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THE DEVELOPMENT OF DOWNSTREAM PETROCHEMICAL INDUSTRIES IN DEVELOPING COUNTRIES

Issue Paper*

Prepared by the
UNIDO secretariat

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I. BACKGROUND

The Second Consultation on the Petrochemical Industry, held in Istanbul, Turkey from 22 to 26 June 1981, discussed the issue of "Opportunities for co-operation between industrialized and oil- and gas-producing developing countries for the development of downstream petrochemical industries in other developing countries" and recommended UNIDO to take further action for future consideration.1/

The Third Meeting of the Advisory Panel on Petrochemicals, convened in Vienna, Austria, from 3 to 5 June 1985, discussed the requirements, contributions and difficulties that might be faced in the development of downstream industries in developing countries and recommended UNIDO to carry out a study on the main forces governing the development of these industries on project, national and regional levels, in order to help developing countries optimize their resources, giving special emphasis to countries which are currently embarking on the establishment of such industries.

To this end, UNIDO has established a network of continuous seminars (consultation-weeks) on downstream petrochemical industries in developing countries, involving regional organizations and companies from developed countries, to expose and discuss topical issues in this field. Such seminars have been held, for example, on man-made fibres in Bombay, India, in April 1982; on polymers and petrochemicals in Porto Alegre, Brazil, in May of the same year and in Saudi Arabia in October 1984. One seminar on synthetic fibres is scheduled in Beijing, China, for November 1985, and another on plastics in agriculture in Alexandria, Egypt, for December 1985.

1/ ID/WG.336/71/Rev.1

II. INTRODUCTION

World demand for plastics, fibres and rubbers is estimated in 1985 at 70 million tons, representing a value of production, as final technical goods, surpassing 100,000 million US dollars. Recently, the industry has grown at a relatively slower pace compared with earlier years as shown in table 1. While the demand for synthetic rubbers has contracted lately, some segments like engineering resins have witnessed impressive growth rates averaging around 30% in 1984.

Table 1

Demand for the main plastics, rubbers and fibres
(1000 metric tons)

					Average annual growth rate (%)		
	1970	1975	1980	1984	1970-75	1975-80	1980-84
PVC	6200	7800	11600	13300	5,2	8,7	3,7
LDPE[2/]	5700	7400	11200	13600	6,0	10,3	5,4
HDPE	2000	2900	5700	7500	9,0	19,3	7,9
PP	1700	2700	4750	7100	11,8	15,2	12,4
PS	2200	3900	4800	5900	15,5	4,6	5,7
Total Plastics	17800	24700	38050	47400	7,8	10,8	6,1
Rubbers	6400	7600	8800	8300	3,75	3,2	-1,4
Fibres[3/]	2600	5000	6000	6700	18,5	4,0	2,9
Total Downstream	26800	37300	52850	62400	7,8	8,3	4,5

Source: UNIDO Data Base

2/ including LLDPE

3/ yarn not included

Last year, however, demand for plastics registered a vigorous rebound since the recent recession which hit bottom in 1982. Compared with other industrial sectors, the downstream petrochemical industries have performed better during the last ten years, notwithstanding the effect of major oil price increases.

During the 5 year period 1982 - 1987 the global growth in demand for commodity plastics is expected to be 4,5 per cent. However, this growth is expected to be more pronounced in developing countries, about 6-9 per cent yearly, and less in developed countries, about 2,5 per cent in Europe, and 4,4 per cent in the USA.

Considering the basic segments of the downstream petrochemical industries, plastics have achieved the best performance, followed by fibres and then rubbers which have recently suffered from stagnating, or even shrinking, demand. In developed countries, rubbers faired better than fibres, whereas in developing countries both grew at a healthy rate.

Recent technological advances in polymerization techniques, raw material and product compositions, process development etc., have given new vigour to the process of substitution of traditional products, especially in plastics and to a lesser extent in rubbers and fibres. The properties of some of the new products are clearly superior to those of traditional products, such as steel. This development has opened a growing potential of the new technologies for innovative applications.

