

It has also been accepted that expatriates need to be gradually replaced by national personnel. However, owing to rapid technological change, updating of technical and managerial skills sometimes could be best done by expatriates coming out for short periods from parent enterprises, or other enterprises acting as a medium of transfer of knowledge. A major government pre-occupation is making sure that multinational petrochemical companies contribute to the transfer of know-how and training needed for various skills and particularly for managerial and highly professional positions.

The assistance of the educational institutions of the industrialised countries and the co-operation of engineering and construction enterprises as well as that of process-owners is also vital to developing countries to ensure the transfer of know-how needed.

To summarise, manpower resources should be developed and trained at all levels and for various functions existing in the petrochemical industry. For this purpose, the general education system should be reoriented to put greater emphasis on the natural sciences, technology and vocational skills. Technician training should be expanded and on-the-job training be given direct assistance by the local industry and by facilitating the transfer of know-how from foreign sources, in particular from multinational petrochemical companies, including temporary use of expatriate personnel where required. The national vocational training schools and university departments dealing with petrochemical training need to be expanded in quantitative and qualitative terms and co-ordination between industry and educational systems improved. The regional co-operation among the developing countries should be established and strengthened and training used with discretion and when appropriate.

Table No. 1

Regional Manpower Structure in Petrochemical Industry in Developing Countries
(%)

	1976	1980	1985	2000		
				UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	36	37	37	31	31	31
Africa	4	6	10	15	15	15
Asia	60	57	56	54	54	54
Middle East	6	9	11	13	13	13
East Asia	38	32	21	15	15	15
South Asia	16	16	24	26	26	26
TOTAL	100	100	100	100	100	100

Table No. 2

Regional Manpower Structure in the
Petrochemical Industry in Developing Countries

	1976	1980	1985	2000		
				UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	29,140	50,200	98,100	446,400	297,600	220,100
Africa	3,230	7,550	27,900	216,000	144,000	106,500
Asia	49,300	77,920	159,400	777,600	518,400	383,400
Middle East	4,960	12,520	30,900	187,200	124,800	92,300
East Asia	31,380	43,800	59,300	216,000	144,000	106,500
South Asia	12,960	21,600	68,600	374,400	249,600	184,600
TOTAL	81,670	135,670	284,900	1,440,000	960,000	710,000

Table No. 3

Manpower Indices for Petrochemicals
(1976 = 100)

	1976	1980	1985	2000		
				UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	100	172	336	1,531	1,021	755
Africa	100	233	848	6,687	4,458	3,297
Asia	100	158	323	1,577	1,051	777
Middle East	100	252	622	3,774	2,516	1,860
East Asia	100	139	190	688	458	339
South Asia	100	166	529	2,888	1,925	1,424
TOTAL	100	166	348	1,763	1,175	869

Table No. 4

Occupational Manpower Structure for Latin America

	1976	1980	1985	2000 UNIDO Scenario	2000 Leontief Scenario	2000 Cavendish Scenario
TECHNICAL PERSONNEL	25,350	43,600	85,300	388,400	258,900	191,500
Engineers and Managers	870	1,600	3,200	13,400	8,900	6,600
Technicians and Foremen	2,920	4,600	9,100	44,600	29,800	22,000
Skilled Workmen	13,110	22,000	43,800	200,900	133,900	99,100
Unskilled Workmen	8,450	15,400	29,200	129,500	86,300	63,800
ADMINISTRATIVE PERSONNEL	2,620	4,400	8,500	40,200	26,800	19,800
Managerial Staff	580	900	1,700	8,900	6,000	4,400
Clerical Staff	2,040	3,500	6,800	31,300	20,800	15,400
MARKETING PERSONNEL	1,170	2,200	4,300	17,800	11,900	8,800
Managerial Staff	580	900	1,700	8,900	5,900	4,400
Clerical Staff	590	1,300	2,600	8,900	6,000	4,400
T O T A L	29,140	50,200	98,100	446,400	297,600	220,100

Table No. 5

Occupational Manpower Structure for Africa

	1976	1980	1985	2000 UNIDO Scenario	2000 Leontief Scenario	2000 Cavendish Scenario
TECHNICAL PERSONNEL	2,810	6,560	23,800	187,900	125,300	92,700
Engineers and Managers	100	260	1,000	6,500	4,300	3,200
Technicians and Foremen	320	730	2,800	21,600	14,400	10,700
Skilled Workmen	1,450	3,400	12,500	97,200	64,800	47,900
Unskilled Workmen	940	2,170	7,500	62,600	41,800	30,900
ADMINISTRATIVE PERSONNEL	300	660	2,400	19,500	13,000	9.600
Managerial Staff	70	130	500	4,300	2,900	2,100
Clerical Staff	230	530	1,900	15,200	10,100	7,500
MARKETING PERSONNEL	120	330	1,200	3,600	5,700	4,200
Managerial Staff	50	130	500	4,300	2,800	2,100
Clerical Staff	70	200	700	4,300	2,900	2,100
T O T A L	3,230	7,550	27,400	216,000	144,000	106,500

Table No. 6

Occupational Manpower Structure for the Middle East

	1976	1980	1985	2000 UNIDO Scenario	2000 Leontief Scenario	2000 Cavendish Scenario
TECHNICAL PERSONNEL	4,320	10,920	26,900	1[illegible],900	108,600	80,300
Engineers and Managers	150	420	1,100	5,600	3,700	2,800
Technicians and Foremen	500	1,200	3,200	18,700	12,500	9,200
Skilled Workmen	2,230	5,600	14,100	84,300	56,200	41,500
Unskilled Workmen	1,400	3,700	8,500	54,300	36,200	26,800
ADMINISTRATIVE PERSONNEL	450	1,100	2,700	17,000	11,200	8,300
Managerial Staff	100	200	500	3,700	2,500	1,800
Clerical Staff	350	900	2,200	13,300	8,700	6,500
MARKETING PERSONNEL	190	500	1,300	7,300	5,000	3,700
Managerial Staff	90	200	500	3,200	2,00	1,800
Clerical Staff	100	300	800	4,100	3,000	1,900
TOTAL	4,960	12,520	30,900	187,200	124,800	92,300

Table No. 7

Occupational Manpower Structure for East Asia

	1976	1980	1985	2000 UNIDO Scenario	2000 Leontief Scenario	2000 Cavendish Scenario
TECHNICAL PERSONNEL	27,480	38,100	52,100	187,900	125,300	92,700
Engineers and Managers	940	1,300	1,900	6,500	4,300	3,200
Technicians and Foremen	3,140	3,700	5,300	21,600	14,400	10,700
Skilled Workmen	14,120	19,200	26,500	97,200	64,800	47,900
Unskilled Workmen	9,280	13,900	18,400	62,600	41,800	30,900
ADMINISTRATIVE PERSONNEL	2,880	3,800	5,200	19,500	13,000	9,600
Managerial Staff	640	800	1,00	4,300	2,900	2,100
Clerical Staff	2,240	3,000	4,200	15,200	10,100	7,500
MARKETING PERSONNEL	1,020	1,900	2,600	8,600	5,700	4,200
Managerial Staff	380	800	1,000	4,300	2,800	2,100
Clerical Staff	640	1,100	1,600	4,300	2,900	2,100
T O T A L	31,380	43,800	59,900	216,000	144,000	106,500

Table No. 8

Occupational Manpower Structure for South Asia

	1976	1980	1985	2000 UNIDO Scenario	2000 Leontief Scenario	2000 Cavendish Scenario
TECHNICAL PERSONNEL	11,310	18,700	59,600	32,830	217,500	161,000
Engineers and Managers	390	600	2,200	11,200	7,500	5,600
Technicians and Foremen	1,300	1,800	6,200	37,000	25,000	18,500
Skilled Workmen	5,850	9,500	30,400	171,500	112,500	83,300
Unskilled Workmen	3,770	6,800	20,800	108,600	72,500	53,600
ADMINISTRATIVE PERSONNEL	1,170	1,900	6,000	33,700	22,500	16,600
Managerial Staff	260	400	1,200	7,500	5,000	3,700
Clerical Staff	910	1,500	4,800	17,500	17,500	12,900
MARKETING PERSONNEL	480	1,000	3,000	12,400	9,600	7,000
Managerial Staff	220	400	1,200	5,400	4,200	3,000
Clerical Staff	260	600	1,800	7,000	5,400	4,000
T O T A L	12,960	21,600	68,600	374,400	249,600	184,600

Table No.9

Evaluation of the Number of Managers and Engineers in the Petrochemical Industry in Developing Countries
(Technical Personnel)

	1976	1980	1985	2,000 UNIDO Scenario	2,000 Leontief Scenario	2,000 Cavendish Scenario
Latin America	870	1,600	3,200	13,400	8,900	6,600
Africa	100	260	1,000	6,500	4,300	3,200
Asia	1,480	2,320	5,200	23,300	15,500	11,600
Middle East	150	420	1,100	5,600	3,700	2,800
East Asia	940	1,300	1,900	6,500	4,300	3,200
South Asia	390	600	2,200	11,200	7,500	5,600
T O T A L	2,450	4,180	9,400	43,200	28,700	21,400

Table No. 10

Turnover of Managers and Engineers

(2)

	1976	1980	1985	2,000 UNIDO Scenario	2,000 Leontief Scenario	2,000 Cavendish Scenario
Latin America	37	160	320	1,340	890	660
Africa	10	26	100	650	430	320
Asia	148	232	520	2,330	1,550	1,160
Middle East	15	42	110	560	370	280
East Asia	94	130	190	650	430	320
South Asia	39	60	220	1,120	750	560
TOTAL	245	418	940	4,320	2,370	2,140

Table No.11

Quantity of engineers and managers who have to go through skill improvement training courses once every 5 years

($)

	1976	1980	1985	2,000 UNIDO Scenario	2,000 Leontief Scenario	2,000 Cavendish Scenario
Latin America	174	320	640	2,680	1,780	1,320
Africa	20	52	200	1,300	860	640
Asia	296	464	1,040	4,660	3,100	2,320
Middle East	30	84	220	1,120	740	560
East Asia	188	260	380	1,300	860	640
South Asia	78	120	440	2,240	1,500	1,120
T O T A L	490	836	1,880	8,640	5,740	4,280

Table No. 12

Increase in Engineers and Managers during the forecasting periods ($\Delta E = E_2 - E_1$)

	1976 - 1980	1980 - 1985	1985 - 2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	730	1600	10200	5700	3400
Africa	160	740	5500	3300	2200
Asia	840	2880	18100	10300	6400
Middle East	270	680	4500	2600	1700
East Asia	360	600	4600	2400	1300
South Asia	210	1600	9000	5300	3400
TOTAL	1730	5220	33800	19300	12000

Table No. 13

Total Engineers' and Managers' educational and training needs of technical personnel

$(M = \Delta E + \tau + \delta)$

	1976-1980	1980-1985	1985 - 2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	1210	2560	14220	8370	5380
Africa	238	1040	7450	4590	3160
Asia	1536	4440	25090	14950	9880
Middle East	396	1010	6180	3710	2540
East Asia	750	1170	6550	3690	2260
South Asia	390	2260	12360	7550	5080
TOTAL	2984	8040	46760	27910	18420

Table No. 14

Total managerial and engineers training needs

	1976-80	1980-85	1985-2000		
			I	II	III
Latin America	2,830	5,980	33,180	19,530	12,560
Technical	1,210	2,560	14,220	8,370	5,380
Administrative	810	1,710	9,480	5,580	3,590
Marketing	810	1,710	9,480	5,580	3,590
Africa	558	2,420	17,390	10,710	7,380
Technical	238	1,040	7,450	4,590	3,160
Administrative	160	690	4,970	3,060	2,110
Marketing	160	690	4,970	3,060	2,110
Asia	3,576	10,360	48,550	34,850	23,060
Technical	1,536	4,440	25,090	14,950	9,880
Administrative	1,020	2,960	16,730	9,970	6,590
Marketing	1,020	2,960	16,730	9,970	6,590
- Middle East	916	2,370	14,420	8,650	5,920
Technical	396	1,010	6,180	3,710	2,540
Administrative	260	680	4,120	2,370	1,690
Marketing	260	680	4,120	2,370	1,690
- East Asia	1,750	2,730	15,370	8,610	5,280
Technical	750	1,170	6,590	3,690	2,260
Administrative	500	780	4,390	2,810	1,510
Marketing	500	780	4,390	2,810	1,510
- South Asia	910	5,260	28,760	17,630	11,860
Technical	390	2,260	12,320	7,550	5,080
Administrative	260	1,500	8,220	4,790	3,390
Marketing	260	1,500	8,220	4,790	3,390
TOTAL:	6,964	18,760	109,120	65,130	43,000
Technical	2,984	8,040	46,760	27,910	18,420
Administrative	1,990	5,360	31,180	18,610	12,290
Marketing	1,990	5,360	31,180	18,610	12,290

Table No. 15

Total Foremen' and Technicians' educational and training needs (Æ + τ + S')

	1976-1980	1980-1985	1985 - 2000 UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	3060	7230	48800	29640	19500
Africa	630	2910	25280	15920	11110
Asia	3770	12410	85790	52770	35220
Middle East	1060	2960	21110	13050	8760
East Asia	1670	3190	22780	13520	8610
South Asia	1040	6260	41900	26200	17850
TOTAL	7460	22550	159870	98330	65830

Table No 16

Administrative and marketing clerks educational and training needs

$(\Delta E + \bar{I} + \delta)$

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	2.890	6.010	36.830	20.270	13.370
Africa	550	2.260	19.840	12.350	8.440
Asia	4.040	10.310	65.230	39.370	24.750
Middle East	930	2.250	17.010	10.470	6.660
East Asia	1.850	2.570	16.640	9.150	5.240
South Asia	1.260	5.940	31.580	19.750	12.850
TOTAL	7.480	18.580	121.900	71.990	46.560

Table No 17

Total skilled workmen training needs

($\Delta E + \tau + \beta$)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	12.630	29.250	191.250	112.860	72.150
Africa	2.530	11.230	101.220	63.320	43.540
Asia	17.930	48.770	342.010	202.200	130.960
Middle East	4.320	10.900	84.530	51.650	34.460
East Asia	8.340	11.810	87.220	49.320	29.440
South Asia	5.260	26.070	170.250	101.230	67.060
TOTAL	33.090	89.250	634.480	378.380	246.650

Table No. 18

Educational and training needs for engineers and managers of technical personnel

(yearly average)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	300	510	950	560	360
Africa	60	210	500	300	210
Asia	385	890	1670	1000	660
Middle East	100	200	410	250	170
East Asia	190	235	440	250	150
South Asia	95	455	820	500	340
TOTAL:	745	3120	3120	1860	1230

Table No. 19

Number of technical personnel who should have university degrees (yearly)

($\Delta E + T$)

	1976-80	1980-85	1985-2000 UNIDO Scenario	1985-2000 Leontief Scenario	1985-2000 Cavendish Scenario
Latin America	220	380	770	440	270
Africa	50	170	410	240	170
Asia	270	680	1360	790	510
Middle East	80	155	340	200	130
East Asia	125	160	350	190	110
South Asia	65	365	670	400	270
TOTAL:	540	1230	2540	1470	950

Table No. 20

Number of technical personnel required to join petrochemicals, with chemical university degree

(yearly)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	130	230	460	260	160
Africa	30	100	250	140	100
Asia	160	410	820	470	310
Middle East	50	90	200	120	80
East Asia	70	100	220	110	70
South Asia	40	220	400	240	160
TOTAL:	320	740	1530	870	570

Table No. 21

Number of non-chemical engineers (mechanical, electricial, etc.) required to join petrochemicals, with university degree

(yearly)

	1976-80	1980-85	1985-2000 UNIDO Scenario	1985-2000 Leontief Scenario	1985-2000 Cavendish Scenario
Latin America	90	150	310	180	110
Africa	20	70	160	100	70
Asia	110	270	540	320	200
Middle East	30	65	140	80	50
East Asia	55	60	130	80	40
South Asia	25	145	270	160	110
TOTAL:	220	490	1010	600	380

Table No. 22

University Capacity Required to Satisfy Petrochemical Industry Need for Chemical Graduates

(yearly)

	1976-1980	1980-1985	1985-2000		
			I	II	III
Latin America	260	460	920	520	320
Africa	60	200	500	280	200
Asia	320	820	1640	940	620
Middle East	100	180	400	240	160
East Asia	140	200	440	220	140
South Asia	80	440	800	480	320
Total:	640	1480	3060	1740	1140

Table No. 23

Training and retraining capacities for engineers and technical personnel

(yearly)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	365	690	2225	1420	1005
Africa	70	255	1110	705	520
Asia	495	1170	3885	2490	1800
Middle East	115	255	940	605	440
East Asia	260	360	1060	665	475
South Asia	120	555	1885	1220	885
TOTAL:	930	2115	7220	4615	3325

Table No. 24

Management Training Capacities (initial and refreshment)
(annually)

	1976-80	1980-85	1985 - 2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	120	205	380	225	175
initial	90	155	310	175	140
refreshment	30	50	70	50	35
Africa	25	85	200	125	85
initial	20	70	165	100	70
refreshment	5	15	35	25	15
Asia	150	355	670	400	265
initial	105	270	545	320	205
refreshment	45	85	125	80	60
Middle East	40	80	165	100	70
initial	30	60	135	80	55
refreshment	10	20	30	20	15
East Asia	75	95	175	100	60
initial	50	65	140	80	45
refreshment	25	30	35	20	15
South Asia	35	180	330	200	135
initial	25	145	270	160	105
refreshment	10	35	60	40	30
TOTAL	295	645	1250	750	525
initial	215	495	1020	595	415
refreshment	80	150	230	155	110

Table No. 25

Educational university capacities required for Administrative and Marketing managerial personnel

(yearly)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	324	547	1011	595	383
Africa	64	221	530	326	225
Asia	408	947	1785	1064	703
Middle East	104	217	440	252	180
East Asia	200	250	468	300	161
South Asia	104	480	877	512	362
TOTAL:	796	1715	3326	1985	1311

Table No. 26

Training capacities for administrative and marketing managers (initial and refresher training)

(yearly)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	684	1227	4571	2975	2143
Africa	116	421	2190	1466	1065
Asia	968	2027	7465	4944	3603
Middle East	184	417	1820	1152	900
East Asia	520	650	2188	1440	1001
South Asia	264	960	3457	2352	1702
TOTAL:	1768	3675	14226	9385	6811

Table No. 27

Educational college capacities required to prepare foremen and technicians in the maintenance field

(yearly)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	306	578	1301	790	520
Africa	63	233	674	425	296
Asia	377	993	2288	1407	939
Middle East	106	237	564	348	234
East Asia	167	255	607	361	230
South Asia	104	501	1117	698	475
TOTAL:	746	1804	4263	2622	1755

Table No. 28

Educational college capacities required to prepare chemical specialists to be foremen and technicians in petrochemicals

(annually)

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	918	1734	3903	2370	1560
Africa	189	699	2022	1275	888
Asia	1131	2979	6864	4221	2817
Middle East	318	711	1692	1044	702
East Asia	501	765	1821	1083	690
South Asia	312	1503	3351	2094	1425
Total:	2238	5412	12789	7866	5265

Table No. 29

Training Capacities for Foremen and Technicians

	1976-80	1980-85	1985 - 2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	765	1446	3253	1976	1300
foremen	305	578	1301	790	520
technicians	460	868	1952	1186	780
Africa	158	582	1685	1062	740
foremen	63	233	674	425	296
technicians	95	349	1011	637	444
Asia	942	2482	5720	3518	2349
foremen	377	993	2288	1407	940
technicians	565	1489	3342	2111	1409
Middle East	264	592	1407	870	584
foremen	104	238	563	348	234
technicians	160	354	844	522	350
East Asia	418	638	1519	902	575
foremen	168	255	608	361	230
technicians	250	383	911	541	345
South Asia	260	1252	2794	1746	1190
foremen	105	500	1117	698	476
technicians	155	752	1677	1048	714
TOTAL	1865	4510	10658	6556	4389
foremen	745	1804	4263	2622	1756
technicians	1120	2706	6395	3934	2633

Table No. 30

Annual vocational training capacities required to train skilled workers

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	3157	5850	12750	7524	4810
Africa	632	2246	6748	4221	2903
Asia	4483	9754	22800	13480	8731
Middle East	1080	2180	5635	3443	2297
East Asia	2085	2360	5815	3288	1963
South Asia	1318	5214	11350	6749	4471
Total:	8272	17850	42298	25225	16444

Table No. 31

Capacities of the vocational training schools for skilled workers' training

	1976-80	1980-85	1985-2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	3390	6466	14834	8621	5394
Africa	712	2995	7930	4926	3358
Asia.	4712	10834	26582	15500	9853
Middle East	1222	2467	6596	3989	2627
East Asia	2090	2379	6717	3713	2136
South Asia	1400	5988	13269	7798	5090
Total:	8814	20295	49376	29047	18605

Table No. 32

Specialization Structure of the Vocational Training Capacities required to prepare skilled Workmen

	1976-80	1980-85	1985 - 2000		
			UNIDO Scenario	Leontief Scenario	Cavendish Scenario
Latin America	3390	6466	14834	8621	5394
chemical workers	2373	4526	10384	6035	3776
others	1017	1940	4450	2586	1618
Africa	712	2995	7930	4926	3358
chemical workers	498	2097	5551	3448	2351
others	214	898	2379	1478	1007
Asia	4712	10834	26582	15500	9853
chemical workers	3298	7584	18607	10850	6897
others	1414	3250	7975	4650	3256
Middle East	1222	2467	6596	3989	2627
chemical workers	855	1727	4617	2792	1839
others	367	740	1979	1197	788
East Asia	2090	2379	6717	3713	2136
chemical workers	1463	1665	4702	2599	1495
others	627	714	2015	1114	641
South Asia	1400	5988	13269	7798	5090
chemical workers	980	4192	9288	5459	3563
others	420	1796	3981	2339	1527
TOTAL	8814	20295	49346	29047	18605
chemical workers	6169	14207	34542	20333	13024
others	2645	6088	14804	8714	5581

Table No. 33

Educational and Training Capacities Required for the Petrochemical Industry in Developing Countries
LATIN AMERICA
(annually)

	1976-1980		1980-1985		1985-2000					
					UNIDO Scenario		LEONTIEF Scenario		CAVENDISH Scenario	
	educ.**	training	educ.	training	educ.	training	educ.	training	educ.	training
TECHNICAL PERSONNEL										
Managers	260*	120	460	205	920	380	520	225	320	175
Engineers	-	365	-	690	-	2,225	-	1,420	-	1,005
Foremen	918	305	1,734	578	3,903	1,301	2,370	790	1,560	520
Technicians	306	460	578	868	1,301	1,952	790	1,186	520	780
Skilled workmen	3,390	3,157	6,466	5,850	14,834	12,750	8,621	7.524	5,394	4,810
ADMINISTRATIVE PERSONNEL										
Managers	162	342	273	613	505	2,285	297	1,487	191	1,071
MARKETING PERSONNEL										
Managers	162	342	274	614	506	2,286	298	1,488	192	1,072

* Chemical specialists / Others

** It is understandable that for managers and engineers it is necessary to be of university education level; for foremen and technicians - college or other secondary technical education; for skilled workers - vocational training and general school (8-9 years).

Table No. 34

Educational and Training Capacities required for the Petrochemical Industry in Developing Countries: AFRICA

(annually)

	1976-1980		1980-1985		1985-2000					
					UNIDO Scenario		LEONTIEF Scenario		CAVENDISH Scenario	
	educ.**	training	educ.	training	educ.	training	educ.	training	educ.	training
TECHNICAL PERSONNEL										
Managers	60 *	25	200	85	500	200	280	125	200	85
Engineers	-	70	-	255	-	1,110	-	705	-	520
Foremen	189	63	699	233	2,022	674	1,275	425	888	296
Technicians	63	95	233	349	674	1,011	425	637	296	444
Skilled workmen	712	632	2,995	2,246	6,930	6,748	4,926	4,221	3,358	2,903
ADMINISTRATIVE PERSONNEL										
Managers	32	58	110	210	265	1,095	163	733	112	532
MARKETING PERSONNEL										
Managers	32	58	111	211	265	1,095	163	733	113	533

* Chemical specialists / Others

** It is understandable that for managers and engineers it is necessary to be of university education level; for foremen and technicians - college or other secondary technical education; for skilled workers - vocational training and general school (8-9 years).

