



**TOGETHER**  
*for a sustainable future*

## OCCASION

This publication has been made available to the public on the occasion of the 50<sup>th</sup> anniversary of the United Nations Industrial Development Organisation.



**TOGETHER**  
*for a sustainable future*

## DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

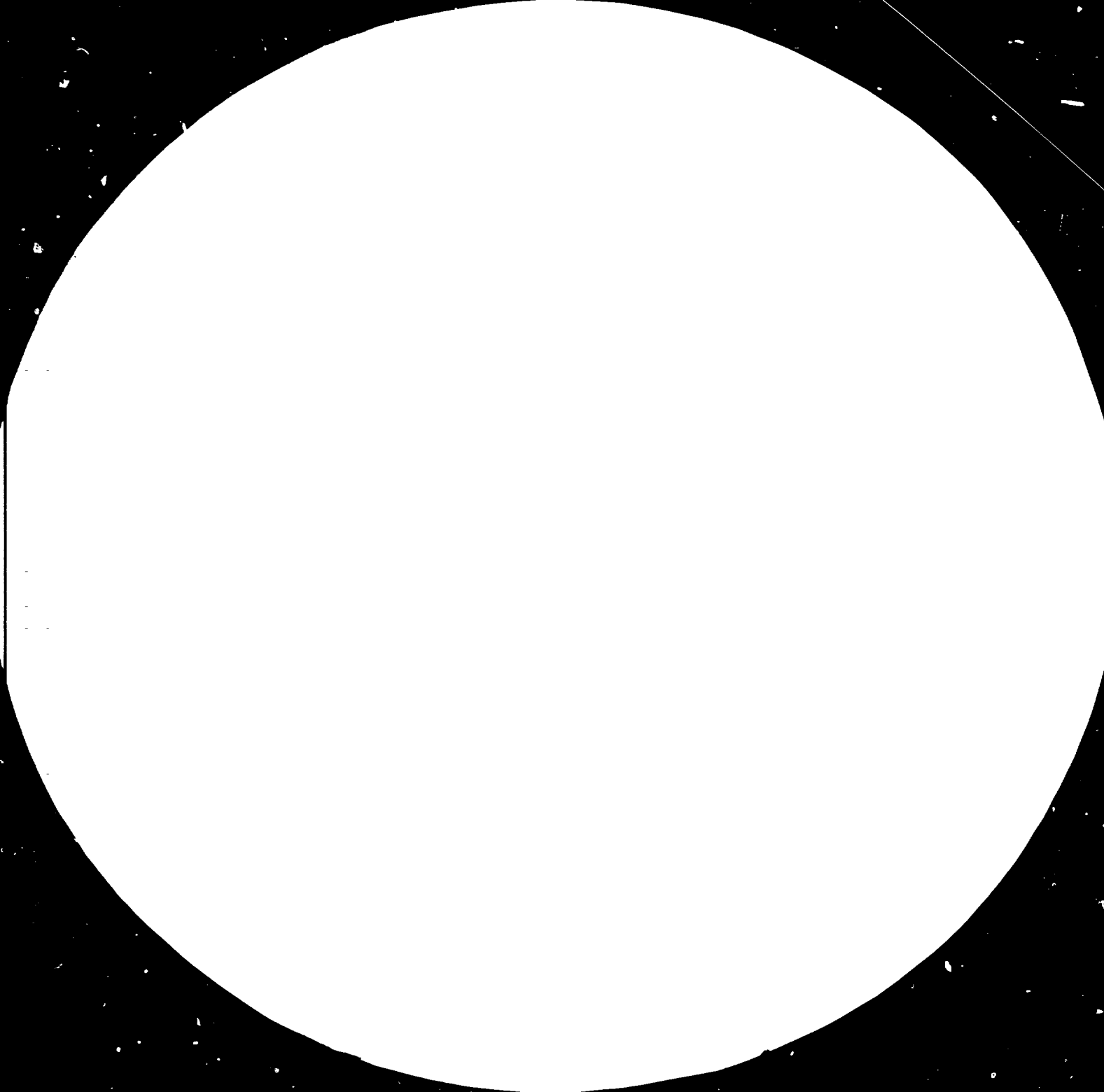
## FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

## CONTACT

Please contact [publications@unido.org](mailto:publications@unido.org) for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at [www.unido.org](http://www.unido.org)





2.8

3.2

3.6

4

U.S. GOVERNMENT PRINTING OFFICE: 1963 O 350-001

For sale by the Superintendent of Documents, Washington, D.C.