A gradual shift from commodity products to specialties characterizes the current development trend in petrochemicals in developed countries, which is backed up by substantive R and D efforts. Expenditure in R and D has now reached 15 per cent of the value of total sales in most companies. An inevitable consequence of the current efforts in commercializing new technologies is the intense degree of integration on a global level, not only in upstream but also in downstream petrochemical industries, including medium or small scale entities.

III. DOWNSTREAM PETROCHEMICAL INDUSTRIES

Customarily, the processing industries of the product groups of plastics, rubbers and fibres, constitute the downstream petrochemical industry. However, there are a number of different, polymerized or non-polymer product groups, various additives, detergents, inhibitors, accelerators, surface active agents, coagulators, paints etc., constituting perhaps over a hundred different chemical groups, called specialty petrochemicals, which are often included in the downstream petrochemical industries.

The composition of the downstream industries varies tremendously between countries and regions. However, virtually every country has established some of these industries, including the least developed countries. The technologically more advanced developing countries like Brazil, Mexico, the Republic of Korea etc. have established a full range of these industries in thousands of operating companies and plants. For instance, in India, there are more than 10,000 plastic processing companies, as compared to only a very few in some African countries. Considering the extremely low per-capita consumption of the products of these industries at present, there is a large potential for their growth in all developing countries. Many areas of application of these industries in the developing countries are considered to be lagging far behind the state-of-the-art industries. The impact of down-stream operations on the development of the industrial sector in general and other sectors of the economy, such as agriculture, construction, transport, the services sector, etc. is such that their development becomes a contributing factor to the overall growth of the economies of the developing countries.

IV. CHARACTERISTICS OF THE DOWNSTREAM PETROCHEMICAL INDUSTRIES

Plastics, fibres and rubbers processing industries, constitute about 75 per cent of total production of downstream petrochemical industries. Plastics are the more prominent group with their versatile uses in countless consumer goods, as well as their ever-increasing penetration in industrial applications where they are commonly referred to as engineering plastics. Generally, downstream petrochemical industries are highly service-oriented industries needing close contact with customers to attend to their specific technical requirements in respect to both production and application.

PLASTICS

Plastics are the most versatile group of all downstream petrochemical industries and as such are characterized by generating a continuous flow of new products and applications. The polymers involved in plastics embrace polyvinylchloride (PVC), polyethylenes (low density LDPE, linear low density LLDPE and high density HDPE), polypropylenes (PP) and polystyrene (PS) as main constituents. Together they form a group which is commonly known as commodity plastics. An impressive new group known as engineering plastics has emerged to fulfil a variety of engineering needs. These are basically composed of hard polymers such as polypropylenes, nylons, polycarbonates, polyphenylenes, acetals, thermoplastic polyesters, polysulfones, polyphenylene sulphides of special grades reinforced with glass fibres, aramid fibres, carbon fibres etc. The application field of this group of products is currently expanding at a fast pace; for example, their average use in motor vehicles has increased from 54,8 kg in 1980 to 74,2 kg per unit this year and is expected to reach some 105 kg by 1990.[4/]

The techniques, commonly used in plastics processing, include extrusion, coating, injection moulding, reaction injection moulding, blow moulding, calendering, thermo-forming and pultrusion and their variations. With these techniques, a variety of products ranging from those commonly used in consumer goods of everyday life, such as cups, bags, toys etc., to industrial products like large-diameter pipes or boats can be produced.

4/ Engineering, May 1984

Some of the main factors contributing to the continuously increasing demand for plastics and their growing potential for substitution of traditional materials are:

1) need for lighter products to save energy;
2) need for easier-to-handle products to save manpower and costs;
3) need for easier-to-form products to save machine and manpower hours;
4) need for more competitive products calculated on cost/performance basis;
5) need for more corrosion resistant, better surfaced products to save in maintenance and capital cost;
6) need for stronger products in rigorous applications;
7) need for new systems and technologies to cater to innovative engineering applications;
8) need for cost-effective systems in sectors, like agriculture, utilities, distribution etc.;
9) need for better and competitive technologies to improve global market sharing; and
10) need for new and better products to improve living conditions.