Table No. 35

Educational and Training Capacities Required for the Petrochemical Industry in Developing Countries
ASIA
(annually)

	1976-1980		1980-1985		1985-2000					
					UNIDO Scenario		LEONTIEF Scenario		CAVENDISH Scenario	
	educ.**	training	educ.	training	educ.	training	educ.	training	educ.	training
TECHNICAL PERSONNEL										
Managers	320 *	150	820	355	1,640	670	940	400	620	265
Engineers	-	495	-	1,170	-	3,885	-	2,490	-	1,800
Foremen	1,131	377	2,979	993	6,864	2,288	4,221	1,407	2,817	940
Technicians	377	565	993	1,489	2,288	3,342	1,407	2,111	939	1,409
Skilled workmen	4,712	4,483	10,834	9,754	26,582	22;800	15,500	13,480	9,853	3,731
ADMINISTRATIVE PERSONNEL										
Managers	204	484	474	1,013	893	3,732	532	2,472	351	1,801
MARKETING PERSONNEL										
Managers	204	484	473	1,014	892	3,733	532	2,472	352	1,802

* Chemical specialists / Others

** It is understandable that for managers and engineers it is necessary to be of university education level; for foremen and technicians - college or other secondary technical education; for skilled workers - vocational training and general school (8-9 years).

Table No. 36

Educational and Training Capacities required for the Petrochemical Industry in Developing Countries: MIDDLE EAST

(annually)

	1976-1980		1980-1985		1985-2000					
					UNIDO Scenario		LEONTIEF Scenario		CAVENDISH Scenario	
	educ.**	training	educ.	training	educ.	training	educ.	training	educ.	training
TECHNICAL PERSONNEL										
Managers	100 *	40	180	80	400	165	200	100	160	70
Engineers	-	115	-	255	-	940	-	605	-	440
Foremen	318	104	711	238	1,692	563	1,044	348	702	234
Technicians	106	160	237	354	564	844	348	522	234	350
Skilled workmen	1,222	1,080	2,467	2,180	6,596	5,635	3,989	3,443	2,627	2,297
ADMINISTRATIVE PERSONNEL Managers	52	92	108	208	220	910	126	576	90	450
MARKETING PERSONNEL Managers	52	92	109	209	220	910	126	576	90	450

* Chemical specialists / Others

** It is understandable that for managers and engineers it is necessary to be of university education level; for foremen and technicians - college or other secondary technical education; for skilled workers - vocational training and general school (8-9 years).

Table No.37

Educational and Training Capacities Required for the Petrochemical Industry in Developing Countries
EAST ASIA
(annually)

	1976-1980		1980-1985		1985-2000 UNIDO Scenario		1985-2000 LEONTIEF Scenario		1985-2000 CAVENDISH Scenario	
	educ.**	training	educ.	training	educ.	training	educ.	training	educ.	training
TECHNICAL PERSONNEL										
Managers	140 *	75	200	95	440	175	220	100	140	60
Engineers	-	260	-	360	-		-	665	-	475
Foremen	501	168	765	255	1,821	608	1,083	361	690	230
Technicians	167	250	255	383	607	911	361	541	230	345
Skilled workmen	2,090	2,085	2,379	2,360	6,717	5,815	3,713	3,288	2,136	1,963
ADMINISTRATIVE PERSONNEL										
Managers	100	260	125	325	234	1,094	150	720	81	500
MARKETING PERSONNEL										
Managers	100	260	125	325	234	1,094	150	720	81	501

* Chemical specialists / Others

** It is understandable that for managers and engineers it is necessary to be of university education level; for foremen and technicians - college or other secondary technical education; for skilled workers - vocational training and general school (3-9 years).

Table No. 39

Educational and Training Capacities Required for the Petrochemical Industry in All Developing Countries

(annually)

	1976-1980		1980-1985		1985-2000					
					UNIDO Scenario		LEONTIEF Scenario		CAVENDISH Scenario	
	educ.**	training	educ.	training	educ.	training	educ.	training	educ.	training
TECHNICAL PERSONNEL										
Managers	640 *	295	1,480	645	3,060	1,250	1,740	750	1,140	525
Engineers	-	930	-	2,115	-	7,220	-	4,615	-	3,325
Foremen	2,238	745	5,412	1,804	12,789	4,263	7,866	2,622	5,265	1,756
Technicians	746	1,120	1,804	2,706	4,263	6,395	2,622	3,934	1,755	2,633
Skilled workmen	8,814	8,272	20,295	17,85	49,346	42,298	29,047	25,225	18,605	16,444
ADMINISTRATIVE PERSONNEL										
Managers	398	884	857	1,837	1,663	7,113	993	4,692	655	3,405
MARKETING PERSONNEL										
Managers	398	884	858	1,838	1,663	7,113	993	4,693	655	3,406

* Chemical specialists / Others

** It is understandable that for managers and engineers it is necessary to be of university education level; for foremen and technicians - college or other secondary technical education; for skilled workers - vocational training and general school (8-9 years).

Table No. 38

Educational and Training Capacities Required for the Petrochemical Industry in Developing Countries

SOUTH ASIA

(annually)

	1976-1980		1980-1985		1985-2000					
					UNIDO Scenario		LEONTIEF Scenario		CAVENDISH Scenario	
	educ.**	training	educ.	training	educ.	training	educ.	training	educ.	training
TECHNICAL PERSONNEL										
Managers	80*	35	440*	180	800*	330	480*	200	320*	135
Engineers	-	120	-	555	-	1,885	-	1,220	-	885
Foremen	312*	105	1,503*	500	3,351*	1,117	2,094*	698	1,425*	476
Technicians	104	155	501	752	1,117	1,677	698	1,048	475	714
Skilled workmen	1,400	1,318	5,988	5,214	13,269	11;350	7,798	6,749	5,090	4,471
ADMINISTRATIVE PERSONNEL										
Managers	52	132	240	480	439	1,728	256	1,176	181	851
MARKETING PERSONNEL										
Managers	52	132	240	480	439	1,729	256	1,176	181	851

* Chemical specialists / Others

** It is understandable that for managers and engineers it is necessary to be of university education level; for foremen and technicians - college or other secondary technical education; for skilled workers - vocational training and general school (8-9 years).

Examples of Training for Computer Process Control for a Petrochemical Plant

(Training provided by computer manufacturers)

Recipients of training	Type of training	Description of training	Length of training
Instrument engineer	Classroom	Computer technology, maintenance, and programming	3 months
Programmer	Classroom	Programming	1 month
Process engineers	Classroom	Computer concepts and programming	1 month
Programme maintenance technician	Classroom and on-the-job	Programming and computer techniques jointly with user staff on site and at vendor facility	12 months
Maintenance foreman	Classroom	Computer technology and maintenance	2 months
Electronic and instrument mechanic	Classroom	Computer technology and maintenance	2 months
Electrical engineer	Classroom	Computer technology and maintenance	2 months

(Training provided by user companies)

Recipients of training	Type of training	Description of training	Length of training
Instrument technician	On-the-job	Computer and instrument maintenance	Periodic
Plant superintendent	On-the-job	Computer technology. Use of computer technology	Periodic
Cracker operators	On-the-job	Operating techniques	Periodic
Clerk	On-the-job	Computational techniques. Use of input-output equipment	Periodic
Operators	On-the-job	Plant operation using computer	8 hours
Process engineers	On-the-job	Computer system familiarisation; programming	4 months
Clerks, operators	On-the-job	Operation of computerised system	1 month
Chemical engineers	Classroom and on-the-job	Programming	7 months
Programming technicians	Classroom and on-the-job	Programming	6 months
Programme maintenance technician	Classroom and on-the-job	Programming and computer techniques, jointly with vendor	1 year
Laboratory technicians	On-the-job	Computer applications to lab. operations	50 hours
Laboratory analysts	Classroom and on-the-job	Computer utilisation	16 hours

Job descriptions and manpower training requirements in petrochemicals

The main features of the petrochemical industry which influence manpower are:

- It is highly capital intensive
- Plant-down-time or under-loading is highly costly
- Product yields depend critically on processing conditions
- Plant instrumentation and equipment are complex
- The process has a high-risk level

Some of the consequences of these features are:

- relatively few people are employed compare to other types of production
- technologically qualified staff are required to support management
- specialised technical staff are required for process and quality control and also to provide the necessary back-up to marketing; in this latter case a detailed knowledge of the products are processes used by downstream producers is necessary
- process operators need special skills and knowledge that generally do not come from other types of production experience.
- process operators need to have a technical understanding of the process and its relationship to other production at the site
- process operators should be able to operate a number of different plants
- maintenance personnel are integrated with processing personnel
- supervisors, operating and maintenance staff need to have skills in fault diagnosis

- long practical experience is less important in the performance of these jobs than a higher educational level, a comprehension of the production process and of written instructions.
- the control of more complex chemical equipment requires a new type of skilled worker, whose attention, thoroughness and reliability, combined with appropriate education, is very important.

There is one common feature in the chemical industry as a whole which makes the skill level issue more critical than in other industries: the great potential hazard to the environment, the community and plant labour force itself. Therefore, all petrochemical workers understand the nature of the processes taking place and their potential danger. This understanding and the consequent responsibility placed upon all workers often entails special training and retaining.

An Example of a Checklist for Planning Safety and Health in the Petrochemical Industry for use in Training

On the matter of training for safety and health, the important consideration is that there should be a totally integrated approach, emphasising systematic planning of all aspects of safety and health.

A summary of key issues is as follows:

1. Design plant, equipment, layout, lighting, heating, ventilation, security fencing and alarm systeme, to minimise hazards.
2. Isolate processee with a high fire, toxic or explosive risk to ensure that accidents never reach disaster proportions, and have completely unobstructed exits at all times for such work areas.
3. Provide a firet-aid room, properly maintained firet-aid equipment and an established routine for obtaining medical help.
4. Have adequate emergency firefighting training and first-aid training, including regular fire drills and aesessment reports thereon with remedial action where necessary to improve arrangements.
5. Ensure a clearly marked passage at all times to and from every place where people have to work. If doors have to be locked for security reasons, eneure that key cabinets are immediately adjacent so that there is no delay in operating locks from the inside.

6. Insist on good housekeeping to avoid accumulation of dirt or product. This can be a potential hazard in itself and moreover leads to slack methods of working deleterious simultaneously to quality, economy, safety and health.

7. Provide suitable protective clothing, goggles and other equipment where required, but try to avoid the necessity for such by proper design of equipment and adequate ventilation.

8. Ensure careful maintenance to avoid leakage of gaseous, liquid or powder products.

9. Ensure proper hygiene via washing, showering or bathing accommodation as necessary and adequate lavatories and messroom facilities.

10. Have a prominently displayed hazard plan easily accessible to the fire brigade showing location of major hazards, fire-fighting and respirator equipment and key shut-down or vent valves in the case of process plants.

Job Description - Training

1. Job designation — Operator

2. Job relation — Takes orders from ohief operator

   Gives orders to assistant operator

3. Duties — The operator is responsible for performing local operations and checking the operation of equipment of the panel operator.

   - At start-up, shut-down and changes in operating conditions, he prepares the product circuits and starts up and shuts down pumps, compressors, furnaces, etc., in accordanoe with the instructions issued by the panel operator or the chief operator and in full observance of safety regulations.
   - By making regular rounds of the installations, notes local parameters and ensures surveillance of instruments. Immediately notifies the chief operator of any irregularities observed.
   - Regularly takes samples for the laboratory and directly performs certain simple tests.
   - Responsible for the cleanliness and order of his working zone.
   - During maintenance operations, prepares the unit by attaching blind joints and by degassing lines.

4. Job requirements

   a) General level of education
      - High school level
      - Trade school

   b) Specialised education
      - Mechanics/chemistry

   c) Professional requirements
      - Understanding of operations he performs and knowledge of the consequences
      - Constant safety sense
      - Fair mechanical ability in order to check pumps and compressors
      - Punctuality in order to relieve shifts
      - Medical certificate of fitness for shift duty

5. <u>Training phase</u>

	Duration (months)
A. Initiation into petrochemical plants	1
B. Industrial and technological training	
1) General organisation of the unit	$\frac{1}{4}$
2) Physical and chemical properties of the products to be handled	$\frac{1}{4}$
3) Safety	$\frac{1}{4}$
4) Technology and operation session	$6\frac{1}{4}$
C. Participation in operation of the unit	2
Total duration	10

Job Description - Training

1. Job designation — Chief operator

2. Job relation — Takes orders from supervisor

   Gives orders to operators

3. Duties — The chief operator is directly responsible for adjustments and operations to be performed on installations in order to achieve daily production target.

   Transmits to panel operators and operators, operating instructions of units during the shift.

   - Verifies the application of adjustment instructions, correct performance of operation, efficient use of equipment.
   - Ensures constant observance of normal working rules.
   - Co-ordinates the operation of his unit with linked areas.
   - Personally manages special operations such as shut-down and start-up.
   - Signs the operating sheet of his shift with appropriate comments and clocks his personnel in and out.
   - Takes all necessary safety precautions.
   - In case of accident, immediately issues precaution measures to be taken, and alerts the supervisor and the safety division.
   - Takes into consideration the training of his personnel during operation.

4. Job requirements

   a) General level of education
      - High school or trade school
      - Technical college

   b) Specialised education
      - Experience or training in plant operation

   c) Professional requirements
      - Experience gained in position of operator and panel operator
      - Thorough familiarity with operating manuals
      - Ability to issue clear orders to his subordinate
      - Punctuality in order to relieve shifts
      - Fair mechanical aptitude to manage correct use of equipment
      - Medical certificate of fitness for shift duty

5. <u>Training phase</u>

The training programme is divided into three phases:

a) Eventual initiation into petrochemical plants so as to get the trainee accustomed to equipment and operation of the units and to facilitate the choice of assigning chief operator.

b) General training phase of which main target is to check acquired knowledge and to supplement it with scientific and technological bases specific to the petrochemical industry.

c) Phase of training on future assigned units including analysis of the equipment and apprenticeship of operating methods.

	Duration (months)
A. Eventual initiation	1
B. General training	
1) Refresher course on fundamental scientific knowledge	3
2) Industrial and technological training	6¼
C. Specialised training phase	
1) Organisation of the unit	¼
2) Process (specific to the unit)	3½
3) Participation in supervision of operation	3
Total duration	17

Job Description - Training

1. **Job designation** — Plant operations supervisor

2. **Job relation** — Takes orders from plant operations superintendent

   Gives orders to chief operators

3. **Duties** — Transmits the superintendent's instructions and is responsible for their execution in optimum safety conditions.

   Transmits routine operating instructions to the chief operators with specific instructions, explanations and comments.

   - Sets up and supervises special shut-down and start-up operations
   - Monitors the operating conditions of the main equipment
   - Every morning, gathers operating sheets, checks results against instructions, transmits this information to the superintendent with appropriate comments
   - Is responsible for initiating routine maintenance work and follows up routine work
   - Analyses incidents
   - Carries out the time-table on schedule of shifts and holidays

4. **Job requirements**

   a) General level of education

      - Bachelor of Science degree

   b) Specialised education

      - Petrochemical, refining chemical or engineering experience of plant operation training

   c) Professional requirements

      - Experience gained in all operational posts: operator, boardman, chief operator
      - Ability to draft and transmit instructions clearly and to make sure they are understood
      - Must maintain good relations with colleagues in the utility and maintenance sections and with personnel under his orders
      - Must be able to consult with, or advise, the technical services division on process improvements and unit modifications

5. Training phase	Duration (months)
A. Introductory seminar	¼
B. Petrochemistry courses	3½
C. Petrochemical technology courses	2
D. Technical training	8
E. Organisation training	2½ 1/
F. Training with engineering company	4
Total duration	20

1/ Of which 1½ months on unit concerned.

Job Description - Training

1. Job designation — Works superintendent

2. Job relation — Takes orders from chief maintenance engineer

   Gives orders to mechanic, electrical, instrumentation piping, common services garage

3. Duties — In charge of implementation of the maintenance operations in the workshops and on plant site.

   Participates in planning:

   - Preventive and incidental maintenance time-table
   - Improvements in equipment reliability and maintenance procedures
   - Preparation of the maintenance works budget

   Manages, implements and supervises:

   - Relations with production, safety, other maintenance section, outside contractors and warehouses to ensure satisfactory progress of operating schedule
   - Verification of stocks of material and spare parts in the warehouses
   - Proper performance of maintenance work
   - Distribution of work to the maintenance service
   - Promotion and training of his personnel
   - Time-table for stand-by personnel holiday schedule

4. Job requirements

   a) General level of education
      - Bachelor of Science degree

   b) Specialized education
      - Mechanical engineering

   c) Professional requirements
      - Experience in any mechanical engineering
      - Experience in maintenance of refinery or petrochemical plant
      - Experience as mechanics foreman
      - Experience in different maintenance services concerning instruments, electrical power system and piping as craftsman, foreman or technician.

5. Training phase	Duration (months)
A. Introductory seminar	¼
B. Petrochemical technology courses	2
C. Technical training	5
D. Organisation training	3½
E. Training with the engineering company and contractors	6
Total duration	16 3/4

Job description - Training

1. Job designation — Chief production engineer

2. Job relation — Takes orders from industrial manager

   Gives orders to plant operation and utilities superintendents

3. Duties — Based on the general guidelines and specific schedules provided by the programming division determines, co-ordinates and supervises all production activities.

   Examines proposed production programmes and schedules the activities of his department.

   - Notifies, co-ordinates and supervises his section heads
   - Checks production results daily
   - Transmits daily production results
   - Enquires about discrepancies and their causes
   - Based on assessments of results, strives for technical and cost improvements in units' performance
   - Is responsible for checking all operating instructions, especially for start-up and shut-down
   - Prepares units and specifies operating conditions for test runs

4. Job requirements

   a) General level of education
      - Master of Science degree

   b) Specialised education
      - Petrochemistry, chemistry, refining or chemical engineering

   c) Typical professional experience and requirements
      - 2 years - shift engineer
      - 2 years - head of operations
      - 1 year - head of utilities

   Thorough familiarity with installations and exact functions of each of his subordinates

   Capacity to withdraw from routine work to reflect on improvements

   Good manager with ability to delegate the maximum of responsibility to his direct subordinates

   Must ensure uniformity of personnel treatment in all sections

5. <u>Training phase</u>

Given the high responsibility attached to the position, the person must have a broad experience of petrochemistry and, if possible, of the specific job.

Recruitment could be very difficult and in case the place is not filled, one should call upon applicants who, owing to their antecedents and characteristics, are potentially able to assume this responsibility within a short time.

In any case this post must be filled by a competent person, and this may mean creating a similar post to be temporarily filled by a technical assistant.

Preparing the applicants who have the capacity to fill these posts will be done not only through a training programme, but also through the acquisition of practical experience linked to this job.

This post could also be filled through internal promotion.

Appendix F

RESEARCH AND DEVELOPMENT ORGANIZATIONS IN DEVELOPING COUNTRIES

Indonesian Petroleum Institute

Main activities:

Exploration

Engine laboratory

Techno-economic department

Asphalt blowing laboratory

Refining and petrochemistry department

Crude-oil evaluation
Techniques of separation
General testing laboratory
Propane deasphalting laboratory
Process and catalysis laboratories

Indian Institute of Petroleum

Main activities:

Crude-oil refining and processing

Evaluation of crude oils and products
Crude-oil processing studies
Speciality products studies (development of specific micro-crystallic wax, rolling oils, extender oils, secondary plasticizers for PVC)
Thermal conversion processes (visbreaking, delayed coking)
Chemical treating processes
Hydroprocessing and catalytic reforming development
Studies on catalysts and catalyst supports
Physical separation processes

Products application

Vehicle emissions and their control
Performance of fuels, lubricating oils, greases and engine components, including standard evaluation techniques
Development of indigenous test techniques for lubricants
Combustion studies
Tribological studies

Petroleum chemicals

Synthesis of polyamides
Additives for petroleum products and petrochemicals (alkylphenols)
Polybutenes
Cetane improver
Petroleum sulphonates
Basic studies on extreme pressure additives
Synthetic fatty acids
Oxidation of pseudocumene and durene
Disproportionation of toluene
Preparation of iso-octane
Methyl-ethyl-ketone and cresols from toluene
Synthesis of sulphotane
Sulphonated fatty acids
Proteins from petroleum
Synthetic lubricants

Supporting R and D work

Studies on corrosion in hydrocarbon handling and processing system
Development of instrumental and other analytical techniques
Basic studies on chemistry of crude oils
Basic studies on liquid-liquid equilibrium and new solvents
Design and development of electronic instrumental process control and measurement techniques
Process design and computer progressing

Supporting technical work

Techno-economic and pre-investment studies
Technical consultancy
Testing and technical services
Training

<u>NIOC Research Centre</u>

Main activities:

Production of petroleum-derived proteins

Quality improvements for insecticides and lubricants

Preparation of aromatics

Preparation of mulch for the stabilization of sand dunes

Preparation of leak-proof reservoirs, and irrigation canals

Perfecting of asphalt blocks

Research into protection against damp, metal corrosion, air and water pollution

Preparation of catalysts

Assessment of the properties of plastics

Determination of the properties of underground water

Perfecting of drilling mud and cement

Laboratory services

Training

<u>Mexican Petroleum Institute</u>

Main activities in the field of technical services and applied research:

Exploration Technology Division

Geology
Geophysics

Production Technology Division

Drilling fluids and cement
Drilling techniques
Well stimulation techniques
Prediction of reservoir performances
Optimum reservoir exploitation
Oil recovery processes
Corrosion problems
Automation of field installations
Economics of production problems

Refining and Petrochemical Technology Division

Pilot plants
Gas chromatography
Physical tests of petroleum
Chemical analysis
Electronic microscopy
Photographic processes

Mass spectrometry
Emission spectroscopy
X-ray methods
Nuclear magnetic and eleotron spin resonance
Ultra-violet and visible absorption method
Infrared and Ruman spectroscopy

Engineering Division

This division realizes a big share of the engineering work required by the oil and petrochemical industries in Mexioo.

Applied Research Division

Applied sciences (mathematics, physics, ohemistry)
Computing

Economics and Planning Division

This division conduots studies on specific problems posed to the Institute and also on those subjeots the Institute oonsiders to be of interest.

Information Department

Library
Information retrieval
Publioations

Quality Control Department

Main activities in the field of metals and polymers.
Servioe shops

In addition the Mexican Petroleum Institute has notable eduoational aotivities, through its Teohnioal Training Division and its Aoademic Courses Department.

Appendix G

FINANCING SOURCES AND SCHEMES: DETAILED DATA

1. The World Bank Group

Origin and Nature

The World Bank Group consists of three international financial institutions:

- The World Bank itself (formally, the International Bank for Reconstruction and Development),

  and two affiliates;
- The International Development Association (IDA);
- The International Finance Corporation (IFC).

Each of the three institutions, which closely co-operate and co-ordinate their efforts, was established to fulfil a distinct function, but all are devoted to the same general objective - the provision of financial and technical assistance for economic development.

The World Bank

Origin and Nature

Early in World War II, the economic and financial experts of the allied nations began to consider what plans could be made to help meet the economic problems of the postwar period. They recognized that attention would have to be given not only to the immediate relief and physical reconstruction of economies disrupted by the war but also to "the expansion, by appropriate international and domestic measures, of production, employment, and the exchange and consumption of goods which are the material foundations of the liberty and welfare of all peoples ...". Discussions were held on a variety of proposals that were intended to help realize these goals.

From deliberations on these plans, the outlines of two complementary financial institutions emerged. The first - to become the International Monetary Fund (IMF) - was to promote international currency stability by helping to finance temporary balance-of-payments deficits and by providing for the progressive elimination of exchange restrictions and the observance of accepted rules of international financial conduct. The second institution - to become the International Bank for Reconstruction and Development (World Bank) - was, as its name implies, to help finance the reconstruction and development of its member countries.

Types of expenditure financed

Normally, a Bank loan or IDA credit provides foreign exchange for expenditures on imported goods and services required for the execution of a project. These include the foreign-exchange element represented by the imported component of domestically produced goods and foreign expenditures under civil-works contracts with local contractors.

The Articles of Agreement also permit the Bank in "exceptional circumstances" (IDA in "special circumstances") to lend foreign exchange to finance local expenditures. The circumstances justifying this kind of lending are typically those in which a country needs more funds for its development than it can provide from its own savings or from loans from external sources other than the Bank, and where these additional funds cannot be effectively transferred by lending only for imported goods and services required by high-priority projects.

