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UNITED NATIONS INDUSTRIAL
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FINAL REPORT

ON ASSISTANCE IN PLASTICS PRODUCTION
AND UTILIZATION IN THE ARAB REPUBLIC OF EGYPT 1/

(SIS/EGY-056 A and B)

September 1972 to January 1973

by

H. Hagen and [illegible]

UNIDO Experts

1/ The views and opinions expressed in this paper are those of the authors and do not necessarily reflect the view of the Secretariat of UNIDO.

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I. INTRODUCTION

Mr. E.G. Hancock arrived in Cairo on 10 September and Dr. H. Hagen on 27 September 1972. We were provided with office accommodation in the Petroleum and Petrochemical Department of the General Organization for Industrialisation headed by Dr. M.A. Oraby. Mr. M. Mansour Zein El-Din of the department was allocated to work with us and he was mainly responsible for arranging visits to plants and works and he personally accompanied us on many of these. Mr. M.B. El-Warraky from the Egyptian Petroleum Corporation was also allocated to work with us and he proved tireless in organizing visits to other ministries and to some end users. We were also provided with an English and German speaking typist.

We would like to express our best thanks to Dr. Taher Amin, the Deputy Chairman of the General Organisation for Industrialisation and to Dr. M.A. Oraby for making such excellent facilities available and particularly to entertaining us as their guests during our visit to companies in Alexandria. We would also like to thank Mr. M. Mansour Zein El-Din and Mr. M.B. El-Warraky as well as their colleagues for the continuous help they gave us and the many valuable discussions we had with them during the course of our work.

We are also greatly indebted to the friendly advice and help given to us by Mr. V.P. Pavicic, the Resident Representative of the United Nations Development Programme and his staff and particularly to Mr. A.A. Vassiliev, the Deputy Resident Representative and Industrial Field Adviser and to Mr. Th. Sabry, the programme officer concerned with our activities.

II. OUTLINE OF THE PROGRAMME OF WORK

The Masr Petroleum Company were planning a petrochemical complex near Alexandria where it was proposed to install a naphtha cracker for the production of ethylene, propylene, C_4's etc.

Downstream plants in the first stage would include the production of 45,000 t/a L.D. Polyethylene, 42,000 t/a of vinyl chloride (by an oxychlorination process) with suspension polymerisation facilities for making 40,000 t/a of P.V.C. combined with a compounding plant the whole producing 47,000 of finished P.V.C. raw material ready for processing and, finally, the butadiene would be extracted from the C4 stream and sold for the best possible price.

In the second stage 30,000 t/a of polypropylene, 10,000 t/a ethylene glycol and 13,000 t/a of synthetic rubber (mainly polybutadiene but also possibly some S.B.R.) would be produced.

We were asked to confine outselves to the markets and outlets for L.D. Polyethylene, P.V.C. and Polypropylene.

The work we undertook was therefore to estimate the demand for these plastics raw materials in Egypt up to 1980, to estimate the capital cost, particularly in foreign exchange, for buying or making the necessary equipment to process the additional polymers to be made, and to estimate how the cost of such production would compare with the price of the traditional materials they were replacing.

Then we had to estimate the need for new workshops for producing moulds and some of the simpler equipment, training centres for training operatives, machinists, etc. and laboratories for testing and evaluating products.

As stated in one of our preliminary reports six months was considered necessary for this study but it was clear from talks with Dr. Oraby that he was not anxious for it to be prolonged so we compromised at 4/4½ months. This has meant that we have not been able to do all we hoped to do. It will be appreciated that Mr. Hagen was not able to estimate the capital required for new equipment until Mr. Hancock had finalised the market estimates. A further handicap, which we had not appreciated when starting, was the long delays in communication with Europe, it often taking 3-4 weeks to get a reply to a letter.

3. The Plastics Industry in Egypt

The plastics industry, as are most other industries, is divided between the public sector (owned by the Government) and the private sector which are mainly very small companies and are owned by individuals or families.

All raw materials, except for a very small quantity of phenol-formaldehyde resin was imported, some from Eastern Europe and countries like Iraq but considerable quantities from Western Europe. The availability of foreign exchange for imports was strictly controlled and appeared to vary according to circumstances so that much of the existing capacity was not fully used. A small allocation was also available to the private sector but much of their raw materials were obtained with so-called non-transferable currency by which they obtained the foreign exchange by buying dollars at 65 Pt instead of the official rate of 43 Pt. The source of these funds was mainly earnings by Egyptians working abroad who were encouraged to repatriate their savings at a special exchange rate. The amount available was at the present one quarter of the funds received in this way and of this half was earmarked for raw materials and half for the renewal of worn-out plant and equipment. This scheme covered the whole of the private sector of industry, the plastics industry was only a very small part, and these funds were strictly on an allocation basis. New equipment, which would expand capacity and create the need for more raw material, went through an entirely different machinery and while priority was undoubtedly given to the public sector there were occasions where private companies obtained permission to expand or start a new process.

3.1 Public sector

There were nine companies processing plastics in the public sector all of whom except Beida Dyers were visited. In addition, we visited three companies in the private sector but we were informed that there are actually 130, all but a dozen or so very small indeed.

The companies in the public sector are given below with brief notes about the activities of each. Their chief executives are mentioned in the list of contacts on pages 67 - 72.

National Plastics

Two factories in Cairo, at Giza and Shobra.

Extrusion, rigid and flexible pipe, decorative sheet and lay-flat tubing for sacks and bags.

Compression moulding: toys, fancy goods, housewear.

Injection moulding: crates, chairs, stools, pipe fittings. Numerous small articles.

Blow moulding: Jerrycans, bottles.

Lamination: Laminated plastics (boards from impregnated paper).

They consumer between 6,500 to 7,000 t/a of plastic raw materials of which about 5,000 t/a were raw materials that could be made at the proposed Alexandria Complex.

They make their own moulds

Medical Packaging Company, Cairo

Injection moulding: bottles, containers for pharmaceuticals and foodstuffs. Hospital syringes and homewear.

Compression moulding: caps for bottles and containers, homewear. Faney goods.

Extrusion: electrical conduits.

Blow moulding: bottles and containers.

They consumed 2,400 t/a plastics raw material of which about 1,500 t/a were raw materials that could be made at Alexandria.

They make their own moulds.

Egyptian Plastics and Electrical Industries, Alexandria

Injection moulding: crates, toys, fancy goods, radio cabinets.

Spreading: Supported P.V.C. sheet, using plastisols.

Compression moulding: laboratory seats, foamed polystyrene packing.

Thermoforming: small containers.

They also make batteries, at present the cases were ebonite but could be injection moulded polypropylene.

They make their moulds in their own shop.

Canaltex Company, Cairo

Nylon carpets and vinyl asbestos flooring.

Consumption 500 t/a vinyl chloride - vinyl acetate co-polymer.

Expansion of flooring is possible.

This company is the most modern in the Egyptian plastics industry. It operates under licence agreements from two British companies.

Electrocable, Cairo

Made P.V.C.-insulated and other types of electric cables.

Consumption 4,500 t/a P.V.C. compound.

Expansion is planned in the 5-year plan 1973-19[illegible].

Delta Industrial Company, Cairo

Consumption 830 t/a of high impact polystyrene.

The company manufacturers refrigerator linings from HOPS - sheets in a two-step process by vacuum forming with 30% scrap. This is an old and expensive process. It should and could be replaced by injection moulding with an existing press at the NASR Company for Television without scrap in a one-step process.

S.A. de Chaussures 'BATA', Alexandria

In addition to leather and rubber shoes, make injection moulded, all plastic shoes and plastic soles for canvas, leather shoes.

Consumption: 1,900 t/a P.V.C. (compound).

They manufacture 13,000 pairs of shoes daily with soles of foamed rubber with a high percentage of scrap which has to be reclaimed in a vessel, which is far too small. It is understood, that project 4.17 of the new five-year industrial plan for making batteries out of reclaimed rubber will give a better opportunity for reclaiming their rubber scrap. But the more economical way should be to turn over to injection moulded foamed P.V.C.

Paper Converting Co. 'VERTA', Alexandria

Make, in addition to paper sacks and packaging material, heavy and light duty polyethylene sacks and bags from lay. Flat film.

Consumption: 750 t/a L.D. polyethylene.

Beida Dyers

Unfortunately, arrangements could not be made to visit this company. They are understood to be mainly textile finishers but also to have equipment for making P.V.C. sheet.

3.2 Private sector

The private sector consumed 2,400 tons of new raw materials in 1971 of which 1,775 tons were their allocation at normal conversion rates. Of this total only 1,100 tons were P.V.C. or polyethylene, nearly half being polystyrene. It is not considered that this represents the whole of their output, however, since a great many articles were produced from scrap sold to them by companies in the public sector or collected from users.

The principal company is Middle East Plastics of Alexandria. They specialised in containers and caps for the pharmaceutical industry and pickers, bottons, spools, etc. for the textile industry but in addition were trade moulders making small injection and compression moulded articles mainly for homewear as ordered by their customers. They were at present consuming about 530 t/a of new plastics raw materials of which only about 130 t/a were products to be made in the Alexandria Complex. They also used large quantities of scrap, they had 50 tons in stock. Quite apart from processing plastics they designed and built simple plastics processing equipment for their own demand and for export.

An examination of the returns of the thirteen largest companies in the private sector showed that the following were the principal products made: homewear, tubs, chairs, shoes, battery cases, bottles, buttons, combs, spectable frames, clothes pegs, nylon bags, educational goods, electrical plugs and sockets and ornaments. Unfortunately, it was not possible to express these quantitatively as different companies made their returns differently, some in weight, some in numbers and some in value.

3.3 General remarks on condition of equipment

Most of the moulds we saw were 'home-made'. The tolerances were not very close and a lot of unnecessary 'trim' was produced which had to be removed by hand. This is almost certainly the result of the moulds not being hardened nor chrome-plated. Hardening equipment exists at the plant of the Medical Packaging Company and this should be made available to other companies making their own moulds. If the capacity there is insufficient new equipment should be installed for hardening and chrome-plating moulds.