These needs explain, to a large extent, the growth in demand for commodity plastics surpassing GDP growth rates, despite heavy restructuring in the upstream petrochemicals and the oversupply situation that has persisted in recent years.

RUBBERS

Synthetic rubbers often in combination with natural rubber, are predominantly used for industrial purposes such as manufacture of conveyer belts and vessel linings and car and truck tyres, with the latter accounting for the bulk of demand. After a steady growth from 1956 to 1973, at an annual rate of 9,7 per cent, consumption of synthetic rubbers suffered a set-back which amounted to a 4% reduction in 1974 and 23% in 1975 from the 1973 peak 5/.

5/ Chemical and Engineering News, April 1984

The advent of radial tyres and other improvements have dramatically increased the average tyre life, thus reducing demand for natural and especially synthetic rubber. The increase in the price of synthetic rubber due to higher costs of feedstocks and energy have also rendered natural rubber more competitive. However, the outlook for synthetic rubber is improving due to some revival in demand, as can be seen from Table 2.

Table 2
Rubber consumption in market economies (thousand tons)

	1982	1983	1984	1985*	1988*	1989*
SBR	2544	2648	2768	2824	2943	3079
Polybutadiene	813	855	969	991	978	1102
Ethylene-Propylene	308	343	408	426	416	496
Polychloroprene	231	241	250	254	259	269
Nitrile	162	167	193	198	196	218
Other	757	740	813	843	828	949
Total Synthetic	4815	4994	5401	5536	5630	6113
Synthetic as % of total rubber consumption	61.8	61.6	62.0	62.1	61.9	62.3

* estimates

The most commonly used synthetic rubbers are styrene butadiene rubber (SBR), polybutadiene rubber (PB), ethylene-propylene rubber (EPR), butyl rubber (BR), nitrile rubber (NR), isoprene and chloroprene.

FIBRES

The most commonly used synthetic fibres are polyester, polyamide and acrylic fibres. However, new entrants such as polypropylene fibres have swiftly increased their share during the 1980's.

Production of synthetics fibres accounted for 70% of the total man-made fibre production in 1984 6/, a year which registered a record level of production in synthetic fibre, which amounted to 12 million tons, up 1.3 million tons or 12.5% over the production figure of 1980.

The synthetic fibres sector was the first to suffer from oversupply in the early seventies. It is also the only sector where an attempt was made to negotiate a global co-operative restructuring through the mechanism of the Multi-Fibre Agreement (MFA), which governs the major part of world's trade in textiles and clothing. The arrangement was first entered into in 1974 and was later renewed in 1978 and 1982 and is due to expire in 1986. Its continuation is currently being negotiated.

6/ Chemical and Engineering News, March 1985

V. RELATIONSHIP BETWEEN THE NATIONAL ECONOMY AND DOWNSTREAM PETROCHEMICAL INDUSTRIES

Downstream petrochemical processing industries supply materials to about all economic sectors and are widely used to provide essential inputs for those related to water management, utilities, information networks, transportation facilities, housing, construction, clothing, packaging, health care, storage etc. The products cover some of the basic needs of the population and provide indispensable materials and equipments.

Although no exact statistics can be quoted to quantify the impact of this industry on the general performance of the economy, some important qualitative factors maybe mentioned for illustrative purposes:

1) The processing of basic, intermediate and polymer production is often carried out by small-scale production units which employ a large number of people;

2) The value added through processing, greatly contributes to the improvement of the economy of the country;

3) The numerous products of this industry and the replacement of imported traditional materials at high cost, improve the balance of payment of the economy;

4) The impact of these products on the performance of other productive and service sectors and the general welfare of the population is appreciable;

5) Greater economic savings are made possible by this industry, through less corrosion, better maintenance, and improvements in infrastructure;

6) Availability of the products of these industries can vitalize other economic sectors; agriculture, utilities, construction and the general economy;

7) Due to the research intensiveness of this industry, there is a positive impact on improving of the technological infrastructure of the country; and

8) Genuine acquisition and mastery of technology embodied in these industries can have a synergistic effect on many other industries and thus on the national economy in general.

