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PETROCHEMICALS IN DEVELOPING COUNTRIES

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Submitted by the Government of the Netherlands

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PETROCHEMICALS IN DEVELOPING COUNTRIES

1. In the context of their understandable desire to achieve a rapid industrialization, developing countries often show a great interest in the possibilities of establishing petrochemical industries. Usually this interest is based on local availability of oil or natural gas, or perhaps only the existence of a refinery. In addition the spectacular growth of this branch of industry in the United States, Japan and Western Europe, the fact that it is an important basic industry and the considerable added value achievable with the consequent saving of foreign currency, make their interest all the more understandable.

2. However attractive the creation of a petrochemical industry may appear at first sight for a developing country, any venture in this field will have to face complicated problems and difficulties.

3. This paper attempts to outline the main factors which require careful investigation before deciding on any major investment, so that full consideration can be given to each aspect. These fall into five main categories, each of which is discussed in detail, and comprise the following:

(a) the supply of raw materials;

(b) the availability of capital;

(c) the availability of sufficiently skilled personnel;

(d) the availability of a market of sufficient size;

(e) other external factors relevant to the project.

In this respect the following detailed observations may be made regarding the petrochemical industry.

RAW MATERIALS

4. The beginnings of the petrochemical industry in the industrialized countries were closely connected with the wish to upgrade the value of certain by-products of oil refineries. These developments had already started before the Second World War, but they were, of course, greatly stimulated by the need to substitute many natural products required during the war by man-made counterparts, such as synthetic rubber.

5. The acceptance of synthetic products as new materials in their own right, having qualities in many cases superior to the older materials they had substituted, led to the spectacular growth of the petrochemical industry after the war. As a consequence, refinery by-products, although still a very important source of raw materials, were no longer adequate to meet requirements, so that the petrochemical industry increasingly found it necessary to produce its own raw materials. Today, much of the latter are being produced by the cracking of suitable oil fractions, such as naphtha. By such processes considerable quantities of chemical "building blocks" are produced, such as ethylene, propylene, butylenes, butadiene and aromatics. This development has enabled the petrochemical industry to scale the production of its own "building blocks" largely to fit in with its own requirements. This situation is, of course, very different from before, when, relying almost exclusively on the supply of refinery by-products, the petrochemical industry was dependent on the refinery programmes. This change was the more important, as frequently fairly large quantities of refinery by-products had to be handled for making even modest quantities of raw materials for the petrochemical industry.

6. It is often supposed that natural gas could be a very attractive raw material for the petrochemical industry. However, this is only true in part, since because of the chemical composition of most natural gas, as well as for economic reasons in general, it can only be used for the manufacture of ammonia and methanol. Only if the natural gas contains a proportion of heavier components, such as is found in the United States, can it be used economically for the manufacture of other chemicals.

7. A further and often underestimated aspect of the petrochemical industry is that it has to rely on supplies of many other kinds of raw materials from other sectors of the chemical industry. The petrochemical industry requires vast quantities of sulphuric acid, chlorine, alkalis and many other intermediate or basic chemicals which are normally made by quite separate chemical companies. In addition, important quantities of sometimes very complicated catalysts and process materials are required, that must be bought from highly specialized chemical manufacturers. In other words, it will be clear that for the successful development of a petrochemical venture, the existence, or at least the simultaneous development, of perhaps very varied supporting chemical plants must be considered

to be of prime importance to the economics of petrochemicals manufacture. It will also be clear that such a balanced development can only be expected if the general "industrial climate" is sufficiently attractive.

8. Applying the foregoing observations on the supply of raw materials to the situation of the developing countries, the following tentative conclusions may be drawn:

(a) The existence of a relatively small-sized and technically simple refinery does not, in itself, provide sufficient justification for establishing a petrochemical industry, particularly in view of the rather large quantities of refinery by-products usually required;

(b) Natural gas can generally be considered only for the possible production of a few low-priced chemicals;

(c) Cracking of special oil fractions, such as naphtha, in order to make raw materials for the petrochemical industry, can only be considered if these fractions can be procured in sufficient quantities and at attractive prices;

(d) Supporting industries will not normally be available and only in very few countries do there seem to be some prospects for the rapid development of these industries.