Bank loans

The Bank normally makes medium or long-term loans, with the principal repayments beginning at the end of a period of grace and thereafter spread over the remainder of the life of the loan. In establishing the length of its loans and the grace period, the Bank follows the principle that the terms should be related to the characteristics of the particular project, adjusted in appropriate cases to the prospective balance-of-payments and external-debt situation of the borrowing country. Normally, the grace period is designed to run until the project becomes operational and starts to yield economic benefits, while the calculation of the amortization period takes into account the estimated useful life of the project.

The rate of interest charged by the Bank on its loans is kept as low as is compatible with the need to maintain the Bank's financial strength and reputation. In determining the rate, due regard is given to the trend of the Bank's earnings; the maintenance of an adequate ratio of Bank earnings to interest requirements on funded debt; the maintenance of a reasonable rate of return on capital and reserves; and the accumulation of adequate reserves. The standard rate for Bank loans is presently 8.2 per cent per annum.

Interest on Bank loans is charged only on that part of a loan which has actually been disbursed. To compensate the Bank for the cost of holding funds pending their disbursement and to encourage borrowers to draw down loans promptly, a commitment charge is normally made on the undisbursed portion of a loan. This charge is now 3/4 of one per cent per annum and accrues from a date 60 days after the date of the loan agreement.

Repartition of loans

The cumulative total loans approved up to June 1977 amounted to US$ 38,610,500,000 out of which only 9.5 per cent were effected to industry. (See Table G1).

This percentage is 12 per cent for the year 1977 over a total amount of loan of US$ 5,759,300,000.

The other loans are effected to 13 other sectors of which the most important are:

	Percentage
Agriculture	17.5
Power	21.9
Development finance companies	10.4
Transportation	24.8

TABLE G1

WORLD BANK (IBRD) LOANS

PURPOSE	CUMULATIVE TOTAL OF LOANS APPROVED DURING THE 1947-1977 PERIOD		LOANS APPROVED FOR 1977	
	AMOUNTS IN 10^6US$	%	AMOUNTS IN 10^6US$	%
WATER SUPPLY AND SEWERAGE	1 344.1	3.48	262.5	4.56
AGRICULTURE	6 780.1	17.56	1 637.8	28.44
TECHNICAL ASSISTANCE	30.6	0.08	1.5	0.03
EDUCATION	1 223.9	3.17	210.1	3.65
POWER	8 454.9	21.90	784.5	13.62
NON-PROJECT	1 854.6	4.80	126.5	2.20
INDUSTRY	3 653.0	9.46	720.6	12.51
(out of fertilizers and chemicals)	(782.3)	(2.02)	(269.3)	(4.67)
POPULATION	119.6	0.31	42.5	0.74
DEVELOPMENT FINANCE COMPANIES	4 012.5	10.49	730.7	12.69
TELECOMMUNICATIONS	934.2	2.42	140.0	2.43
TOURISM	246.9	0.64	98.6	1.71
TRANSPORTATION	9 588.2	24.83	875.6	15.20
URBANIZATION	367.7	0.95	128.2	2.22
TOTAL	38 610.5	100.00	5 759.3	100.00

The International Development Association

Origin and Nature

In the late 1940s, there was already some discussion in the United Nations of the desirability of establishing an international agency which would finance development on terms exceptionally favourable to the less developed countries. This possibility was also touched on by the US International Development Advisory Board in Partners in Progress in 1951. The idea became more topical during the 1950s, when the developing countries as a whole were rapidly adding to their external debt, in many cases by increasing short-term, high-interest supplier's credits.

At the same time as the debt burden of the developing countries grew, their ability to make effective use of capital was tending to increase. The achievement of satisfactory rates of economic development, in many cases, began to require more external borrowing than could safely be provided by loans made on conventional financial terms.

In January 1960, Articles of Agreement were approved by the Executive Directors for submission to the member governments of the Bank. By September 1960, countries representing a sufficient percentage of total subscriptions had accepted the Agreement for it to come into force.

Types of expenditure financed

These are covered in paragraph under same heading above.

IDA's credits

In keeping with its directive to provide finance "on terms which are more flexible and bear less heavily on the balance of payments than those of conventional loans", IDA's development credits, to date, have virtually all been for a term of 50 years and have been interest-free. There has been no commitment charge. A service charge of 3/4 of one per cent per annum to meet IDA's administrative costs is payable on the principal amount withdrawn and outstanding. The credits have carried grace periods of 10 years before repayment has to begin. Thereafter, one per cent of the credit is repayable annually for 10 years and three per cent annually for the final 30 years.

Repartition of credits

The cumulative total credits approved up to June 1977 amounted to $ 11,397,600,000, out of which only 4.3 per cent were effected to the industry. (See Table G2).

This percentage is 1.2 per cent for the year 1977 on a total amount of credit of $ 1,307,500,000.

The other credits are effected to 12 other sectors of which the most important are:

	Percentage
Agriculture	31.9
Power	8.3
Non-project	17.6
Transportation	19.7

TABLE 62

IDA CREDITS

PURPOSE	CUMULATIVE TOTAL OF LOANS APPROVED DURING THE 1960-1977 PERIOD		LOANS APPROVED FOR 1977	
	AMOUNTS IN 10^6 US$	%	AMOUNTS IN 10^6 US$	%
WATER SUPPLY AND SEWERAGE	329.4	2.90	38.2	2.92
AGRICULTURE	3 644.1	31.97	670.1	51.25
TECHNICAL ASSISTANCE	55.4	0.50	15.4	1.19
EDUCATION	647.5	5.68	78.5	6.00
POWER	949.1	8.33	167.00	12.77
NON-PROJECT	2 010.6	17.64	90.0	6.88
INDUSTRY	494.9	4.34	16.0	1.22
(out of fertilizers and chemicals)	(423.4)	(3.71)	-	-
POPULATION	76.0	0.66	4.8	0.37
DEVELOPMENT FINANCE COMPANIES	301.7	2.65	25.5	1.95
TELECOMMUNICATIONS	470.0	4.12	-	-
TOURISM	40.2	0.35	-	-
TRANSPORTATION	2 250.9	19.75	172.0	15.15
URBANIZATION	127.8	1.11	30.0	2.30
TOTAL	11 397.6	100.00	1 307.5	100.00

The International Finance Corporation

Origin and Nature

The International Finance Corporation (IFC) was established in 1956 as an affiliate of the World Bank to assist less-developed member countries in furthering their economic development by encouraging the growth of productive private enterprise. IFC's activities supplement those of the World Bank. IFC has its own subscribed capital and is empowered to borrow funds from other sources, including the Bank.

IFC's aim is to further economic development by encouraging the growth of productive private enterprise in developing member countries. It provides equity and loan capital for private enterprises in association with private investors and management, encourages the development of local capital markets, and stimulates the international flow of private capital. In particular, it supports joint ventures which provide opportunities to combine domestic knowledge of market and other conditions with the technical and managerial experience available in the industrialized nations.

Investment criteria

IFC uses several guidelines in deciding whether to make an investment. The Corporation invests only in less-developed member countries, where sufficient private capital is not available on reasonable terms, in projects of economic priority to the country concerned, and where there are reasonable prospects of adequate returns. This means that each project should not only be a sound and profitable business, but should benefit the host country in some form - such as increasing national income, saving and/or earning foreign exchange, and creating employment.

In considering whether to make an investment, IFC does not choose between the objectives of economic priority and profitability. Rather, it makes an investment only where it is convinced that both objectives will be satisfied.

One of the generally most important criteria of a potentially sound investment for IFC is the availability of sponsors - partners - for new enterprises from among companies with proved industrial competence willing to invest in a joint venture. Experience has shown that such a partnership, which usually involves local and foreign investors, brings together elements that are, together, the best assurance of the viability of a new venture. The local investor provides knowledge of national and regional market conditions and is at home in relations with labour and government. The foreign partner brings to the association a knowledge of the newer industrial techniques as well as up-to-date management and administrative practices.

Range of investments

The range of IFC's investments is steadily broadening. Most of the Corporation's early commitments were made to help basic industries of obvious priority to developing countries, for the manufacture of iron and steel, pulp and paper, textiles, cement and machinery.

In the past few years, IFC has branched out and made investments for the first time in the fields of nickel mining, carbon black and cottonseed oil as well as making two investments to assist the development of capital markets.

IFC's credits

The IFC normally makes medium- or long-term credits.

The standard rate for IFC credits varies from 7 to 8 per cent per annum.

Repartition of credits

The cumulative total credits approved up to 1977 amounted to $ 1,711,900,000, out of which only 5 per cent were effected to the chemical and petrochemical industries. (See Table G3).

This percentage is 0.3 per cent for the year 1977 on a total amount of credit of $ 206,700,000.

The other credits are effected to 16 other sectors of which the most important are:

	Percentage
Development finance companies	11.2
Iron and steel	16.1
Mining	8.0
Pulp and paper products	8.4
Cement	11.0

TABLE 63

IFC CREDITS

PURPOSE	CUMULATIVE TOTAL OF CREDITS APPROVED DURING THE 1956-1977 PERIOD		CREDITS APPROVED FOR 1977	
	AMOUNTS IN 10^6US$	%	AMOUNTS IN 10^6US$	%
DEVELOPMENT FINANCE COMPANIES	191.8	11.20	40.7	19.70
IRON and STEEL	275.8	16.11	11.2	5.42
GENERAL MANUFACTURING	106.0	6.20	23.7	11.47
TEXTILE and FIBRES	205.3	12.00	21.0	10.16
MINING	136.6	7.98	18.5	8.95
MONEY and CAPITAL MARKETS	33.2	1.94	18.2	8.80
PULP and PAPER PRODUCTS	144.8	8.46	17.3	8.37
PUBLIC SERVICES	31.5	1.84	15.0	7.25
CEMENT	189.2	11.05	13.2	6.38
FOOD and FOOD PROCESSING	71.4	4.17	27.6	13.35
CHEMICAL and PETROCHEMICAL Products	85.2	4.98	0.3	0.15
MOTOR VEHICLES and ACCESSORIES	67.7	3.95	-	-
FERTILIZERS	60.3	3.52	-	-
TOURISM	52.4	3.06	-	-
NON FERROUS METALS	38.9	2.27	-	-
MACHINERY	14.8	0.86	-	-
OTHER	7.0	0.41	-	-
TOTAL	1 711.9	100.00	206.7	100.00

TABLE 64

REPARTITION OF THE WORLD BANK GROUP
INDUSTRIAL OPERATIONS BY SECTORS
DURING THE 1967-1971 PERIOD

PURPOSE	BANK LOANS and IDA CREDITS	IFC CREDITS	TOTAL (1+2)	DCF* PROJECTS	TOTAL (3+4)
	(1)	(2)	(3)	(4)	
CHEMICAL INDUSTRIES	47.0	25.8	32.4	8.1	18.4
OIL REFINERIES	-	2.8	1.9	0.8	1.1
DERIVATE INDUSTRIES FROM PETROLEUM AND COAL	-	7.9	-5.4	-	2.3
OTHER	53.0	63.5	60.3	91.3	78.2
TOTAL INDUSTRY: percent	100.0	100.0	100.0	100.0	100.0
TOTAL INDUSTRY: amount in 10^6US$	132.0	288.7	420.7	570.6	991.3
AMOUNT CORRESPONDING TO THE CHEMICAL INDUSTRIES and DERIVATES in 10^6US$	62.0	97.3	159.3	46.2	205.5

* DCF : *Development Finance Companies*

TABLE 85

REPARTITION OF THE WORLD BANK GROUP
INDUSTRIAL OPERATIONS BY SECTORS
FOR THE YEAR 1977

PURPOSE		BANK LOANS	IDA CREDITS	IFC CREDITS	TOTAL
FERTILIZERS and CHEMICALS		30	0	0	28
PETROCHEMICAL		7	0	3.0	6
OTHER		63	100	97.0	66
TOTAL INDUSTRY	percent	100	100	100	100
	amount in 10^6US$	720.8	18	105.2	842
AMOUNT CORRESPONDING TO THE FERTILIZERS, CHEMICAL AND PETROCHEMICAL INDUSTRIES in 10^6US$		289.3	0	0.3	289.6

The Regional Banks

Beyond the World Bank group institutions, the establishment of regional banks has emerged during the last 20 years.

- The Inter-American Development Bank (IDB) is a regional agency bank for the Latin American area. It was created on 30 December 1969.
- The Asian Development Bank (AsDB) is a regional agency bank for the Asian area. It was created on 19 December 1966.
- The African Development Bank (AFDB).
- The Caribbean Development Bank (CarDB).
- The European Investment Bank (EIB).

Functions of the regional banks

All regional development banks are basically similar. They provide funds for the financing of projects that are considered of importance to the economic development of the area they serve. They are usually owned by participating governments, although privately owned regional development banks are becoming more common. The regional banks are generally much larger than the country development institutions, but often concentrate their loans on state-owned borrowers.

The regional development bank carries out these objectives by:

- Promoting the investment of public and private capital for development purposes;
- Utilizing its own capital, funds raised by it in financial markets, and other available resources to finance the development of its member countries, giving priority to those loans that contribute most effectively to their economic growth;
- Encourage private investment in projects, enterprises and activities contributing to economic development and supplementing private investment, when private capital is not available on reasonable terms and conditions;
- Co-operating with its member countries to orient their development policies toward a better utilization of their resources, in a manner consistent with the objectives of making their economies more complementary and of fostering the orderly growth of their foreign trade;
- Providing technical assistance for the preparation, financing and implementation of development plans and projects, including the study of priorities and the formulation of specific project proposals.

Type of expenditure financed

As for the World Bank Group institutions, the ordinary capital resources are used primarily to make loans in such productive economic sectors as industry and agriculture and in such infrastructure sectors as power and transportation.

Frequently such loans are mixed with loans from non-member countries (export credits).

The loans affected to industry represent around 15 per cent of the total loans. As for the World Bank Group, the most important sectors are agriculture, power, transportation, water supply, sewage systems, and urban development.

Regional bank loans

Loans extended from the regional bank's ordinary capital resources are repayable in the currency loaned.

Amortization periods are ordinary capital loans range, in general from 7 to 20 years including grace periods, although they may extend up to 25 years for economic infrastructure projects. The current basic rate of interest is 8 per cent yearly.

In a number of cases the development banks also provide equity financing; in some they insist upon it. A good many of the development banks are also useful to international companies as underwriters and as guarantors of other loans. A large percentage have both local and foreign currencies available, the foreign funds being lent to them by the World Bank Group, and various governments.

The Arab Funds

A third type of international financing institution was established after the boom in the crude oil prices end of 1973. The oil-producing countries who have considerably increased their financial resources have promoted the Arab Fund for Economic and Social Development (AFESD).

The Council of Ministers of the Organization of Arab Petroleum Exporting Countries (OAPEC) created in November 1975 the Arab Petroleum Investment Corporation (APICORP or APIC). The objectives of the company are to participate in financing petroleum industries and projects or any other related activities, with priority given to joint Arab projects. In the fulfilment of those objectives, the company normally conducts all its operations in the member countries, but it may in certain cases participate in projects in other Arab countries.

For example, APICORP participated in a number of bond issues and loans during the first nine months of the year 1977.

- SR 100-million bond issue to the Samir refinery of Morocco;
- SR 150-million bond issue to Algeria's state-owned Compagnie Nationale Algerienne de Navigation (CNAN);
- $ 350-million loan to Qatar General Petroleum Corporation (for gas liquefaction plant);
- $ 100-million loan for the third expansion project of the Jordanian Petroleum Refinery Company;
- $ 100-million loan to the Compagnie Nationale Algerienne de Navigation. CNAN will use the loan as a partial down payment for three 125,000 cu.m. LNG tankers;
- $ 100-million loan to Algeria's national oil oompany SONATRACH. The loan will help finance the additional oosts of the Arzew LNG plant.

Government-sponsored Export Credit

Given the continuing efforts by governments of most industrialized countries to obtain a greater share of the export market, nearly every developed nation has developed its own credit institution.

On the next pages summarized information is given on the government export credits of 14 countries including details of:

- Government insurance agency
- Export credit funds
- Beneficiary of credit
- Percent of contract covered by credit
- Credit period
- Interest rate
- Insurance premium and coverage
- Fees

COUNTRY	AUSTRIA
GOVERNMENT INSURANCE AGENCY	Osterreichische Kontrollbank AG
EXPORT CREDIT FUNDS	Commercial bank
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 100 % of contract price, minus advance payments
CREDIT PERIOD	3 months to over 8 years
INTEREST RATE	Fixed rate of of 7.75 % up to 80 % of the credit, floating rates for the remaining portion.
INSURANCE PREMIUM	Of 0.125 % per quarter
INSURANCE COVERAGE	The Osterreichische Kontrollbank AG will grant coverage of the political and the commercial risks, according to quartely coverage requirement up to 100 % of the credit. In addition, Kontrollbank will charge a handling fee of 0.1 % of the guarantee with a maximum of A.S. 2,000.
FEES	0.1 % per quarter

COUNTRY	BELGIUM
GOVERNMENT INSURANCE AGENCY	O.N.D. (Office National du Ducroire)
EXPORT CREDIT FUNDS	Commercial bank
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 85 % of contract price
CREDIT PERIOD	From 2 to 10 years
INTEREST RATE	Fixed rates between 9.3 % and 9.8 %. If Government funds are available for subsiding interest rate, then net rate will be 8.25 % fixed.
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	O.N.D. (Office National du Ducroire) can grant coverage of political risk up to 95 % and commercial risk from 90 to 95 %.
FEES	Rate fixing commission : 0.2 % p.a. payable three times a year in arrears on unutilized portion of credit. For buyer's credit only : management fee : 1 % flat.

COUNTRY	CANADA
GOVERNMENT INSURANCE AGENCY	EDC (Export Development Corporation)
EXPORT CREDIT FUNDS	Commercial bank and EDC
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 85 % of contract price for goods and services of Canadian origin
CREDIT PERIOD	From 18 months to 8 years according to size and type of project
INTEREST RATE	EDC portion : fixed rates established in accordance with nature of project, length of commitment and international agreements. Commercial bank portion : floating rates based on the Canadian prime or London interbank rate.
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	EDC can grant coverage of the political and commercial risks up to 90 % of the credit.
FEES	On buyer's credit only : Management fee : variable in accordance with transaction Commitment fee : 0.5 % p.a. minimum

COUNTRY	FRANCE
GOVERNMENT INSURANCE AGENCY	COFACE (Compagnie Française d'Assurance pour le Commerce Extérieur)
EXPORT CREDIT FUNDS	BFCE and/or commercial banks
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 85 % of contract price
CREDIT PERIOD	From 18 months to 10 years from date specified in purchase contract
INTEREST RATE	Fixed rates between 7.25 % and 8 % depending on buying country and length of credit.
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	COFACE can grant the following coverage : Buyer's credit : up to 95 % of political and commercial risks Supplier's credit : up to 90 % of political risk and 85 % of commercial risk
FEES	For buyer's credit only : Management fee : 0.3 % flat minimum Commitment fee : 0.3 % p.a. minimum

COUNTRY	FEDERAL REPUBLIC OF GERMANY
GOVERNMENT INSURANCE AGENCY	HERMES credit insurance
EXPORT CREDIT FUNDS	Ausfuhrkreditgesellschaft mbH (AKA) Kreditanstalt für Wiederaufbau (KfW)
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to approximately 75 % of contract price in case of a supplier's credit and up to 100 % of the outstanding amount due to the exporter on date of drawdown (normally delivery date) in the case of a buyer's credit.
CREDIT PERIOD	No maximum term has been fixed. The duration will depend on the deferred payment period covered by HERMES credit insurance.
INTEREST RATE	AKA "A" line : variable rate depending on money market conditions (presently 7 % p.a.) AKA "B" line : variable rate of 1.5 % over the Deutsche Bundesbank rate (presently 5 % p.a.) AKA "C" line : 1. Variable rate (presently 7.25 % p.a.) 2. Fixed rate : 3 possibilities - 9 % for 5 years. After this period, if any, the fixed rate is assessed on basis of the then prevailing market conditions. Also, possibility to negotiate a change from the fixed rate to a flexible rate. - 9.5 % p.a. fixed for the whole life time of the loan. - assessment of interest rate 3 months before first disbursement on basis of the then prevailing fixed rate.

FEDERAL REPUBLIC OF GERMANY (continued)

INTEREST RATE (continued)	KfW : Supplier's credit : fixed rate 8.75 % p.a. Buyer's credit : fixed rate 8 % p.a. All variable rates payable 90 days in advance. Fixed rates in arrears.
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	HERMES credit insurance can grant coverage of political risks up to 90 % and of commercial risk up to 85 % of the credit.
FEES	AKA "A" line : Commitment fee : 0.5 % p.a. Stamp duties : 0.15 % p.a. AKA "B" line : Commitment fee : 0.1 % p.a. Stamp duties : 0.8 % p.a. AKA "C" line : Commitment fee : 0.125 % to 0.5 % p.a. KfW : Commitment fee : 0.25 % p.a.

COUNTRY	GREAT BRITAIN
GOVERNMENT INSURANCE AGENCY	E.C.G.D. (Export Credit Guarantee Department)
EXPORT CREDIT FUNDS	Commercial bank
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 85 % of contract price
CREDIT PERIOD	From 2 to 10 years
INTEREST RATE	Fixed rates between 7.25 % and 9 % payable semi-annually in arrears.
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	E.C.G.D. will grant coverage of political and commercial risks of the credit
FEES	Commitment fee : 1 % flat Negotiation fee : up to 0.2 % flat. For buyer's credit only : management fee : 0.05 % p.a. on the first £ 5 million and a smaller percentage to be negotiated on the remainder.

COUNTRY	ITALY
GOVERNMENT INSURANCE AGENCY	I.N.A. (Instituto Nazionale delle Assicurazioni)
EXPORT CREDIT FUNDS	Commercial bank
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 85 % of contract price
CREDIT PERIOD	Normally 5 years
INTEREST RATE	If Governments funds are available for subsidising commercial interest rates, then the fixed rate will amount to between 8 % and 9 %/
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	I.N.A. can grant coverage of political and of commercial risks for the whole or part of the credit
FEES	Commitment fee : 0.5 % p.a.

COUNTRY	JAPAN
GOVERNMENT INSURANCE AGENCY	M.I.T.I. (Ministry of International Trade and Industry)
EXPORT CREDIT FUNDS	Export-Import Bank of Japan
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 80 % of contract price in case of a supplier's credit and up to 85 % in case of a buyer's credit
CREDIT PERIOD	Normally 3 to 8 years
INTEREST RATE	Supplier's credit : normally the Export-Import Bank of Japan grants up to 60 % of the credit at fixed rates between 6.5 % and 8 % p.a. Commercial banks grant the remaining part of credits at fixed rate based on the long term prime rate (9.2 % p.a. at present). Buyer's credit : The Export-Import Bank of Japan singly or jointly with commercial banks grants normally 85 % of the contract price at fixed rate between 7.5 % and 8 % p.a.
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	M.I.T.I. can grant coverage of the political and commercial risks up to 90 % of the credit.
FEES	For buyer's credit only : Commitment fee : normally 0.5 % p.a.

COUNTRY	NETHERLANDS
GOVERNMENT INSURANCE AGENCY	N.C.M. (Nederlandsche Credietverzekering Maatschappij N.V.)
EXPORT CREDIT FUNDS	Export Financing Arrangement (EFA)
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 85 % of contract price
CREDIT PERIOD	Normally 5 years. In some cases, 7 to 10 years.
INTEREST RATE	Commercial rates currently vary from 9.75 % to 10.25 % p.a. fixed. If and as far as the Export financing Arrangement (EFA) applies, the interest rate may be reduced to 8.5 % p.a. fixed (August 1978).
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	N.C.M. can grant coverage of political and commercial risks up to a maximum of 90 % of the credit (exceptionally 95 %).
FEES	For certain buyer's credit : Management fee : 0.375 % to 0.5 % flat Commitment fee : 0.5 % to 1 % p.a. payable monthly.