VI INTEGRATION OF THE DOWNSTREAM PROCESSING INDUSTRIES

Traditionally, the petrochemical industry in many developing countries starts with the establishment of downstream processing industry in the field of plastics, fibres and rubbers. This is not surprising, since the requirements of processing plants can be relatively modest with regard both to capital deployment and skilled manpower. Moreover, the establishment of this industry is further encouraged by the replacement of imported and costly traditional products and materials. In many cases foreign companies, producers of polymers, participate, through joint ventures or other mechanisms, in establishing those industries in the developing countries in order to expand their marketing activities.

In view of the above, the development of the petrochemical industries often takes shape under conditions not necessarily compatible with the needs and socio-economic priorities of the developing countries. When the economies of these countries develop further, it then becomes difficult to readjust the initially imposed constraints in the establishment of this industry, characterized by fragmented development, to the process of resource optimization through backward and/or forward integration in the economy. Since the petrochemical processing industry dictates the type and pattern of demand for polymers, which, in turn, determine the type of intermediate and basic petrochemicals needed for their production, the processing industry becomes the most vital link in the chain of integrated development of the petrochemical industry.

It is thus imperative for developing countries, aspiring to produce bulk petrochemicals to streamline the progressive path of developing their downstream processing industries in order to create the necessary market conditions needed to absorb commodity petrochemicals. This streamlining can obviously transcend their national boundaries to neighbouring developing countries, in order to create, on co-operative basis, the necessary market outlet that could absorb the production of a world scale production unit.

The occurance of market fragmentation, based on marginal differentiation in the characteristics of commodity products, which is becoming increasingly prevalent in the developed countries, could greatly undermine the future integration of downstream petrochemical processing industry in developing countries with the production of basic, intermediate and finished petrochemical products. This process should always be viewed within the context of the real development needs of developing countries.

VII. IMPACT OF TECHNOLOGICAL INNOVATION ON DOWNSTREAM PETROCHEMICAL PROCESSING INDUSTRIES

Numerous technological innovations applied to the downstream processing industries have led to improved new products and applications. Better and stronger polymers have enabled considerable downsizing of final product thicknesses in films and pipe-walls at lower costs, increasing the competitiveness of plastics applications. In production facilities, the invention of co-extrusion, to join two or more base plastics, has introduced tremendous versatility to adjust product specification and to prepare customer-oriented products for specific application.

Composite materials are increasingly contributing to the creation of improved additives, fillers, stabilizers, smoke depressants etc. Changes in the processing facilities, like tools, moulds etc., are another expression of technology refinements.

The numerous innovations applied in plastics have their counterparts in the rubber technology. Major improvement in tyres manufacturing have been mainly directed towards improved radial tyres, better tread, ozone resistance etc., which will eventually increase the average tyre life to 100,000 miles. The average weight of a passenger car tyre has already been reduced from 13 kg in 1973 to 9,8 kg in 1983. At the same time, rubbers, such as ethylene-propylene-diene monomer have increased the non-tyre uses.

No breakthroughs in fibre technology has been recorded recently, although some innovations are in the pipe-line. The main synthetic fibres; polyesters, polyamides and acrylics, have held their position. However, they are subject to similar innovative changes as those occuring in plastics to satisfy consumer preferences for natural feel and breathability. Already, polyesters imitate silk and wools, nylons have gained the feel of cotton by blending nylon-6 and polydioxa-amide. Also such new entrants such as 4,6-nylon, high strength polyethylene fibres, composite fibres, etc. might hasten the traditionally stable and uneventful development of the fibre sector.

It should be indicated that these innovations have not had an adverse impact on the demand of the conventional volume plastics. These volume plastics will maintain their position of dominance in the market place for a long time, particularly in developing countries.

VIII. PROBLEMS LINKED TO DOWNSTREAM PETROCHEMICAL INDUSTRIES IN DEVELOPING COUNTRIES

Contrary to the highly concentrated nature of the upstream basic, intermediate and finished petrochemicals, the downstream industry processing those products are generally fragmented, small scale and often require only limited financing.