The processing machines in the private sector are mostly old-fashioned and in poor condition, while many in the public sector are not very much better. They must be renewed when the Egyptian machine shop (mentioned later in this report) is in operation.

It is, however, doubtful whether many of these machines could last more than a few years - the time will soon come when the machines will be only half time on production, maintenance and repair taking up the other half.

4. FORECAST OF DEMAND IN 1980

This was done by two different methods:

(1) a macro-economic technique

(2) an outline field survey

4.1 Macro-economic method

A very simple method was used. An average year was chosen as base. The three factors concerned in growth population increase, G.N.P. increase and the penetration factor was added together and assumed to remain constant to 1980. The technique was applied to the total consumption of plastics (not the consumption of plastic raw materials), i.e. including the plastics in imported products such as motor cars. The total figure for 1980 was then divided amongst the various types of raw materials according to the break-down in the UK as forecast in 'The Plastics Industry and its Prospects' published by National Economic Development Office, London. Finally, the possibility of replacing some of the polymers not to be made in the Alexandria Complex by those to be made there was taken into account.

The base year chosen was 1970, the latest for which full statistics were available and, it was hoped sufficiently far from the 1967 setback to be an average year.

The import figure could be summarised as follows:

Imports of plastic raw materials	22,800 tons
Imports of plastic goods	2,641 tons
Plastic content of imported goods containing plastics	1,130 tons
	26,570 tons

From this figure must be substracted 790 tons of plastic goods or plastic content of other goods exported giving a net consumption of 25,800 tons

Population increase has been at the rate of 2.1/2% p.a. over the last 10 years and is expected to increase at the same rate. G.N.P. has increased between 7.8% over the last 10 years and is the target for the next 10 but as volume rather than value is required, specialists in this field have advised that a rate of 4.1/2% p.a. at today's prices would be more appropriate.

Penetration, i.e. replacement of traditional materials by plastics and altogether new products is forecast as 6% for the UK over the next 10 years and it should reasonably be higher in Egypt; we have taken 8%. This gives an overall increase of 15% p.a. and lead to a consumption of 106,000 t/a by 1980. Taking into account that this figure includes compound and moulding powder, the breakdown expected from the UK forecasts breakdown applied to the actual demand in Egypt is as follows:

Type of raw material	% consumed	Actual in Egypt in 1980
PVC compound	31.1	33,000 tons
L.D.P.E.	15.8	16,700
Polystyrene	13.7	14,500
Polypropylene	9.4	10,000
H.D.P.E.	4.6	4,900
Other thermo-plastics	5.9	6,200
Total thermo-plastics	80.5%	85,300 tons
Total thermo-setting	19.5%	20,700 tons

Then assuming 90% of the H.D.P.E. could be replaced, one quarter by L.D.P.E. and three quarters by polypropylene; one third of the polystyrene (i.e. approximately the proportion of high impact materials) replaced, one quarter by rigid PVC and three quarters by polypropylene; while 10% of the thermosetting moulding powder could be replaced by polypropylene, we have the following consumption for products to be produced at Alexandria in 1980:

P.V.C. compound	34,200 tons
L.D.P.E.	17,802 tons
Popypropylene	18,738 tons

It must be emphasized that the technique used in these calculations assumes free availability, naturally if the Government restricts the availability of raw materials and equipment for processing it, the consumption can be reduced to any arbitrary figure.

4.2 Outline Field Survey

4.2.1 Agriculture

Egypt being an important agricultural country might be expected to be a large user of plastics in this field. Partly, however, because of different climatic conditions and partly because agriculture is largely (95%) in the hands of small farmers, traditional methods appear to have retained their hold and today there is negligible use of plastics in this outlet.

Discussions have, however, opened up several major possibilities and these are outlined below:

4.2.1.1 Drainage

Owing to the very heavy nature of the soil and a virtually impermeable sub-soil adequate drainage is an important factor in improving the yield of crops, increases of 10-15% have been reported. The Government is carrying out a widely publicised scheme which is being partly financed by the World Food Programme and in which the International Bank for Reconstruction and Development is participating. Cement tiles are at present being used but experts have been seriously considering PVC pipes and they are at the moment under test under field conditions. They believe that, when the simplicity in laying is taken into account, PVC will be not more expensive than the present system, while PVC will have advantages over cement in its resistance to sulphates and its overall stability. For Lower Egypt, the Nile Delta Authority for Tile Drainage has been set up under the Ministry of Irrigation who, however, control these developments directly in Upper Egypt.

Corrugated perforated rigid pipe was considered most suitable and by 1978 it was estimated that 14 million metres of 100 mm diameter pipe would be required in the Nile Delta and immediate further requirements were likely to increase by 20% p.a. The plan for Upper Egypt envisaged a demand for 12 million metres per annum. The market for PVC resin allowing for rejects (10%) and compounding ingredients was estimated to be 13,000 tons in 1980.

4.2.1.2 Irrigation

The traditional method of irrigation by canals, pumps and ditches is so well established in the cultivated areas that there appears no scope for plastics. Even lining the ditches, e.g. with polyethylene film is not worthwhile as the loss of water through seepage is very small, less than 10%, due to the impervious nature of the sub-soil.

In order, however, to increase the available land for cultivation, and hence the available supply of foodstuffs, a Ministry of Land Reclamation has been established and in discussions with the Minister and members of his staff it appeared there were several possible outlets for plastics. Thus, due to the much lighter soil in the reclaimed areas, linings were required for the irrigation canals. At present, these canals were lined with cement but if 1 mm thick polyethylene film were available, it was thought this would be an acceptable substitute. Some 200,000 sq metres per annum would be required based on the estimated rate of progress and this would need 200 tons of L.D.polyethylene.

Various new irrigation systems are being tried out in these areas involving sprinkling and drip feed. In the sprinkler system the set up can be either fixed or movable. At present, aluminium pipes are used but they would be replaced by plastic pipes if suitable for fixed installations, in situations where it was necessary continually to be moving the pipes to fresh sites, popypropylene would be more suitable as P.V.C. exposed all the time to sunlight could become brittle under such treatment. As planned, 750,000 metres per annum each of 75 mm and 100 mm pipes would be required in polypropylene which, at the necessary thickness to withstand the required 6 and 9 atm pressure respectively would weigh 0.93 and 2.4 kg and consume altogether 2,500 t/a polypropylene. Similarly, the expected demand for the P.V.C. pipe would need 1,200 tons of P.V.C. resin.

A rough estimation of cost has, however, shown that whereas P.V.C. pipes can be produced more cheaply than similar aluminium pipes, this is not the case with polypropylene pipes, so unless it is found by experience that P.V.C. pipes can function satisfactorily in movable systems it will be necessary to retain aluminium pipes in this application. The trend is, however, towards the fixed system so the use of plastics in this application would only be delayed.

The drip feed technique is specially suitable for orchards or for crops spaced at regular intervals. 10 mm pipes are needed with valves spaced according to the distance between successive trees, plants or bushes, allowing a trickle of water to pass continuously through a 3 mm pipe right to the roots. Plans are in hand to apply this system both to citrus fruits and to vegetable crops but we feel at the present time it is a little speculative and we have confined our estimate to the plans for fruit trees to which the system seems particularly suited. This involves an installation covering 60,000 feddan (1 feddan = 4,200 sq. metres) in the first stage with a further 90,000 feddan to follow. We have taken one tenth of this for implementation in 1980 making a demand of 100 tons of polypropylene per annum including a proportion for the valves.

4.2.1.3 Mulching

Little enthusiasm could be detected for the use of polyethylene film in mulching, mainly because of the conservative nature of the small farmer and the necessity for his getting physically to most of his crops to apply water and fertilisers by hand so that any film would soon be destroyed.

There was some interest in the limited public sector and there were definite plans for using polyethylene film in connection with strawberry cultivation. Trials were at present in progress and it is hoped to have 1,000 feddan under cultivation before 1980. This would create a demand for 750 tons of polyethylene film 0.2 mm thick.

4.2.1.4 Other Uses

Many other suggestions for the use of plastics arose during discussions but they were either too hypothetical to be included in our estimates or would only consume a few tons of plastics at best. Amongst the former was an ingenious suggestion to spread perforated polyethylene film 15 cm below ground level to conserve both water and fertilizers. Such a system could of course only be used with shallow rooting crops. Special machinery would be needed for laying the film and we gathered there were no real plans for putting such a scheme into operation even over a limited area.

Amongst the small uses were film for greenhouses, cloches for forcing crops in cold weather and for crop protection, e.g. protecting wheat stacks from birds. There was also a definite application for a few tons for making bags for growing seeds in special soils.

4.2.2 Packaging

This has become the largest outlet for plastics in many countries and appears likely to be the largest in Egypt too. Probably 6,000 tons of plastics, mostly polyethylene but some P.V.C. and polystyrene are being used in this application now and the potential increase is considerable.

4.2.2.1 Heavy Duty Sacks

We see potential here for packing fertilizers, some sugar and plastic raw materials from the Alexandria complex itself in sacks made from polyethylene lay-flat tubing while bitumen (for export) could be packed in sacks made from polypropylene. The fertilizer industry is already using L.D.P.E. sacks, some 4,500 tons per annum are at present being made and plans are in hand for expansion. The current output of fertilizers is over 600,000 tons per annum and this is expected to expand to over 2,000,000 tons by 1980 and, packed in 50 kg sacks, would require over 40 million of them. We estimate that between 13,400 and 13,500 tons of L.D. polyethylene will be required for this end-use by 1980. Sugar for direct sales could also be packed suitably in such sacks and this could account by 1980 for a further 1,200 tons of polyethylene.

Many other possibilities have been discussed for using these sacks; sulphur is a distinct possibility while other chemicals, rice salt, etc. are worth studying. We have assumed there will be some extension of their use by 1980 and have allowed a further 1,000 tons of polyethylene for such applications.