CAPITAL

9. Over the years process and engineering improvements have enabled the petrochemical manufacturer, by building larger and more efficient plants, to reduce the unit cost of production quite significantly. As a consequence, product selling prices have tended, under competitive pressures, to be set by production costs in these large and efficient plants. Because of their very size this has meant that the amounts to be invested in a so-called "integrated" petrochemical complex have risen considerably compared with only a decade earlier.

10. At present the amount required for such a complex, for example based on a naphtha cracker for its raw materials supplies, could easily amount to some hundreds of millions of Dutch guilders. An interesting feature in this respect is the inter-relationship between the capacities of the plants producing the raw materials and the consuming plants. As a direct consequence of the much increased

capacities of the first, more and larger consuming plants will need to be built in order to establish a balanced and economical complex.

11. Because of the large capacities now required, it often happens that the plant is under-loaded during the first years of operation, although the loading should normally increase to capacity as demand builds up. Consequently the company may be faced with a quite long period during which no profits or even losses will be made.

12. From the above it should be clear that when studying the possibilities of establishing a viable petrochemical industry in a developing country, careful consideration will have to be given to the choice of the most economical capacity in relation to potential sales. The technical developments in this branch of industry (with an experience of less than forty years!) have led to an astonishing growth of this so-called "most economical capacity". To illustrate this, it can be stated that in the 1930's the optimum size of an ammonia plant was of the order of 25,000 tons per annum in one line, but under present circumstances only a line with a capacity of some 250,000 or even 350,000 tons per annum of ammonia would be considered an economically attractive proposition.

13. It should be borne in mind that in addition to the considerable investments referred to above, very large sums will have to be invested in infra-structure projects, possibly also in supporting industries such as those mentioned under (a) above, and perhaps even in plants for the manufacture of machinery and equipment, etc.

14. It is understandable that the task of simultaneously developing an integrated petrochemical industry together with the necessary infra-structure, and perhaps supporting industries to provide ancillary products, can present almost insurmountable difficulties to many developing countries. This is particularly the case when it is remembered that large sums of foreign currency will inevitably be required for the construction of these complexes.

PERSONNEL

15. The petrochemical industry has reached a stage of development which demands an extremely high level of both technical and professional ability from its staff, from top management down to the plant operative. The extreme sensitivity of

process operating conditions to factors such as high pressures, high temperatures and precise control of material flows in the highly complicated petrochemical plants of today carries with it the risk that inexperience, or even less than first-class supervision can lead to disastrous consequences for the plant itself and for human life. It is vital that personnel at all levels be not only highly trained and qualified, but must gain experience elsewhere before being entrusted with the running of such plants.

16. The present experience is that such personnel are not normally available in the developing countries, or certainly not in sufficient numbers. Moreover, it frequently appears that in these countries the availability of men of the required managerial ability is very limited. In consequence, it is certain that appreciable numbers of experienced non-national staff will have to be appointed, and such people are usually expensive.

17. An important feature of the petrochemical industry is that, contrary to what may be frequently supposed, it does not require a large labour force. In view of the predominantly continuous processes, a modern petrochemical plant can normally be run with only a very limited number of operators. It can hardly be seen, therefore, as an important user of direct labour. For illustration: a petrochemical complex may require an investment of between Nfls. 150 and 200 million and may well require less than 400 total labour and staff, resulting in an investment per head of some Nfls. 450,000.

18. This development to a relatively low labour-intensive industry was probably caused by three factors:

(a) because normally speaking, instruments can largely avoid the risk of human failures;

(b) because in the industrialized countries it became more and more difficult to find qualified technicians;

(c) because the high wages demanded by highly skilled labour in the industrialized countries have provided a strong incentive to reduce manpower costs.

