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Distr.
LIMITED

ID/WG.27/8
31 October 1968

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on the Development of the Plastics Industry in Developing Countries

Vienna, Austria, 11 - 15 November 1968

TRENDS IN PRODUCTION AND CONSUMPTION OF PLASTICS IN THE WORLD[1]

by

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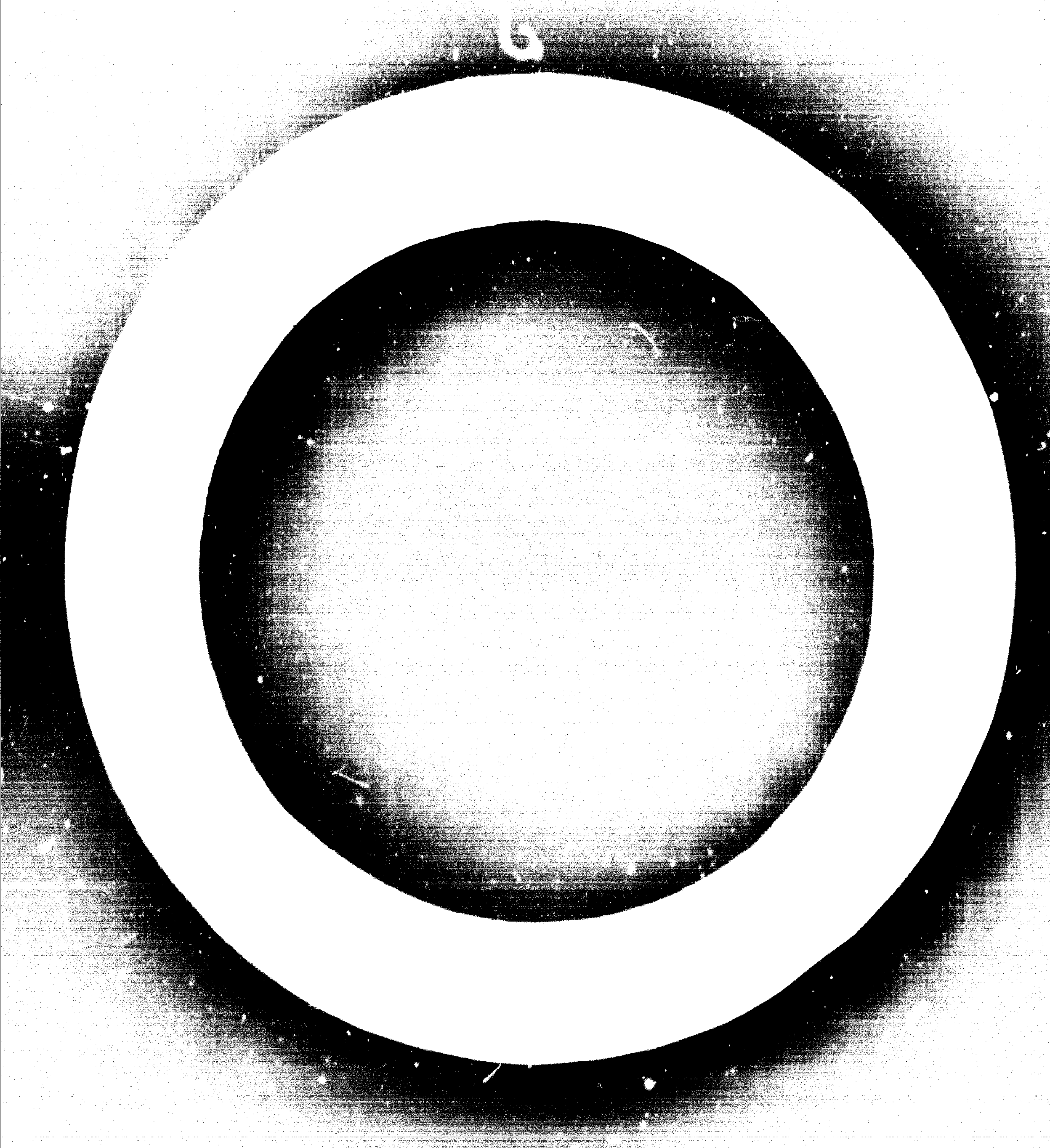

Capacity

The present capacity for plastics world-wide is about 20,000,000 tons made up as follows:

U.S.A.	7.0 million
EEC countries	4.5 million
Japan	3.0 million
U.S.S.R.	1.5 million
U.K.	1.3 million
Developing countries	0.8 million
Other developed countries	1.9 million

New plants are being announced almost every week but not all come on-stream to time nor do they function at 100% capacity immediately. Further, older plants go out of production with little or no announcement so often actual capacity is appreciably less than it would appear. Even so, it would seem probable that world capacity will be well over 100,000,000 tons by 1980 and approaching 1,500,000,000 by 2,000.