COUNTRY	NORWAY
GOVERNMENT INSURANCE AGENCY	Garantiinstituttet for Eksportkreditt
EXPORT CREDIT FUNDS	Commercial bank
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Normally up to 90 % of contract price.
CREDIT PERIOD	Normally 5 years
INTEREST RATE	Fixed rates between 9 % and 9.5 % p.a. depending on credit-worthiness of the borrower and length of the loan.
INSURANCE PREMIUM	Premium percentage not available.
INSURANCE COVERAGE	Garantiinstituttet for Eksportkreditt will grant coverage of the political and commercial risks up to 90 % of the credit.
FEES	Commitment fee : none Management fee : none

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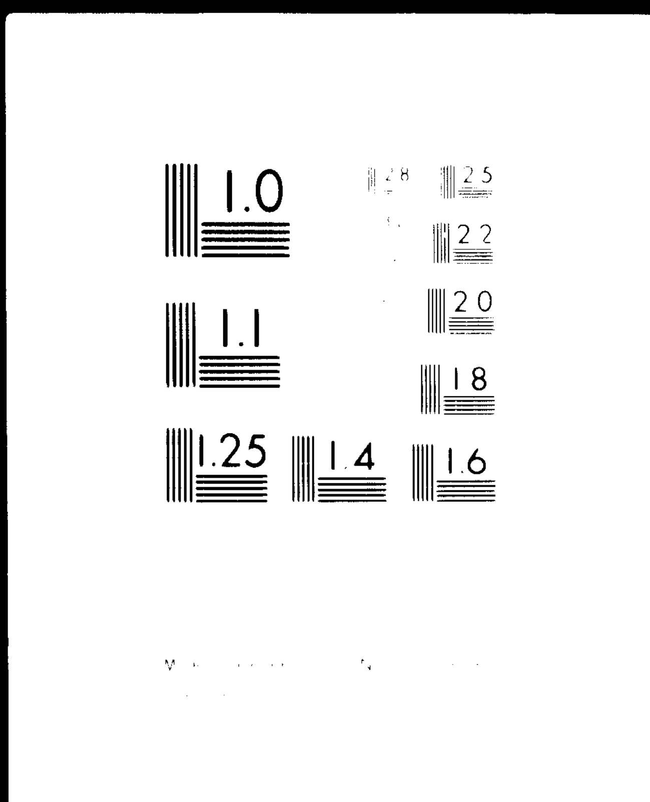

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COUNTRY	SPAIN
GOVERNMENT INSURANCE AGENCY	C.E.S.C.E. (Compania Espanola de Seguros de Credito a la Exportacion)
EXPORT CREDIT FUNDS	Commercial bank
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	80 % to 85 % of contract price in the case of a supplier's credit, and 90 % in the case of a buyer's credit
CREDIT PERIOD	Normally 5 years. Longer maturities must be specially approved by Spanish authorities.
INTEREST RATE	Normally a fixed rate of 7.5 % payable semi-annually in arrears.
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	C.E.S.C.E. can grant coverage for political risk up to 95 % and for commercial risk up to 90 % of the loan, depending on the credit standing of the borrower.
FEES	Management fee : 0.6 % p.a. to be paid on the initial amount of the credit and again on the outstanding at the beginning of each one year period.

COUNTRY	SWEDEN
GOVERNMENT INSURANCE AGENCY	E.K.N. (Exportkreditnamnden)
EXPORT CREDIT FUNDS	Svensk Exportkredit
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	80 % of contract price
CREDIT PERIOD	From 6 months to 10 years.
INTEREST RATE	Fixed rate of 10 % payable semi-annually in arrears in case
INSURANCE PREMIUM	Premium percentage not available
INSURANCE COVERAGE	E.K.N. will grant coverage of political risk up to 90 % and commercial risk up to 80 % of the credit.
FEES	Commitment fee : 0.6 % p.a.

COUNTRY	SWITZERLAND
GOVERNMENT INSURANCE AGENCY	Federal Government through "Geschäfsstelle für die Exportrisikogarantie"
EXPORT CREDIT FUNDS	Commercial bank
BENEFICIARY OF CREDIT	Supplier or Buyer
PERCENT OF CONTRACT COVERED BY CREDIT	Up to 85 % of contract price
CREDIT PERIOD	Up to 5 years (exceptionally up to 10 years)
INTEREST RATE	Fixed rates between 6 % and 7.5 % payable semi-annually in arrears, i.e. from 1.5 % to 2.5 % above interest rates of medium term notes with corresponding life issued by the banks at the date of drawdown, with adjustment according to the same formula after 5 years)
INSURANCE PREMIUM	Premium percentage not available.
INSURANCE COVERAGE	Federal Government through "Geschäftsstelle für die Exportrisikogarantie" can grant coverage of political and commercial risks up to 95 % of the credit. For privately owned buyers and guarantors, the commercial risk can be covered by private insurance companies.
FEES	None

COUNTRY	UNITED STATES
GOVERNMENT INSURANCE AGENCY	Eximbank or F.C.I.A. (Foreign Credit Insurance Association)
EXPORT CREDIT FUNDS	EXIMBANK - Commercial bank(s)
BENEFICIARY OF CREDIT	Buyer, Financing Bank or Supplier
PERCENT OF CONTRACT COVERED BY CREDIT	Normally up to 85 % of contract price for goods and services of U.S. origin.
CREDIT PERIOD	Up to $ 5 million - normally 3-5 years on a supplier credit basis. Over $ 5 million - normally 5-7 years (exceptionally 7-15 years for project credits) on a buyer credit basis.
INTEREST RATE	Supplier credits : fixed negotiated rates (normally 9 % p.a.) or floating rates (based on the U.S. prime or London interbank rates). Buyer credits : normally via participation credits :

Lenders	% of contract price	Interest
Eximbank	30-55	8.25 % to 9.5 % p.a.
Commercial bank(s)	55-30	negotiated rates
Maximum credit	85 %	
Minimum combined rate		7.5 % p.a.

UNITED STATES (continued)

INSURANCE PREMIUM

Fee/premium percentage nor available

INSURANCE COVERAGE

Supplier credits :
Eximbank or F.C.I.A. (Foreign Credit Insurance Association) can grant coverage of the political and commercial risks up to 90 % of the credit.

Buyer credits : for a fee and on a case-by case basis, Eximbank may guarantee a portion (exceptionally all) of the commercial bank(s)' portion of a participation credit.

FEES/PREMIUM

Supplier credits (3-5 years)
- Eximbank/FCIA coverage : 1%-6 % of credit amount
- Other costs : on a negotiated basis.

Buyer credits :
- Eximbank guarantee : 0.75 % to 1.5 % p.a. plus 0.125 % p.a. commitment fee.
- Other costs (including commitment and management fees and letter of credit commissions) : on a negociated basis.

Compensation deals

Barter trading, the original means of exchanging goods since primitive times, is making a big comeback in East-West trade. It first resurfaced after the Second World War but it wasn't until the early 1970s that it began to attain its present importance. Because of its nature, the chemical industry is particularly suited to this form of trade. Although exact comparisons are lacking, simple observation leads to the conclusion that most contracts for chemical plant construction in eastern Europe nowadays contain provisions for payment in goods and, more often than not, products from the particular plant in question. The former is clearly barter trading, the latter a specialized form of it known as buy-back or compensation agreements.

It is easy to see why these arrangements are so attractive to the East. They enable industrial development to proceed at a pace unhindered by the availability of hard currency. Moreover, precious reserves of foreign exchange can be conserved for those overseas purchases for which there is no alternative. Although these considerations are clearly paramount, there are other beneficial side effects: investment in the East bloc is presently geared towards exportable production and to have part of a plant's output already sold in the West at the time of the signature of the contract for its construction is the best proof there is that a market exists for the product. Having a Western partner, who might be an experienced trading firm or, in the case of technology licensors and sometimes the contractor's parent company, a producer, can also help ease the product into a very highly competitive market.

Attitudes within the various Eastern countries clearly differ as to the relative importance of these factors. The Soviet Union, which sees these agreements as a way to ensure speedy development of its vast raw material resources, nowadays tends to seek 100 per cent compensation in most negotiations. Bulgaria, it is said, is so enthusiastic about compensation agreements that it once asked somewhat ambitiously for 200 per cent compensation. Hungary, on the other hand, claims to dislike them on principle but says a Western partner is necessary to break into Western markets. So far only China has led out against them, preferring a purely autarkic pace of development. China only accepted the principle of buyer's credit comparatively recently and before that was quite content to pay cash.

In the West, however, there has always been resistance to compensation trading. The reason why it came into such widespread use in the early seventies was mainly due to the low level of investment in the West, which turned the contracting business into a buyer's market, enabling the Eastern countries to set their own terms for repayment. Governments in the West have also been quick to pursue plant deals at any price, by opening up cheap lines of credit without any real attempt to assess: the benefits accruing from the increased business. This seems to have been motivated partly by a desire to accelerate the process of detente and also, it must be said, partly for internal political kudos. Prime examples of the latter are the £950m. credit line opened to the Soviet Union by the then British Prime Minister, Harold Wilson, in 1975 and the various trade deals announced by the French government in a blaze of publicity but still yet to take concrete form.

COMECON's rapidly rising debts to the West, estimated at some $40 billion, make further borrowing difficult and compensation agreements are a way out. Experts predict that by 1980 these debts will still double, which clearly indicates that compensation trade is here to stay for a while yet, and even companies which have resisted locking themselves into these agreements are beginning to do just that.

As the scale and frequency of compensation agreements has increased, particularly during the recent recession, concern has steadily been mounting over their possible long-term effects. A number of authorities are now seriously worried that they carry ominous undertones for investment and employment prospects in Western markets. As might be expected, manufacturers whose markets are likely to be affected head the list, but the concern spreads far wider than this to now include, belatedly, national governments and trade unions. The real results cannot fully be seen yet as these trade deals are only now coming to maturity. The real test is likely to come next year when the largest of them - the $ 20 billion occidental petroleum fertilizer deal with the Soviet Union - starts to come into effect. Many see this as a barometer for the future.

Though serious enough by itself, the threatened invasion of Western markets by imports from eastern Europe is merely the forerunner of a much larger problem. Whereas the Eastern countries are themselves large and rapidly expanding markets which will ultimately be in a position to absorb their own production - the same cannot be said of the next large buyers of chemical plant - the oil rich middle eastern countries. Their investment drive stems from the availability of feedstocks and the wish to broaden their industrial base, rather than the need to supply an expanding home market. Fed with cheap raw materials and planned with scant regard to the reality of the growth in demand, exports of base chemicals from the Middle East could be a destabilizing influence on the market for years to come. (Extracted from ECN, July 1977).

Examples of compensation deals signed with the Soviet Union on petrochemical complexes are shown in Table 65 below.

Actual Cases

On the next pages actual cases of petrochemical complexes are presented.

In the first series of tables the following information are summarized:

- Type of project
- Company names
- Joint venture information
- Loan origins
- Contractor names
- Total investment cost.

Of the cases summarized in the above tables, the following are developed:

Brazil	-	COPENE
Brazil	-	PETROQUIMICA UNIAO S/A
Venezuela	-	I V P (EL TABLAZO)
Qatar	-	QAPCO
Turkey	-	PETKIM (ALIAGA)
Morocco	-	SNEP
Portugal	-	CNP EPSI (SINES)
Philippines	-	PNOC APDC
USSR	-	SOUZCHIMEXPORT/SOYUZNEFEXPORT

TABLE G6 MAJOR COMPENSATION DEALS SIGNED WITH THE SOVIET UNION

COMPANY	YEAR SIGNED	DESCRIPTION OF CONTRACT	VALUE	PRODUCTS TO BE TAKEN BACK	YEAR PRODUCTS WILL START COMING IN
SALZGITTER, West Germany	1972	Supply of 120 000 t/year low density polyethylene plant for Kazan	DM 126 m.	Repayment in low density polyethylene. Between 150-250 000 tons in total. Bochako markets production in the West. Until 1983/84.	1971
SALZGITTER, West Germany	1973	Supply fo 240 000 t/year low density polyethylene plant for Severodonetsk	DM 174 m.	Marketing by Bochako of 250-350 000 tons of low density polyethylene in the West. Until 1986.	1978
LITWIN, France	1973	Supply to the USSR of plants to produce 300 000 t/year styrene, 100 000 t/year high impact polystyrene and 100 000 t/year expandable polystyrene for Shevchenko	$ 120 m.	Polystyrene to be bought back over a period of 8.5 years beginning in 1979. At present prices the deal works out at around 24 000 t/year polystyrene	1979
MONTEDISON, Italy	from 1973	Supply to the USSR of several plants to be repaid in product. So far the company signed for 11 plants. the original 7 were valued at $500 m. By now the value is thought to be in the region of $800 m. The plants include : 42 000 t/year cellulose triacetate at Fergana for completion 1977 ; 30 000 t/year polypropylene, Guryev (1977) ; 270 000 t/year sodium chloride crystallization,	$ 800 m.	250 000 t/year of ammonia to be received back as well as a "symbolic" amount of acrylonitrile and some urea	1981

TABLE G6 MAJOR COMPENSATION DEALS SIGNED WITH THE SOVIET UNION, continued

COMPANY	YEAR SIGNED	DESCRIPTION OF CONTRACT	VALUE	PRODUCTS TO BE TAKEN BACK	YEAR PRODUCTS WILL START COMING IN
MONTEDISON, Italy (con.)		Sterlitamak (1977) ; 500 000 t/year urea, Gorlovka (1978) ; 150 000 t/year acrylonitrile, Saratov (1978) ; 40 000 t/year chlorofluoromethanes, Yavan (1979) ; 100 000 t/year poly-triacetate at Fergana for completion 1977 ; 30 000 t/year polypropylene, Guryev (1977) ; 270 000 t/year sodium chloride crystallization, Sterlitamak (1977) ; 500 000 t/year urea, Gorlovka (1978) ; 150 000 t/year acrylonitrile, Saratov (1978) ; 40 000 t/year chlorofluoromethanes, Yavan (1979) ; 100 000 t/year poly-propylene, Tomsk (1980) ; 500 000 t/year urea, Berezniki (1979) ; 500 000 t/year urea, Kemerovo (1979) and a 5 000 t/year dyestuffs complex			
KLOCKNER, West Germany	1975	Supply to the USSR of 250 000 t/year PVC plant for Zima	DM 154 m.	To be repaid with 10 000 t/year of vinyl chloride monomer for 10 years beginning in 1977 also 8 000 t/year PVC for 10 years starting in 1980.	1977
SNIA VISCOSA, Italy	1975	Supply to the USSR of 80 000 t/year caprolactam plant based on toluene to be located near Tashkent	$ 180 m.	To be repaid in caprolactam. At current prices the amount should be over 200 000 tons.	1980/81
KLOCKNER/DAVY POWERGAS GmbH, West Germany	1976	Supply to the USSR (Perm) of a 60 000 t/year phthalic anhydride plant and a 3 000 t/year fumaric acid unit. Also catalyst plant.	DM 100 m.	Repayment with 5 000 t/year of phthalic anhydride, 3 000 t/year fumaric acid (total amount of plant) and 15 000 t/year of urea over a period of 10 years.	1980

TABLE G6 MAJOR COMPENSATION DEALS SIGNED WITH THE SOVIET UNION, continued

COMPANY	YEAR SIGNED	DESCRIPTION OF CONTRACT	VALUE	PRODUCTS TO BE TAKEN BACK	YEAR PRODUCTS WILL START COMING IN
KLOCKNER/DAVY POWERGAS GmbH, West Germany	1977	Supply to the USSR (Rubezhnoye, Donetsk) of 60 000 t/year of phthalic anhydride plant and 3 000 t/year maleic anhydride plant.	DM 100 m.	Repayment with 5 000 t/year of phthalic anhydride, also 3 000 t/year maleic anhydride (total plant capacity) and 15 000 t/year of urea over 10 years.	1980
SALZGITTER, West Germany	1976	Construction in the USSR (Gorkii) of a 200 000 t/year ethylene oxide plant	DM 200 m.	Repayment mainly in mono ethylene glycol, some other chemicals as well. Until 1989.	1979
TECHNIP, France	1976	Construction in the USSR (Omsk and Ufa) of two aromatics complexes each producing 125 000 t/year benzene, 165 000 t/year orthoxylene and 165 000 t/year paraxylene	$ 500 m.	The original contract provides for the purchase over a period of 10 years of : orthoxylene 20 000 t/year } fixed paraxylene 20 000 t/year } tonnage benzene 50 000 t/year } flexible diesel oil 290 000 t/year } part naphtha 250 000 t/year }	1980/81
RHONE-POULENC, France	1976	Signed a three part agreement with the USSR : 1. Sale to the USSR of technology and equipment to produce pesticides, fertilizers to the value of FF 2.5 billions 2. Receive chemicals from the USSR to the value of FF 2.5 billions over a period of 10 years beginning in 1980.	Total value FF 6 billions	Deliveries of oil products including naphtha as well as some chemical products. These will include about 40 000 t/year of ammonia from the Creusot Loire deal, methanol and orthoxylene. The company is still in negotiations on this.	1980

TABLE G6 MAJOR COMPENSATION DEALS SIGNED WITH THE SOVIET UNION, continued

COMPANY	YEAR SIGNED	DESCRIPTION OF CONTRACT	VALUE	PRODUCTS TO BE TAKEN BACK	YEAR PRODUCTS WILL START COMING IN
RHONE-POULENC, France (con.)		3. Sale to the USSR of Rhône-Poulenc products to the value of FF 1 billion. So far Speichim signed a contract with the USSR to use Rhône-Poulenc technology in fertilizer plants (value FF 450 m.) and Krebs in phosphoric acid plant (value FF 90 m.).			
C J B , United Kingdom	1977	Construction of a 200 000 t/year high density polyethylene plant in Kazan based on Union Carbide technology. Neither company involved in buy-back. A third party will market production in the West.	£ 50 m.	Third party to market the product, about 160 000 tons in total	1981
KRUPP-KOPPERS, West Germany	1976	Supply to the USSR of a 60 000 t/year dimethylterephthalate plant for Mogilev. Licensor Dynamit Nobel	DM 150 m.	Products involved : DMT, paraxylene and other petrochemical products. Dynamit Nobel will take a small amount of DMT, also paraxylene and other petrochemical products.	1981
UHDE/HOECHST, West Germany	1977	Supply of 35 000 t/year of polyester staple fibre plant for Mogilev. First one in a series of 230 000 t/year total capacity.	DM 140 m.	Products involved : DMT, paraxylene methanol, crude cotton. Brenntag will market DMT, paraxylene, methanol and other products. Adix und Cordes will market crude cotton. Hoechst will take products it can use in own plants including DMT, paraxylene and others.	1980/81

TABLE G6 MAJOR COMPENSATION DEALS SIGNED WITH THE SOVIET UNION, continued

COMPANY	YEAR YEAR SIGNED	DESCRIPTION OF CONTRACT	VALUE	PRODUCTS TO BE TAKEN BACK	YEAR PRODUCTS WILL START COMING IN
DAVY POWERGAS/ICI/ KLOCKNER, United Kingdom	1977	Construction in the USSR (Gubakha and Tomsk) of two 2 500 t/day methanol plants based on ICI technology	over $ 250 m.	ICI and Klöckner will market about 300 000 t/year of methanol over a period of 10 years. Of the 300 000 t/year about 200 000 t/year will be used in the United Kingdom. For the first two years (1981-82) a minimum of 280 000 t/year will be shipped in.	1981

PROJECT	CAPACITY tons/year	COUNTRY	SITE LOCATION	COMPANY	JOINT VENTURE BETWEEN Company's name (foreign)	%	Company's name (local)	%	LOANS Country origins	%	Amount in US$	CONTRACTOR	TOTAL INVESTMENT COST in US $
PETROCHEMICAL COMPLEX Steam cracker	(1) 120 000 (1) 200 000	ARGENTINA	BAHIA BLANCA	SAI and C	Private capital	43	Argentin Government	[illegible]					
Downstream units					Private capital	[illegible]	Argentin Government	[illegible]					
PETROCHEMICAL COMPLEX Steam cracker Pygasoline hydro. Butadiene extract. Aromatics extract.	 420 [illegible] 400 [illegible] [illegible] 14[illegible]	BRAZIL	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	
PETROCHEMICAL COMPLEX	(1) 380 000	BRAZIL		PETROQUIMICA DO NORDESTE SA COPENE	Ordinary shares Cr$x10^6 750 USERS 33% foreign Preferential shares Cr$x10^6 [illegible] USERS 33% foreign	 45.[illegible] 39.63	PETROQUISA PETROQUISA FINOR OTHERS	[illegible]	[illegible]		[illegible] $		
PETROCHEMICAL COMPLEX	300 000	BRAZIL		PETROQUIMICA UNIAO SA	International Finance Corp. Bamerical Intern. Finance Corp. Citicorp Venture Capital Ltd Provident Intern. Corp.	[illegible].58 [illegible].72 [illegible] [illegible]	PETROQUISA UNIPAR	[illegible]	[illegible]		[illegible] $		

PROJECT	CAPACITY tons year	COUNTRY	SITE LOCATION	COMPANY	JOINT VENTURE BETWEEN Company's name (foreign)	%	Company's name (local)	%	LOANS Country origins	%	Amount in US$	CONTRACTOR	TOTAL INVESTMENT COST in US$
[illegible] COMPLEX													
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ATL Chemie or DOW Chemical	n.a.	[illegible]	n.a.					[illegible]
Potash	300-350 000												
PETROCHEMICAL COMPLEX		MOROCCO	MOHAMMEDIA	[illegible]			[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
[illegible]							SAMIR	[illegible]	[illegible]				
VCM PVC	25 000						BRPM						
							ZALIDIA	[illegible]					
							BNDE	[illegible]					
PETROCHEMICAL COMPLEX		PORTUGAL	SINES				C.N.P.(B.)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Steam cracker	[illegible]			C.N.P.(B.)					FRG credit	[illegible]		[illegible]	
Polyethylene	[illegible]			[illegible]					[illegible]	[illegible]			
					CdF CHIMIE	28	C.N.P.(B.)	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible] polyethylene	60 000			EPSI								[illegible]	[illegible]
Polypropylene	50 000			EPSI									
PETROCHEMICAL COMPLEX		TURKEY	ALIAGA	PETKIM PETROKIMYA									
Steam cracker	[illegible]								[illegible]	[illegible]	[illegible]		
[illegible] polyethylene	[illegible]								UK credit	4[illegible]	48 [illegible]	STONE&WEBSTER	[illegible]
Phthalic anhydride	30 000								[illegible]		[illegible]	[illegible]	[illegible]
Others									[illegible]			[illegible]	[illegible]
													[illegible]

PROJECT	CAPACITY tons/year	COUNTRY	SITE LOCATION	COMPANY	JOINT VENTURE BETWEEN Company's name (foreign)	%	Company's name (local)	%	LOANS Country origins	%	Amount in US$	CONTRACTOR	TOTAL INVESTMENT COST in US$
PETROCHEMICAL COMPLEX Steam cracker	(1) 280 000	QATAR	UMM SAID	QAPCO	CdF Chimie	16	Qatar General Petroleum	84	[illegible]	[illegible]	[illegible]	[illegible]	
LD polyethylene General services utilities	140 000					16		84	Arab [illegible]	[illegible]	[illegible]	[illegible]	
PETROCHEMICAL COMPLEX	(1) 450 000	SAUDI ARABIA	JUBAIL		EXXON [illegible]	50	SABIC	[illegible]					
PETROCHEMICAL COMPLEX	(1) 450 000	SAUDI ARABIA	JUBAIL	[illegible] PETROCHEMICALS	PE[illegible] ARABIAN [illegible]	[illegible]	SABIC	[illegible]					
PETROCHEMICAL COMPLEX	(1) 450 000	SAUDI ARABIA	JUBAIL		DOW [illegible] CHEMICAL	[illegible]	SABIC	[illegible]					
PETROCHEMICAL COMPLEX	(1) 450 000	SAUDI ARABIA	YANBU		MOBIL [illegible]	50	SABIC	[illegible]					
PETROCHEMICAL COMPLEX Steam cracker LD polyethylene HD polyethylene Polypropylene	(1) 175 000 2x55 000 2x27 000 1x60 000	PHILIPPINES	BATAAN	[illegible]	[illegible] Taiwan [illegible] Taiwan [illegible] Japan	4[illegible] 4[illegible] 4[illegible]	PNOC [illegible] PNOC [illegible] Other Philippine [illegible]	[illegible]	[illegible]				