70401



11446



United Nations Industrial Development Organization

Distr.  
LIMITED

ID/WG.368/16  
29 April 1982

ENGLISH

Petrochemical and Polymer Consultation Week  
Porto Alegre, Brazil, 17 - 21 May 1982

THE PETROCHEMICAL AND POLYMER INDUSTRIES

IN ECUADOR\*

by

Miguel A. Morales-Betancourt\*\*

000070

\* The views expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

\*\* Chief, Petrochemical and Industrial Projects Department, Corporación Estatal Petrolera Ecuatoriana, Jan León Mera y Av. Orellana, Quito, Ecuador.

THE PETROCHEMICAL INDUSTRY IN ECUADOR

Ecuador as member of the Andean Group, is subject to many international engagements, one of which, is the fulfilment of the Decision 91 from the Comisión del Acuerdo de Cartagena, that is related to the implementation of the Andean programme for the petrochemical industry.

In Ecuador, the Corporación Estatal Petrolera Ecuatoriana, CEPE, is the Corporation in charge of executing, among others, the petrochemical plans and programmes, and at the industrial field, the CEPE's activities have two clearly defined lines of action:

- The industrialization of the gas from the Guayaquil Gulf.
- The industrialization of the oil from the oriental region.

Industrialization of the gas from the Guayaquil Gulf

Ecuador has very important natural gas measures which are situated in the Guayaquil Gulf. The chemical composition of this natural gas, reveals methane as its principal component, which concentration is 98.5 molar; for this reason, the industrialization of the hydrocarbon resources is directed to the production of ammonia and urea, due to the urgent necessity of improving the agricultural sector, in what is related to the best soil fertilization.

CEPE has developed in a detailed way, the studies corresponding to the fertilizer market and the location of this Complex. Relying on this previous studies, it has been established that the Ammonia plant will have 1000 MT/Y of capacity and the Urea plant will also have 1000 MT/Y of capacity. Consider-

ring that not all the ammonia production will be destined to the urea production, the exportation of the exceeding production of ammonia to the international market has been foreseed.

Industrialization of the oil from the Oriental Region

The industrialization of the oil from the Oriental Region has two goals:

- a) Production of hydrocarbon derivatibes for national market consumption; and,
- b) Production of basic, intermedium and finals petrochemicals, according to the stipulations of the Petrochemical Programmes of the Andean Group, for local consumption, for the countries of the Andean Group and to the international markets.

In order to fulfill the demand of these two groups of the mentioned products, from 1980-1990, CEPE has considered the operation of the Petrochemical Complex, constituted by a Refinery of 75.000 BPD and petrochemical plants. The Refiney which basic engineering designs are finished, has the following units:

	<u>Capacity</u>
	<u>BPD</u>
Atmosferic Destillation	75.000
Vacuum Destillation	34.000
Visbreaking	18.500
Visbreaking-vacum unit	34.000
FCC	30.000
Gas Concentration Unit	
Merox L.P.G.	10.000
Merox Gasoline	
C <sub>3</sub> /C <sub>4</sub> Splitter .	
C <sub>4</sub> =/C <sub>4</sub> Splitter	
Alquilation unit	5.000

The atmospheric distillation unit will receive 75.000 BPCD of oil, coming from the oriental region of the country, while the Vacuum distillation and Visbreaking vacuum distillation units will receive additionally 19.839 BPDC of reduced crude from the existing refineries (Península de Santa Elena refineries).

In this refinery, CEPE will implementare a polypropylene planta (Flant N° 1) which will be operated with the propylene recovered from the gaseous current from the Fluid Catalitic Cracking unit (FCC)

#### Actual conception of the Petrochemical Complex

As said before, CEPE in order to fulfill the stipulations of the Decision 91 from the Acuerdo de Catagena and to have the necessary technical and economical justifications, in order to take the decisions of implementating at the high government levels, contracted with BEICIP-PROCONSULT, the elaboration of the Feasibility Studies for the Ecuadorian Petrochemical Complex. Nowadays the elaboration of these studies are finished; following are some parts of major interest of the different stages done up to this date.