4.2.2.2 Light Duty Sacks and Bags

These are mostly made at present in the private sector where 434 tons of L.D.P.E. film was imported in 1971, presumably mainly for the production of such bags. 500 tons of thin lay-flat film was produced in the public sector, some of which was sold to the private sector and most of remainder made directly into bags. The idea of wrapping goods in plastic bags in Egypt is rapidly spreading, thus it is expected that all milk from the public sector (pasteurised) will be packed in plastic sacks within a few years. These sacks will consume about 1,600 t/a of L.D. polyethylene and, with additional allowances for shoes and clothes together with foodstuffs, we can forecast a use of 2,800 t/a of L.D. polyethylene for light duty sacks, etc. by 1980.

4.2.2.3 Split Film Sacks (Woven)

These can be conveniently made from polypropylene and one company is already starting production on a small scale. These will replace jute sacks for many applications where it is necessary for the product to breath. From the information we have been able to obtain the cost of production of a polypropylene sack is cheaper when the delivered price of polypropylene is not more than 1.8 times the delivered price of jute which is at present within the range LE 120-140 per ton. 12,000 jute sacks were imported in 1971 with a c.i.f. value of LE 2,117,000. Flax, grown in Egypt, is used as a partial substitute in weaving the sacks. Polypropylene sacks, to perform a similar duty to jute sacks, are much lighter in weight, estimates have varied from one third to one sixth. One of the main objections to polypropylene is that, if such a sack should split, the contents are lost while a jute sack can be patched up. Another is that they do not 'sit' so conveniently on the ground and are less popular with many users. There have been complaints too about their stacking ability but this is largely a question of the weave. Polypropylene, like jute, sacks can be used for products such as rice, cotton, many vegetables and seeds where their nature prevents their being confined in totally closed containers such as film sacks. The current production is being used for sand bags where of course popypropylene is much more durable. The demand for all these sacks is at least 30 million now and will certainly rise to 50 million by 1980. If all the jute were replaced by polypropylene, the demand for the latter would be 8,000 tons (a 50 kg P.P. sack weighing about 160 gm). To some extent, the degree of change over can be controlled by the Government, particularly since either jute or popypropylene sacks can be woven on similar looms in the same factory. We think that a fair estimate would be based on a 50% change over, i.e. a consumption of 4,000 tons of polypropylene in 1980.

4.2.2.4 Bottles

This is another major potential outlet for plastics. We considered three industries in some detail: soft drinks, wines and spirits and edible oils. Some plastic bottles have already been used by the edible oil industry. In all cases, these will replace glass and as glass bottles are produced in Egypt, the effect that such a change would have on this industry must be taken into account. It is interesting to note that if all the glass bottles were replaced, the consumption of P.V.C. for this application alone would considerably exceed the capacity of the P.V.C. part of the Alexandria complex.

Another factor to be considered is that glass bottles, particularly for soft drinks, are returnable, plastic are not. Quite apart from its affect on the price structure, the use of plastic bottles will eventually produce a disposal problem, empty P.V.C. bottles lying about the streets, etc. On the other hand, P.V.C. bottles are far less dangerous when broken.

We have, therefore, assumed only a 10% change over in soft drinks as well as in wines and spirits, in the latter case this happens to represent roughly the proportion that goes on the home market, exports must on no account be affected adversely by a change in the container. The P.V.C. formulations will need careful attention so as to be non-toxic and not to affect the flavour in any way (Anton Krasny und Söhne, Dresdenerstr. 81-85, A-1200 Vienna, who supply the cola essences to Egypt, agree P.V.C. is suitable and they are willing to co-operate). The soft drink manufacturers estimate 2,208 million bottles a year (on a non-returnable basis) would be required by 1980 which on the 10% basis would require 6,000 t/a of P.V.C. resin. On a similar basis, 1,200 tons would be required for wines and spirits. The beer manufacturers were not met but we cannot disregard the potential here since plastic bottles are being proposed for beer in some Western European countries. The chief doubt seems to lie in the possible loss of CO_2 through the very slightly permeable plastic. Egyptian beer does not appear to have a very high CO_2 content compared with some European beers, so we do not consider this a major snag. Again on a 10% change over, 3,500 tons would be required of P.V.C. resin.

While P.V.C. is prefered to polyethylene for edible oil bottles, the need to consume as much L.D.P.E. as possible led us to make a division here, the rationed oil, which sells very quickly, would be bottled in L.P.D.E. and the free market, higher priced oil in P.V.C. bottles. This avoided any possible criticism that the 'relatively' slow-moving oil could turn rancid due to percolation of oxygen into the oil, through the L.D.P.E.

3,000 tons of L.D.P.E. and 5,000 tons of P.V.C. would be required for this outlet in 1980. The reason for the lower weight of L.P.D.E. for actually the same number of bottles is first its lower density and secondly the ready re-usability of scrap when processing L.D.P.E.

Vinegar is a product suitable for packing in L.D.P.E. bottles and since some 5 million litres are bottled a year in half litre or one litre bottles, 250 t/a could be consumed now and we think this might reasonably rise to 900 t/a in 1980.

There is a small tonnage but large number of small bottles and containers for the pharmaceutical industry, at present, mainly in polystyrene. Bottles for powdered cleaners are also being produced. Detergents could be packed in L.D.P.E. bottles or containers. Basing our calculations largely on the probable demand for detergents, we have added another 1,500 tons for consumption in this field.

4.2.2.5 <u>Containers</u>

There is a very large potential demand for small vacuum-formed containers for cheese, youghurt, ice-cream and pharmaceutical products. Containers for youghurt and pharmaceutical products are already being produced in polystyrene and for ice-cream in waxed paper. Care would be needed in calendering the thin P.V.C. sheets required, but otherwise there is no reason why all the stiffer containers should not be made from P.V.C. and the flabbier ones, e.g. for ice-cream, from L.D.P.E. About 2,700 tons of P.V.C. resin are estimated to be required for these applications in 1980 together with about 8 tons of polyethylene for the very light ice-cream cartons.

Larger containers holding 1-50 litres, mostly in the form of jerry cans are already being blow-moulded and there is likely to be a major increase in the demand for them. They are used as water containers, gasoline containers (after antistatic treatment) and containers for lubricating oils. Here, of the products available, polypropylene is most suitable and between 900 and 1,000 t/a is our estimation for its consumption by 1980.

4.2.2.6 <u>Crates</u>

There is a growing use in Europe of polypropylene for replacing wood and metal in the production of crates for holding bottles. Great interest was shown in their production in Egypt though manufacturers who had started producing them said they were a 'hard sell'. They are obviously much more expensive than the wooden crates at present widely used in Egypt but have far greater durability and need negligeable maintenance. Wood has to be imported and no doubt strong official pressure will be applied in appropriate instances to make use of these plastic crates. It is difficult to make realistic estimates under these circumstances. Thus, if the beer bottling industry changed over entirely to P.P. crates and, assuming these to last five years, [illegible] tons of polypropylene would be required per annum now, much more to get the float started. The soft drinks industry could consume another 7,000 tons per annum. To get out of this difficulty we took the current UK demand for crates and scaled it down to the Egyptian market pro rata to G.N.P. and population and obtained a demand for 2,300 t/a for polypropylene. This would be today's figure and we thought an increase to 3,000 t/a in 1980 reasonable.

4.2.2.7 Wrapping paper substitute

Polyethylene film could be used in considerable quantitites to replace ordinary wrapping paper. This would be produced from the lay-flat tubing obtained as an intermediate stage in the production of bags and sacks. The total demand in tons, however, is not very great and can be considered to have been covered in the L.D.P.E. required for sack production.

4.2.2.8 Shrink film

This can be produced by stretching lay-flat tubing during cooling by a special process which leaves the film dimensionally unstable so that on re-heating it contracts. This is used in numerous applications for packing irregularly shaped articles such as poultry and joints of meat as when shrunk it holds the object tightly. Much interest has been expressed in this application in Egypt and 100 tons per annum has been allowed for the consumption of this type of film, polyethylene of course being used.

4.2.3 Electrical Products

The Government has in hand a major project for the extension of electricity supplies to rural areas and hence the demand for electrical equipment is likely to be very great. There is a well established cable industry in Egypt already consuming nearly 5,000 t/a of plasticized P.V.C. compound and a rapid increase is expected - 20% p.a. for at least some years. We have estimated a demand of between 15,000 and 16,000 tons of P.V.C. compound in 1980 or about 8,000 tons of resin.

In the UK the official forecast is that cables will consume almost equal quantities of P.V.C. resin and polyethylene but we have found little interest in polyethylene here. Apparently its use in telephone cable was tried on a small scale but we understand the quantities now being used are negligeable. However, we feel sure some use must come and we have allowed a consumption of 500 tons in 1980.

No gramophone records appear to be made now in Egypt and in any case, they traditionally use a co-polymer.

About 110,000 TV sets are expected to be made per annum by 1980 and the case and back projection are suitable for moulding in polypropylene and this application should consume 550 tons. Broadcast receivers are normally small, the printed circuits would need resins not to be made on the Alexandria complex. 120,000 were made in 1971 and it seems unlikely that this quantity will increase noticeably. Even if we allow 200 gm for a polypropylene case on each set, the consumption would only just exceed 20 tons.

In the field of domestic appliances, refrigerators and washing machines are made in Egypt and between 800 and 900 tons of high impact polystyrene is expected to be needed for the linings and the trays, etc. of the former. While this might with great difficulty be made in vacuum formed P.V.C., it is with regret that in the present stage of technology we must advise against this. Washing machines could consume about 50 tons of polypropylene by 1980 if the present cast aluminium bowl be changed for one of polypropylene and the impeller changed from phenol formaldehyde resin to polypropylene.

Plugs and sockets and similar small items have for a great many years been made from phenol-formaldehyde moulding powders and were produced, almost entirely by the private sector, to a value of LE 60,500 in 1971. Plugs, but not wall fittings, could be P.V.C. but it is probably scarcely worth contemplating a change over.