It is not easy to see how such capacity will be divided between the various products but as a first approximation we might assume that by 1980 polyolefin capacity will reach about 30-35,000,000 tons, polyvinyl chloride including co-polymers 20-25,000,000 tons, polystyrene including ABS perhaps 10-15,000,000 tons.

Polyolefins and polyvinyl chloride, largely because their raw materials are gases but also because in order to obtain economical production continuous processes in large establishments are necessary, are capital intensive. Polystyrene is intermediate but most of the thermosetting resins have in the past been made in relatively simple equipment and only recently are continuous processes being developed. Traditionally therefore they have been labour intensive but the position is slowly changing.

Much capacity will probably be devoted to new plastics. A lot of these will be new copolymers of existing monomers, thus the polyolefin figures given above are assumed to include copolymers of olefins with modest proportions of other monomers. There will also however be a limited production of entirely new products by 1980 giving special properties such as heat resistence or greater stiffness.

Production

Chart 1 shows the world production of plastics to 1966 and then projected to 1980 giving upper and lower limits. The mean figure is slightly over 100,000,000 tons. Below is given a similar projection for the developing countries (figures up to 1966 have been collected from the countries it is proposed to invite to the Baku Conference). It seems likely that production will be rising at a slightly greater rate than that of developed countries merely because of the enormous potential consumption. The two curves show an average increase 1965-1980 of 17% for the developing countries and 14.4% per annum for the total world.

Consumption

There are four ways in which plastics consumption can increase:

1. By an increase in population of the country concerned, meaning more consumers.
2. By an increase in the standard of living in the population, giving greater consumption per head.
3. An increase in the replacement of traditional materials, wood, metal, cement etc., by plastics.
4. The creation of new applications as a result of the properties which plastics possess, this is of course almost impossible to quantify and can be only very approximately covered in a projection.

World population, according to a forecast published in Modern Plastics August 16th 1966, page 98, is expected to increase from 3,500 million at the present day to 7,000 million by 1980 which would by itself account for a two-fold increase in consumption. It is appreciated of course that forecasts of the increase in population are notoriously prone to error and many divergent forecasts have been published on this subject.

The standard of living is very complicated to forecast as it is partly related to the increase in population and also to the effect of political activity. Some figures of national income for different countries are however given in Table 3.

The replacement of traditional material by plastics can be examined a little further by looking at the relative properties and prices of different materials. This could be carried to great lengths but in the time available only two very simple studies can be made.

Chart 2 shows the world production of steel, consumption in any year will be a little less than this due to material in transit, in stock or scrap. On the same chart but below are given the production figures in the developing countries, due to imports and exports the consumption of developing countries cannot be calculated directly from the chart.

Both curves are projected to 1980 and comparison with Chart 1 will show the slow rate of growth of steel compared with plastics (steel averaging 4.7% per annum compared with plastics growth of 14.4% per annum taken between the years 1965 and 1980).

For many applications volume is more significant than weight and if the world volumes are plotted on one chart (see Chart 3) it becomes clear that the volume of plastics produced in the world is likely to exceed the volume of steel by the early 1980s. The average density of plastics has been taken as 1.0 in the necessary calculations involved.

The other approach is to compare a key property together with the price of some traditional constructional materials and some plastics. The following figures have been extracted from a paper by W. O. Alexander published in Contemporary Physics Volume 8 1967 and are based on U.K. prices but converted to dollars at £1 = $2.40.

TABLE I

BASIC DATA OF STRUCTURAL MATERIALS

	Tensile Strength (ton/sq. in.)	Density	Cost per ton in U.S.$	Average cost ¢ per cu.in.	Cost per ton in ¢ per unit of tensile strength
Steel	40	7.8	216	2.7	0.067
Reinforced concrete	1	2.4	19.2	0.07	0.070
Timber	0.5	0.5	121	0.065	0.013
Copper castings	15	8.9	1,560	22.9	1.53
Aluminium sheet	16	2.7	1,032	4.5	0.28
Polyethylene	1	0.9	360	0.55	0.55
PVC (rigid)	4	1.4	240	0.57	0.14
Nylon plastic	5	1.15	1,680	2.7	0.54
Glass weave-polyester laminates	50	1.87	2,768	8.0	0.16

For purely structural applications it is clear that plastics cannot yet compete with steel, reinforced concrete or timber on price. They have however a great number of advantages, some of which are as follows:

(1) Very much easier to manipulate than conventional materials.

(2) Resistant to water and many corrosive chemicals.

(3) Attractive colour ranges.

(4) Excellent electrical insulation.

(5) Much more resistant to bacteria than wood.

(6) The price of plastics is falling due to improved techniques of manufacture and the scale of production while that of traditional materials is tending to rise in most industrial nations.

Considerable thought has been given as to how the consumption of plastics in individual developing countries could be examined.