#### MARKET

The analysis of the market has covered all the products assigned to Ecuador through the Decision 91, having been analysed them at national, andean and internation levels. The charts presented bellow, put together the principal characteristics of the national and adean markets situation for the analysed petrochemical products, Generally speaking, knowing that there is not at the moment a local production of the principal petrochemical products, these must keep being imported in order to fulfill the local market, and at the Andean Group level, a broad future perspectives can be appreciate for the placement of the petrochemical products, specially those corresponding to plastics.

As a direct result of the market analysis, it concludes that the production of the following petrochemicals products is commendable in order to satisfy the requests of the markets shown bellow (Valed for 1978).

Products	Ecuadorian Market	Andean Market	Outside the Andean Market
Low Densidty Polyethy- lene	x	x	x
High densitu Polyethy- lene		x	x
PVC	x	x	
		x	x
		x	x
		x	
Butadiene			x
Bencene			x
VCM			x

#### SIZE AND LOCATION

The identification and the definition for the size and the scheme of the Ecuadorian Petrochemical Complex as well as for the location of the same was done in two stages, the first that corresponded to the fulfillment of the contractual terms of reference and the second considering different conditions of implementarion and operation of the Complex. But any way, the actual and future relation between the national supply and demand of combustibles has been the nominative factor in the size of the Complex as in its location. The enclosed numerical charts clearly explain the situation of the future national combustibles market.



The Petrochemical Complex identified as basic for the technical and economical analysis to be developed in the feasibility studies has the following size and operation characteristics:

<u>Petrochemical Plants</u>	<u>Capacity MT/Y</u>
"Steam Cracking"	140.000 (Ethylene)
High density polyethylene	65.000
Low density polyethylene	70.000
Polypropylene	72.000
Butadiene	25.000
PVC suspension	30.000

MARKET OPEN TO A COMPLEX IN ECUADOR, IN TERMS OF TOTAL  
DOMESTIC CONSUMPTION

IN 10<sup>3</sup>TONS

	1986	1988	1990	1992
Low density polyethylene	45	56	70	88
High density polyethylene	20	25	35	42
Polystyrene	12	16	20	25
Polyvinyl chloride	31	37	43	51
Polyvinyl chloracetate	2.2	2.5	2.7	3
Polypropylene	18	21	26	31
ABS resins	3.5	4.1	4.8	5.6
SAN resins	0.8	1.0	1.2	1.4
PBR rubber	2.2	2.5	2.7	3
SBR rubber	7.6	9.2	10	12
Monoethylene glycol	7	9	11	13
Diethylene glycol	0.3	0.3	0.4	0.4
Triethylene glycol	neg.	0.05	0.1	0.1
Polyethylene glycol	0.2	0.3	0.4	0.4
Ethylene glycol ethers	1.1	1.2	1.4	1.5
Monoethanolamine	0.2	0.3	0.4	0.4
Diethanolamine	neg.	neg.	neg.	neg.
Triethanolamine	0.1	0.1	0.1	0.1
Linear alcohols, ethoxylated	0.5	0.6	0.8	1.0

MARKET OPEN TO A COMPLEX IN ECUADOR, IN TERMS OF THE  
ANDEAN GROUP'S TOTAL INTERNAL CONSUMPTION

IN 10<sup>3</sup>TONS

	1986	1988	1990	1992
Low density polyethylene	321	393	462	590
High density polyethylene	150	186	230	285
Polystyrene	100	123	151	185
Polyvinyl chloride	232	284	349	425
Polyvinyl chloracetate	14	16	18	20
Polypropylene	112	142	178	225
ABS resins	16	20	26	33
SAN resins	3.7	4.8	6.4	8.4
PBR rubber	28	32	36	41
SBR rubber	10	122	135	150
Monoethylene glycol	65	76	89	104
Diethylene glycol	2.9	3.2	3.6	4.0
Triethylene glycol	0.3	0.4	0.4	0.5
Polyethylene glycol	2.2	2.5	3.0	3.5
Ethylene glycol ethers	9.6	10.9	12.3	14.0
Monoethanolamine	2.5	2.8	3.1	3.4
Diethanolamine	0.3	0.3	0.4	0.4
Triethanolamine	0.5	0.6	0.6	0.7
Linear alcohols, ethoxylated	3.3	4.0	4.3	6.0