4.2.4 Automotive Applications

Motor vehicles in Egypt are normally made under licence from some European (or, possibly in the future, Japanese) companies so that it can be assumed that the average quantity of plastics will be used. Using data from European sources, the demand for plastics in automotive application in Egypt is likely to be as follows:

Number estimated to be produced in 1980	Type	Wt of plastics per unit	Total plastics
12,000	Lorry	25 kg	300 tons
3,000	Tractor	very small	10 tons (nominal)
1,500	Bus	200 kg	300 tons
30,000	Private car	80 kg	2,400 tons
		Total	2,010 tons

Based again on European forecasts, 20.5% or 617 tons would be P.V.C. resin mainly for covering upholstery, decorative uses and trim. 22.0% or 662 tons would be polypropylene and 14% or 421 tons A.B.S. It is considered that at least some of the A.B.S. outlets could be replaced by polypropylene where hardness was not of special importance.

While it will probably be possible for much of the P.V.C. applications to be made in Egypt, the P.P. application will be mainly injection moulded and it will depend on the number 'off' as to whether the special moulds will be justified. Further, the motor vehicle policy will have a major effect, thus how far components are to be imported via the licensors. 600 t/a of P.V C. have been allowed for this end use and 660 t/a of polypropylene which may exclude some polypropylene applications but include some A.B.S. These figures are a little speculative and as mentioned will depend largely on motor vehicle policy.

4.2.5 Furniture

Chairs and stools are already being made by injection-moulding polypropylene and in the drive to save wood it is expected that there will be a rapid increase. 509,689 chairs were made in 1971 and it is suggested that half these might be suitable for manufacture from polypropylene, thus saving timber. Assuming 2 kg P.P. per chair, average, 500 tons of polypropylene would be required, now rising to 1,200 tons in 1980. A further 300 tons might be consumed for stools.

Discussions have indicated a potential of 200 tons in 1980 for carpets, carpet backing and seat covers - the producer of nylon carpets might be persuaded to change partly or wholly to polypropylene fibres.

A large number of applications in furniture will involve P.V.C. supported or unsupported sheet. The borderline between furniture proper and domestic applications such as curtains, table cloths, etc. is very narrow and we have allowed 750 tons of P.V.C. resin for such applications in 1980.

Other uses in furniture are mainly in foam and products like Formica which cannot be produced from polymers to be made at Alexandria.

Lavatory seats in Egypt are, at present, mainly made from phenol formaldehyde moulding powder but they are unsatisfactory and brittle and a change to polypropylene will be welcomed. [illegible] units a year will be needed in 1975 and we foresee a doubling by 1980. This means the consumption of 500 tons of polypropylene.

4.2.6 Building

This is one of the largest if not the largest consumer of plastics in Europe but very little interest has been noted in Egypt. The climate is of course different, a great many plastic applications are connected with the removal of rainwater or preventing damp penetrating a structure. Nearly half the use of plastics in the UK is connected with plumbing and here the very complicated water systems inside houses with roof tanks, sometimes supplementary tanks for central heating applications, combined with the danger of cold water systems freezing in cold weather, give enormous scope for plastic material. The water system in Egyptian homes is usually much simpler and no precautions are necessary against freezing. Much of the other use of plastics is connected with insulation, adhesives and surface coatings none of which involve products to be made at Alexandria.

After discussions at the Ministry of Housing and Construction, a rough macro-economic picture was drawn up which disclosed the small potential for plastics in this field.

The total current budget for building and construction, including civil engineering, was LE 500 million of which 45% or LE 225 million was for actual building. 15% of this budget covered 'finishing' and about 10% of the finishing budget included products that could be made from plastics, that is a value of LE 3,375,000.

It was considered that 30% would at present actually be plastic applications rising to 60% in 1980. The overall growth was subject to Government decision but 7% p.a. might be taken as reasonable figure. Taking LE 500 as the cost of a ton of plastic product, 6,900 tons would be required in 1980 of which probably no more than half, 3,450 tons, would represent products made from 'Alexandria' raw materials. From other sources we obtained a very small estimate for rainwater goods, 130 tons, while electrical conduits are being made and expected to consume 800 t/a by 1980. Finally, one manufacturer has installed a project for making P.V.C. corrugated sheet for which we have allowed 500 tons by 1980. The remaining 2,000 tons, frankly on a guess, will be divided equally between polyethylene film and pipes, and polypropylene pipes, i.e. 667 t/a each.

It will be appreciated that our contacts with the building industry were strictly limited which largely explains the vagueness of the information.

4.2.7 Shoes

This is a major outlet for plastics in Egypt. Shoe production is a major industry, 80% private. Thus 21.8 m pairs of leather shoes were produced in 1972, of which about 3% were exported. In addition, 4 million pairs of all plastic shoes and 2.4 million pairs of canvas shoes were produced. The producers expect a major increase in the production and demand for plastic shoes though they do sound a warning that fashions may change. Increase in other types of shoes are much more limited and there is a semi-official forecast of 28 million pairs of leather shoes being required in 1980.

It is further estimated that if P.V.C. was in free supply and the injection moulding equipment available, half the leathor soles would be changed over to P.V.C. due mainly to the growing shortage of leather.

The demand for various types and the P.V.C. required in 1980 is as follows:

	Number of pairs	P.V.C. compound demand per pair	P.V.C. compound required
All P.V.C. shoes	15 million	366	5,500
Canvas shoes with plastic soles	3.6 million	321	1,150
Leather shoes with plastic soles	14 million (i.e. 50% of production)	285	4,000
Soles of shoes with artificial leather uppers	12 million	250	3,000
			13,650

This gives a total of 13,650 of compound or about 8,140 tons of P.V.C. resin.

The artificial leather for the shoes mentioned as having these uppers is being made by spreading a plastisol on a fabric. Such plastisols, being derived from emulsion-polymerized P.V.C., cannot be made from Alexandria-produced material. While it is planned to install a calendar whereby the coated fabric can be made by the alternative route from suspension grade P.V.C. the fact that the spreading equipment is already installed, makes the change over very problematic and we would counsel waiting to see how markets develop before reaching a decision as to a change over. Some 700 t/a of P.V.C. resin would be required by 1980.

4.2.8 Other applications

4.2.8.1 Industrial

Some ropes are already being made from polypropylene and the demand is likely slowly to increase. In addition, fishing nets which are suitable for production on the same equipment are made from polypropylene in some countries, notably the Philippines. In Egypt, nylon is at present preferred, but we foresee some 'directed' change over when polypropylene becomes available. We have therefore allowed 1,000 t/a for the combined applications.

There would also be a small demand for flexible pipe and section. We have allowed 150 tons of P.V.C. resin for this and 50 tons of L.D.P.E.

There was considerable interest in plastic fish trays to replace wooden ones. Ideally they should be made from H.D.P.E. and as they were liable to be kept in refrigerators, P.P. was out of the question. It was considered that L.D.P.E. could be used for this application, provided the trays were made thick enough and 250 tons was allowed for this purpose.

Storage batteries were being assembled on a considerable scale in Egypt, the cases being from ebonite (hard-rubber). The 'five-year' plan envisaged a factory to make 240,000 batteries per annum, the cases being from hardened reclaimed rubber from tyre manufacture. We are recommending this be abandoned and machinery to make these cases by injection moulding polypropylene installed. Due to the large number of different sizes and hence the number of moulds which would be needed it was decided to restrict polypropylene production to nine most popular sizes and this would consume 1,000 tons of polypropylene by 1980.

There are also considerable production of ancillary articles for the textile industry such as pickers and bobbins which could consume perhaps 100 t/a polypropylene.

4.2.8.2 Domestic and housewear

Here is a major opportunity for plastics, the only trouble being that a large proportion of articles in this field are traditionally made from polystyrene or thermosetting resins. Some of those made from high impact polystyrene can be changed over to polypropylene as can certain of the articles made from thermosetting resins albeit with some change in their feel and appearance.

The products from polypropylene would almost invariably be made by injection moulding. P.V.C. would only have specialised applications in this field.

Most manufacturers agree that the market is many times the existing one, conservatively put at 2,000 tons. But it would not just be a question of a larger number of the same articles, the increase in sales would come from different articles for which new moulds would be required.

The types of articles falling into this group include the following:

- Plates, cups, saucers
- Knives, spoons and forks
- Badges
- Brush handles
- Clothes' pegs
- Combs
- Condiment sets
- Egg cups
- Hair slides
- Ink stands
- Lables
- Pipe clips
- Pen trays
- Hand bags
- Belts (clothing)
- Pencil boxes
- Photo frames
- Picnic sets
- Toys and games
- Dolls
- Trays
- Vases
- Plate racks
- Telephones
- Kitchen bowls and buckets
- Educational aids
- Buttons
- Ornaments
- Luggage

Normally, by ckecking in the shop, plastic articles appeared to be cheaper than the corresponding glass, metal or enamel products.

We have allowed 2,400 tons of polypropylene including 400 tons for polypropylene suit-cases replacing leather, 2,000 tons of L.D.P.E. and 730 tons of P.V.C. resin as supported and unsupported sheets mainly for handbags and other applications replacing leather together with a small quantity, 100 tons, for P.V.C. injection moulded articles.

4.2.8 Summary

The following table sums up the estimated demands in the various fields in 1980:

	P.V.C. resin	L.D.P.E.	P.P.
Agriculture	14,000	950	2,600
Packaging	18,400	24,140	9,750
Electrical	8,000	500	620
Automotive	600	-	660
Furniture	750	-	1,500
Building	1,300	1,340	670
Shoes	8,100	-	-
Other applications	980	2,300	4,400
	52,420	29,230	20,200

4.3 Comparison of the various forecasts for 1980

BEICIP, a subsidiary of Institut Francais du Petrole, had also provided a forecast of the Egyptian market though this was obtained by rather different means from ours. Further, IDCAS had recently done a forecast for all the Arab States as had Hoechst for UNIDO in 1969, and those for Egypt are included for comparison. These different forecasts are shown in the table below:

	Our macro-economic	Our field	BEICIP macro-economic	BEICIP field	IDCAS	Hoechst
PVC	26,000	53,000	45,000	5[illegible],000	28,500	15,000
LDPE	18,000	29,000	30,000	30,000	28,500	15,000
PP	18,500	20,500	15,000	16,000	very small	very small

Notes

BEICIP state their P.V.C. is 'resin and compound', so should probably be reduced a little compared with ours which is strictly 'resin'.