PROJECT	CAPACITY tons/year	COUNTRY	SITE LOCATION	COMPANY	JOINT VENTURE BETWEEN Company's name (foreign)	%	Company's name (local)	%	LOANS Country origins	%	Amount in US$	CONTRACTOR	TOTAL INVESTMENT COST in US$
[illegible]	[illegible]	SINGAPORE		[illegible] SINGAPORE [illegible] CHEMICAL COMPANY	Holding of 33 Japanese firms with SUMITOMO as leader 30 % is financed by the FOND de COOPERATION ECONOMIQUE D'OUTRE MER	50	SINGAPORE GOVERNMENT	50				[illegible]	
[illegible]	4[illegible]	Romania	BLACK SEA	[illegible]	KUWAIT Government	49	Romanian Government	51					
[illegible] COMPLEX	[illegible]	USSR	[illegible]	[illegible] APORT and [illegible] APORT					French credit [illegible] associated to a "COMPENSATION DEAL" [illegible] Italian credit		[illegible]	[illegible]	[illegible]
[illegible] COMPLEX	[illegible] 48 000	CHINA	LIAOYANG						French supplier's credit COFACE		260 [illegible]	[illegible]	[illegible]

PROJECT	CAPACITY tons/year	COUNTRY	SITE LOCATION	COMPANY	JOINT VENTURE BETWEEN Company's name (foreign)	%	Company's name (local)	%	LOANS COUNTRY ORIGINS	%	AMOUNT IN US$	CONTRACTOR	TOTAL INVESTMENT COST IN US$
[illegible]	[illegible]	VENEZUELA	VALENCIA	[illegible]	PHILLIPS INVEST[illegible]	[illegible]	I.V.P. [illegible] Inversiones Shell Inversiones Venez[illegible]	[illegible]					
[illegible]	[illegible]	VENEZUELA		[illegible]	DART INDUSTRIES	[illegible]	I.V.P. [illegible] Grupo Zuliano	[illegible]					
[illegible]	40[illegible]	VENEZUELA		[illegible]	[illegible]	50	I.V.P. [illegible] Grupo Zuliano	[illegible]					
	[illegible]	VENEZUELA		[illegible]	The [illegible]	[illegible]	I.V.P. [illegible] Empresa Nacional de Salinas	[illegible] [illegible]					
[illegible]	[illegible]	COLOMBIA	BARRANQUILLA	[illegible]	STAMICARBON N.V. Holanda	18.78	I.V.P. [illegible] Empresa Nacional de Salinas Venezolana Empresa Colombiana de Petroleo Instituto de Fomento Industrial Colombia	[illegible]					
[illegible]	[illegible]	SPAIN	TARRAGONE	[illegible]									

PROJECT	CAPACITY tons/year	COUNTRY	SITE LOCATION	COMPANY	JOINT VENTURE BETWEEN Company's name (foreign)	%	Company's name (local)	%	LOANS COUNTRY ORIGINS	%	AMOUNT IN US$	CONTRACTOR	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	JAPANESE GROUP Mitsui&Co 45% Toyo Soda 30% Mitsui Toatsu 15% Mitsui Petro[illegible] [illegible]% Japa[illegible] [illegible]%	50	[illegible]	[illegible]				[illegible]	
[illegible]lyester fibre		ROMANIA							[illegible]				

N O T E S

(1) Tons of ethylene

(2) SABIC (Saudi Basic Industries)

(3) IJPC (Iran Japan Petrochemicals Company)

(4) NPC (Iran's National Petrochemicals Company)

(5) NPC (National Petrochemical Corporation)

(6) French export buyer credit promoted by WORMS and BFCE Banks led by CIAVE Paris with COFACE insurance

(7) English export buyer credit promoted by HILL SAMUEL Bank led by CIAVE London with ECGD insurance

(8) C N P (Compania Nacional de Petroquimica)

(9) PNOC (Philippines National Oil Company)

(10) I V P (Instituto Venezolano de Petroquimica)

(11) APICOR credit (Arab Petroleum Investment Corporation)

(12) I B R D (International Bank for Reconstruction and Development)

(13) I D B (Inter-American Development Bank)

(14) French credit (French export buyer credit with COFACE insurance)

(15) International export credits (5 or 7 foreign export buyer credits)

(16) French credit (French credit buyer credit promoted by BNP with COFACE insurance)

(17) B N D E credit (Brazilain credit)

(18) French export buyer credit of US$ 110,000,000 promoted by PARIS et PAYS BAS Bank with COFACE insurance and a French export commercial credit of US$ 27,000,000

(19) French export buyer credit of US$ 310,000,000 promoted by CREDIT LYONNAIS within the framework of the Governmental agreement "FRANCO-RUSSE".

PROJECT	CAPACITY T/year	COUNTRY	SITE LOCATION	COMPANY	CONTRAC-TOR	TOTAL INVESTMENT cost in US $
Petrochemical complex		ALGERIA	SKIKDA	SONATRACH		
Ethylene	500.000				KTI	
PVC	35.000				TEC	
VCM	40.000				TEC	
Xylene, para	38.000				SNAM	
Aromatics extraction	95.000				SNAM	
Petrochemical complex		LIBYA	TOBRUK	N.O.C.		1 000 000 000
Ethylene	330.000				S & W	
Styrene	175.000				"	
Polyethylene ld	100.000				"	
Polyethylene hd	50.000				"	
Petrochemical complex		IRAQ	BASRAH	M.I.		1 000 000 000
Ethylene	138.000				Lummus/ Thyssen	
PVC	60.000				"	
VCM	66.000				"	
Polyethylene ld	60.000				"	
Polyethylene hd	30.000				"	
Petrochemical complex		INDIA	BARODA	INDIAN PETROCHEM.		300 000 000
Gasoline hydrotreater	110.000				Engr.Ind.	
Acrylonitrile	31.000				EI/Badger	
Benzene	24.000				EI/Procon-france	
Ethylene	130.000				EI/Lummus	
Ethylene glycol	20.000				EI/SD	
thylene oxyde	5.000				EI/SD	
Polybutadiene	20.000				EI/Polysar	
Polypropylene	30.000				EI/Technip	
DMT and xylene	26.000	INDIA	BENGAI-GAON	BENGAI-GAON Rfy & Pe-trochem.	Engr.Ind.	
Petrochemical complex		MEXICO	CANGRE-JERA	PETROLEOS MEXICANOS		300 000 000
Ethylene	500.000				IMP/Lummus	
Ethylene oxide	100.000				Bufete/SD	
Styrene	150.000				IMP/Lummus	
Toluene	371.000				Fluor	
Xylene, Meta	130.000				-	
Xylene, Ortho	55.000				Fluor	
Xylene, Para	240.000				Fluor	
Polyethylene ld	240.000				Sim-Chem	

Foreign Loans required to Finance the Petrochemical Industry in the Developing Countries

In order to evaluate the amount of foreign loans required to finance the petrochemical industry in the developing countries, the first approach to the problem is to fix the foreign currency part of investment in relation to the degree of development in the developing countries.

In the second place, the foreign loan amounts will be evaluated from the foreign currency parts.

Evaluation of Local and Foreign Currency Portions

Petrochemical industry investment cost breakdown

The petrochemical industry investment cost breakdown is as follows:

	Percentage		
	From	To	Average
Material and equipment FOB	50	35	42
Transport FOB to site	5	5	5
Erection works	20	30	25
Civil works	10	15	13
Engineering services	15	15	15
TOTAL	100	100	100

Local and foreign currency portions

As indicated in the above table, the breakdown between the local and foreign currencies will depend mostly on the capability of the developing countries to manufacture equipment and perform erection works.

In a first approach, the developing countries can be classified according to three industrialization levels depending on whether their industrial development started:

- during the last ten years
- at least ten years ago
- at least fifteen years ago.

Other criteria have also influenced the level of industrialization in the developing countries, such as the relative degree of development of the different industrial activities.

The local and foreign currency portions evaluated for three industrialization levels are shown below.

	<10 years			From 10 to 15 years			>15 years		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Material and equipment FOB	42	0	0	42	20	8.5	42	45	19
Transport FOB to site	5	50	2.5	5	50	2.5	5	70	3.5
Erection works	25	36	9	25	60	15	25	90	22.5
Civil works	13	92	12	13	100	13	13	100	13
Engineering services	15	10	1.5	15	20	3	15	45	7
	100			100			100		
Average local currency portion			25			42			65

Local currency variations 15 to 35% 35 to 50% 50 to 80%

Foreign currency variations 85 to 65% 65 to 50% 50 t 20%

(1) *investment price breakdown*

(2) *local currency value*

(3) = (1) x (2)

Total Foreign Loan Amounts required to Finance the Petrochemical Industry in the Developing Countries

Evaluation of foreign currency amounts

This evaluation is made for the year 1978 on the basis of the investment cost presented in chapter 4.2.5.

(a) Investment cost for the year 1978

In 10^9 US$

	1977 to 1980 (from § 4.2.5)	For 1978
Latin America	5.9	1.6
Africa	1.[illegible]	0.3
Middle East	2.2	0.6
South Asia	2.4	0.7
East Asia and Pacific area	0.9	0.3
Total	16.1	4.5

(b) Foreign currency amounts

	GNP per capita 76 US$	FOREIGN CURRENCY PERCENT IN TOTAL INVESTMENT — Industrialization periods: < 10 years	10 to 15	> 15 years	Investment cost in 10^9 US$	Foreign currency amounts in 10^9 US$ From	to
LATIN AMERICA	970			20 to 50	1.6	0.3	0.8
EAST ASIA and PACIFIC AREA	360	65 to 85			1.3	0.8	1.1
MIDDLE EAST	(1) 300	65 to 85			0.6	0.4	0.5
AFRICA	(2) 300	65 to 85			0.3	0.2	0.25
SOUTH ASIA	140		65 to 50		0.7	0.35	0.45
				TOTAL	4.5	2	3.1

(1) *Excluding IRAN, SAUDI ARABIA and UNITED ARAB EMIRATES*

Including IRAN, the GNP per capita increases from 300 to 750 US$

(2) *Breakdown* : NORTH AFRICA US$ 680 (TUNISIA, ALGERIA, MOROCCO)
WEST AFRICA US$ 330
EAST AFRICA US$ 175

Foreign Loan Amounts

Usually in Europe, export credits at the preferred interest rates cover 85 per cent of the foreign currency portion leaving the rest for financing by commercial banks. Therefore, 100 per cent of the foreign currency portion can be financed by loans.

From the above table the total amount of foreign loans required to finance the petrochemical industry in the developing countries will vary from US$ [illegible] to [illegible] billion for the year 1978.

APPENDIX [illegible]

REPORTED DEVELOPMENT POLICIES IN DEVELOPING COUNTRIES

[illegible]	[illegible]	[illegible]	[illegible]	[illegible] measures [illegible]	[illegible] difficulties [illegible] establishing a petrochemical industry	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] petrochemical [illegible]	[illegible] supporting [illegible] Research [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	The [illegible] size [illegible] plants; [illegible] difficulty of exporting. The capital-intensive nature [illegible] the [illegible] The heavy [illegible] of research. The necessity for [illegible]	[illegible] supporting [illegible] as	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] balance of payments		[illegible] market development through development of petrochemical [illegible] plastics [illegible] and polyesters [illegible] development of market through [illegible] Trade Association (AFTA) [illegible] encourage [illegible] make possible the economic utilization [illegible] raw materials	[illegible] was taken [illegible] polyester [illegible]

[illegible]	Population	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
		Average Annual Rate of Growth of Manufacturing Output [illegible]	Share of Manufacturing [illegible]					
			1960 %	[illegible] %				
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	6.4	[illegible]		[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]			Reported [illegible] Reasons [illegible] priority to the petrochem[illegible] industry	Reported difficulties in establishing a Petrochemical Industry	[illegible] Measures used for establishment of the Petrochemical Industry	[illegible]
		Average Annual Rate of Growth of Manufacturing Output 1960-1970	Share of Manufacturing Output in GDP 1960 %	1970 %				
[illegible]	[illegible]	4.9	[illegible]	[illegible]	[illegible] absence [illegible] and [illegible]	[illegible] raw material [illegible] limited [illegible] facilities owing to the limited cracking and [illegible] capacity.	Incentives [illegible] Import of additional raw mater[illegible] machinery, against [illegible] customs and excise [illegible] tax concession [illegible] export earnings [illegible] for investment [illegible] exemption from tax [illegible] new industrial [illegible] additional [illegible] allowances, exemption on income tax [illegible] between [illegible] facilities [illegible] remittance [illegible] withdrawal of foreign capital.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] reserves of natural gas can be used as feedstocks [illegible] important means of increasing [illegible] and [illegible] foreign trade.			[illegible]
BURMA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] its products will be [illegible]		To [illegible] use of fertilizers more or less [illegible] required [illegible]	

Appendix I

ENVIRONMENTAL PROBLEMS IN THE PETROCHEMICAL INDUSTRY

Summary

This presentation is designed to give an overview of environmental problems in the petro-chemicals industry and their effective management. It is intended for those technical persons responsible for planning and managing petro-chemicals plants in developing countries. An environmental impact evaluation procedure raises the key environmental questions that should be dealt with in the initial stages of planning a new petrochemical plant. Pollution regulations and the importance of maintaining pollution control standards are briefly discussed. Sources are given for detailed regulations as applied by developed countries.

The problems of air and water pollution are covered in depth, as are the technical means of combating these problems. Economic costs of reducing pollutant emission levels are indicated for many air pollution solutions used in certain chemical processes, and the overall costs of treating plant waste-water in activated sludge and anaerobic-aerobic treatment procedures are given.

EVALUATING THE ENVIRONMENTAL IMPACT OF A NEW PETROCHEMICALS PLANT

The purposes of evaluating environmental impact are two-fold:

(1) To prevent the deterioration of natural resources, such as the river which is to receive plant waste waters, so that these resources can continue to provide a basis for further economic development; and

(2) To give ample warning of deleterious side effects of the projects, which may result in economic or social costs not normally identified in the project review procedure.

The following guidelines, adapted from General Reference 1, are applicable from the raw material phase of a project through construction to the final disposal of the material produced. The definitions of guideline steps are:

1. Raw materials linkage: Considerations from extraction or arrival in country to project under evaluation;
2. Site assimilative capacity: Present or baseline analysis of air, land and water carrying capacity to determine original conditions and project's effects;
3. Project design and construction: Analysis of alternative possibilities for unit operations and energy sources;
4. Operations: Maintenance of project and monitoring (analysis of outputs, including byproducts and wastes for treatment and reuse; monitoring waste discharges);
5. Social aspects: Social implications of project;
6. Health aspects: Safety and welfare of population affected by plant;
7. Final resting place: Recycling, reuse or assimilation of product and future products;
8. Long-term considerations: Plant expansions;
9. Optimization: Cost analysis of alternatives.

The environmental impact procedure is presented in part through the posing of key questions to the planner or engineer in the developing country who is responsible for project planning.

Step 1: Raw materials linkage: This step includes environmental considerations from the original extraction of the raw material to the time it enters the projected plant. If the material is an import, the linkage may start with its arrival in the country. The raw materials would include all organic materials, such as liquid, solid and gas fossil fuels, and other organics not used for fueling, including crude oil.

An example of the linkage can be seen in a decision to fund a naphtha cracker to produce feedstock for polyethylene. The linkage would begin with the drilling of a well or with the arrival of the crude at the seaport, go through the refining process to separate the naphtha fraction by distillation, and then follow on to the building of the cracker, which is the actual project under construction. The particular problems to be considered in this linkage would be oil spillage, oil storage and transportation, and the refinery operations. The refinery would produce a range of gases, liquids and solids, of which the naptha feedstock would be only a small part. Plans for the treatment and disposal of the full range of waste materials should be formulated at the same time.

Question 1a.

Does a comprehensive development plan link the project to environmental aspects of raw materials, byproducts utilization, shipping and processing?

Step 2: Site assimilative capacity: The purpose of this guideline is to analyse and interpret the natural resource characteristics of a proposed site for ability to sustain an industrial project's environmental impact. Environmental parameters relating to water, land and air should be inventoried and interpreted to indicate likely project impact on the local ecosystem. Direct and indirect effects should be assessed within the guideline framework both for the local site as well as the regional environment.

Site assimilative capacity should not necessarily be constrained only to the localized environmental impact of an industrial project. Local and regional natural resource characteristics such as the river which will receive project waste waters should be assessed for assimilative capacity. Proposed settlement patterns generated by an industrial project should be compatible with the land and its related resource charactertics, e.g. basic infrastructure, such as water supply, sewage and solid waste disposal, road layout and design. Land stability for housing construction and other land use settlement criteria should be considered part of the site assimilative capacity guideline.

Question 2a.

Have alternative sites or locations of the plant been considered in an effort to avoid or mitigate environmental degradation?

Question 2b.

Have hydrologic, geologic, seismological, and meteorological studies of the site been made to anticipate and minimize possible damage to humans, fish and wildlife resources and vegetation?

Question 2c.

Will environmental considerations, including present human land-use patterns in the vicinity, be incorporated as appropriate into the selection of technology, the location, scale and the design of the plant?

Step 3: Project design and construction: This step includes the decisions on basic processes to be used in the projected plant, the source(s) of energy for power and heat, and the supply of air and water. The environmental aspects of any projected plant start with the decision to use a particular process. Analysis of sources of energy should consider materials available in the area in addition to the traditional supplies.

Question 3a.

What features for environmental protection will be incorporated in the design and operation?

Question 3b.

Will construction personnel be exposed to unique local health problems, or will they introduce diseases?

Question 3c.

Is there a comprehensive construction plan that takes into account ecological factors?

Question 3d.

Are road patterns, land excavation, fill sites, refuse disposal activities, etc. planned to minimize damage to the natural environment?

Question 3e.

What provisions have been made for restoring sections of the construction area?

Step 4: Operations: The most important consideration in waste management is that the alternatives be planned to fit with the plant processes and the site. Emphasis should be placed on reuse of waste materials or sale as byproducts whenever possible, and discharge into the natural ecosystem should be considered as a last resort. If discarded, adequate waste treatment should be provided. In this way, treatment is not the complete pollution solution; rather it is a part of the solution.

An important objective is to develop and maintain a project administrative framework capable of monitoring the performance of process and control devices. Staff structuring should include expertise in environmental engineering pertinent to the proposed industrial projects.

Environmental functions include monitoring systems of materials flow from raw material input to final product output to ensure that design tolerances are maintained. Environmental data would be compiled and analysed to monitor deviation from baseline (starting) conditions and the approach to the thresholds of ecological carrying capacity. An environmental engineering staff would serve in evaluating a change in process technology or industrial project expansion. Project quality control criteria could include an active assessment of the cumulative effects of waste streams.

The monitoring would include both chemical and biological activities to identify trends away from the baseline study of the site. Environmental operations would also include maintenance, monitoring, education for safety and environmental awareness, and possibly research and development for future work to assess the impact of plant expansion.

Question 4a.

Will unloading and loading methods of handling petroleum and petrochemicals incorporate human and environmental safeguards?

Question 4b.

What are the dangers of an explosion or spill of hazardous materials?

Question 4c.

Will contingency plans, including manpower and materials, be available to cope with accidents?

Question 4d.

Has adequate attention been given to the design and construction of safe storage facilities for hazardous materials?

Question 4e.

Will provision be made to prevent liquid losses during storage, utilizing, for example, floating roof tanks?

Question 4f.

What types and quantities of effluents or particulate emissions will the plant produce?

Question 4g.

Has pollution control equipment been planned?

Question 4h.

Will the discharges of effluents and sludge into water bodies be compatible with other present and future uses of the receiving waters, particularly during periods of minimum stream flow?

Question 4i.

Will effluents enter into synergistic effects with other elements?

Question 4j.

Will effluents contain toxic materials?

Question 4k.

If effluents are to be discharged directly or indirectly into a water body, have studies been made of the physical and chemical properties of the receiving water, such as temperature, current patterns, flow rates, dissolved oxygen, and presence of organic chemicals?

Question 4l.

What are the expected effects of effluents on water supply sources downstream, algae growth, and invertebrate and fish populations?

Question 4m.

How will plant effluents and emissions be controlled and monitored?

Question 4n.

What control techniques will be employed to remove toxic materials from effluents?

Question 4o.

If solid wastes are produced, what disposition will be made of them?

Question 4p.

Has the recycling of solid wastes been considered?

Question 4q.

What provisions have been made for training plant operators in environmental protection?

Question 4r.

Will odours be controlled?

Step 5: Social aspects: This step previews social implications for the environment generated by the project investment. Projects employing a large labour force during construction and operation influence in-migration of populations, thus affecting land-use patterns.

Locational requirements associated with the in-migration of a labour force and its families' impact on land-use patterns should be evaluated in the light of available food, water, shelter, medical services, and accessible transportation systems, based on local institutions, mores and customs.

Guidelines assessments should generally preview the land and its related resources, identifying the ability of the area to sustain development pressures generated by habitation patterns characteristic of local cultural preferences. Attention to these potential problems can result in minimal social disruption.

Question 5a.

How and to what degree will the presence and operation of the plant alter the size and economic activities of the local population? Will urban problems be created or accentuated?

Step 6: Health aspects: This step deals with the need to monitor and maintain the health and welfare of project employees, and local and regional populations adjacent to the project facility. In-house safety procedures can be designed to include employee education. Job specifications should stress safe work habits.

Clear and concise management policy statements should stress safety in operations.

Product safety hazards, implicit and explicit, should be clearly defined for consumer protection. Attention needs to be paid to petrochemicals for consumer use. Pollution vectors - water, land and air transport - should be closed or minimized where local and regional health may be endangered.

Question 6a.

Will the plant produce emissions that will directly or indirectly be detrimental to health?

Question 6b.

Are new health problems likely to occur?

Question 6c.

What measures have been taken to ensure a programme of employee safety and occupational health?

Question 6d.

Will plant employees and their families be provided with a system of health care?

Step 7: Final resting place: This step is considered in the overall evaluation in a manner similar to the raw materials linkage. Everything ends up someplace; there is no such thing as ultimate disposal. The step can be as complicated as a mercury flow chart locating every gram of the metal, or it can be as general as a discussion of paper showing the amount to be recycled into pulp, the amount to be saved, and the amount to be land filled. The step is important because every disposal technique has a cost associated with it. The disposal cost may be high because the substance is nondegradable or because a product is toxic. All these costs require evaluation.

A plant producing polyvinylchloride can serve as an example. This non-biodegradable material is resistant to compaction, and large amounts can not be easily handled in sanitary land fills or compost heaps. Alternative means of disposal such as salvage or high temperature incineration must be considered. The costs of disposal of solid, liquid and gaseous wastes from the plant itself have to be considered.

Step 8: Long-term considerations: Plant expansions.

Question 8a.

Is an expansion of facilities envisioned and, if so, how will it affect the environment?

Question 8b.

How will future projects fit into the environmental context of present plant operations?

Step 9: Optimization: Costs must be analysed for the various alternatives for wastes disposal. Costs for protecting environmental values and natural resources require that traditional costing procedures must be augmented. The previous steps have called attention to information requirements which are reviewed in the last step. Choices of industrial processes will all be associated with different costs. Since there will be considerable variation from project to project in terms of amounts and kinds of costs, the aim in these guidelines is to establish concepts which guide the judgements to be rendered.

For example, incurring the costs of avoiding river pollution may avoid the cost of a water treatment plant downstream to render water potable, or may allow the use of the ecological carrying capacity of the river for a more productive enterprise or for public recreation, for tourism or fishing.

The costs can be generally identified by following through the information in the guidelines. Whether these costs are borne by the project or by society is a matter for discussion and negotiation in each case. Often the social benefits from a project will outweigh the social costs so that the net judgement for the project is positive, and the assignation of the costs is accepted by society. Historically, this has often been true, but recent changes in public values and strategies of economic development require a reassessment of the position.

In summary, the environmental guidelines for appraisal include a broad array of concerns. These are designed to assess costs that would result if projects were to impair the future productivity of a country's natural resource base or result in other adverse side effects of investments. As indicated in the nine steps of analysis, the impact of investments on the human environment requires a systematic and integrated view of projects which focuses on materials flow within production processes and outside the plant.

Proceeding through the nine steps from the raw materials linkage to optimization calls attention to the interrelationship between choice of process and recycling and reuse potential, between plant location and urbanization issues, between waste management and process design. These connections are an effort to persuade the project manager to design an integrated project which is sensitive to environmental needs.

POLLUTION REGULATIONS

In recent years, more and more countries have expanded or adopted new environmental legislation. Governments have created official bodies which are responsible for the elaboration of new legislation and the application and enforcement of regulations. As a guide to present practice, a comprehensive listing of air quality[1/] and pollutant emission[2/] standards from a number of countries, including the USA, the USSR, Japan, and several European countries, can be found in a recent World Bank publication[3/]. Criteria for maximum concentrations of various water pollutants in public waterways are also found in that reference.