The only simple way seemed to be to assume that imports were equivalent to consumption after allowing for any production and, in one or two cases, exports.

By these means we have calculated the consumption of plastics for 1966 in a number of developing countries for which figures were readily available (mostly from UN sources) and then, using the appropriate population figures, calculated the consumption in lbs/head. Results are shown in Table 2 below.

TABLE 2

CONSUMPTION PER HEAD OF INDIVIDUAL DEVELOPING COUNTRIES

	Prod.	Imp.	Exp.	Cons.	Pop. in millions	Cons. lbs/head
	('000s tons)					
INDIA	39.4	16.8	0.9	55.3	498	0.248
PAKISTAN	Nil	17.2	Nil	17.2	105	0.366
MALAYSIA	Nil	29.0	Nil	29.0	96	0.679
TAIWAN	45.6	26.2	0.7	71.1	12.8	1.25
INDONESIA	Nil	14.0	Nil	14.0	107.8	0.294
PHILIPPINES	16.2	29.3	Nil	45.5	33.4	3.3
THAILAND	Nil	36.9	Nil	36.9	31.5	2.62
IRAN	Nil	23.4	Nil	23.4	25.8	2.03
LEBANON	Nil	13.7	Nil	13.7	2.5	12.4
UNITED ARAB REPUBLIC	Nil	12.9	0.2	12.7	30.1	0.94
KENYA	Nil	29.4	Nil	29.4	9.6	6.85
GAMBIA	Nil	1.8	Nil	1.8	3.8	1.06
CONGO (Leopoldville)	Nil	3.7	Nil	3.7	16.0	0.52
ALGERIA	Nil	8.5	Nil	8.5	12.1	1.57
MOROCCO	Nil	10.5	Nil	10.5	13.7	1.72
ARGENTINA	58.9	14.6	0.7	72.8	22.7	7.18
BRAZIL	53.4	17.3	Nil	70.7	83.1	1.90
COLOMBIA	2.0	18.3	Nil	18.3	20.3	1.98
MEXICO	71	53.3	0.2	124.1	44.1	6.3
VENEZUELA	Nil	35.5	Nil	35.5	8.9	4.0

The corresponding figures for the U.S.A. are 59 lbs/head, the EEC 47 lbs/head, and U.K. and Japan about 40 lbs/head, these have been taken for 1966 from the writer's article in the Financial Times June 19th 1967, page 15.

These latter figures compared with those in the table showing consumption in the developing countries emphasize enormous scope for increased consumption purely as a result of an increased standard of living which we all hope will take place in the not too distant future.

An attempt was made to go a little further by comparing plastics consumption with the national income. Plastics were valued at $500/ton on average and the final column gives the ratio of the value of plastics consumption (x 1,000) to the national income. Only certain countries have been included owing to the difficulty of getting reliable figures.

TABLE 3

RELATION OF PLASTICS CONSUMPTION TO NATIONAL INCOME

	A National Income (1966) in U.S. dollars x 10^9	B Value of plastics consumed in U.S. dollars x 10^6	B x 1000 / A
Taiwan	2.53	35.8	14.2
Lebanon	0.87	6.85	7.85
Thailand	3.78	18.4	4.9
Philippines	4.91	22.7	4.7
Mexico	19.7	62.05	3.15
Argentina	16.3	36.4	2.22
Morocco	2.37	5.25	2.22
Iran	5.42	11.7	2.16
Zambia	0.78	0.9	1.15
India	32.1	27.65	0.87
Brazil	42.4	35.3	0.84
Pakistan	11.7	8.6	0.73

On the same basis the table below shows the figures for U.S.A., U.K. and Japan.

U.S.A.	621	2590	4.16
U.K.	76	488	6.41
Japan	53	882	16.6

It is not very easy to see the reason for the differences here, there seems to be some indication that countries less well endowed with natural resources whether or not they are prosperous in the sense of having a large national income, tend to use larger proportions of plastics. It would be most interesting to have the views of other people during the discussion period.

Breakdown of Consumption Between Products

Many forecasts have been made as to the trend of various plastic materials. Normally if we attempt to add up the individual forecasts they fall a long way below the total or leave you with the alternative of assuming a very large production of miscellaneous or until now unknown materials by 1980. I have given some suggestions for the capacity of the major thermoplastics in the first paragraph. In a rapidly growing product consumption tends to lag behind production due to the necessity for the increase in stocks so it is probably reasonable to assume a world consumption of 95,000,000 tons by 1980. Of this 95,000,000 the following would be a reasonable breakdown:

Polyolefins including copolymers containing a major proportion of olefins	26,000,000 tons
PVC and copolymers	23,000,000 tons
Polystyrene and other styrene plastics including ABS	12,000,000 tons
Phenolic resins	4,000,000 tons
Urea formaldehyde and melamine formaldehyde resins	5,000,000 tons
Polyurethanes	5,000,000 tons
Acrylics	1,000,000 tons
Polyvinyl acetate	2,000,000 tons
Cellulosics	3,000,000 tons
Alkyds	4,000,000 tons
Unsaturated polyesters	6,000,000 tons
Nylon plastics	1,000,000 tons
Miscellaneous and new materials	3,000,000 tons

Production in Developing Countries

The next table shows the raw materials required for the principal plastics and from what source they are obtained. To avoid over-elaboration with detail we have confined ourselves to the principal processes.