BEICIP give two sets of figures for their macroeconomic projection depending on whether production is or is not in force in Egypt. We cannot see that this should have any affect on a free market unless the prices are grossly different. Anyhow, we have chosen the higher figure for this table.

IDCAS state that their 'polyethylene' figure contains both L.D.P.E. and H.D.P.E. This would make their actual for L.D.P.E. a little lower than that given.

Comments

We think our macroeconomic figure is about right, based on free availability and conventional considerations. Only the polypropylene is perhaps a little high due to some substitution of other plastics not being made at the Alexandria complex. The much higher figures obtained in our field survey are because we have assumed a certain amount of compulsion or, at least, very strong encouragement to change over from traditional materials to plastics. BEICIP's field surveys and ours show remarkable agreement though done entirely independently, only our popypropylene is higher and that is the result of substitution.

BEICIP's macroeconomic estimates assuming no local production are much closer to ours, in fact the totals for the three thermoplastics are almost the same: theirs - 65,000 tons compared with ours - 62,500 tons.

5. EXPORTS

It is clear that the demand in Egypt for polyethylene and polypropylene is going to fall for some years at least considerably short of the capacity of the proposed plants at the Alexandria complex. Suggestions have been made that the excess should be exported and a special investigation is being carried out under the auspices of UNCTAD to examine the possibilities. Whatever the results of such an investigation, which at first sight does not seem to present great possibilities, we suggest that it would be much better to export finished products. The reason for this is that:

1. Countries such as Hong Kong have already achieved very big business in this field and with Egypt's geographical advantages it should be able to secure some similar business.
2. While the production of the raw materials is capital intensive, the production of at least some of the finished products is distinctly labour intensive and here Egypt has a big advantage over the more industrialized countries.
3. As a result of efforts by UNCTAD, many industrialized countries are giving favourable import facilities by reduction or elimination of tariffs to non-traditional manufactured products from developing countries. The current position is shown in an Appendix.
4. The capital expenditure on equipment for processing the plastic raw materials has in many cases to be paid for in hard currency and the logical way to pay for it is to export a quantity of the goods to be made from it.

At the moment, exports of the principal commodities produced in Egypt are on a budget basis and it is the function of the trade organization to locate the customers. This excludes major barter deals, e.g. with Eastern European countries which would be organized at a higher level. Outside the budgeted exports only limited efforts appear to be made to obtain business, most of the producers sell all they can make on the home market and there is little encouragement to export.

It is therefore recommended that an export group for plastic products be set up under the auspices at one of the trading organizations. The members of this group shall be people with a good knowledge of plastics application and will be prepared to travel abroad seeking business.

But currently with this, a UN project (UNIDO or UNCTAD) shall be carried out to locate the countries to which the prospects for exports of plastic products are most favourable and to make specific proposals for agents or importing firms in those countries where this is appropriate.

If the Arab Free Area really gets under way, there should be considerable scope for exports of finished goods to other Arab countries but at the present time the tariffs represent a stiff barrier. Although figures for the estimated consumption of plastic raw materials to these countries are available up to 1980 (see Appendix), these are not really comparative without a knowledge of imported plastic products and products containing plastics, which could only be obtained by a detailed study of the import statistics of each country and probably discussions with people knowledgeable in this type of business. It is assumed of course that the duties of the proposed UNIDO/UNCTAD project would incorporate this.

6. **DEDUCTIONS FROM MARKETING INVESTIGATION**

(1) If all the P.V.C. outlets develop as foreseen the capacity for P.V.C. resin in the Alexandria complex as planned will fall short of the market by over 10,000 tons. Some of the P.V.C. applications are, however, a little speculative and there would be no difficulty in reducing the demand to capacity level. P.V.C. bottles replacing glass bottles and soles of shoes where the capital expenditure is particularly high come particularly to mind.

(2) The polyethylene market however falls short of the planned capacity by some 16,000 tons. If however only stage I of the complex goes ahead some of the polypropylene applications could be transferred to L.D.P.E. Actually it is considered that the following could be transferred: 'pipes for irrigation', lavatory seats, half the jerry cans, half the general housewear, i.e. nearly 5,000 tons of L.D.P.E. This would therefore reduce the surplus capacity to 11,000 tons. The alternatives would seem to be to export the polyethylene for any price it would fetch, (caution Dumping) or produce polyethylene goods for export which is dealt with in more detail in the section on Exports or to run the plant below capacity. The effect of doing the latter is shown with some comparative costings further on in Section 7. The effect of this operation is of course complicated by having to make a decision on how to dispose of the excess ethylene.

(3) The polypropylene market falls nearly 10,000 tons below capacity. Polypropylene is however scheduled as a second stage project along with ethylene glycol and polybutadiene. There is nothing inherently impracticable in transferring polypropylene by itself to the first stage it merely means a higher additional cost. However, we shall see more clearly what it involves when the costings in Section 7 are examined.

It will be appreciated that the ratios of the PP/LDPE PVC capacities are completely out of step with the demand in Western Europe. Thus in the U.K. the consumption of PP is relatively high but even so the forecasted ratio for 1980 is only 34/66/100. The capacity of the Alexandria complex shows a ratio of 75/112/100 so that it is clear that the polypropylene capacity, in particular is much too high compared with the capacities for LLPE and PVC.

Further some of the P.P. applications are a little 'forced'. In a free economy many of them would be made from other plastics, sometime for technical reasons and sometimes because the alternative raw material would be cheaper. If therefore it is decided to implement stage 2 at an early date it is important that free supplies of polypropylene be made available at an early date so that the plastics industry in Egypt can become polypropylene oriented.

(4) When considering these estimations it should not be forgotten that they refer to a single moment of time only. Obviously provided processing equipment is available the demand for the polymers will increase and excess capacity will gradually be absorbed. Thus even by 1983 our, admittedly very tentative, forecast shows a demand for 25,000 tons of polypropylene and more than 35,000 tons of L.D.P.E.

(5) It will be appreciated that all our estimates of consumption have been made on the basis of free availability. The Government can hold down the demand to any level it chooses by limiting imports of equipment or materials. But it is no use holding down consumption of plastics till, say, 1978 and then expecting them to rise to the estimated level by 1980, there may easily be a delay of 3 - 4 years, perhaps more.

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However the economic control exercised by the Government makes it possible to 'bend' a little the concept of free availability. Thus, in many applications: fertiliser sacks, split film woven polypropylene sacks, bottles and other containers, pipes for irrigation and drainage, the Government can order a change over provided it is satisfied with the plastic product, both technically and economically (although if in the long term foreign exchange is saved economic viability may be stretched a little). What is important is that the plastics product be thoroughly tried out well in advance so that any snags to its manufacture and use can be overcome and actual production started before the coming on stream of the Alexandria plant.

(6) However every possible step should be taken to encourage the use of products from P.V.C., L.D.P.E. and P.P. by increasing the availability of raw materials where producers can use them and discouraging the use by tariffs or otherwise of competitive materials. Many of these actions are stressed in the recommendations.

Mention must be made briefly of the effect of using plastics on other industries and on the economy generally. In many instances plastic products will replace those of other industries, cement, glass, jute, etc. all well established in Egypt. We have not attempted to examine the effect pushing plastics will have on these industries. Generally the manufacture and application of plastic products are labour saving and hence employment, at least for the time, decreased. It should be mentioned that one factory manager gave it as his opinion that if plastic crates superceded wooden ones in his industry at least 600 men, now employed in making and repairing crates, would be thrown out of work.

7. PLANT OPERATION ALTERNATIVES

7.1 Variations in operation of plant as planned

It is clear that any specific recommendations will be intimately bound with a decision as to whether the complex is to be brought on stream in one stage or two. We think it therefore helpful to rough out its cost and transfer price of ethylene and its effect on the cost of P.V.C. and L.D.P.E. by operating the complex in various ways and then see how the results differ.

The six sets of conditions compared are the following:

(1) Bringing on stream both stages together or nearly together, the cost and transfer price of the ethylene being based on the BEICIP report.

(2) Bringing on stream the first stage only, full operation of the steam cracker, the P.V.C. and L.D.P.E. plants, burning the excess ethylene as fuel gas, incorporating the propylene in L.P.G. and selling the butadiene for what it will fetch in the world market (we have assumed a price of US$ 100 per ton f.o.b.).

(3) As (2) but the polyethylene plant only being operated to give the home-market demand i.e. 35,000 t/a (including therefore the estimated substitution of polypropylene), the extra excess ethylene again being treated as fuel gas.

(4) As (3) but the steam cracker now being operated below capacity to give only sufficient to produce the 58,000 t/a ethylene sufficient for the V.C.M. plant working to capacity and to make 35,000 tons of polyethylene.

(5) As (3) but with polypropylene production and the steam cracker operated at still lower capacity to make 53,000 tons of ethylene sufficient for the V.C.M. plant and to make 29,000 tons of polyethylene. The propylene co-produced will just happen to fall in the right ratio to make 20-24,000 tons of polypropylene, the transfer value of the propylene being as fixed by BEICIP, i.e. US$ 66 per ton.

(6) As scheme (5) but with the transfer value of the ethylene being raised to US$ 100 per ton.

The results are shown in the following table:

(All figures in US$ per ton: 1 US dollar LE 0.435 (commercial rate)

Scheme	Cost of ethylene	Transfer price of ethylene	Cost of PVC compound	Cost of LDPE	Transfer price of propylene	Cost of PP
1	53.4	87.0	293	237	66	257
2	84.2	118.3	310	270	-	-
3	103.4	138.0	323	320	-	-
4	98	132.6	319	310	-	-
5	89.6	123.4	312	375	66	323
6	75.0	109.6	306	311	100	360

The method of working out these values was to use the BEICIP data from Tables 1 to 6 on pp. 7-12 and also the value of the co-and by-products on p.15 of Vol. II of their Feasibility Study.