MARKET WITHIN THE ANDEAN GROUP OPEN TO A COMPLEX IN ECUADOR  
TAKING INTO ACCOUNT THE CONSEQUENCES OF DECISION 91  
END-PRODUCTS AND INTERMEDIATES

PRODUCT	ASSIGNATIONS	MARKET OPEN TO A COMPLEX IN ECUADOR 10 <sup>3</sup> TONS							
		1986		1988		1990		1992	
		Consump- in ECUADOR	Consump- in other Andean countries	Consump- in ECUADOR	Consump- in other Andean countries	Consump- in ECUADOR	Consump- in other Andean countries	Consump- in ECUADOR	Consump- in other Andean countries
Low density polyethylene	all countries	45	-	56	-	70	-	88	-
High density polyethylene	ECUADOR-BOLIVIA-VENEZUELA	20	18	25	22	33	28	42	35
Polystyrene	all countries	12	-	16	-	20	-	25	1
Polyvinyl chloride suspension	all countries	28	-	33	-	40	-	42	1
Polyvinyl chloracetate	all countries	2.2	-	2.5	-	2.7	-	3	-
Polypropylene	ECUADOR-BOLIVIA	19	46	21	58	26	74	31	95
ABS resins	ECUADOR-COLOMBIA	3.5	5.9	4.1	6.9	4.8	8.2	5.6	9.5
SAN resins	ECUADOR-COLOMBIA	0.8	0.8	1.0	1.3	1.2	1.9	1.4	2.5
SBR rubber	COLOMBIA-PERU-VENEZUELA	-	-	-	-	-	-	-	-
PBR rubber	COLOMBIA-PERU-VENEZUELA	-	-	-	-	-	-	-	-
Monoethylene glycol	ECUADOR	7	58	9	67	11	79	13	91
Diethylene glycol	ECUADOR	0.3	2.5	0.3	2.9	0.4	3.2	0.4	3.8
Triethylene glycol	ECUADOR	Neg	0.3	0.05	0.35	0.1	0.4	0.1	0.4
Polyethylene glycol	ECUADOR	0.2	1.9	0.3	2.20	0.4	2.6	0.4	3.1
Ethylene glycol ethers	ECUADOR	1.1	8.7	1.2	9.6	1.4	10.6	1.5	12.5
Monoethanolamine	ECUADOR	0.2	2.3	0.3	2.5	0.4	2.7	0.4	3.0
Diethanolamine	ECUADOR	Neg	0.31	Neg	0.34	Neg	0.37	Neg	0.40

MARKET WITHIN THE ANDEAN GROUP OPEN TO A COMPLEX IN ECUADOR  
TAKING INTO ACCOUNT THE CONSEQUENCES OF DECISION 91

END PRODUCTS

PRODUCT	ASSIGNATIONS	MARKET OPEN TO A COMPLEX IN ECUADOR 10 <sup>3</sup> TONS							
		1986		1988		1990		1992	
		Consump- in ECUADOR	Consump- in other Andean countries	Consump- in ECUADOR	Consump- in other Andean countries	Consump- in ECUADOR	Consump- in other Andean countries	Consump- in ECUADOR	Consump- in other Andean countries
Triethanolamine	ECUADOR	0.1	0.43	0.1	3.48	0.1	0.54	0.1	0.60
Linear alcohols ethoxylates	ECUADOR	0.5	2.8	0.6	3.5	0.8	4.2	1.0	5
Ceprolactem	ECUADOR-COLOMBIA	9	19	10	21	11	23	12	27
Dimethylterephthalate	COLOMBIA	-	-	-	-	-	-	-	-
Acrylonitrile	PERU	-	-	-	-	-	-	-	-
Styrene	BOLIVIA, VENEZUELA	-	-	-	-	-	-	-	-
Phthalic anhydride	all countries	6.5	-	8	-	9	-	11	-
Vinyl chloride	all countries	(1)	-	(1)	-	(1)	-	(1)	-
Ethylene chloride	all countries	(1)	-	(1)	-	(1)	-	(1)	-