TABLE 4

RAW MATERIALS FOR THE PRINCIPAL RESINS AND PLASTIC POLYMERS

Resin or Plastic Polymer	Secondary Raw Material	Basic Raw Material
Polyethylene	Nil	Ethylene
Polypropylene	Nil	Propylene
Polyvinyl chloride	Vinyl chloride	Ethylene Chlorine
Polystyrene	Styrene	Ethylene Benzene
Nylon 6	Caprolactam	Benzene Propylene Ammonia
Nylon 66	Adipic acid Hexamethylene diamine	Benzene Ammonia
Polymethyl methacrylate	Acetone Hydrogen cyanide	Propylene Methane Ammonia
Saturated polyesters	Teraphthalic acid Ethylene glycol	Paraxylene Ethylene
Unsaturated Polyesters	Phthalic anhydride Maleic anhydride Propylene glycol Styrene	Orthoxylene Benzene Propylene Ethylene Benzene
Polyvinyl acetate	Vinyl acetate	Ethylene Acetic acid
Poly acrylates	Alkyl acrylate	Propylene Appropriate alcohol
ABS	Styrene Butadiene Acrylonitrile	Benzene Ethylene Propylene Ammonia
Cellulose acetate	-	Cotton linters Acetic acid
Phenol formaldehyde resins	Phenol Formaldehyde	Benzene Propylene Methyl alcohol
Urea formaldehyde resins	Urea Formaldehyde	Ammonia Methyl alcohol
Melamine formaldehyde resins	Melamine Formaldehyde	Ammonia Methyl alcohol

Table 4 (Cont.)

Resin or Plastic Polymer	Secondary Raw Material	Basic Raw Material
Polyurethanes	Polyols Isocyanates	Propylene Toluene Ammonia Carbon monoxide Chlorine

It is remarkable how the whole range of plastics can be prepared from so few base materials. These are repeated in Table 5 below with their method of production.

TABLE 5

Plastics Base Material	Method of Production
Ethylene Propylene Butadiene	Steam cracking of naphtha or natural gas containing substantial proportions of C_2 and above.
Benzene Toluene Orthoxylene Paraxylene	Catalytic reforming of special naphtha fraction, followed by solvent extraction and, if necessary, dealkylation.
Methane	Natural gas.
Ammonia Methyl alcohol	Steam reforming of oil fraction, particularly naphtha, to give synthesis gas followed by the appropriate catalytic reaction.
Carbon monoxide	By-product in many processes.
Chlorine	Electrolysis of brine.
Acetic acid	Oxidation of naphtha.

To be viable all these except methane and carbon monoxide are only justified if produced on a very substantial scale. Further, the co-products of the first two reactions mean a planned disposal of all of them, unco-ordinated demand again greatly raising the price.

Where the carbonization of coal e.g. for the production of metallurgical coke, is carried out, limited quantities of by-product benzene, toluene and xylene as well as phenol and ammonia are produced.

For countries where electricity is cheap and brine is available chlorine and caustic soda would probably be made for other chemical purposes. As a corollary it must be mentioned that, if coal is available the cheap electricity may be used to make calcium carbide and hence acetylene which will react with hydrogen chloride to produce vinyl chloride, the monomer of PVC.

A certain amount of aromatics, e.g. benzene, toluene and xylene, can be extracted from the liquid phase produced, depending on the condition of operation, in the steam cracking of naphtha.

In the production of plastics, there are four stages.

(1) The production of the primary chemicals from the oil feedstock.

(2) The production of the secondary chemical or chemical which is to be the subject of polymerisation or condensation process.

(3) The polymerisation or condensation stage to give the primary polymer.

(4) The compounding or colouration of the polymer or in some cases the product of said sheet or tubing to give the raw material from which the plastic product or article is made.

As will be seen from the list in Table 4, all these stages are not necessarily present in every plastic material.

Normally a developing country wishing to start on plastics production should not attempt stage (1) unless a major petrochemical industry including a wide range of chemicals, is proposed. It would be unwise to envisage an ethylene cracker or any ammonia production with less than 100,000 ton per annum capacity for new plants. Of these, ammonia is far more likely to be viable due to the advantage of having home-produced nitrogen fertiliser.