The small or middle sized entrepreneur plays a crucial role in the development of this industry. A number of end uses are often developed on the basis of ideas and experiences of technically-oriented people, who with modest funds, proceed with implementation. However, this can lead to a haphazard development of this industry, unless it is carefully monitored and organized. In spite of the apparent simplicity in the establishment of plants there are a number of problems which have to be solved. The main difficulty of this industry is the sophistication and fast changing nature of its technology. It requires user oriented information which is technically complicated and not readily available. Without this information it is difficult to produce durable products and enhance their acceptability to customers. Consequently, it is often hard to find entrepreneurs who accept the risks involved without proper incentive schemes.

Moreover, these industries require appropriate back-up on a continuous basis in the field of the production as well as for market research, distribution and marketing. The mere existence of a product and the demand for it does not automatically guarantee its sale and application, without extra marketing and after-sales services efforts.

Thus to ensure the viability of these projects, specialized training at different sectoral and product levels is needed to sustain successful development in the burgeoning plants, prior to start-up and for a long time thereafter.

IX. SUCCESSFUL SOLUTIONS TO THE DEVELOPMENT OF DOWNSTREAM PETROCHEMICAL INDUSTRIES

The various general advantages arising from downstream petrochemical processing industries have been mentioned earlier. It is, however, essential to study the case of each country on its merits, paying special attention to the size of its markets, availability of feedstocks, stage of economic and social development, national priorities, availability of natural resources, and other pertinent factors. A detailed analysis of development indicators, relevant to these processing industries and the end-use sectors such as water management (including drinking water, irrigation, waste water, water storage) packaging and storage of foods, agricultural uses, transportation, construction of houses and factories, health care, household products, textiles etc., should be evaluated in order to define the market size, possible share and future potential of each segment of this industrial sub-sector.

The public sector, through central statistical offices and other similar institutions, could play a crucial role in collecting market information, import/export statistics at product level, which provide the necessary background to help develop these industries according to the market needs and potential demand for the products of this industry. The involvement of institutions, research centres, academia, "centres of excellence", associations etc., in studying, collecting and dissemination technical, legal and financial information on this subject could greatly help these industries, especially at their incipient stages.

Since entrepreneurs play a significant role in this area, suitable incentives could be provided by governments to help them in the construction and successful operation of their plants. Government-sponsored training and education schemes become an essential element for the success of these industries.

Bearing in mind the complexities of these industries and need to adapt them to the environment of developing countries, extensive co-operation, at company and country levels on both South/South and North/South levels, would be needed. Such co-operation would be most useful in the areas of processing needs, product quality control and other related technical parameters. One important factor which has always to be borne in mind when contemplating this industry, is the extent of its potential backward integration in the petrochemical industry and how effective it will be in influencing the development of other sectors of the economy.

X. THE ISSUES

Downstream processing industries in developing countries cover a vast number of products, production lines and applications spanning the full spectrum of operating companies, whose intermediate materials are overwhelmingly supplied from developed countries. Such dependency offers little, if any, possibilities for the development of autonomous technologies. Resource endowment, unsaturated and expanding markets and basic necessities all would warrant an accelarated growth of these industries in the developing countries. Viewed against this background, it becomes imperative that special effort should be made by the developing countries to upgrade their involvement in this vital sector. Co-operation in organizing and co-ordinating these activities would increase their benefit and spread their costs over the number of participating companies/countries. UNIDO could, for its part, contribute to such co-operation. It is proposed that the following activities be considered by the Consultation as possible issues for closer investigation and follow up action:

1) Survey and analysis of downstream petrochemical industries in developing countries with a view to fostering regional co-operation;

2) Based on the above-mentioned survey and directed towards the promotion of co-operation between developed and developing countries and among developing countries, preparation of a directory of capabilities existing in the area of downstream processing industries in developing countries;

3) Drawing-up guidelines on national policies for the promotion of downstream petrochemical processing industries; and

4) The establishment of a programme/scheme of active ECDC and North/South co-operation in downstream petrochemical processing industry.