MARKET

19. It is perhaps not surprising that the petrochemical industry is concentrated mainly in a number of highly industrialized countries. An important home market is of vital importance for any industry and no less so for the petrochemical industry; this factor on its own has already resulted in this apparent concentration.

20. In addition, under the influence of the severe competition prevailing, the factor of manufacturing cost has become of increasing importance. With the rapid increase in consumption of a number of liquid products, many customers now prefer to accept deliveries in bulk, usually enjoying a corresponding reduction in price compared with deliveries in packed form, such as drums. This factor has again stressed the importance of close proximity of the petrochemical industry to its major markets.

21. Moreover, the sector of the petrochemical industry dealing with the so-called "performance chemicals" is of growing importance. This is particularly the case in the field of plastics, where it is essential that there is a continuous contact between the supplier of the resins and the consuming industries. It appears that in this field satisfactory results can be achieved only if producers and consumers are fully au fait with each other's possibilities and performance requirements. Also in this field the so-called "technical sales service" is of growing importance, a work that can be done only in large, well-equipped and therefore very expensive laboratories to build and run. As this service is a charge usually carried by the producer, it can only be justified for markets of sufficient size.

22. Finally, it should be mentioned here that it is a fact that the chemical industry in the widest sense is the best customer of the petrochemical sector. This implies that a fully integrated and balanced petrochemical industry can be expected only where there is a large variety of supporting industries, consumer plants and similar industries capable of transforming its products into consumer goods.

23. The opportunities for exporting petrochemicals from a new plant built in a developing country with little or no home market to countries where a large and well-developed market for such products already exists, are very few. It must be stated that most of the developed markets are catered for by petrochemical plants within their own borders or within tariff unions and such petrochemical manufacturers see to it that the markets they supply do not lack products for want of capacity.

EXTERNAL FACTORS

24. As soon as it can be established that on the basis of raw materials, capital, personnel and market, a viable investment proposal could be developed, serious consideration will have to be given to the effect of the relevant external factors, which fall into two broad classes of either a political or of an economic character.

Political aspects

25. It will be clear that for private enterprise, continuing political stability in a country, together with a consistent and reasonable attitude vis-à-vis the business world as a whole, is an important factor when considering major investment decisions. In particular any foreseeable likelihood of nationalization of existing industries or financial institutions such as banks, will almost certainly scare away potential investors for a long time to come.

Economic aspects

26. Under this heading much attention will have to be paid to the situation of the balance of payments of a country, the stability of its currency in the world money market, possibly existing or pending import restrictions, local purchasing power, etc.

WHAT CAN BE DONE IN THE DEVELOPING COUNTRIES?

27. Coming now to the question of what exactly can be done in the developing countries, it will be clear from the foregoing that these countries, generally speaking, are not well placed for establishing a petrochemical industry. Very briefly, the reasons for this seem to be as follows:

(a) only very rarely will these countries have an outstanding position for raw materials;

(b) locally available capital is normally very scarce and therefore will have to be acquired abroad at normal ruling money market conditions;

(c) shortage of skilled labour;

(d) national markets are generally far too small to justify fully integrated petrochemical complexes of the size currently regarded as economic. Large quantities will therefore have to be exported to sell at prices competitive with other producers in such markets as are open to imports at international prices;

(e) general political and economic conditions frequently are not conducive to attracting foreign investors.

28. In view of the above it would not seem to be surprising that the petrochemical industry remains largely concentrated in the highly industrialized countries.

29. This leads to the conclusion that, at the present time, the establishment of a fully integrated petrochemical industry is too ambitious a task for most developing countries. A theoretical solution to some of the problems mentioned might be found by the pooling of resources of a number of countries on a regional basis, which might enable the establishment of one regional complex. The latter could then provide the countries concerned with their requirements of petrochemicals. It must be realized however that such far-reaching co-operation will be extremely difficult to achieve in practice.