Stage 2 usually also involves heavy capital investment and only in special circumstances should it be recommended. Some countries, it is true, notably Australia, have gone ahead with major chemical projects and protected the output by a high tariff ring. Presumably this is only intended to be temporary but a developing country adopting this course might find the need for protection anything but temporary and would as a result invite retaliation. Further the mere admission of the necessity for such protection implies that home production cannot compete with world prices and this means its own population having to pay over the odds for the products.

Stage 3 is more controversial. The production of polyolefins (there is no Stage 2 here) would never be recommended, the raw material is a gas and relatively expensive to transport although great progress is being made in this field. Further as already mentioned, the process is capital intensive.

With the other extreme the production of phenol formaldehyde or urea formaldehyde resins can be effected in relatively simple equipment and is far more labour intensive. Nevertheless knowledge of the correct formulations and considerable skill is needed in their production and such operations should never be attempted with untrained staff.

Stage 4. This is the stage which a developing country wishing to start a plastics industry would normally enter. Compounding the manufactured polymer, colouring it, plasticising it or adding the filler, are not by any means simple processes, they need considerable knowledge and skill but they can be carried out with relatively simple equipment in a batch process. Extruded sheet or tube or blow moulded [illegible] making are also processes which can be carried out on unit equipment of modest capacity and, if the necessary technical skills are available, at a competitive cost. Thus, in the U.K. there are hundreds of small moulders carrying out these and similar operations at a profit.

Much of what has been said in this paper will be thought to be controversial, this is deliberate to promote discussion and no apology is offered.

In an appendix a list of the petrochemical plants already erected in some of the developing countries is included. Many of these were planned some years ago when the importance of bulk production was not fully appreciated and are really too small to compete with the bulk production now being carried out or planned by some of the major industrial countries and a decision will have to be taken soon whether to go ahead with a major plant or to import and concentrate on plasticising, tinting and working up as mentioned in Stage 4.

APPENDIX I

The following is an attempt to give the latest position on the production of ethylene and the production of the principal thermoplastics and some other information where possible in more interesting developing countries. It is not claimed to be comprehensive, and many of the sources of information contradict each other. Further, there is obviously an enormous amount of planning going on. Major new plants are continually referred to in the literature but it is rarely certain whether these are actually under construction or awaiting finance or approval from the government.

POLAND

An ethylene cracker is on-stream at Blachownia with a capacity of 65,000 [illegible] per annum and another Linde plant at Plock is due on stream 1969 with [illegible] of capacity.

There is a substantial production of thermosetting resins in Poland-- [illegible],000 tons per annum of phenolics, [illegible],000 tons of amino resins while alkyds and unsaturated polyesters are made in substantial quantities. A [illegible] tons per annum high pressure polyethylene plant is on-stream at [illegible] ([illegible]) while there is a small [illegible] tons per annum polystyrene unit in operation at Oswiecim and this is being expanded. There is considerable production of PVC, a major plant of the [illegible],000 ton order at Oswiecim and a [illegible] ton plant at Tarnow based on acetylene from natural gas.

There is also expected to be a large plant at Pulawy (Lublin) but there is some doubt whether this is actually on-stream. This also makes vinyl chloride [illegible] acetylene produced from natural gas.

RUMANIA

There is one ethylene plant with a capacity of 35,000 tons per annum which is being increased. There is a 24,000 tons per annum polyethylene plant on-stream at Ploesti and another large plant, [illegible],000 tons per annum, under construction at Ploesti due on stream 1969.

A small polystyrene plant, [illegible] tons per annum is on-stream at Gheorghe-Gheorghiu Dej. Other plants are planned or under construction.

There is a [illegible],000 tons per annum PVC plant just on-stream at Rimnicu Vilcea which appears to get ethylene from Ploesti. There are also small plants at Turda and Tirnaveni.

YUGOSLAVIA

Organsko Hemijska Ind. produces 50,000 tons per annum of ethylene by naphtha cracking at Zagreb and polyethylene and polystyrene are also produced.

ARGENTINA

P.A.S.A., Ipako and Duperial all have small ethylene plants, the combined capacity being about 40-45,000 tons. Substantial expansions to the last two are planned. In the plastics field Koppers has a plant producing some 11,000 tons per annum of polyethylene while I.Q.A.D. (ICI's subsidiary) is constructing a 14,000 tons per annum plant. Duperial produces 15,000 tons per annum but is expanding while P.A.S.A. is building a 20,000 tons per annum plant. Monsanto's Argentine subsidiary has been producing PVC on a 4,500 tons per annum plant but plans to sell to private interests. It also produces [illegible],500 tons of polystyrene while a similar quantity is produced by Ipako. There are many plants in the Argentine producing thermosetting resins from home produced phenol urea and formaldehyde.