(1) Consumed by the PVC units then operating in Ecuador

PETROCHEMICAL SUPPLY/DEMAND BALANCE IN  
ANDEAN COUNTRIES (1976-1985-1992)

---

	1976	1985	1992
ABS/SAN Resins	neg.	(20)	-
High density polyethylene	(40)	(30)	10
Low density polyethylene	(80)	(30)	-
Polystyrene	(10)	-	-
Polypropylene	(20)	-	-
Polyvinylacetate	-	(10)	-
Polyvinyl chloride	(40)	(10)	-
Acrylic fibres	(10)	(10)	-
Polyamide fibres	(10)	(10)	-
Polyester fibres	-	-	-
Polybutadiene rubber	(10)	20	20
SBR rubber	(50)	(20)	20
Ethylene oxide	-	-	-
Ethylene glycol (mono)	(10)	(20)	(20)
Ethylene glycols (excl. mono)	-	-	-
Glycol ethers	-	(10)	-
Ethanolamines	-	-	-
Linear alcohol ethoxylates	-	-	-
Acrylonitrile	(10)	10	10
Caprolactame	(10)	10	10
DMT/TPA	(20)	(40)	(40)
EDC	-	10	-
Styrene	(20)	(30)	(30)
Vinyl acetate	(10)	-	-
Vinyl chloride	-	-	(40)
Ethylene	-	-	-
Butadiene	-	-	10
Propylene	10	(50)	10
Benzene	(10)	10	90
Toluene	20	10	10
O-xylene	(20)	-	-
P-xylene	-	-	-
Phthalic anhydride	10	-	-

PROSPECTIVAS DE EXPORTACION PARA LOS PRODUCTOS PETROQUIMICOS VALORES EN 10<sup>3</sup> TM

PRODUCTOS	CRITERIOS MAS IMPORTANTES DEL MERCADO							PROSPECTIVAS (incl. otros factores del mercado)
	TALLA DEL MERCADO		COMERCIO	AREAS EN DEFICIT	SOPORTE EN EL MERCADO:	MARKETING	TRANS- PORTE	
	1985	1992	1985-86	1986-92	INTERIOR			
BUTADIENO	9 400	12 800	620	USA, EUROPA Del Este	BAJA	FACIL	CARO	MEDIANA
BENCENO	31 100	32 900	500	JAPON, L.A.M., EUROPA del Oeste	AMPLIO	FACIL	FACIL	BASTANTE MEDIOCRE
TOLUENO	1 600	2 900	400	EUROPA del Oeste	BAJA	FACIL	CARO	MUY MEDIOCRE
O-XILENO	3 700	6 000	120	Pocas	NINGUNO	FACIL	FACIL	MUY MEDIOCRE
P-XILENO	6 200	9 600	250	L.A.M, EUROPA Del Oeste	NINGUNO	FACIL	FACIL	MUY MEDIOCRE
EOC	32 800	58 800	310	Pocas	MODERADO	DIFICIL	FACIL	MUY MEDIOCRE
VCM	19 700	32 300	420	P.D.	MODERADO	FACIL	CARO	MEDIANA
ESTIRENO	15 300	24 800	680	P.D. EUROPA	NINGUNO	FACIL	FACIL	MUY MEDIOCRE
ANHIDRIDO FTALICO	4 200	6 600	90	P.D.	BAJA	MOD. FACIL	FACIL	MUY MEDIOCRE
DMT	9 100	14 100	940	P.D.	NINGUNO	MOD. FACIL	FACIL	MUY MEDIOCRE
CAPROLACTAMA	3 100	4 450	320	P.D.	MODERADO	DIFICIL	FACIL	MUY MEDIOCRE
ACRILONITRILLO	4 850	7 300	170	A.A.D.	NINGUNO	DIFICIL	FACIL	MUY MEDIOCRE
OXIDO DE ETILENO	3 100	13 800	-	-	AMPLIO	DIFICIL	PELI- GROSO	NINGUNO
ETILENGLICOL (MONO)	7 000	10 500	350	L.A.M, EUROPA Del Oeste A.A.D.	AMPLIO	MOD. FACIL	FACIL	BASTANTE BUENA
OTROS ETILENGLICOLES			NÓ EVALUADO	P.D.	BAJA	DIFICIL	FACIL	MUY MEDIOCRE
ETANOLAMINAS	700	1 290	50	P.D. (excp.LA)	BAJA	DIFICIL	FACIL	MUY MEDIOCRE
ETERES DEL ETILENGLI- COL	1 000	1 550	80	P.D.	AMPLIO	DIFICIL	FACIL	BASTANTE BUENA