30. Finally, when looking for more realistic possibilities, it should be appreciated that most petrochemical products are only a half-way stage in the manufacture of finished consumer goods, i.e., they are raw materials for further processing industries. Taking into account the lack of these processing industries in most developing countries, it follows that serious consideration should be given to the possibilities of starting at the other end of the line, i.e., with the processing industries. One very valid additional argument for this is that far less capital will be involved here, partly because these plants are less complicated and partly because they can be built on a much smaller scale.

31. In this respect the following possibilities may be mentioned:

(a) manufacture of plastic products on the basis of imported resins, i.e., household goods, pipes and tubes, films, sacks, etc.;

(b) manufacture of plastic foams;

(c) manufacture of products made from synthetic rubber, e.g., shoes, tyres, etc.;

(d) local formulation of household detergents;

(e) local formulation of pest control products;

(f) manufacture of fertilizers on the basis of imported ammonia;

(g) manufacture of surface coatings.

32. If and when these kinds of industries have become well established, at a later stage it may then be considered whether the time has come for building plants to make their raw materials.

33. It will perhaps be of interest to illustrate the above line of thought by the following practical example:

34. In November 1962, in an Indian village not far from New Delhi, a water pipeline was laid within a remarkably short time which transported the water from the well, via a pump and water tower, to the streets of the village. Some fourteen hydrants were set up from which pure drinking water in any desired quantities could be obtained, quickly and without difficulty.

35. The pipeline was laid by a leading European plastic pipe company which was considering establishing a subsidiary company in India. It was intended to serve as a pilot venture in order to test whether pipes and fittings made of hard polyvinylchloride would stand up to the conditions found in this tropical country.

36. For the village this water pipeline meant a tremendous social improvement and the results have not gone unrecorded. Not without pride the doctor of the local hospital can show sets of figures which clearly indicate that infectious diseases have considerably declined since 1963 when the pipeline came into use. If all the villages in India could be provided with such a water supply system, this would undoubtedly improve the general health of the Indian people.

37. This ideal is still a long way off, but a step in the right direction was the setting-up of a plastic pipe factory in India by the same company, the opening of which took place in January 1967.

38. The capacity of this factory is as yet small and so was the investment of some Nfls. 2 million. At present some seventy people are employed in the factory, so that the average investment per employee was less than Nfls. 30,000, i.e., rather less than 1/15 of that in an integrated petrochemical complex.

39. Up till now mostly metal pipes have been used for water distribution systems in the large towns in India. In this case, technically skilled people are required for laying the pipes, of whom far too few are available in India. With plastic pipes, however, any skillful villager with common sense can carry out this work after only a little instruction.

40. Viewed in this light the mass production of relatively inexpensive plastic pipes contributes to reducing unemployment - one of India's greatest problems. Not only will many millions of Indians get pure drinking water, but thousands of them will also earn their keep by transporting, laying and servicing of PVC pipe networks.

41. The plant will make use of PVC, a petrochemical raw material which is now being produced in India. Whilst in the foreseeable future this material can be sold on a sufficiently large scale in a country like India with a population of over 400 millions, it should be appreciated that this is not likely to be so in most other developing countries. In those cases, a pipe factory might well be based on imported PVC.

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PETROCHEMICALS IN DEVELOPING COUNTRIES