BRAZIL

There is a naphtha cracker at Cubatao with a capacity of 35,000 tons per annum of ethylene. Petrobras, the state-owned refinery, produces streams that are converted to chemicals thus Union Carbide and Petrochlor have a joint venture making polyethylene ([illegible],000 tons per annum with a large expansion in view). Polystyrene is produced by Koppers (capacity [illegible],500 tons per annum) and Bakol S.A. (Brazil) with a capacity of [illegible],000 tons per annum. PVC is made by Eletrochloro with a capacity of [illegible],000 tons and [illegible] Brasil with [illegible],000 tons capacity. There is still some production of ethylene and other chemicals from the fermentation of cane sugar, in fact there is a small production of polyethylene from such raw material.

CHILE

I.N.A.S. has a [illegible],000 tons per annum ethylene plant under construction at Concepcion. A small quantity of polyvinyl acetate is made and numerous thermosetting resins are made from [illegible] chemicals in modest quantities. It is understood that plants for producing polyethylene, PVC involving foreign aid are under consideration.

COLOMBIA

Numerous plants have been announced but it is doubtful whether there are very many yet on-stream other than ammonia and urea although Ecopetrol has a 20,000 tons per annum ethylene plant based on crude oil. There is appreciable production of phenol, urea and melamine formaldehyde resins, Dow has a small polystyrene plant 3-4,000 tons per annum capacity and there are two small plants making PVC each about 3,000 tons per annum capacity.

VENEZUELA

I.V.P. have an ethylene cracker (from propane) under construction but it is unlikely this will be on-stream for some years yet. Many plants are planned e.g. PVC, polyethylene, polystyrene, but are not yet in production.

The other South American countries have negligible production of petro-chemical or plastics raw materials.

MEXICO

Pemex has a capacity of some 50,000 tons per annum of ethylene with major expansion under construction and possibly on-stream. This is a Mexican Government organization. It also has a 24,000 tons per annum polyethylene plant and another major expansion is planned for next year. B.A.S.F. Mexicana S.A. is producing polystyrene, up to 10,000 tons per annum and Prodesa (40% Sinclair-Koppers) is planning a plant. There is about 20,000 tons per annum of PVC produced with several small producers:

	Geon de Mexico	7,500
	Henkel	2,500
	Monsanto	10,000
	Plasticos Omega	3,500
also	Promociones Industriala Mexicana S.A.	10,000

which should be almost on-stream now.

CHINA (Mainland)

Information scanty and somewhat confused. Little, if any, real petrochemical production, most chemicals and plastics are based on coke oven gas, coal-tar or from acetylene via carbide. Capacity for the latter is 300,000 tons per annum.

Benzene is even made by trimerising acetylene. There is also a production of chemicals from fermentation.

Ammonia is produced by several plants with a combined capacity of some 200,000 tons per annum while others are under construction. Chlorine production in 1967 was said to be 500,000 tons per annum while plastics production in 1966 was given as 60-70,000 tons per annum.

A Simon Carves plant based on ICI know-how at Lanchu is capable of producing polyethylene and a little polypropylene but it is believed to have been damaged in the cultural revolution.

10,000 tons per annum of unsaturated polyesters are made on know-how supplied by Scott Bader.

There is also a production of about 100,000 tons per annum of PVC.

<u>INDIA</u>

India has a large number of chemical complexes many of them making plastics. The following list is by no means complete but perhaps contains some of the most interesting.

PVC is made by the Delhi Cloth Mills with a capacity of 12,000 tons per annum, Calico Mills with a capacity of 4,000 tons per annum and Chemicals and Plastics (India) Limited with a capacity of 6,000 tons per annum.

Allied Resins and Chemical PVT Limited makes phenol formaldehyde resins etc. at Calcutta.

Indian Plastics Limited and Indian Resins Manufacturing Company both make synthetic resins at Bombay. Rajasthan Vinyl and Chemical Industries make calcium carbide, caustic soda and apparently also PVC (from acetylene). Synthetic and Chemicals Limited of Bombay (Firestone interested) produces synthetic rubbers, styrene monomer, ethyl benzene, toluene, acetaldehyde and butadiene. Union Carbide India Limited at Calcutta produces ethylene from naphtha cracking while it is understood that the Indian Government has a similar plant but which is not yet on-stream. NOCIL has a 60,000 ton ethylene cracker on-stream from which various chemicals are made and a PVC plant is under construction. Ethylene is also supplied to an associated company Polyolefin Productions Limited who make polyethylene. There is also a production of some 10,000 tons per annum of polystyrene by Polychem (Dow interest).

INDONESIA

Although there is ample refinery capacity the only petrochemical production is ammonia and urea at Paolenbang, Sumatra.

IRAN

The State Authority National Petrochemical Company has a 25,000 ton ethylene plant on-stream and major increases are planned. A new petrochemical complex is being set up at Abadan, where propane will be cracked to give ethylene for vinyl chloride, a 20,000 ton PVC plant is expected on-stream this year.

IRAQ

No petrochemical plants at present in spite of substantial raw materials available.