## CHARACTERISTICS OF THE UNITS

### Production units

The general balance corresponding to the petrochemical units is shown in the enclosed scheme.

### Steam-cracking Unit

The steam cracking can operate with two different loads: naphta ( $C_5$  -180°C and naphta  $C_5$  -204°C, this unit produces the ethylene (139.000 MT/Y) that feeds the high and low density propylene unit and polypropylene N° 2, and propylene (59.200 MT/Y) that feeds the polypropylene and high density polyethylene. Besides of that the Steam Cracking produces: a cut  $C_4$  that feeds the butadiene extraction unit, fuel oil that is used for energy (power plant) hydrogen, fuel gas consumed in the complex, LPG and gasoline of high octane number partially hydrogenated sent to the pool of gasolines at the Refineries.

### Butadiene extraction

The unit separates the butadiene from the cut  $C_4$ , produced in the steam cracking. At its full capacity the unit produces 20.000 MT/Y of butadiene sent to storage (butadiene is stored at -5°C) and 17.600 MT/Y of cut  $C_4$  sent to the refinery.

### Low density Polyethylene (l.d. PE)

The production capacity of this unit is based in the satisfaction of the ecuadorian market. This unit produces 70.000 MT/Y of low density polyethylene from 76.000 MT/Y of ethylene from the steam cracking.

### High density Polyethylene

The production capacity of this unit is based in the satisfaction of the ecuadorian market and a part of the Andean market. This unit produces 60.000 MT/Y from 62.000 MT/Y of ethylene and 1.000 MT/Y of propylene coming from the steam cracking.

### Polypropylene N° 2

The production of this unit will be destined to the ecuadorian market and to the other Andean countries markets. This unit will produce 57.000 MT/Y of from 58.400 MT/Y of propylene and 1000 MT/Y of ethylene coming from the steam cracking.



### PVC

The production capacity of this unit is based on the satisfaction of the ecuadorian market. This unit will produce 40.000 MT/Y of PVC from 46.000 MT/Y of imported vinyl chloride.

On what is related to the location of the Petrochemical Complex, it is necessary to point out that this will operate in the Provincia del Guayas Peninsula de Santa Elena, in Atahualpa.

### Technological evaluation

As a part of the stage called Preliminary Engineering work, the Consultant Asociated firms BEICIP-PROCONSULT, made an evaluation of the technological characteristics that different international companies presented to CEPE and to the Consultants. The basis, in order to make this evaluation, have principally the following parts:

- Process references.
- Description and main characteristics.
- Technical qualities of the process.
- Technical specifications of raw materials and products.

Another additional technical, economical and financial criterons are considered.

### PETROCHEMICAL COMPLEX INVESTMENT

In order to establish the investment of the Petrochemical Complex, two stages of execution completely different have been indentified: Stage 1 : which has the implementation of the Refinery and the Polypropylene Plant Nº 1 that uses propylene recovered from the gaseous current FCC, and Stage 2 has the implementation of different petrochemical units with their basic characteristics determined in the size stage. The investments corresponding to this last stage are analysed bellow, and constant prices have been established in accordance to the economical conditions prevailed in the world, during the sencond quarter of 1981. The budgets have been studied for each one of the petrochemical companies and the obtained values are based in Ecuador.

TOTAL INVESTMENT REQUIRED FOR THE IMPLEMENTATION OF THE PETROCHEMICAL COMPLEX

THOUSAND DOLLARS

PLANTS	INVESTMENT
Steam Cracking	388.630
Low density polyethylene	108.455
High density polyethylene	105.930
Polypropylene	109.230
PVC	<u>59.155</u>

T O T A L      US \$    771.400 x 10<sup>3</sup>