SUMMARY

Submitted by the Government of the Netherlands

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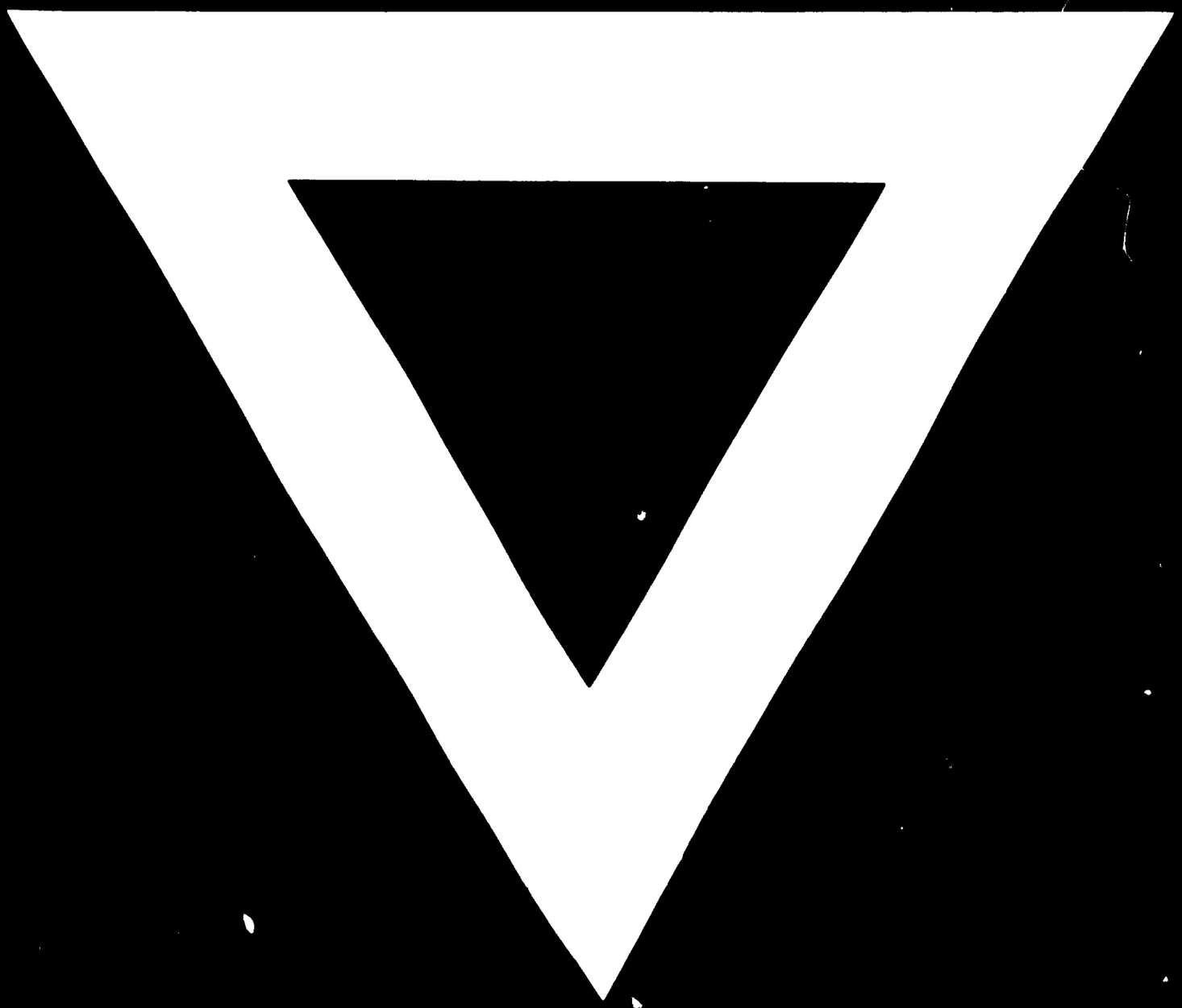
1. The main factors which require extensive investigation before deciding on the manufacture of petrochemicals in developing countries are discussed under the following headings:

(a) the supply of raw materials;
(b) the availability of capital;
(c) the availability of sufficiently skilled personnel;
(d) the availability of a market of sufficient size;
(e) other external factors relevant to the project.

2. After careful consideration it is concluded that generally speaking developing countries are not well placed for establishing a petrochemical industry, and that, at the present time, the establishment of such an industry is too ambitious a task for most developing countries.

3. A theoretical solution might be found by the pooling of resources of a number of countries on a regional basis, which might enable the establishment of one regional complex, providing the countries concerned with their petrochemical requirements. It is felt, however, that such a far-reaching co-operation will be extremely difficult to achieve in practice. Therefore a more realistic alternative is indicated, i.e. the establishment of processing industries. Examples of the latter include the manufacture of plastic articles, plastic foams and consumer goods made from synthetic rubber.



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