ISRAEL

Electrochemical Industries Limited produces PVC resins. Israel Petrochemical Enterprises Limited produces ethylene and polyethylene. [illegible] Enterprises Limited produces polyvinyl acetate, polyethylene, polyurethane foam.

PAKISTAN

Ammonia and urea based on synthesis gas from natural gas are in operation at Multan, Western Pakistan and Fenchuganj, Eastern Pakistan combined capacity being 1[illegible]0,000 tons of nitrogen. Any plans for ethylene appear to be based on the dehydration of ethyl alcohol from fermentation. Valika Chemical Industries has a 3,000 tons per annum polystyrene plant.

KUWAIT

Petrochemical Industries Company is constructing a plant to make fertilizers.

LEBANON

Esso is understood to be building a fertilizer plant.

MALAYSIA

The Chemical Company of Malaysia Limited (ICI has an interest) is building chlorine and fertiliser plants at Port Swettenham while Esso Standard Malaya Limited is building an ammonia plant at Port Dickson.

PHILIPPINES

No petrochemical plants although Esso is planning a 10,000 ton ammonia plant near to their refinery and Marcinduque Iron Mines are planning a 33,000 ton ammonia plant at Mindanao based on partial oxidation of fuel oil.

TAIWAN

The Chinese Petroleum Corporation has a 35,000 tons per annum naphtha cracking plant for producing ethylene. Fertilisers are produced by several companies. The Taiwan Polymer Corporation (National Distillers U.S.A.) has a 15,000 tons per annum polyethylene plant just on-stream. PVC is made by Cathay Plastics ([illegible] tons per annum), Chinese Plastics Corporation (several thousand tons) and Formosa Plastics (30,000 tons). Tai Fa Chemical Company (Mobil interest) produces polystyrene in a small way.

THAILAND

No petrochemical industry.

ALGERIA

No petrochemical industry.

UNITED ARAB REPUBLIC

Fertilisers and chlorine produced but negligible petrochemical interests.

KENYA

No petrochemical interests.

MOROCCO

No petrochemical interests.

TUNISIA

Believe that the Government has approved plans for an ammonia plant.

UGANDA

No petrochemical interests.