A specific problem of the developing countries in carrying out the function of environmental protection utilizing specific regulations is a lack of experience. A large number of the developing countries, never having had to face these environmental problems due to industrial pollution, have no specific regulations at hand. Such regulations are, however, indispensable to the contractor for the design of pollution control systems and should therefore be in effect at the time the tender documents are sent out. Thus, it is recommended that the particular ministries concerned, such as industry, health and development, should draw up the relevant regulations, referring as necessary to the experiences of other countries cited in the previous paragraph.

1/ An air quality standard requires that the concentration of a pollutant in the atmosphere at the point of measurement shall not exceed a specified amount.

2/ An emission standard requires that the amount of a pollutant emitted from a specific source shall not exceed a specified concentration.

3/ General Reference 1. This reference is available free upon writing to the Office of Environmental and Health Affairs, The World Bank, 1818 H Street, NW, Washington D.C. 20433, USA. The material was originally published in Reference 2.

AIR AND WATER POLLUTION PROBLEMS IN THE PETROCHEMICAL INDUSTRY

The main environmental problems caused by the petrochemical industry are air pollution and water pollution [3]. Disposal of solid wastes is a lesser problem. Consequently, the latter is mentioned in the text in conjunction with the air or water pollution control device which gives rise to a solid waste requiring disposal.

AIR POLLUTION

All US dollar references to costs of air pollution control in this section are 1973 dollars.

There are more than 200 different petrochemicals produced in large volumes in the world. It is obvious that the need is to control emissions from the processes which are the largest tonnage, fastest growing and which produce the greatest volume of air pollution or especially toxic pollutants.

There are 32 chemicals produced by 41 processes which require special control. Several of the chemicals are produced by two or more processes which are sufficiently different to warrant separate study. These are:

Acetaldehyde (2 processes)
Acetic acid (3 processes)
Acetic anhydride
* Acrylonitrile
Adipic acid
Adiponitrile (2 processes)
* Carbon black
Carbon disulfide
Cyclohexanone
Dimethyl terephthate and terephthalic acid
Ethylene
* Ethylene dichloride (2 processes)

* Ethylene oxide (2 processes)

** Formaldehyde (2 processes)

Glycerol

Hydrogen cyanide

Isocyanates (Toluene di-isocyanate, methylenediphenyl-isocyanates and polymethylene polyphenyl-isocyanates)

Maleic anhydride

Nylon 6

Nylon 6, 6

"OXO" alcohols and aldehydes

Phenol

* Phthalic anhydride (2 processes)

Polyethylene (high density)

Polyethylene (low density)

Polypropylene

Polystyrene

* Polyvinylchloride

Styrene

Styrene-butadiene rubber

Vinyl acetate

* Vinyl chloride

Those 12 chemicals and processes marked with an asterisk are those causing the most severe air pollution problems and are therefore discussed first [4]. Following that section are briefer discussions of air pollution problems caused by production of the other 29 chemicals [5].

The 12 Most Severe Polluters

(1) Acrylonitrile

The primary commercial route to acrylonitrile is the ammoxidation of propylene. Generally, a fluid bed catalytic process is utilized.

Air pollutants from the process fall into four categories:

1. Hydrocarbons - paraffins (20%), olefins, nitriles (4%);

2. Carbon monoxide (50%);
3. Oxides of nitrogen - these are produced rainly from incinsration of by-products and waste (3%);
4. Particulates - catalyst fines (trace).

Total pollutants emitted by this process range betwesn 0.25 and 0.35 lbs/lb of acrylonitrile produced. In the United States in 1973, total emissions amounted to 400 million pounds per year. Presently, there is a change in catalyst from one based on uranium to one based on bismuth and molybdenum. Use of the new catalyst is expected to reduce overall emissions by one-third.

The main vent from the absorber is the chief source of air pollution in the process. Plants normally use a mist eliminator to minimise the carry-over of water (ths absorbing medium) into the venting stream. Howevsr, nons of the current manufacturers in the United States employs any additional air pollution control devices on this stream. In the design of new plants, some form of incineration should be designed for the effluent from the main absorber vent. Absorber vent gas incinerators could reduce overall plant pollution by 90%, except that there will be an sstimated 50% increase in emissions of nitrogen oxides.

Ths installation of a thermal incinerator on the absorber vent of a 200 million lbs/year acrylonitrile plant will cost an sstimated $350,000. The annual operating cost of this unit is estimated to be $136,000.

An incinerator for by-product waste would require a capital investment between $200,000 and $400,000. Operating costs will be between $50,000 and $70,000 per year depending on capacity.

Incorporating these pollution control measures will result in a reduction of about 6% in profit before taxes. Applied to United States' industry, this would represent a reduction in return on investment from 8.5% to approximatsly 8%.

(2) Carbon Black

Historically, carbon black producing plants were characterized by a black plume rising from the smoke stack and visible for miles. In the United States and Europe the carbon black producers have made great progress to reduce particulate emissions from their plants. Efficiencies of particulate removal now exceed 99% with the advent of new designs for bag filters and the development of new quality filter cloth. The inclusion of these particulate removal devices should be a part of every new carbon black plant.

Another major pollutant is carbon monoxide, typically emitted at a rate equal to about 1.3 lbs/lb of carbon black produced. Common practice in the United States and Europe is to incinerate this material. The estimated capital requirements of approximately $1 million is required per combustion unit for a new carbon black plant of annual capacity of 90 million lbs.

It is estimated that the carbon black industry in the United States would, in 1985, emit about 6.5 billion lbs. of carbon monoxide if no incineration were practiced. Incineration can reduce this emission to about 0.6 billion lbs. per year. Another half billion lbs. of particulates is also projected to be emitted.

The estimated profit for carbon black manufacturers is relatively small. In 1974 in the United States, average production costs were 6.54c /lb and the selling price was 7.25c /lb. Any additional expenditures for pollution control equipment would probably result in a higher carbon black selling price. Including thermal incineration of vent gas would result in an estimated 2% increase in the production cost of carbon black.

(3) + (4) Ethylene Dichloride (2 processes)

Almost all production of ethylene dichloride takes place in large plants employing a balanced combination of two processes. One process is the direct chlorination of ethylene with chlorine. HCl is a by-product. This HCl is then used as feed for the second process, oxychlorination, where ethylene, hydrogen chloride and oxygen react to form ethylene dichloride.

The major source of emissions from the direct chlorination process is the HCl scrubber vent. Both chlorinated hydrocarbons and light hydrocarbons are emitted to the atmosphere from this source. More modern plants employ a condenser to recover some ethylene dichloride before the stream enters the scrubber.

Some storage losses of ethylene dichloride occur because storage tanks often have simple vents to the atmosphere. However, these losses are small because of the low vapor pressure of ethylene dichloride. Estimated losses are about 0.0006 lbs/lb of ethylene dichloride produced.

Average overall emissions for the production of ethylene dichloride are about 0.035 lbs/lb of ethylene dichloride produced. Over half of this total represents chlorinated hydrocarbons and about 20% each is due to ethylene and carbon monoxide. To reduce emissions, incineration could be carried out on the main process vent. If supplemented by scrubbers, total emissions could be reduced 98%. However, this control technology has not been demonstrated commercially. The main problem is that incineration of chlorinated effluents produces hydrogen chloride. This is corrosive to metal at high temperatures.

A capital investment for the thermal incinerator, a scrubbing system and supplemental equipment will be about 1.2 million dollars. Operating costs are estimated at $400,000 per year. These are estimates for a 700 million lbs capacity plant.

Incorporation of these pollution control devices in an American industry would result in a 25% reduction of net profit after taxes. A 2% price increase would restore the net profit and most of the return on the investment.

(5) + (6) Ethylene Oxide (2 processes)

Two general types of direct oxidation processes are in general use for ethylene production. One process uses air as the source of oxidant and the other uses high purity oxygen. Ethylene is oxidised in both cases to ethylene oxide. In general, the air pollutants from both processes are chiefly ethylene and ethylene oxide. In the case of the air oxidation process, some producers incorporate a catalytic converter on the main process vent. The vent stream is thereby heated to a sufficiently high temperature for use in the gas turbine driver of a process compressor. Overall, air pollutants from air oxidation plants are about 0.029 lbs/lb of ethylene oxide produced. For oxygen oxidation plants, estimated air pollutants are about 0.012 lbs/lb of ethylene oxide produced. If methane is added and the vent gas burned, air pollutants are reduced to 0.004 lbs/lb of ethylene produced. The trend in the industry is to reduce emissions and recover energy using the technology described.

For a 200 million lbs per year oxidation plant, an estimated $250,000 of capital equipment would be required to install a catalytic incineration/gas turbine system on both the main process vent and the CO_2 purge vent. After taking credit for energy recovery, the net operating costs would be about $7,400 per year.

In summary, this industry can reduce emissions and conserve fuel without significant financial burden. Air oxidation plants can accomplish this utilising the demonstrated technology of a catalytic converter and gas turbine on the main process vent. Oxygen oxidation plants can add methane and incinerate the off gas.

(7) Formaldehyde (Silver Catalyst)

The production of formaldehyde from methanol using a silver gauze catalyst is one of the two principal commercial methods of synthesis. The reaction mixture of methanol and formaldehyde is passed into an absorber liquid which is an aqueous solution of 28%-30% formaldehyde and 20%-22% methanol. Contact takes place in a packed tower. Uncondensed vapors and non-condensibles are withdrawn from the top of the primary tower and blown into a secondary absorber. The secondary absorber recovers the major portion of the non-condensed vapors. Distillation produces pure methanol and about a 37% aqueous solution of formaldehyde.

The emissions from the absorber vent constitute the most important source of air pollution in the production process. Emissions from this vent are as follows:

Component	lbs/lb of 37% formaldehyde solution
Formaldehyde	0–0.001
Methanol	0–0.004
Methylformate	0–0.008
Methylal	0–0.001

Some emissions occur from the vacuum source exhaust of the distillation column.

A sizeable source of emissions can occur during start-ups of the production unit but these may only occur once a month or so.

Total emissions for this process are, on the average, about 0.022 lbs/lb of 37% formaldehyde. Of this total, over 80% is carbon monoxide. A plant equipped with an efficient incineration device would emit practically no carbon monoxide and very little hydrocarbons. If the waste gas stream were used as a fuel supplement, a great fuel gas savings would also result. The estimated capital cost of installing the necessary equipment on new plants is less than $50,000 per plant. The net pollution abatement cost would then be very little.

(8) Formaldehyde (Mixed Oxide Catalyst)

A second process for formaldehyde production is presented because it is equally common and neither appears to have any significant advantage. The second process also utilizes methanol as a raw material in an air oxidation process. However, the process utilises a mixed metal oxide catalyst and a methanol lean feed mixture. Air pollutants from the mixed oxide catalyst system are formaldehyde, dimethylether, methanol and carbon dioxide. Essentially, no oxides of nitrogen or sulphur or particulates are emitted. Presently, total air pollutants are about 0.04 lbs/lb of 37% formaldehyde. If the main vent stream from the reactor is recycled, emissions can be cut in half. In both cases, carbon monoxide accounts for about 0.016 lbs of pollutant per lb of 37% formaldehyde. It should be noted that all plants have a water scrubber on the main process stream before it is vented to the atmosphere or recycled.

Calculations indicate employing a thermal incinerator for emissions would reduce the overall air pollution released to about 0.001 lbs/lb of 37% formaldehyde. At 1973 prices, these incinerators installed in plants of 100 million lbs per year capacity would cost approximately $54,000 each. However, nearly $40,000 would be added in fuel cost per plant.

(9) + (10) Phthalic Anhydride (2 processes)

Two commercial processes are presently utilized for producing phthalic anhydride. The older process is based on naphthalene whereas the newer process is based on ortho-xylene. In general, air pollutants from both processes consist of organic acids and anhydrides, hydrocarbons and carbon monoxide plus some particulates which consist of heavier organic materials. Also, ortho-xylene plants have some sulphur oxide emissions resulting from the addition of sulphur as a catalyst activator and nitrogen oxide from waste incinerators.

Average air pollutants produced by the ortho-xylene process are about 0.10 lbs/lb of phthalic anhydride produced. Pollutants emitted by the napthalene process are about 0.055 lbs/lb of phthalic anhydride produced.

Most ortho-xylene plants have some form of pollution control device. This is either a main process vent gas incinerator (sometimes with heat recovery) or a main process vent gas scrubber followed by a scrubber water incinerator. Some incineration of fractionation wastes is carried out.

Control of organic particulates such as phthalic anhydride, maleic hydride and benzoic acid can be efficiently carried out using either a scrubber or an incinerator on the main process vent. An incinerator is the most efficient control device to simultaneously reduce emissions of particulates and carbon monoxide. If a water scrubber is used in ortho-xylene based plants, a 90% reduction in particulates would be achieved. However, no significant reduction in carbon monoxide emissions would be achieved. Overall, emissions would be reduced to about 0.1 lbs/lb of phthalic anhydride if main vent scrubbers are used followed by a combination of water and fractionation waste incinerators. There is no presentation of most feasible emission control schemes for the napthalene based plant because the process is not expected to expand. However, current practice is the use of either a scrubbing system or an incineration system. This accounts for the relatively low levels of air pollutants emitted by this process.

Costs of installing the various pollution control devices on a new 130 million lbs per year ortho-xylene based plant are the following: Scrubber on the main process vent followed by incineration of scrubber water and fractionation wastes: capital costs - $1,450,000; operating costs - $420,000. This represents about 13% of the total invested cost in the factory.

A dual incineration system can also be installed which will also minimize carbon monoxide emissions. Total air pollutant discharge would be reduced to about 0.04 lbs/lb of phthalic anhydride with the dual incineration system. The dual incinerator system with waste heat recovery would require about $1,400,000 in capital investment.

(11) Polyvinyl Chloride

Included in this class of materials are copolymers of vinyl chloride with small amounts of vinylidene chloride, vinyl acetate, ethylene, propylene or acrylates as well as the homopolymer itself.

The air pollution emissions discussed here are based on data that were reported prior to August 1974. In January, 1974, vinyl chloride monomer was reported to be carcinogenic. Since that time, industry has reduced fugitive losses as well as vinyl chloride in process vent streams.

Four processes are used to produce polyvinyl chloride. These are: i) suspension polymerization; ii) emulsion polymerization; iii) bulk polymerization; and iv) solution polymerization.

Of the four processes used to produce polyvinyl chloride, air emissions of vinyl chloride are lowest for the solvent polymerization whereas highest emissions occur from emulsion polymerization. For the suspension process, on the average, air pollutants consisting of polyvinyl chloride dust from polyvinyl chloride processing are 0.0175 lbs/lb of polyvinyl chloride produced. Vinyl chloride emissions average 0.0345 lbs/lb of polyvinyl chloride produced for this process.

Pollution sources

1. Vent from the vinyl chloride recovery system - All the vinyl chloride vapours drawn from the stripper and the reactor are compressed and condensed to recover unreacted monomer. This is a major emission source because of the high concentration of vinyl chloride. Emissions can be reduced by condensing under pressure and low temperatures and by using a vent scrubber or carbon adsorber. Losses range between 0.001 to 0.01 lbs of vinyl chloride/lb of product;
2. Dryer stacks and miscellaneous solid handling - If stripping of vinyl chloride is done poorly, over 20% of the total emissions can occur here. This is a difficult stream to control with a pollution control device because of the high volume of air. Particulate polyvinyl chloride emissions result from solids handling. Particulate emissions can be reduced with cyclones and bag filters. Losses range between 0.0005 to 0.006 lbs of vinyl chloride/lb of product;
3. Centrifuge vent - The centrifuge vent is associated with the suspension process. Losses range between 0.00001 and 0.004 lbs of vinyl chloride/lb of product;
4. Blend tank - Blend tank emissions are only found in the suspension and emulsion polymerization processes. Vinyl chloride losses range between 0.0001 and 0.007 lbs/lb of product;
5. Unloading and charging facilities - Some emissions always result from unloading operations and from the charging of reactors. Reported losses from these sources range between 0.0004 - 0.001 lbs of vinyl chloride/lb of product;
6. Reactors - A frequent reactor emission occurs when the vessel is purged and during cleaning. If no equipment is provided to recover vinyl chloride from the reactor vent, the vinyl chloride emissions can be as high as 0.04 - 0.08 lbs/lb of product. Efficient recovery operations can reduce the vinyl chloride emissions to as low as 0.001 lbs/lb of product;
7. Fugitive emissions - Fugitive emissions can occur from safety valve strippers, pumps, filters and so on. Average fugitive emissions for the suspension, emulsion, and bulk processes are similar (0.005 - 0.01 lbs of vinyl chloride/ lb of product). Fugitive emissions for the solvent process are much lower.

Total reported air emissions for various polyvinyl chloride plants vary over a wide range. Variation is partly due to differences in processing schemes and the amount of emission control equipment utilized.

Model plant

A proposed model plant would utilize the following devices and procedures to reduce vinyl chloride emissions:

1. Improved stripping;
2. Refrigeration of the vinyl chloride recovery system vent;
3. Canned pumps;
4. Leak detection programme.

The total manufacturing costs per year for a typical 200 million lbs/year poly vinyl chloride plant are about $34 million. Incorporation of the emission control devices suggested above would represent a total capital investment of about $1 million and annual operating costs of $125,000.

A more extensive pollution control system would incorporate a gas holder. All controllable emissions to the vents, stacks, etc. are compressed in the gas holder and sent to the vinyl chloride recovery system. This modification would add about $1 million of capital investment to the pollution control system as well as an additional $25,000 in annual operating expenses.

Total average emissions of vinyl chloride from a plant without the aforementioned pollution control devices are about 0.0345 lbs/lb of poly vinyl chloride produced. Addition of the first set of pollution control devices would reduce emissions to about 0.0157 lbs/lb of poly vinyl chloride. If the gas holder were also incorporated, emissions would be further reduced to 0.0070 lbs/lb of poly vinyl ohloride.

(12) Vinyl Chloride

Almost all the vinyl chloride produced goes into the manufacture of polyvinyl chloride. Because the economics of production favour large scale processes all new plants are expected to be designed to produce at least 500 million lbs of vinyl chloride/year. Over 90% of the vinyl chloride monomer produced in the United States is obtained by cracking diohloroethane. Vapour emissions from the cracking process are small, provided that the HCl produced can be recycled to a dichloroethane plant (this is often the case) or has value for another operation. In most cases, the vapour emissions from the cracking operation include vinyl chloride but are small in quantity. Vinyl chloride can also be produced from ethylene dichloride. This chemical, in turn, is produced by the oxychlorination of ethylene with HCl. Air pollution from either process can also result from a heavy chlorinated hydrocarbon tar if this material is incinerated.

(A) General process pollutants

The natural gas fired to heat the cracking furnace produces very little pollution. In the case of one producer of 700 million lbs/year of vinyl chloride, less than 600 lbs of sulfur per year are emitted as SO_2 out of the stack.

Scrubbers are employed to recover HCl as a by-product. The non-condensible streams from the HCl recovery section plus other light ends from the vinyl chloride purification unit are either vented, flared, or sent to a pollution control device on another process. This is the main source of air pollution in the process.

A drying step is required before the dichloroethane can be cracked. Vent losses from a drying column form a small source of air pollution.

(B) Vinyl chloride emissions from process operations

Since January 1974, it has been known that vinyl chloride is carcinogenic at low concentrations (under 500 PPM). The emission losses reported here are based on information obtained prior to September 1974. Vinyl chloride emissions have undoubtedly been reduced substantially since then.

The preparation of vinyl chloride is a continuous process. The continuous air emissions of vinyl chloride from the process are as follows:

1. Distillation columns - Most plants have distillation columns to separate impurities from vinyl chloride. Inert gases from these columns after refrigeration or scrubbing contain some vinyl chloride. Depending on the manufacturing unit, these gases are either vented to the air or to a control device;

2. Flash drums - A number of vinyl chloride plants have a flash drum to separate the vinyl chloride from water streams. The vinyl chloride vapours are generally fed to an emission control device;

3. Oxychlorination vent gas - This stream consists of the gross oxychlorination reactor effluent after quenching and cooling for recovery of ethylene dichloride. In the United States, about 65% of the ethylene dichloride from the air oxychlorination process is produced in plants that incorporate absorber-stripper or chlorine recovery systems;

4. Direct chlorination process vent - This is the major source of air pollution from the direct chlorination of ethylene. Composition of the stream is about 0.02 lbs of hydrocarbons plus ethylene, 0.0025 lbs/lb of vinyl chloride, ethylene dichloride (0.0016 lbs/lb of vinyl chloride) and small amounts of vinyl chloride.

There are a number of intermittent air emissions. These are:

1. Loading areas - This is the largest source of intermittent emissions. Emissions can be significant if vinyl chloride is used for initial purging of oxygen from barges or tank cars;

2. Storage vents - Vinyl chloride tanks are pressurized to reduce storage losses and vents are compressed and recycled. It should be mentioned that one manufacturer reports vinyl chloride storage losses of 150,000 lbs/year from depressurizing the storage tanks for maintenance or relief valve lifting. This represents about 0.0002 tons of vinyl chloride/ton produced.

3. Safety and relief valves - Most plants use rupture disce in front of safety valves to minimize leakage. Fugitive emissions are very low and come from filters, pumps and other equipment. Emissions can result from equipment cleaning and inspection unless vinyl chloride is steamed out to normal venting areas before the vessel is opened.

In vinyl chloride manufacture, emission control devices are of primary importance in reducing vinyl chloride losses into the atmosphere. This is because the manufacture involves a continuous process in which vinyl chloride emissions are normally very low and cannot be changed markedly if at all, by changes in process operating conditions. In addition to emission control devices, good housekeeping and proper equipment maintenance will help minimise vinyl chloride emissions.

Emission control devices

1. Absorbers - Ethylene dichloride is used as an absorber to effectively remove vinyl chloride vapors. The vinyl chloride is then recovered by means of a stripper. One plant which uses such a system reports no continuous emissions other than fugitive emissions. Calculated vinyl chloride recovery efficiency is 99%;

2. Flares - Vent streams containing vinyl chloride along with other combustibles are often directed to a plant flare. No data on the effectiveness of the flare is available but it is assumed that vinyl chloride monomer is completely consumed;

3. Refrigeration - Vinyl chloride emissions can be reduced by compressing the fractionation vent stream to chill the stream and thereby condense out most of the vinyl chloride;

4. Waste heat boilers - One company has a waste heat boiler that burns a number of hydrocarbons and chlorinated waste including vinyl chloride monomer. Caustic scrubbers are used for removing HCl and Cl_2 from the waste feed gas.

Cost for reducing vinyl chloride emissions

In order to reduce total vinyl chloride emissions by about 55%-60% for a 700 million lbs/year plant, a total capital investment of $650,000 would be required. A 90% reduction of vinyl chloride emissions would require a capital investment of about $2 million. These pollution control costs would be additional to a total plant capital investment of $42 million.

29 Other Major Polluters

(1) Acetaldehyde via Ethylene

The oxidation of ethylene to form acetaldehyde can take place either in a two stage or a one stage process. The two stage process is more common commercially. Ethylene is reacted at 10 atm. with a water solution of palladium chloride and cuprous chloride. The acetaldehyde yield is 95% and the ethylene conversion is 99%. By-products include chloroacetaldehyde, ethyl chloride, chloroethanol, acetic and oxalic acids, crotonaldehyde and chlorocrotonaldehyde.

Reaction products are sent to a flash tower where the pressure is reduced to atmospheric and acetaldehyde is vaporized and separated. The bottoms are sent to an oxidizing reactor to regenerate the catalyst. After catalyst separation, the other materials are sent to a scrubber. Some product and by-products are recovered here. Gases leaving the scrubber are vented to the atmosphere. Total hydrocarbon emissions are reported as 0.00045 lbs of acetaldehyde but may reach 0.001 lbs.

The acetaldehyde from the flash tower is then distilled. Light ends are removed first and the gas exiting from the top of the tower is water scrubbed and then vented to the atmosphere. Hydrocarbon emissions from this source are around 0.00047 lbs/lb acetaldehyde but may vary.

No particulates, oxides of nitrogen, sulphur oxides, or carbon monoxide are emitted from the process as described.

(2) Acetaldehyde via Ethanol

Atmospheric emissions generated by the ethanol process are associated primarily with the absorber vent gas stream. All other sources of emissions are minimal.

Acetaldehyde is produced by passing ethanol vapors and preheated air over a silver catalyst at 300°-575°C. Overall alcohol conversion varies from 25%-45% and yields are 85%-95%.