The values of the co-and by-products were changed so as to value butadiene at US$ 100 per ton and other values altered as necessary according to the various schemes. Except in scheme 6 where the transfer price of propylene was deliberately increased by 50% the ethylene actually used chemically was made to bear the residual cost of operating the cracker. The mark up between the cost of production and the transfer price of ethylene used by BEICIP was used in all the schemes.

When dealing with reduced production the fixed costs were left unchanged while the price of raw material and the variable costs altered proportionally to the decrease in production. We realise this is a little 'rough' but we did not have sufficient detailed information to make the calculation in any other way.

Due to the lower ethylene content of the P.V.C. the effect of the different schemes on P.V.C. cost is much less than that of L.D.P.E. quite apart from the fact that the V.C.M. and P.V.C. plants being operated in all six schemes at full capacity.

If stage I is to be operated in advance it is clearly best to operate the cracker according to scheme 4, i.e. at reduced output to give sufficient ethylene to satisfy 100% of V.C.M. and P.V.C. capacity but to make only 35,000 tons of L.D.P.E. instead of 45,000. We do not think it possible to consider exports from scheme 2 which at first sight looks more viable, the cost of the polymers will be too high. Exports will only be even possible if the cost of the polymers is kept down by implementing scheme 1, i.e. both stages being brought on stream simultaneously or nearly so. We must mention that we see no serious problems arising if for instance polypropylene and, preferably, the other products start being produced up to one year after the implementation of Stage I, this is very different from implementing stage I and postponing stage II to some indefinite date in the future.

After considering all the points arising, our recommendation would be to operate the full schemes as in (I) except that the ethylene glycol might have to be sold on the world market if the Cairo complex were not ready to take it.

Two other suggestions might be mentioned though we have not the data to evaluate them in any way.

(1) The V.C.M. and P.V.C. plants might perhaps be expanded by 10,000 tons and the capacity of the L.D.P.E. plant reduced by 5,000 tons. This change would absorb about the same quantity of ethylene.

(2) Use lighter naphtha in the cracker. This would have the effect of increasing the production of ethylene at the expense of the propylene and higher hydro-carbons. A suitable naphtha would appear to be available from the Cairo complex where a full range naphtha is topped and only the higher boiling portion sent to the reformer to produce xylenes.

If however stage II is postponed for some years consideration should be given to selling the propylene for chemical use rather than incorporating it in L.P.G. This would mean splitting the propylene from the propane and it is not at all clear whether the first stage would cover this without some additional expense. So we have not attempted to evaluate it.

Propylene should however fetch US$ 50-60 per ton f.o.b. in the free market which is an improvement on US$ 37.3 per ton as L.P.G. There are numerous propylene consumers not tied to any supplier and willing to buy in the cheapest market.

7.2 Alternative plants

During the visit to the Egyptian Petroleum Co. at Alexandria various alternatives were discussed in case it was found impracticable to proceed with the whole project.

One was a German process which, using a light naphtha with a final boiling point of 130°C, converted this into a mixture of 1.6 pts. of ethylene and 1 pt. of acetylene. The total investment for producing 92,000 tons of ethylene and 58,000 tons acetylene was US$ 26.3 m. This compared with US$ 26.7 m for producing 77,000 tons of ethylene, 33,500 tons of propylene and 10,000 tons of butadiene in addition 57,000 tons of very high antiknock gasoline, 16,000 tons of fuel oil and 18,500 tons of L.P.G. by the project as planned. The cost of the acetylene produced was stated to be US$ 114 per ton and the ethylene US$ 71.3 per ton. This compared with US$ 53.4 per ton for ethylene produced by the orthodox cracking process.

The most interesting outlet for the ethylene/acetylene process would be to chlorinate the ethylene to ethylene dichloride, crack the latter to vinyl chloride and hydrogen chloride and react the hydrogen chloride with acetylene to give more vinyl chloride. In theory some 259,000 tons of vinyl chloride could be produced by this process still leaving 30,500 tons of ethylene for other purposes, e.g. polyethylene. If this could be scaled down to one fifth it would be interesting to produce some 50,000 tons V.C.M. but the residual ethylene, 6,000 tons, would not be sufficient for a viable polyethylene plant. Also the relative capital cost and cost of operation would be substantially increased.

But in general, processes involving acetylene production from other hydrocarbons are tricky to operate, often troublesome, yields falling far short of the design capacity. We cannot recommend them for a developing country.

A simpler alternative to the full complex would be to start by erecting the vinyl chloride polymerisation and compounding plant and purchase the vinyl chloride for the first few years. We have attempted to calculate, somewhat approximately, what the savings in foreign exchange might be.

We have used BEICIP figures where available, compared P.V.C. polymerising and compounding with stage I of the process and assumed:

(1) The foreign exchange element in the "PVC plant" only is proportional to that of Stage I of the complex as a whole.

(2) Utilities and services for the PVC plant have been calculated pro rata to the whole complex, this is probably too high.

(3) It is assumed that the capital is borrowed over 4 years for Stage I of the complex and over 2 years for the PVC plant only.

(4) Interest is payable at 6% immediately after borrowing and the capital paid back 10% per annum immediately after the plant is presumed in operation. The basis was taken after discussion with the General Organisation for Industrialization. It is the practice of the French Government at present to give facilities to French companies to supply plant on the following basis: no payment for first two years, then repayment at 20% per annum with 7% interest on the balance outstanding.

(5) In addition to the purchase of vinyl chloride monomer an element of foreign exchange has been allowed for purchasing polymers not being manufactured. No increase in this element is allowed over the period since it is assumed that more and more can be purchased from soft currency countries. An extra amount has however been allowed in the build up period for each plant.

(6) The foreign currency element of Stage I of the complex has been taken as US$ 83.8 and that of the PVC plant only (including compounding) US$ 11.0.

(7) The cost of the VCM is taken as US$ 100 per ton c.i.f., US$ 140 c.i.f., delivered, duty and taxes paid US$ 170 per ton. This compares with US$ 176 per ton as the price at which V.C.M. made on the complex would be charged into the polymerisation plant.

The results shown in the table below have not been discounted to year one as it was not felt any worth while information would be obtained by this operation. All purchase of raw materials are assumed to have been made at present day prices.

Stage I of complex (Cost in million of dollars)

Year	Interest	Capital Repayments	Polymer purchases	Total
1	Nil	Nil	3.5	3.5
2	1.34	Nil	5.25	6.59
3	2.68	Nil	7.0	9.68
4	4.02	Nil	10.5	14.52
5	5.36	8.88	1.0	15.24
6	4.83	8.88	1.0	14.71
7	4.29	8.88	1.0	14.17
8	3.76	8.88	1.0	13.64
9	3.22	8.88	1.0	13.10
10	2.68	8.88	1.0	12.56
			Total	117.71

P.V.C. only

Year	Interest	Capital Repayments	VCM Purchases	Polymer Purchases	Total
1	Nil	Nil	Nil	4.5	4.5
2	0.33	Nil	Nil	5.0	5.33
3	0.66	Nil	4.7	3.5	8.86
4	0.66	1.1	4.7	3.5	9.96
5	0.60	1.1	4.7	3.5	9.90
6	0.53	1.1	4.7	3.5	9.83
7	0.47	1.1	4.7	3.5	9.77
8	0.40	1.1	4.7	3.5	9.70
9	0.34	1.1	4.7	3.5	9.64
10	0.27	1.1	4.7	3.5	9.57
				Total	87.06

It is to be made clear that the above summation has nothing to do with profits, it is merely an attempt to estimate the relative outgoing in foreign exchange. On this calculation the saving over 10 years is only US$ 27.69 m. or an average of US$ 2.77 m. per year or L.E 1.19 million per annum. We frankly doubt whether this is justified especially as it is only a planned delay to the complex not abandoning it altogether. While we have not the data to express this in figures we feel sure that building the first stage in two parts, i.e. the PVC polymerisation and compounding plant first and then the cracker, PE and VCM plants would cost more than if Stage I was implemented as a whole.

It might be argued that there would be a further saving if the PVC polymerisation and compounding plant was installed first in that expenditure on equipment for processing the additional polyethylene would be saved i.e. about L.E 4 million (US$ 9 million). However it is part of our overall plan that sufficient of the goods made from the new equipment should be exported, thus defraying at least a major part of this foreign exchange expenditure.

We have not therefore included any saving on process equipment in the overall figure above.

8. INVESTMENT COSTS OF PLASTICS PROCESSING EQUIPMENT

8.1 Kind of Investment Calculations

There are no up-to-date offers for processing machinery in Egypt so the figures have had to be based on past experience.

The list contains the prices only for the processing machines with the addition of 10% for spare parts

To put a factory in operation the total investment may be 50-100% higher than that of basic equipment to cover the cost of maintenance shops, storage, transport, supply of energy, tools, etc. Some of these extra requirements may be available from Egyptian sources but this is far from certain and an extra 50% has been added to the cost of foreign currency to cover such eventualities. Exceptions are the compounding plant, 30% and the calender (where equipment is supplied in a more complete form) 20%.

An average of 5% of non-returnable scrap must be allowed for, so this must be added to the total cost of capital if full capacity is required.

Prices have been estimated at 1972 values but an increase of 15-20% p.a. has been taking place in European countries.

8.2 Separation of different production lines

It is a golden rule that different plastic raw materials should not be processed in the same shop even when the processing equipment is similar or identical. Otherwise scrap from different raw materials which are mutually incompatible are obtained. The operators cannot differentiate these and it is most important that scrap and trim from different raw materials should be reclaimed separately. In view of this the different sections of the processing plant must each work with one raw material only.

8.2.1 Machine costs for processing PVC

Item	Comp. t/y	PVC resin t/y	Investment LE'000
1. Compounding plant	30,000	20,000	350
2. Corrugated pipes 100 mm. ϕ		13,000	770
3. Irrigation pipes 670 km. 100 mm ϕ Irrigation pipes 250 km. 75 mm ϕ		1,200	50
4. Pipes electrical 25 mm. ϕ		1,000	50
5. Bottles		8,500	860
6. Injection moulding		200	150
7. Corrugated sheet		500	50
8. Shoes and soles	13,650	6,850	2,728
9. Cables	16,000	8,000	600
10. 2 Calenders		3,000	5,250
11. Extrusion	250	150	33
12. Automobile parts			-
			10,891
+50% (+30, +20)			3,801
	29,900	42,400	14,692

The total figure of PVC consumption is substantially lower than the total figure of 4.2.8 as the latter includes estimated requirements of a general character that cannot at this stage be linked to specific processing equipment.