Chart I

Plastics production - 1958-80

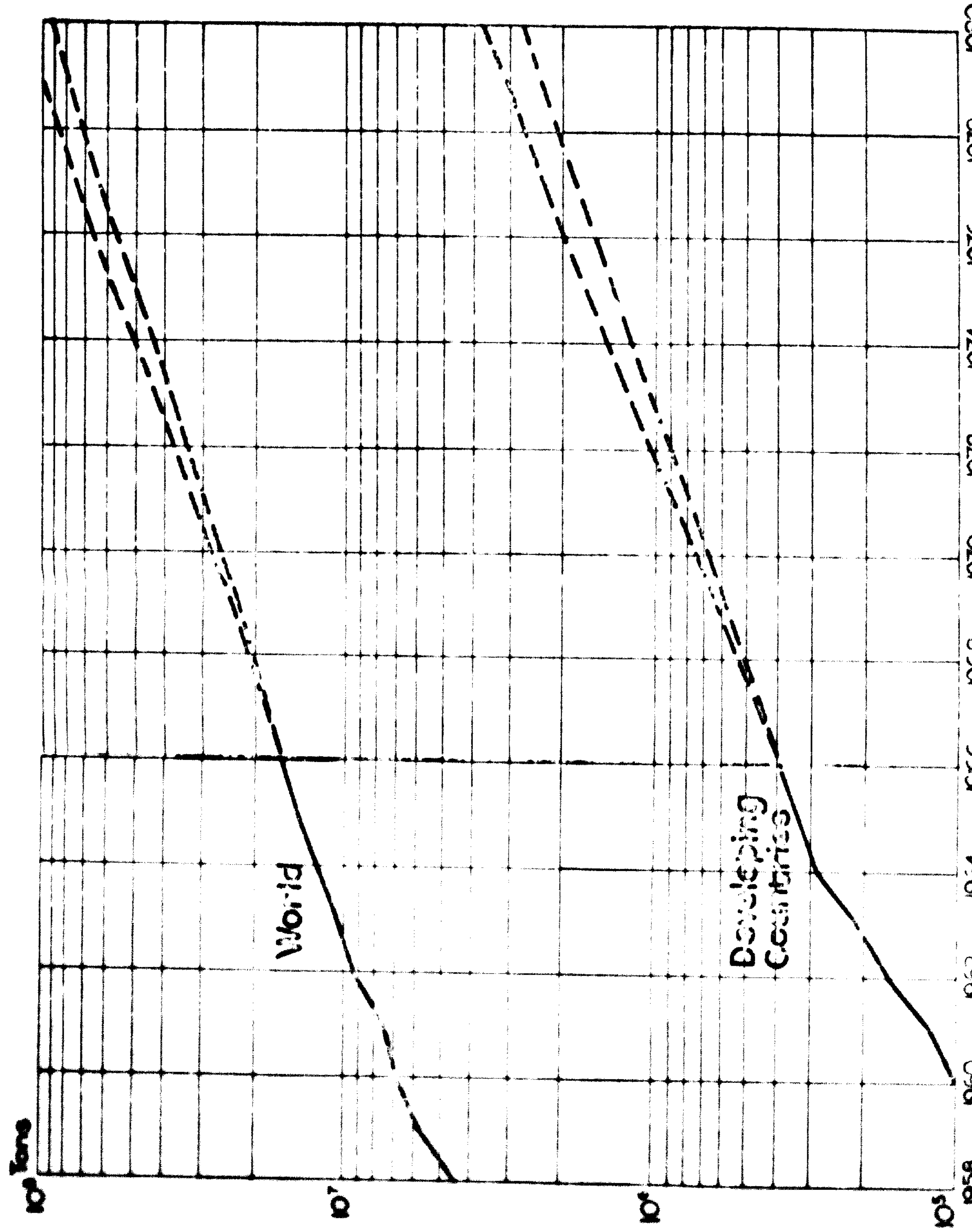

Chart II

Steel production

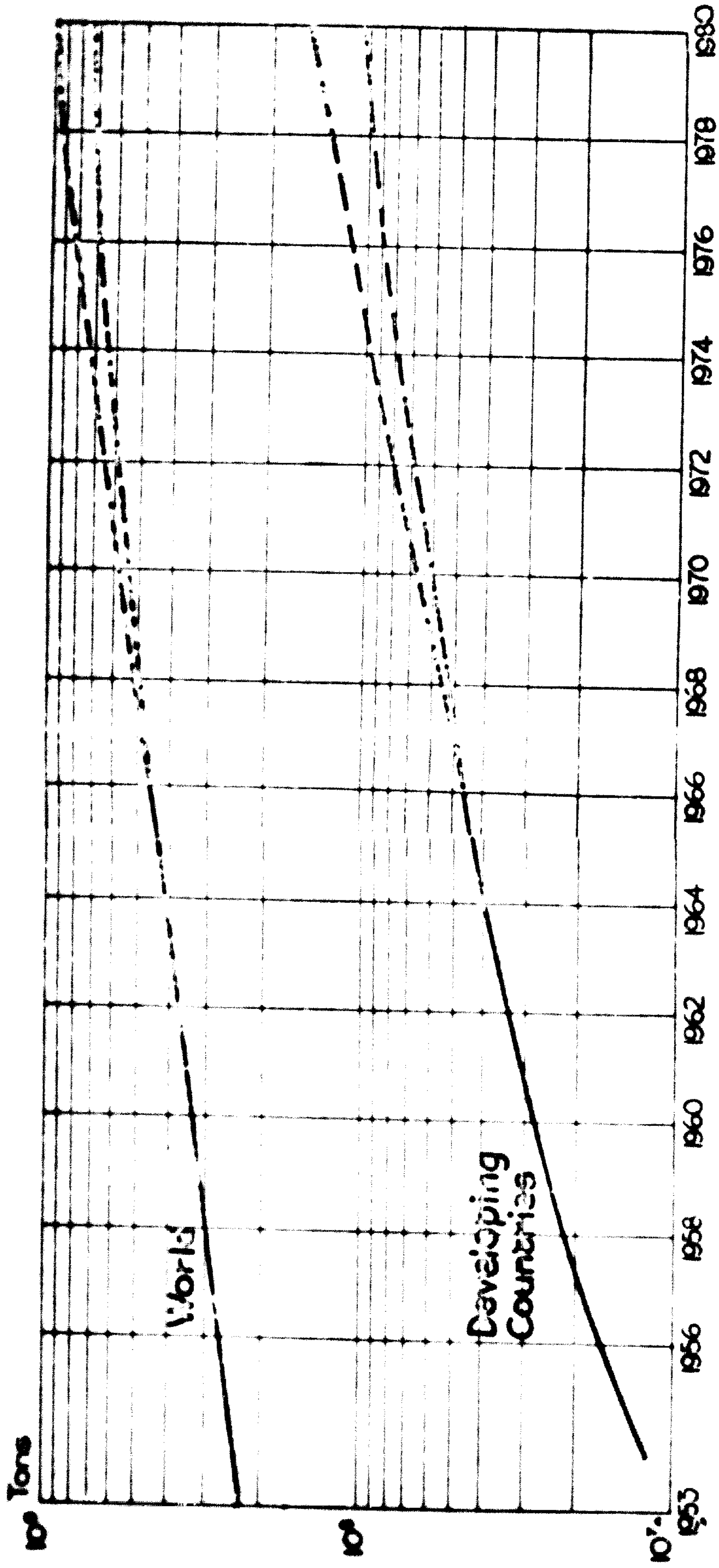

Chart III

Steel, cement and plastics world production - on volume basis