The gases leave the reactor and pass through a condensor to a phase separator where the vapor phase is absorbed in refrigerated waters. This is combined with the liquid phase and acetaldehyde is distilled out.

Emissions are as follows:

Component	Lbs/lb acetaldehyde
water	0.00088
CO	0.00271
CO_2	0.00934
H_2	1.12450
CH_2	0.01950
O_2	0.02240

Some emissions of SO_2 are produced during the combustion of fuel during reactor startings but these are negligible. Some ethanol is released from venting from the ethanol storage task.

(3) Acetic Acid via Methanol

This newest industrial synthetic route for acetic acid involves carbonylation of methanol. Methanol is reacted with a synthesis gas containing H_2, CO, CO_2 and hydrocarbons. The BASF process uses temperatures around $500^{\circ}F$ and pressures of 7,500-10,000 atm. with a cobalt iodide catalyst. Yields of 99+% of acetic acid are reported. The reaction is as follows:

$$CH_3OH + CO \rightarrow CH_3C\begin{matrix}=O\\-OH\end{matrix}$$

This process could be a large source of air pollution if excess synthesis gas were vented directly to the air. This problem can be eliminated by flaring the exit gas. This is apparently being done in manufacturing plants now using this process. Complete combustion of the exit gas would yield only CO_2 and water.

Other sources of air pollution are negligible.

(4) Acetic Acid via Butane

The oxidation of butane is carried out in recycle reactors due to low butane conversion. A large number of by-products are produced which are recovered. When the butane is recycled, CO_2, CO and some hydrocarbons are vented or flared. Typically, these are flared and only CO_2 and water are emitted. Some hydrocarbons are vented from the reactor itself. Total hydrocarbon emissions are 0.03824 lbs/lb product along with CO-emissions of 0.01354 lbs/lb product.

Estimate of storage task losses are 0.00087 lbs of product + by-product/lb of acetic acid.

(5) Acetic Acid via Acetaldehyde

One commercial oxidation of acetaldehyde to acetic acid is carried out continuously in the liquid phase using air or oxygen in the presence of manganous or cobalt acetate. Both a liquid and a gaseous stream exit from the reactor. The gaseous stream is scrubbed many times to remove reactant and product. No information on effluents is available for this process.

A mixture of acetaldehyde and ethanol is also commercially oxidized to acetic acid using air or oxygen in the liquid or vapor phase. Ethylacetate is recovered as a by-product to this reaction.

The emissions from the absorber vent constitute the only major air pollution source from this process. The following emissions have been noted:

Component	Lbs/lb acetic acid
Acetaldehyde	0.00481
Ethyl acetate	0.00507
Carbon dioxide	0.02089
Carbon monoxide	0.00202

(6) Acetic Anhydride

The largest scale commercial process for producing acetic anhydride is the pyrolysis of acetic acid. Pollution from the cracking and absorption processes can be readily avoided by flaring the tail gas to produce CO_2 and H_2O. However, at least one commercial processor in the United States vents this tail gas (consisting of hydrocarbons, CO, CO_2 and H_2) directly to the atmosphere.

(7) Adipic Acid

Nearly all commercial production of adipic acid is based on oxidising cyclohexanone or cyclohexanol with nitric acid. The various oxides of nitrogen produced during the oxidation process constitute the principal source of air pollution for this process. The nitrogen components formed are predominately N_2O, NO and NO_2. Some organic acid by-products are formed, chiefly acetic acid, glutaric acid and succinic acid. In large plants, these may be recovered and sold.

After the oxidation reaction, the dissolved NO_x gases plus light hydrocarbon by-products are stripped from the product solution with air and steam. Most of the NO and NO_2 are recovered by absorption in nitric acid. The NO_x emissions vary from 0.03 to 0.34 lbs of NO_x per lb of adipic acid produced in the various commercial plants. The ten-fold variation in emission rates is apparently the result of: a) The differences in performance of NO_x recovery systems; and b) Variations in the percentage of N_2O in the reaction mixture. N_2O cannot be easily removed. Storage losses and start up losses are low.

The emissions of NO_x could be reduced by converting the oxides to N_2. This requires incineration using special burners and a reducing atmosphere provided by about 10% excess fuel. NO_x reductions of 75%-90% have been reported using this method.

(8) Adiponitrile via Butadiene

There are a number of routes to adiponitrile but the process utilizing butadiene is pre-eminent. The process involves four distinct steps: chlorination, cyanation, isomerization and hydrogenation.

The process vents from chlorination emit the rather insignificant amount of 0.002 lbs of butadiene and chlorinated hydrocarbons/lb of product.

The vents from the cyanide synthesis process constitute about 70% of the pollution of the overall synthesis. Emissions amount to about 0.038 lbs/lb of product.

Waste liquids from the cyanation and isomerization processes are burned as fuel. Emissions amount to about 0.0069 lbs of aerosols (HCl)/lb of product and 0.0569 lbs of NO_x/lb.

Pollution control devices used in the process are scrubbers.

(9) Adiponitrile via Adipic Acid

In terms of production capacity, the adipic acid process is the major one in Europe and ranks second in the United States.

The nitrogen compounds NH_3 and NO_x are the pollutants produced by this process.

Adipic acid reacts with ammonia in the presence of a dehydrating agent to form adiponitrile.

Estimated noxious emissions, based on the assumption that ten percent of N becomes NO_x, amount to 0.00027 lbs of NO_x/lb of adiponitrile produced. When an absorber/scrubber is utilized to treat this stream, pollutant emission is virtually nil.

Approximately 0.0036 lbs/lb of ammonia are discharged from vacuum ejectors operating in the product recovery area. No treatment is employed at present to treat this stream.

(10) Carbon Disulphide

Carbon disulphide is produced by the catalytic reaction of methane with sulphur vapour. Yields of over 90% are typical. Natural gas is usually burned to produce the heat required for the reaction. Small amounts of pollutants are thereby produced. In lbs/lb of CS_2 produced, there are: 0.00004 particulates, 0.00014 NO_x, and 0.00009 hydrocarbons.

Often heavy waste produced by the process is burned. This results in about 0.0066 lbs of SO_2/lb of CS_2 produced.

Approximately 0.00028 lbs of sublimated sulphur/lb of CS_2 produced are lost to the atmosphere from the sulphur pit area and storage task vents.

H_2S gas is produced as a by-product in the process. This is sent to a Claus plant where sulphur is recovered and recycled. Emissions from carbon disulphide production are primarily associated with the Claus plant, but figures of quantitative losses were not available.

(11) Cyclohexanone

Cyclohexanone is produced by the air oxidation of cyclohexane. Substantial quantities of cyclohexanol are also produced. As in the case of many other air oxidation processes, venting of the spent air accounts for the majority of emissions associated with the process. Another significant source of emissions is venting from the distillation process. When there is a separate process for dehydrogenating cyclohexanol, there is a vent containing hydrogen and some hydrocarbons. In some cases, this is scrubbed prior to venting and in some cases not.

(12) Dimethyl Terephtalate and Terephtalic Acid

A variety of processes are currently in use to produce dimethylterephtalate. For that reason, a general characterization of atmospheric emissions is difficult. From process to process, emissions vary considerably, both qualitatively and quantitatively.

The predominant process in the United States is the Amoco process, based on very high purity terephtalic acid. This process is one of the lowest polluters. The Amoco process involves the direct esterification reaction of terephtalic acid with ethylene glycol.

The oxidation step of most processes involves the liquid phase oxidation of p-xylene with air to form terephtalic acid. The oxidizer vent constitutes one of the main sources of emissions for all processes, releasing primarily carbon monoxide and hydrocarbons.

Purification of the terephtalic acid is carried out in a separate process. Rather surprisingly, the emissions from this operation of the various processes are as significant as those from the oxidizer process.

Methanol is a common solvent during esterification. In one plant, emissions of methanol from a solvent recovery operation were very high, 0.08 lbs of methanol/lb of dimethylterephtalate.

A scrubber or an absorber is commonly used to reduce emissions, but no quantitative data are available. Bag filters are commonly employed in the purification of the terephtalic acid to prevent escape of fine particles of the acid to the atmosphere.

Water condensors are used to prevent the loss of xylene from xylene storage tank vents.

Various types of incinerators are also used in connection with the processes and combust waste acid and methanol. The most efficient is a catalytic incinerator which converts the NO_x in the feed gases to N_2.

(13) Ethylene

Most of the air emissions from ethylene production result from one of two operations:

1. The removal of acid gases (H_2S and CO_2) from the cracked gas; and
2. Hydrocarbon venting and/or flaring during plant start ups and emergencies.

Ethylene is produced primarily by the pyrolysis of hydrocarbons, or cracking. Subsequent to quenching the cracked gases are compressed. Then there is a treatment step for removal of the acid gases CO_2 and H_2S. The acid gases are normally absorbed by monoethanolamine, caustic and water and subsequently desorbed. After desorption, the contaminants are vented or flared. The highest emission rate for a plant in the USA is 0.0012 tons of SO_2 per ton of ethylene.

Start-up and emergency venting are relatively common in this industry. One US operator estimated that about 1.5 per cent of his production in 1973 (8.9×10^6 lbs) was flared due to process upsets and a major plant turnaround.

Small losses are common around pump seals, control valves, safety valves, compression seals, and process unit tanks. One US manufacturer has reported annual losses of 323,000 lbs, or 0.0008 lbs losses/lb of ethylene.

(14) Glycerol

Allylchloride is converted into glycerol by a series of three reactions. First, allylchloride reacts with hypochlorous acid to form glycerol dichlorohydrin. This is converted to epichlorohydrin. In the third step, the epichlorohydrin is converted to glycerol.

Vent streams from vacuum process condensing equipment and others contain a variety of chlorinated hydrocarbons and other constituents such as propyl chlorides, trichloropropane, epichlorohydrin, acrolein, dichloropropenes, dichlorohydrins, acetone and chlorine. Quantitative data on total process emissions are not available.

Epichlorohydrin, toluene, and glycerol are stored without vapor conservation but emission loesee are low.

(15) Hydrogen Cyanide

The most important commercial proceee for manufacturing HCN ie a direct route from methane, ammonia, and air. Purified reactante are passed over a precioue metal gauze at 1000^{o}-$1200^{o}C$. About 20% of the ammonia paeees through unreacted and ie removed overhead in an ammonia abeorber. The process etream then paesee to an HCN absorber. After that, the acqueous solution of HCN ie fractionated. Ueually the HCN ie then used directly in integrated procese equipment for conversion to the ultimate commercial product.

Large quantities of hydrogen-rich hydrogen cyanide off gae are sometimes used as boiler fuel. In this case, some oxides of nitrogen are produced or emitted. One commercial eetabliehment estimates 30% of the nitrogen ie converted to NO_x.

Procese sample pot vents can contain rather high concentratione of HCN, ranging from 25 to 200 PPM.

Typically procees tank vent etreame are flared, and concentrations of HCN can run as much as 3 volume percent. Proceee start-up and emergency vents of feed gae are aleo typically sent to flares.

(16) Isocyanates via Amine Phosgenation

The aromatic-based di- and polyisocyanates are the only ones covered here because they account for almost the entire market. Attention ie given to toluene diisocyanate, polymethylene polyphenylisocyanate, and 4,4' - methylene diphenylieocyanate.

Isocyanatee are made almoet exclusively by the phosgenation of amines dissolved in a chlorinated aromatic eolvent. The main pollutants from this process are HCl, traces of phosgene, which hydrolizee to HCl in moist air, chlorinated hydrocarbone, and CO from the phosgene generation etep. The overall emissions are odorous, but plante seem to exercise care and good pollution control. This ie neceesary becauee both phoegene and CO are poisonous.

After the reaction to form ieocyanatee, the HCl and phosgene go through a separator where the bulk of the phosgene is removed and recycled. The next step is usually the absorption of HCl in water. Residual quantities of HCl then go to a caustic scrubber where the HCl is absorbed as NaCl and the phosgene is decomposed to HCl and CO_2. Inert gases, CO_2 and trace quantities of HCl and phosgene go either to a stack or an incinerator. In plants which do not flare this stream, there is an emergency NH_3 stream which is injected and forms ammonium chloride if the phosgene concentration exceeds about 100 PPM. In general, the phosgene decomposers work quite well with an efficiency of over 99.9%. The vent stream from the isocyanate purification stream contains small quantities of isocyanates and chlorinated hydrocarbons.

(17) Maleic Anhydride

Nearly all of the production of maleic anhydride is based on the vapor phase oxidation of benzene. Normally, a V_2O_5-based catalyst is used.

After the reaction takes place, the vapours from the condensor are vented to a scrubber for the recovery of uncondensed maleic anhydride. The effluent gases which pass through the scrubber are vented to the outside air. Many plants route streams from other sections of the production unit through this same scrubber in order to gain economy of operation in limiting effluents.

No quantitative data are available on emissions, but small quantities of CO, maleic anhydride, benzene, formaldehyde, formic acid, and xylene are emitted.

In the case of storage of the maleic anhydride, a scrubber is usually used on the atmospheric vent in order to minimize emissions.

(18) Nylon 6

Nylon 6 is produced commercially by the continuous polymerization of caprolactam. Air emissions associated with the polymerization result from small vents from numerous process operations.

In the mixing tank, molten caprolactam is mixed with water and catalysts prior to reaction. Approximately 0.00012 lbs. of caprolactam/lb of Nylon 6 are vented from this process.

In the polymerization vessel, some caprolactam is carried out with N_2 from a nitrogen cap. The amount is about 0.00034 lbs/lb of Nylon 6.

When the molten polymer is quenched with cold water or an inert gas, the rather substantial amount of caprolactam amounting to 0.00337 lbs/lb of Nylon 6 is emitted.

Oligomers and caprolactam are extracted from the final polymer and sent to a depolymerization unit. Some caprolactam is often vented to the atmosphere from this unit. Trace amounts of caprolactam are also lost during the caprolactam recovery distillation process.

(19) Nylon 6, 6

Nylon 6, 6 is prepared by polymerization of hexamethyldiammoniumadipate. The vent from the polymerization unit can contain small amounts of hexamethylene diamine and polymer. Occasionally, these emissions are sufficient to cause a blue haze and substantial odours. The emissions can be controlled through the use of a scrubber.

Other small amounts of emissions, mostly monomer, result from spinning, oonveying, and finishing operations.

(20) The Oxo Process

The Oxo process is a synthesis process for aldehydes and alcohols from olefins and synthesis gas ($CO + H_2$). Hydrocarbons and particulates are the main air pollutants associated with these plants.

The main odour problems are caused by adlehydes and alcohols in vents from distillation columns and tanks. Small amounts of particulates are lost to vents from metallic oxide catalysts. Off-gases from the process consist of CO, H_2 and C_1 to C_4 hydrocarbons. These are not emitted but either flared or sent to refinery fuel gas. Some hydrocarbons and CO may escape unburned. Most off gases come from the Oxo reactor system.

(21) Phenol

The cumene process is used by most producers to synthesize phenol. Air is introduced into an aqueous sodium carbonate emulsion with cumene to produce cumene hydroperoxide. Dilute H_2SO_4 is added in a second reactor to cleave the cumene hydroperoxide into phenol and acetone.

As with many other air oxidation processes, the venting of spent air from the reactor accounts for a major portion of the emissions. In general, emissions of phenol are low, in keeping with the toxicity of the material. However, often phenolic odors are noted within the manufacturing plants. Low molecular weight hydrocarbons are emitted from the product recovery and purification sections of the plant.

The spent air from the oxidizer can be passed through a carbon adsorption column, a scrubber, or can be sent to an incineration unit prior to passing into the atmosphere. When the proper precautions are taken, emissions are low. When these are not taken, emissions can run as high as 0.0067 tons/ton of phenol produced.

Acetone is the main emission from the distillation train vent. This can be as high as 0.0043 tons/ton of phenol produced.

(22) High-Density Polyethylene

The major portion of emissions from the production of high density polyethylene come from the separation and repurification of solvents and unreacted monomer. Emissions also result from the pneumatic conveyor system used to transport the polymer to various blending and storage facilities.

The slurry process is the predominant polymerization route. Ethylene is polymerized on a metal oxide surface, often chromic oxide. Catalyst particles are kept in suspension by agitation.

All producers recycle solvent and most recycle unreacted monomer. After the purification of these streams, the light and heavy ends are usually either vented or flared. This results in one of the main air pollution sources in the production of high-density polyethylene.

Both hydrocarbons and particulates are emitted from the vents associated with the pneumatic conveyors. Cyclones are used to remove polyethylene dust from the conveyor system.

In some cases, bag filters are used to rsmove catalyst fines from the atmospheric vent associated with catalyst activation operations.

Start-up and emergency vents consist primarily of hydrocarbons. These are usually flared. If the dssign is adequate and the load light, only CO_2 and H_2O will be emitted.

(23) Low-Density Polyethylene

Low-density polyethylene is produced by polymerization of ethylene at high pressures using a free radical catalyst.

Unreacted monomer is recycled and this process requires purification. In some cases, ths light and heavy ends from the purification process are vsnted, causing a sizeable amount of air pollution. A pollution control device such as a flare can be used to control emissions.

Semi-finished and finished granules of low-dsnsity polyethylene are often transported in plant by means of pneumatic conveying systems. Atmospheric vsnts associated with thess systems are a source of air pollution. Ethylene diffuses from the pellets and through the vents. Particulate emissions are often sliminated using cyclones or bag filters.

Vents associated with start-up operations as well as emergency vents are usually connected to a flare.

Liquid storage is carried out under a nitrogen blankst, pressurized, refrigerated, or, if the liquid is of low volatility, at atmospheric pressure. Some storage losses occur.

Because of the extremely large volume of low-density polyethylene production, the associated air pollution problem is relatively major.

(24) Polypropylene

Emissions from polypropylene production arise from polymerization, recovery, drying, purification of materials from recycle, materials handling, storage, packaging, and fugitive sources. The pollutants are mostly hydrocarbons and finely divided solids.

The polymerization of propylene can yield several isomeric polymers, two of which are stereoregular. The isotactic form, in which the methyl groups lie in the same plane, is the predominant commercial form. Substantial amounts of copolymers with ethylene are also produced. Production is heterogeneous utilizing a stereospecific catalyst such as titanium trichloride with aluminium alkyl. The propylene is usually dissolved in a hydrocarbon solvent. When the isotactic polymer is formed, it precipitates from solution. The reaction slurry is then transferred to a vessel where unreacted polypropylene and some solvent are stripped. Polymer is later washed and dried. Polymer and copolymer are produced in a variety of compositions for different end uses.

When unreacted monomer is purified, the light and heavy ends represent a potential pollution source. These can be vented directly, and hence become pollutants, or flared to yield CO_2 and H_2O.

The solid polymer is transported in plant using pneumatic conveyors. This is a source of atmospheric pollution from fine particles. Cyclones + bag filters can be used singly or in tandem to reduce these emissions. In some cases, water scrubbers are used. Relatively small hydrocarbon vapour losses occur in transport.

In-process venting of polymerization vessels occurs routinely, but the vent usually is directed to a flare. Vents associated with start-up operations or used for emergency purposes are also typically connected to flares.

It appears that fugitive emissions are typically rather high in this industry. These can occur from agitation shaft seals, pump and compressor seals, or valve stems.

(25) Polystyrene

The primary pollutant emitted during the production of polystyrene is styrene. The monomer is emitted during feed preparation, polymerization and from the devolatilization process. Also some polystyrene dust is discharged to the atmosphere during pneumatic conveying. In general, relatively little air pollution results from polystyrene production.

Styrene is usually polymerized using an organic peroxide catalyst, such as benzoyl peroxide. The most important commercial techniques for polymerization are solution and emulsion polymerization. In the case of solvent polymerization, a low pressure, high temperature devolatilization is required to strip off unreacted monomer and solvent. In the case of emulsion polymerization, a simple wash of the polymer beads is all that is required.

In the case of solution polymerization, the system is very sensitive to catalyst poisons. Hence, there is a purge of the feed preparation section.

One manufacturing plant has reported over 700,000 lbs of styrene/year as emissions from the polymerization vent. It appears that reactors are normally vented to the atmosphere and that this represents a significant portion of total emissions for this process.

Only solution polymerization plants have an emission associated with the solvent recovery vent. One such manufacturer has reported 75% of the overall emissions eminating from this source.

Polymer drying vents are a source of small amounts of polymer, hydrocarbons, and HCl.

A pneumatic conveyor system is used within the plant for transporting polymer. Polymer dust is emitted to the atmosphere through vents, but no quantitative data are available.

The exhaust air from the extruding operations contains small amounts of styrene.

(26) <u>Styrene</u>

The commercial process used to make styrene is the catalytic dehyrogenation of ethylbenzene. The styrene produced is primarily used in polymerization processes, such as polystyrene and styrene-butadiene rubber production.

Emissions from styrene production are relatively low. These emissions result from distillation column vents, fuel consumption, storage tank losses, and miscellaneous leaks and spills.

Non-condensibles and small amounts of condensible organic vapors are released from the distillation columns employed in the process. A condensible vapor conservation system is commonly employed so emissions to the atmosphere are normally low. Light gases such as H_2, CO_2 and CH_4 plus small amounts of benzene and toluene are lost from the column used for the recovery of the benzene and toluene produced as by-products in the styrene synthesis. Small amounts of styrene are released through the finishing column vent. A plant without a vapor recovery system emitted total hydro-carbons of 0.0042 lbs/lb of styrene from the distillation column. One plant with a recovery system reported zero emissions.

Small amounts of pollutants are released when a mixture of fuel gas and natural gas are burned to provide super heated steam.

When a stripper is used prior to the distillation column, toluene and ethylbenzene are emitted, amounting to 0.00096 lbs and 0.0032 lbs/lb of styrene produced by one manufacturer.

One manufacturer reports annual storage tank losses of 370,000 lbs of styrene or 0.00067 lbs/lb of styrene produced. Vapor conservation can reduce these losses by a factor of 100.

Start-up and emergency vents are used infrequently, and emissions can be substantially reduced by flaring.

(27) Styrene-Butadiene Rubber (SBR)

The dominant method of producing styrene-butadiene rubber is emulsion polymerization. There are five main sources of air pollution associated with the process. These are:

1. Butadiene absorber vent gases;
2. Carbon black emissions from masterbatch mixing operations;
3. Dryer exhaust gases;
4. Talc from dusting of rubber bales during final packaging operations;
5. Fugitive emissions.

In general, the process can be classified as a low air polluter.

After polymerization is finished, the unreacted butadiene is flashed off, condensed and recycled. Small amounts of butadiene (about 0.0001 lbs/lb SBR) are vented along with the non-condensibles.

Substantial carbon black is usually added to the SBR as a filler. The handling of the black during these processes results in the emission of carbon black particles to the air. The average amount emitted is about 0.001 lbs/lb of SBR.

After breaking the SBR completed polymerization emulsion, the rubber takes the form of crumb. The crumb may contain up to 30% moisture. During the process of continuous drying, exhaust gases containing styrene and fine particles of SBR are vented to the atmosphere. Various manufacturers have reported SBR emissions from this source in the range of 0.00001-0.00009 lbs/lb of SBR produced and 0.021 to 0.0846 lbs of styrene/lb of SBR produced.

During the final packaging operation, talc is air-blown into 75 lb packaged bales of SBR. One manufacturer reports an atmospheric emission of 12,000 lbs/year (0.00003 lbs/lb of SBR) from this process.

Fugitive emissions occur from the reactor section, monomer recovery, the tank farm, and the compressor house. These can amount to a substantial percentage of the total emission during the production process. The amount of emissions is approximately 0.00008 lbs of styrene and 0.00085 lbs of butadiene, both per lb of SBR produced.

(28) <u>Vinyl Acetate via Acetylene</u>

Vinyl acetate is used to produce polyvinylacetate and copolymers with vinylchloride, ethylene and other monomers. It is commonly produced by the zinc acetate-catalysed reaction of acetylene with acetic acid.

Acetylene is recovered from a light ends cut after the reaction is completed. Emissions from the light ends vent constitute the most important source of air pollution. The stream consists of acetaldehyde, acetylene, acetone, vinyl acetate, and acetic acid. The most severe case reported was 0.040 lbs/lb of vinyl acetate produced. The least polluting manufacturer reported 0.0082 lbs/lb of vinyl acetate. It should be possible to recover chemicals from this stream in many cases. Where not feasible, the stream could be incinerated. In one plant, acetic acid in the amount of 0.0002 lbs/lb of vinyl acetate is discharged through a heavy ends vent.