8.2.1.1 Compounding plant for PVC 30,000 t/y

It is considered urgent that the compounding plant be installed as early as possible to enable processors to get accustomed to using Egyptian compounds and to find out any snags in producing compounds so that time is available for overcoming them.

There are 2 offers:

- **National Plastics** for 12,000 t/y LE 150

  For 30,000 t/y guess LE 380,000

  10% 40,000

  LE 420,000

- OOI from Pochiney

  Capacity: 14,000 t/y compound
  5,500 t/y PVC-pipe

  For 20,710 FF LE 185,000

  Guess: 2/3 for compounding 125,000

  30,000 t/y 250,000

  10% 25,000

  LE 285,000

  LE 285,000
  LE 420,000

  LE 705,000 : 2 = LE 350,000 Total LE 350,000

There exist several plans:

The following companies wish to have their own compounding facilities: Electrocable - National Plastics - Bata.

It is recommended to install only one central factory for all demands, and this should be in Cairo adjoining the Plastics Development Centre (see recommendations). Reasons:

Lower price of equipment and running costs

Concentrated experience

Central development (lower costs)

The compounds should not be coloured. The factory delivers master batches of about 8 colours as pallets. So the customer can easily colour according to his demands.

8.2.1.2 Corrugated pipes

The sum of LE 770,000 covers the equipment for production of pipes. When planning this activity it must be remembered that special excavating machinery (Badger) will be required and also the transport of pipes to the sites will need 15 lorries working in two shifts. This assumes that the pipe extruder is in the middle of the Delta where the maximum distance is only 90 km.

It has been suggested that the extruder could be located on lorries and the pipes extruded close to the sites where they are required. But this is not recommended because:

no clean cooling water available (large demand)
no dust free rooms available
no possibilities for making joints
no skilled workers
no repair shop

8.2.1.3 2 Calenders - 1,800 mm width

In this respect a license agreement has to be signed with a company who has the knowhow of all the different kinds of production as calendering, printing, embossing, etc. European companies who have experience in the installation of a complete modern factory are:

ALKOR - Munique together with Kraus-Maffei-Munique
Solvay-Paris together with Repiquet-Paris
Renolit-Wor[illegible]s (FRG) with different machine suppliers

The licensor has to train the Egyptian manager and workers at his own factory, to supervise construction and installation of all equipment, deliver the guaranteed runs.

It is rather impossible to run PVC calenders in case electricity fails more often than once a year.

8.2.1.4 Automobile parts 300 t/y

There are many different parts needed in each car.

The problem is, shall it pay to make moulds for only 20-30,000 parts per year, especially if the moulds have to be paid in foreign currency.

When the proposed factory will run in Egypt for making moulds, it will be much easier to decide to manufacture the moulds locally.

Therefore in this report no foreign currency is recommended for the production of automobile parts.

8.2.2 Machine costs for processing LDPE

		t/y	Investment LE'000
8.2.2.1	Heavy duty sacks a 250 g. a/	16,330	800
2	Light duty bags (milk .5 g/piece)	1,600	120
3	" " " (shirts, shrink)	1,300	165
4	Mulching film (0.2 mm)	750	33
5	Irrigation sheet 1 mm	200	54
6	Bottles	4,800	390
7	Fish trays	250	76
8	Cable	500	45
9	Pipes	720	50
10	Injection	2,000	1,100
11	Film	730	36
		29,180	2,869
	50%		1,434
			4,303

a/ Remarks to 8.2.2.1 - Heavy duty sacks

It is recommended to install at least one complete line for 10 m bags/y:

3 extruders at Kima factory

3 extruders at Verta

3 extruders at Egyptian Plastics

3 extruders at National Plastics

During our visit we learnt that 9 private factories got the allowance to install new facilities for heavy duty bags from the Minister for Industrialisation, the capacities of which are unknown to the GOI.

Before the installation of the 12 proposed lines the possible competition with these new factories has to be examined.

Type of bags

There are 2 types of bags: open mouth and valve-type. Assuit and Helwan are working with the valve type. These cannot at present be manufactured in Egypt. These bags are more expensive and filling them takes more time. The production of valve type bags with PE (heating tools required) is more difficult than from soft PVC (high frequency welding). But blow extruding of PVC is rather difficult and produces more scrap.

Recommendation

Assuit and Helwan should switch over to PE open mouth bags.

8.2.3 Machine costs for processing PE

		t/y	LE'000
8.2.3.1	Crates (1.5 kg)	3,000	650
2	Battery cases	920	240
3	Jerry cans	250)	784
4	Petrol + lub. oil	685)	
5	Heavy duty bag (bitumen)	1,800	200
6	Ropes + fishing nets	1,000	125

		t/y	LE'000
7	Mesh nets 1/	300	21
8	Chairs/stools	1,200	132
9	Lavatory seats	500	70
10	TV sets	550	195
11	Washing machines	50	5
12	Luggage 2/	400	151
13	Woven sacks + carpets	6,450	770
14	Houseware	2,000	1,100
15	Sprinkler pipes	2,500	1,500
16	Drip irrigation	95	45
17	Pipes	670	20
		22,370	6,008
	50%		3,004
			9,012

Remarks:

1/ 8.2.3.7 - Mesh nets

For the use of these very light and stable nets it is necessary to have packing machines, hand operated, with scales, the prices of which are not included. They have to be bought by the customer who packs onions, potatoes, apples, etc., for the coming supermarkets.

2/ 8.2.3.12 - Luggage

200 t/y for the bigger cases are blow extruded,
200 t/y of the smaller are injection moulded.

8.3 Main processing machines required for 1980

8.3.1 Extruders

Screw diameter	45	60	60		90	120	150
Number of extruders	4	13	5		39		5
Blow moulding extruders		53			54		
Moulds g shot	50	100	200	500	1,000	2,000	5,000
Number of moulds		60	40		2	10	10

8.3.2 Injection moulding machines

g/shot	50	100	200	500	1,000	2,000	5,000
Number of machines	11	10	30	31	24	30	8
Moulds	40	41	43	40	46	74	14

8.3.3 Round table injection moulding equipment

Number of machines	125
Moulds	125 for each station of the round table

8.4 Machine and building plant

Present situation in building of plastic processing machines.

Some of the Egyptian plastic companies build already their own equipment, especially for making moulds:

(1) Medical Packaging (Public sector)
Well equipped workshop with the possibility of hardening steel (delivered from Degussa, West Germany).

(2) Egyptian Plastics and Electrical Industries (Public sector)
Special workshop for manufacturing of new machines, especially moulds.

(3) National Plastics, Shobra (Public sector)
Mould making.

(4) Helbawy Plastics (Private sector)
Small but well equipped workshop for maintenance and mould making.

(5) Middle East Plastics (Private sector)
The only factory which sells and exports different plastic machines, e.g. the following ones:

Extruders (45, 60, 90 mm. diameter);
Injection moulding machines (up to 3,200 g/shot);
Blow moulding equipment presses (up to 500 tons); and
Tables (up to 650 x 800 m), a line for the production of raffia is under construction as well as an automatic welding machine for making bags.

Serious doubts as to the quality of these machines have been expressed by the Technical Manager of a plastics processing company in the Government sector.

Summary

(1) Not one of the above 5 companies is equipped with modern tool making machines and they all lack the special equipment as listed below. (Appendix 1 to sub-section 8.4)

(2) Only the Middle East Plastics make their own designs for plastic processing machines, but even here further training in this field is needed.

It is recommended that a training centre be established as part of a Plastics Development Centre, details of which are given in the section on recommendations for UNIDO action.

For manufacturing plastic processing machines in Egypt itself

Current situation in the processing of plastic raw materials in Egypt (rough estimation):

Plastic raw materials being processed	25,000 t/y
Capacity not in operation due to lack of raw material	10,000 "
Total potential consumption of plastic raw materials with existing machines in 3 shifts	35,000 t/y
Amount of raw material which has to be imported even when Alexandria plant is in production (HDPE, PS, thermosettings)	5,000 "
Current potential capacity in Egypt for raw materials to be made at Alexandria	30,000 t/y
Full capacity of Alexandria Petrochemical Plant	115,000 "
New processing equipment needed	85,000 t/y

If all these machines be bought abroad, very large amounts of foreign currency will be needed, which are not mentioned in the 5-year plan 1973-1977 (ARE). So a considerable proportion of these machines should be manufactured locally.

Objections that may be raised against local production

(1) Less production security (longer times for shutdown and repair).

(2) Lower quality of finished products.

(3) Lack of well trained management for a machine making plant.

(4) No designers.

(5) Insufficient experience with the quality of the machines made by the Middle East Company.

Reasons for manufacturing plastic machines locally

(1) Industrialization of Egypt needs specialized machine shops.

(2) Possibility of designing simpler machines than the sophisticated European designs.

(3) Central service for all plastic processors.

(4) Central production of moulds of better quality.

(5) Less costs than for European equipment as labour costs are less.

(6) Less foreign currency.

(7) Short delivery times.

(8) Replacing of old fashioned processing machines without too much foreign currency.

(9) Rapid delivery of spare parts.

8.6 Total investment costs of processing machines for various activities

PVC processing	LE 14.7 million
LDPE "	4.3 "
PP "	8.9 "
Machine shop	0.26 "
Mould shop	0.1 "
Application laboratories	0.2 "
Floor tiles (PVC - PVA copolym)	0.6 "
	LE 29.06 million

9. TYPES AND GRADES OF SYNTHETIC RESINS

For the demand of the proposed finished products:

9.1 PVC - The Alexandria plant will only produce suspension PVC (S-PVC). For most of the proposed applications this will be sufficient except:

9.1.1 VC-VA copolymer for floor tiles at the Canaltex Company.

9.1.2 Emulsion-type of PVC which is essential for making plastisols for coated fabrics.

9.1.3 K-values of S-PVC may vary from 55-65 for pipes, fittings and blow moulding to 66-75 for calendering and cables.

With such a wide range of different types, polymerisation should be performed batchwise and not continuously. All the qualities of PVC will have to be held in stock in sufficient quantities for immediate delivery from the plant.