One manufacturer incinerates heavy liquid wastes from the process. Combustion to CO_2 and H_2O is virtually complete.

Release of vinyl acetate through storage tank vents can be significant. One plant reported losses of 0.0075 lbs/lb of vinyl acetate.

Reactor purge gas is an intermittent source of emissions. The purge gas is a mixture of nitrogen and acetic acid. The process occurs perhaps 10 times a year. Annual emissions are 0.0001 lbs acetic acid per lb of vinyl acetate.

The only emission control device utilized by manufacturers using this procsss is the incinerator.

(29) Vinyl Acetate via Ethylene

The newer commercial routes to vinyl acetate utilize a reaction route via ethylene. The reaction typically involves the reaction of ethylene, acetic acid, and oxygen in the vapor phase using a noble metal catalyst. In addition to vinyl acetate, small amounts of oxygenated hydrocarbons are produced by the process.

The only apparent emissions result from the flaring of light hydrocarbons and incineration of heavy liquid waste. The only emissions to the atmosphere are trace amounts of NO_x. The light hydrocarbons are purged from the water scrubber and light ends distillation column. The light ends consist of ethylene and oxygenated hydrocarbons. The heavy liquids are thoseremoved from the acetic acid vaporization tower. The stream consists of acetic acid, mixed glycol diacetates, vinyl acetate, polyvinylacetate, and ethyl acetate.

Vinyl acetate is typically stored under a nitrogen blanket or a floating roof Acetic acid is allowed to vent to the atmosphere. Storage losses should be small.

WATER POLLUTION

General Considerations

The petrochemical industry presents a waste treatment problem because productions are so widely varied. Therefore, waste streams are complex. One must focus on the ability of known methods of waste treatment to handle the key materials and intermediates and end products of the industry [6].

The most prevalent chemicals expected to end up in the wastewater of the industry were selected from the lists of production figures of the US Tariff Commission for (1) Crude products derived from petroleum or natural gas; and (2) Intermediates. 15 Major chemicals were chosen from lists (1) and (2). Eight large volume chemicals were chosen and seven chemicals were chosen from the list of cyclic intermediates [7].

These chemicals are benzene, 1.3 butadiene, n-butane, cyclohexane, dodecylbenzene, ethylbenzene, ethylene, monochlorobenzene, phenol, phthalic anhydride, propane, propylene, styrene, toluene and p-xylene. Actual treatment experiences of waste waters containing many of these materials appear later in the section.

The sources of wastes which are generated from petrochemical operations can be divided into seven general categories [8]:

1. Wastes containing a principal raw material;
2. Product remaining in solution after a separation;
3. By-products produced during reactions;
4. Spills, washdowns and vessel clean-outs;
5. Cooling tower and boiler blow down, steam condensate and water treatment waste;
6. Storm water run-off;
7. Sanitary wastes.

The principal contaminants in the wastewaters include oils, organic chemicals, suspended solids, acidity, heavy metals and other toxic materials, color and taste and odour-producing compounds.

The sources and quantities of pollutants should be considered during the design phase of a petrochemical plant and process treatment and overall waste water treatment facilities should be incorporated in the construction of new facilities or additions.

The most effective petrochemical wastewater collection system incorporates the segregation of waste streams. These can be classified as the following:

a. "Clean" water containing cooling tower or boiler flow down;
b. Highly contaminated process wastes including spills, batch dumps, etc.;
c. Oily water;
d. Contaminated storm run off;
e. Uncontaminated storm run off;
f. Sanitary sewers.

The types of waste treatment methods applicable to the petrochemicals industry can be categorized as: physical, chemical, biological and special in-plant methods. An evaluation of treatability and pretreatment requirements of each waste stream is a prerequisite to determination of the integration of processes which will make up the overall waste treatment system of the plant.

Physical methods include gravity separation, air flotation, filtration, centrifugation, vacuum filtration, evaporation and carbon adsorption. Gravity separators and air flotation units are designed to remove floating oil and settleable solids. Filtration is used primarily as a pretreatment. Centrifugation and vacuum filtration are used for sludge dewatering. Evaporation is utilized when available land allows for ponding and the climate is favorable. Carbon adsorption will remove refractory organic materials.

Chemical treatment methods include coagulation-precipitation, chemical oxidation, ion exchange, chemical pretreatment and sludge conditioning. These methods are useful for removal of oily substances and solids.

Biological treatment methods which are available include waste stabilization ponds, aerated lagoons, trickling filters and activated sludge [9]. Prior to utilization of biological treatment, some pretreatment is usually necessary.

Such pretreatment may eliminate shock loading at low or high pH (by neutralization or holding capacity) and remove oils, suspended solids, or toxic substances. The activated sludge process is generally considered the most effective biological process for treating petrochemical waste, with rsmoval efficiencies in the range of 70 to 95 of BOD* and 30 to 70 of COD+.

The activated sludge process allows the continuous mixing of biological growths and wastewater in the presence of dissolved oxygen. The micro-organisms remove organic material from the waste primarily through biological oxidation and to a lesser extent by physical sorption. The suspension of biological floc is then separated by settling. A portion of the sludge is then recirculated to the aeration basis for additional contact with the waste. Oxygen and mixing in the basin can be provided by diffused or mechanical aeration.

Extended aeration is particularly useful for petrochemicals waste treatment. The longer detention times allow the micro-organisms more time to degrade the complex organic chemicals. The most recent information indicates a critical sludge age of 3.5 days for petrochemical wastes treated at 30°C in an aerated basin and 8 days for waste treated at 10°C (Chemical Enginsering, 15 August 1977, p. 134).

A trickling filter utilizes a biological slime coated on a fixed bed media, such as stone, to remove dissolved and colloidal organic materials as the wastewater flows past. Biochemical oxidation of the organic material occurs at or near the surface of the slime in the presence of dissolved oxygen. The media should provide a maximum surface contact area of active biological slime and maximum wastewater-slime contact time without clogging. Good ventilation throughout the bed is required.

Other secondary treatment processes which are utilized include aerated lagoons, waste stabilization ponds, ozone treatment, nitrification-denitrification and a sequence of anaerobic and aerobic lagoons.

Various tertiary processes are also available. These include chemical coagulation and precipitation, gas stripping, microscreening, carbon adsorption, electrodialysis, ion exchange, evaporation, reverse osmosis, chlorination, and rapid sand filtration.

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*Biochemical oxygen demand

+Chemical oxygen demand

The first rule of in-plant waste treatment is good waste control practice in the different process operations [10]. These practices may include recovery of unreacted chemicals and by-products, multiple re-use of water where permissible, and good housekeeping techniques. In-plant control methods include stripping and other recovery operations, neutralization, oil recovery, and temperature control. In some cases product recovery will result in a cost credit for the particular process. These practices and controls can not only reduce the waste loadings given to the plant-wide treatment facility, but enhance its operation. Problems associated with pretreatment operations of waste from a particular process may arise from excess concentration of free or emulsified oils, high or widely fluctuating temperature, acidity or alkalinity, or other contaminants.

The design of the biological treatment unit for the overall facility must consider the possibility of spills, storm run-off, variations in flow and contaminants, and toxic or inhibitory substances.

In any wastewater treatment plant, large quantities of sludge accumulate daily and the cost of its dewatering and disposal may exceed the cost of any other unit process. Facilities for treating accumulated primary and secondary sludges represent a substantial capital investment. The processes involved are sludge concentration, dewatering, transportation and final disposal.

One inexpensive method of sludge disposal is lagooning. Of the sludge digestion methods, the aerobic solution is at present preferred to anaerobic, and both methods call for sludge thickening techniques. Dewatering can be carried out by means of vacuum filtration, filter pressing, or centrifugation. The final sludge may be transported to a land-fill site or incinerated.

The following types of treatment facilities have actually found application in the petrochemical industry:

Primary treatment

Separators

Neutralization

Equalization

Coagulation-precipitation

Sedimentation

Sludge handling

Centrifugation

Digestion

Thickening

Filtration

Landfill

Incineration

Secondary

Deep well injection

Filtration

Activated sludge

Trickling filter

Waste stabilization ponds

Anaerobic-aerobic lagoons

Activated Sludge Treatment of Petrochemical Wastes

The activated sludge process has been one of the best means of treating waste for the last 50 years. The process involves biological degradation in a system where a heterogeneous mass of organisms is brought into contact with the waste in the presence of sufficient dissolved oxygen. A portion of the waste removed by activated sludge is used for cell synthesis and storage products, thereby consuming little oxygen. The remainder of the substrate undergoes oxidation to provide the required energy for the metabolism.

$$\text{Total BOD removal} = \underset{\text{(respiration)}}{\text{oxidation}} + \underset{\text{(growth)}}{\text{synthesis}}$$

An automated activated sludge plant was developed for petrochemical wastes at the Dow Chemical Company Texas Division [11]. In order to optimize the activated sludge process, several variables were adjusted. These interact both independently and dependently. The rate determining steps were: the dissolution of oxygen from the air into the waste liquid, the mass transfer of nutrients and dissolved oxygen to the bacterial cell surface and the respiration and metabolism of the aerobic bacterial cells.

Suitable conditions of pH, temperature, nutrients, oxygen supply and adequate mixing must be supplied. Then the kinetics are determined by the nature of the organic material in the waste water and the activity of the biomass.

The problems of automated control of activated sludge plants lie in selecting parameters and developing sensors for these parameters. The analysis and presentation of the accumulated data is not difficult.

In the Dow study, instrumentation was developed to control an industrial activated sludge plant with the same degree of sophistication that controls a chemical process operation.

This plant was successfully operated to process a high salt (8%-10%) industrial waste containing polyhydric organics (such as glycols and glycerine) extending the activated sludge process into salt concentrations not previously believed possible.

Control of the feed pH and air supply to the aeration basis were standard features of the plant. Control of nutrients proceeded by sensing the carbon in the feed and adding a nutrient solution with known amounts of nitrogen and phosphorous in an optimal ratio to the carbon.

Control of the ratio of food to micro-organisms, or the loading ratio, was kept constant by measuring concentrations of bacteria in the overflow and concentrations of substrate in the feed and transmitting the data to a differential controller to keep a constant loading ratio by a control valve on the sludge return line.

Alum was added to flocculate the effluent according to automated measurements of turbidity. The pH in the flocculator was controlled at the optimum for alum flocculation.

An upstream sensing device was developed to detect toxic incoming loads. The device measured the rate of biological reaction of the culture and the feed. When the presence of a toxin was sensed, the feed was diverted to a holding pond and an alarm sounded.

A total oxygen demand instrument was employed to monitor final effluent quality and to thereby assess the performance of the plant. A computer programme was developed to facilitate routine data handling and to calculate parameters which described the plant performance. Daily averaged values of total oxygen demand, total carbon, mixed liquor volatile suspended solids, turbidity, temperature, pH, and flow were input. Outputs included total oxygen demand removal, oxygen transfer efficiency and sludge age.

Kinetic data were sufficient so that a computer simulation of biological growth and substrate removal could be calculated on the basis of nutrient to micro organism control system dynamics.

Percent removal efficiencies for oxygen demand removal were reported in the range of 91 –96 .

Anaerobic Treatment of Petrochemical Wastes

An extensive pilot scale study by the Union Carbide Corporation, United States of America, of anaerobic treatment of petrochemical wastes indicated that this process is both the performance and economic choice in warm, spacious locations [12]. The 30 gallon per minute anaerobic pilot plant was followed by aerated stabilization ponds. A BOD removal of greater than 90 was obtained and the system was resistant to organic loading and pH shocks.

The anaerobic-aerobic system was less costly than a strictly aerobic system due to lower sludge disposal and oxygen requirements. Lagoon performance decreased markedly at temperatures above 43°C and below 20°C. Within this temperature range, the system was found to be less costly than and offer performance advantages over an activated sludge plant. Overall cost of the operation was 3.4¢ per lb of BOD_5 removed. This cost represented about 25 investment and 75 operating costs.

The advantages of the anaerobic process are:

1. No aeration equipment is required for organic reduction. Many costs are thus avoided.
2. System loading is not limited by oxygen transfer.
3. Cellular material is produced in lower quantity and more stable form.
4. There are savings in nutrients and other chemicals, equipment and labour.
5. Certain organic-chemicals which are difficult to degrade aerobically will degrade anaerobically.
6. Methane produced can be utilized.
7. The anaerobic system can work at more elevated temperatures than can be employed for activated sludge.

Disadvantages are:

1. High temperatures are needed for maximum rates.
2. High biomass concentration is needed for reasonable reaction rates.
3. Long solids retention and acclimation times are required due to long regeneration times for methane bacteria (2 to 11 days at 37°C).
4. The system is potentially sensitive to shock of methanorganic organisms.
5. It is difficult to produce effluents with less than 50 ppm BOD with good aesthetic properties.
6. Gases produced are odorous if released.

The lagoons were subjected to many pH shocks and shock loading when the influent COD levels would at least double. In no case did the influent variation cause problems in lagoon operations.

In the aeration stabilization ponds an average retention time of 3 days was selected for the study. Operating observations indicated that a DO 1/ level of 1.5 mg/l was necessary to avoid problems.

In many instances the effluent from the aerated stabilization process needs to be clarified before release to receiving waters. Because the produced biosolids are non flocculent and settle at a slow rate, a conventional clarifier may not provide efficient separation. Facultative lagoons of a six-foot depth at 2 days retention time were selected for separation and storage of the solids. A dissolved oxygen residual was noted throughout the lagoons.

Useful life of the lagoon system can be estimated as follows:
If a 4 foot allowable sludge depth, a 4 percent final sludge concentration, and a 240 mg/l TSS 2/ influent are assumed, then the two 2-day lagoons used in this study would have a useful life of 4.6 years before cleaning.

The series of lagoons consistently provided a BOD removal of greater than 90% and a soluble BOD removal of greater than 95%. The COD removal was in the range of 75%-80%.

The anaerobic-aerobic system for which cost studies were made includes pH adjustment, primary clarification, anaerobic lagoons, aerated stabilization, and facultative (solids removal) ponds. For the wastes studied, an influent COD of about 1600 mg/l would be expected.

1/ Dissolved oxygen.

2/ Total suspended solids.

Overall construction costs for plants with daily flows of 0.5, 10.0 and 25.0 million gallons were $[illegible], $[illegible] and $28 per lb of BOD applied/day. Operating costs were [illegible].3¢, [illegible].2¢ and [illegible].[illegible]¢ per pound of BOD in [illegible] dollars.

Cost comparisons were made between Activated Sludge and the Anaerobic-Aerobic Stabilization systems from [illegible] million gallons/day system at an influent strength of [illegible] mg/l BOD.

	Anaerobic-Aerobic Stabilization	Activated Sludge
Land required (acres)	100	10
Effluent BOD (mg/l)		
Warm	35	84
Cold	35	84
Effluent suspended solids	75	100
Cost/lb of BOD removal (1971 dollars)	$0.034	$0.04[illegible]

Details of cost comparison can be found in the original reference [12].

The following constituents were detected in the waste used as fuel: acetaldehyde, acetic acid, acetone, ethylenediamine polymers, benzene, isobutanol, n-butanol, bis (2-chloroethyl) ether, ethanol, ethylenedichloride, ethylene glycol, isobutyraldehyde, n-butyraldehyde, hexanol, methanol, isopentanol, n-pentanol, isopropanol, n-propanol, propionaldehyde, and methylethylketone.

The α-β unsaturated aldehydes were particularly inhibitory to unacclimated anaerobic systems at low concentrations of 20-100 mg/l (acrolein; 20-50 mg/l formaldehyde; 50-100 mg/l). Other chemicals which were inhibitory were 2-ethyl-1-hexanol (500-1000 mg/l), methyl isobutylketone (100-300 mg/l), diethylamine (300-1000 mg/l), acrylonitrile (100 mg/l), 2-methyl-5-ethyl pyridine (100 mg/l), ethylene dichloride (150-500 mg/l), ethyl acrylate (300-600 mg/l) and phenol (300-1000 mg/l). Inhibitory effects were more severe at high volatile acid concentrations [13].

Introduction of test material at a gradually increasing level to continuously mixed batch-fed digesters resulted in acclimation and increased resistance to inhibition to crotonaldehyde, ethyl acrylate and phenols. In general, acclimation of anaerobic organisms in mixed digester cultures is a difficult and long-term procedure with only moderate chances of success.

Petrochemical processes which result in these materials being present in the waste stream should be provided with separate pretreatment operations if the process wastes are to be sent to an anaerobic treatment plant. Another control mechanism could be dilution of the problem waste with other waste streams to maintain a concentration below that found to be inhibitory. Given a steady feed of inhibitory chemicals in the waste stream, a possible solution would be to develop bacterial acclimation to allow higher concentrations of problem chemicals to be treated without inhibition. Treatment of these wastes by an activated sludge process is probably a better choice.

An Application of Activated Carbon

Activated carbon was used to reduce the COD of input of process water and rain water run-off in one petrochemical plant from 250 ppm to 50 ppm [14]; over a 2 year period, the plant processed 172 million gallons of effluent with a removal of 408,000 lbs of COD. The unit was operated at a cost of 40¢/1,000 gallons of water treated, or 18¢/lb of COD removed.

Activated carbon is carbon that has been processed to obtain surface areas of the order of 1000 square metres/gram by penetrating the particles with molecular sized pores. Molecules are physically bound, or adsorbed, onto the pore structure of the activated carbon.

The only interference to efficient operation of the activated carbon was the presence of algae.

A convenience of using activated carbon is that it can be regenerated by exposure to high temperatures (1700°-1850°F) for several days.

Energy Considerations and Costs of Pollution Control in Some Petrochemical Processes

The costs of water pollution control as well as energy consumption have been summarized below for some processes of the petrochemical industry. The reader can utilize the column which specifies per cent of operating costs represented by pollution costs to get a measure of the expense involved in cleaning up waste water from this industry. In general, the table shows that pollution control costs are not a substantial percentage of operating expenses and the use of energy for pollution control is small.

Process	Process operating costs $/ton	Pollution control operating costs $/ton	Pollution costs of operating	Process energy usage million Btu/ton	Pollution control energy usage million Btu/ton	Pollution-control energy usage, of operating energy
Olefins						
Ethane propane coil cracking	194	1.0	0.5	84.2	0.03	0.04
Naphtha coil cracking	259	2.2	0.9	124	0.09	0.07
Gas-oil coil cracking	250	3.4	1.4	167	0.16	0.10
Ammonia						
Via natural gas	97	1.1	1.1	37.0	0.7	1.1
Via coal gasification	136	9.8	7.2	35.5	0.6	1.7
Via heavy-oil gasification	146	4.6	3.1	35.0	0.5	1.4

Case Study - El Tablazo Petrochemical Complex in Venezuela

A new petrochemical complex which will ultimately include more than two dozen individual process units is under construction on the banks of Lake Maracaibo in Venezuela. The complex employs the first industrial waste treatment facility of its kind in Venezuela [15].

A comprehensive system had to be designed because of the diversity of plants scheduled to go on stream, yet the system had to be economically practical.

The first step was to undertake a base line survey to determine the water quality of the lake before construction of the plant. Water samples were taken from the lake at different locations and depths in various seasons. Analyses of the samples provide a bench mark against which future measurements of effects of effluent discharge can be compared.

To develop the pollution control system, different types of treatment processes were evaluated. Bench scale studies were carried out using waste water samples collected from operating plants in the USA which use the same processes as those planned for El Tablazo. Results indicated that the process which was the most effective and economically reasonable of treating waste waters to obtain the desired quality level would be an activated sludge system.

The activated sludge system is designed to achieve overall pollutant reduction of 80% chemical oxygen demand and over 90% biochemical oxygen demand. The system requires that each process unit pre-treat effluent if necessary prior to discharge to the activated sludge plant. The plant presently handles a design flow of about 21 million litres/day and incorporates provision for expansion to triple that capacity. A holding basin of 68 million litres provides surge capacity for incoming waste water not suitable for treatment, storm water, or any effluent not suitable for discharge into the lake. An oil recovery system is fitted for the basin. Sludge from the waste water treatment plant is thickened, aerated and trucked to a 20 hectare land farming area where it is dried, spread and disced into the soil.

A cost allocation programme allocates proportionate costs for waste water treatment to the different process operations. The major incoming waste streams are continuously sampled and charges for treatment are computed based on the quantity and relative treatability of the waste. The cost allocation is based on the BOD_5 and COD. Waste streams are also analysed for certain toxic substances which could reduce removal efficiency and increase treatment costs.

By including both presently planned facilities and potential expansion into account, the waste water treatment system will allow the El Tablazo petrochemical complex to make an important contribution to the Venezuela economy without harming the valuable resources of Lake Maracaibo.

Case Study of Water Pollution Control - Waterton Gas Plant of Shell Canada Ltd.

The Waterton Gas Plant, one of the largest sour gas plants in North America, generates three waste streams [16]:

1. Organic waste - Water from the gas treating process contains sulphides, oil and grease, and traces of methanol, glycol, and sulphinol. The chemical oxygen demand averages about 3,000 to 4,000 mg/l; the average flow rate is 120 US gallons/minute;

2. Non process waste - This waste water is generated from boiler blow downs, cooling tower blow-downs and floor drains from non-gas processing areas. The chemical oxygen demand is about 60 mg/l, and the average flow is 110 US gallons per minute;

3. Domestic wastes from the staff facilities.

New waste water treatment facilities to handle these wastes were built at an expense of $4.3 million. This plant has been on stream since mid-1975 and has met stringent design specifications selected to more than meet requirements of the Alberta Province Department of Environment. Proof of effluent quality is constantly demonstrated by growing young fish in a flowing effluent stream after treatment of waste water.

To develop the waste treatment facilities, a three month pilot study investigated various treatment processes. A bench scale study using actual waste samples evaluated the alternatives of chemical treatment, filtration and activated carbon adsorption.

The final design of the full scale plant includes oil removal, two sequential aerobic biological processes (an aerated lagoon and improved trickling filter), chemical treatment, filtration, and activated carbon adsorption. Sludge is thickened, dewatered and combusted in a multiple hearth furnace.

Maintenance of the system costs $50,000 per year plus a chemicals cost of $6 per thousand gallons treated. The processes and corresponding purpose are summarized in Table 1 below. Table 2 shows the waste characteristics of the influent and the resulting effluent.

TABLE 1

Process	Purpose
Evaporation ponds	Accept shock waste loads and provide system stability
Free and emulsified oil removal	Prepare waste for biological treatment by removing biologically inhibitory or toxic oil levels
Aerated lagoon	Treat waste biologically and equalize loads
Improved trickling filter	Provide high-rate biological treatment
Equalization pond	Provide equalization and surge capacity; allow constant flow to trickling filter
Chemical treatment	Remove biological suspended organics and phosphates; prepare the waste for filtration
Filtration	Remove remaining suspended solids
Activated carbon adsorption	Remove remaining dissolved organics, color and toxicity
Bioassay	Ensure effluent's nontoxicity to sensitive fish species

TABLE 2

	Waste stream	Goal effluent
COD, mg/l	3,200	25 - 50
Suspended solids, mg/l	160	0 - 10
Sulfide, mg/l	50	0 - 0.2
Oil and grease, mg/l	40	0 - 10
Ammonia nitrogen, mg/l	5	0 - 5
TON (threshold odor number)	> 200	< 25
Toxicity	Extreme	Non-toxic to rainbow trout fingerlings

Case Study - Upgrading the Effluents Discharged from a Petrochemical Facility

A study was made of a petrochemical complex producing polyester resins to determine appropriate waste treatment facilities.

The sources of wastewater were as follows:

1. Process wash and rinse resulting from periodic cleaning of reaction vessels. COD = 6000 mg/l;
2. Scrubber blow down from intermediate product wastes. COD = 100,000 mg/l;
3. Base flow - a composite of other wastewaters from a multiple of sources exclusive of 1. and 2. COD = 2,500 mg/l;
4. Storm run-off. COD = 2,500 mg/l.

The pH of scrubber blow down was 1.5. pH values from other streams are variable but normally in the vicinity of 7.

The final recommendations of this survey included:

(a) Segregation of the highly concentrated scrubber blow-down from the other process streams. Liquid incineration was recommended as the disposal process;
(b) Altering the design of the collection system so that the remaining waste streams discharge was to a single point. This flow was to receive biological treatment.

The impact of variable flow loadings was accounted for by providing a completely mixed biological treatment sized for excess capacity.

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