9.2 LDPE - Polymerization of ethylene is a continuous process. Therefore the production should be concentrated on a few types only. If we allow two different densities (0.917 - 0.920 and 0.924) and 3 melt indices, this involves 6 types of PE; the demand for each quantity will differ but the largest demand will be that with density 0.917 - 0.920 with melt index 1 to 3 and 0.924 with meld index 2. But to avoid long delivery times the others have to be in stock in quantities which enable the factory to manufacture the main products in long runs.

Most important is the quality of LDPE (and PP respectively) in their physical respects. The dispersion of small amounts of stabilizers, lubricants, antistatic materials, light stabilisers, pigments (especially carbon black) has to be perfect. So the kind of mixing equipment has to be the best and so must the quality control. That i why the pilot lab has always one small extruder on stream to control the amount of fish, holes, etc., so that products of inferior quality can be reserved for injection moulding.

From all three compounding factories LDPE, PP and PVC master batches of different colours have to be produced in granules 5-7 colours should be sufficient, so the customer can easily colour his raw materials by a simple mixing process (by hand or with drum mixing).

Up to now only small amounts of the finished products are black, especially heavy duty bags are still in natural. This could change further, e.g. films for mulching, so at a later time it could be advisable to deliver a black PE.

9.3 PP

Here once more different types are necessary:

for fibres, monofilments:	meltindex	3,	density	0.903
for blow moulding, pipes:	"	1.5,	"	0.902

It has to be considered whether it may be advisable to produce HDPE in the same equipment according to the Ziegler-Natta process, as some important products would be better made from HDPE as from PP or LDPE.

9.4 PVC-compounding plant

There are 2 different manners of compounding PVC with stabilisers, lubricants, plasticisers.

9.4.1 For rigid formulae PVC powder is mixed with stabilizers lubricants, etc., with a high speed agitator. The temperature may rise up to 100-110°, somewhat under gelation temperature, and immediately (ca. 10 minutes mixing time) cooled down. During this process the PVC powder agglomerates and is suitable for feeding extruders.

9.4.2 Soft PVC is mostly granulated in an extruder after mixing which can be done as in 9.4.1 with a high speed agitator or with low speed ribbon mixer. The extruder bears a pelletizing die with cooling equipment.

9.4.3 Calenders normally produce soft PVC film with formulae by the hundreds and in low quantities, one ton in the same width, thickness, colour and formula normally is the maximum order. Therefore the calendar-lines have to be very flexible in their mixing department even working with much more colour grades than the compounding plant for pipes, shoes, cables, etc.

9.5 Plasticizers

The formulae of soft PVC compounds in Egypt are not so sophisticated as in European countries. The normal phthalic esters (octyl-2 ethyl hexyl butyl)will be sufficient.

9.6 Lubricants, stabilizers, etc.

The choice depends widely on the specification of the finished articles and on the quality of the processing machines. Badly designed extruders can cost a lot of running costs p.e. in overstabilised compounds. And stabilisers are expensive.

10. COSTS OF PRODUCTION

We have tried to make some very rough estimates of the cost of production of some of the products which must be made in bulk if the demand in our forecasts is to be realised. It has shown up the very high proportion of the cost which is made up by raw material so that the transfer price from the complex is critical. The transfer prices chosen which are given in the next section are as low as we consider reasonable on the assumption that the Alexandria complex is working to full capacity and with maximum efficiency. If this is not the case the transfer price and the cost of production of the product must be increased accordingly. The costing also assumes that the processing plant is working to full capacity and only a modest allowance is made for rejects and contigencies. Nevertheless the processing equipment is new and there is no reason why it should not work to this degree of efficiency.

10.1 Notes on costing

10.1.1. Transfer prices

	LE/Ton
PVC flexible compound but in the form of its constituents i.e. not blended	145
Rigid PVC (for bottles and pipe)	150
L.D. Polyethylene	145
Polypropylene	161

10.1.2. Factors taken

(1) The price for buildings was taken as LE 15 per sqm.

(2) Utilities, services, moulds and ancillary equipment were taken as 50 per cent of the equipment cost.

(3) Repayments on capital were 10 per cent p.a. and 6 per cent interest on balance outstanding.

(4) Depreciation 10 per cent.

(5) Direct and laboratory labour at an average of LE 1 per day.

(6) Between 5 - 20 per cent was allowed for rejects according to the product.

(7) 10 per cent contingency allowance was included.

(8) A figure according to product and application, usually 10 per cent, was allowed for storage, marketing and transport.

10.2. **Products made**

10.2.1 Unsupported flexible PVC sheet (2,500 t/a)

	LE
Capital cost	6,020,000
Fixed costs	1,773,000
Variable costs	460,000

Cost, 1.3 m wide, 0.2 mm thick 37.6 pt per running metre.

Current selling price for imported unsupported sheet, 1.2 m wide is 70-120 pt per running metre.

10.2.2 Heavy duty LDPE sacks (3000 t/a)

	LE
Capital cost	300,000
Fixed costs	97,000
Variable costs	445,000

Cost per 50 kg sack(weighs 300 gm) 6.9 pt.

		pt.
Current selling prices for 50 kg sacks -	plastic film sacks	10-12
	jute sacks	18
	paper sacks	3-4.5

10.2.3 Bottles

(1) from PVC, 15,500 tons: 1/2 litre (75 gm) and 183 ml (25 gm) bottles.

	LE
Capital costs	2,392,000
Fixed costs	877,000
Variable costs	2,405,000

Cost per bottle 1/2 litre 2.15 pt.

" " " 183 ml 0.94 pt.

Current selling prices for 1/2 litre glass bottles 2.6 pt. each

(2) from LD Polyethylene, 4,500 tons of 1 litre bottles (weight 40 gm).

	LE
Capital costs	666,000
Fixed costs	253,000
Variable costs	716,000

Cost of a litre bottle 1.024 pt.

10.2.4 Polypropylene extruded pipe

2,600 tons of 75 and 100 mm. pipe weighing 0.93 kg/m and 2.4 kg/m respectively

	LE
Capital costs	2,490,000
Fixed costs	611,000
Variable costs	518,600

Cost of one metre of 75 mm pipe 51.5 pt.
" " " " " 100 mm pipe 132 pt.

Current selling price of 100 mm diametre aluminium pipe 85 pt. per metre, but it is expected that polypropylene will wear larger so the initial costs are not so important.

10.2.5 PVC corrugated pipe

13,000 tons of 100 mm pipe weighing 0.48 kg per m.

	LE
Capital costs	1,758,000
Fixed costs	582,000
Variable costs	2,000,000

Cost of 100 mm diametre pipe 12.1 pt. per metre.
Current price for cement tiles 8 pt. per metre (but as mentioned earlier the laying costs of PVC tiles are much cheaper).

10.2.6 PVC rigid pipe

1,200 tons of 100 mm pipe weighing 1.3 kg. per metre

	LE
Capital costs	77,400
Fixed costs	40,300
Variable costs	190,000

100 mm pipe costs 31.5 pt. per metre
Selling price of 100 mm. aluminium pipe, 85 pt. per metre

11. TARIFF ON GOODS ENTERING EGYPT AND CHANGES RECOMMENDED

In addition to the appropriate tariff expressed as a percentage of the CIF value the following charges are made:

10 per cent of CIF 'Consolidation of Economic Development' Tax

3 per cent on combined tariff and 'Consolidation of Economic Development' Tax

1 per cent of CIF 'Statistical Duty'

and a few minor charges in addition.

Plastic raw materials, plastic products and some competitive materials	5
Plastic raw materials in liquid, paste or powder form	25
Plastic rod sticks, tubes and profile shapes (in 'rough' form)	30
Plastic sheets, film or foil (in 'rough' form)	50
Plastic products (other than those mentioned below)	100
Plastic travel goods	2
Raw jute	35
Jute fabrics	40
Plastic coated fabrics	40
Jute sacks	100
Plastic shoes (and all shoes)	100
Glass bottles	75
Plastic combs	25
Cement tiles	40
Containers from iron or steel	50
Containers from aluminium	25
Crates (from wood)	
Chemicals of interest to Alexandria Complex	10
Ethylene	10
Propylene	10
Butadiene	10
Plasticisers	

Changes recommended on coming into operation of Alexandria Complex: 20

(1) increase duty on plastic raw materials to 50

(2) " " " " rod tubes, sheets and film, etc. to 50

(3) " " " jute sacks to 50

(4) " " " cement tiles to

(5) Reduce duty on plasticisers to nil - this should be carried out immediately a compounding plant is in operation.

12. RECOMMENDATIONS FOR ACTION BY UNIDO

(1) Set up a project to examine the export market for plastic products made in Egypt. The project should take into account the raw materials and the products planned to be produced and should investigate which countries would have the best markets for their products bearing in mind the favourable rate of duty granted by many countries to Egyptian manufactured goods. The best means of marketing in each country should be assessed and preliminary contacts made with possible agents, distributors, etc. in each country. Very close contact should be made with the Export Group recommended to be set up in Egypt.

(2) To set up a Plastics Development Centre in Cairo with UNIDO assistance to provide the following services:

(i) <u>A Training Section</u>

This will be equipped to train technical personnel at various levels to manufacture plastics processing equipment and moulds. The equipment and moulds so produced would be in the first instance used for teaching and also demonstration purposes in the Application centre but as equipment and moulds would continuously be produced there would be some available for sale to industry. It is not intended that the Training Section be the main source of equipment and it is recommended that a separate factory be erected, preferably on an adjoining site for the actual production operations. As soon as such a factory is operating efficiently it is recommended that the mould-making shops in industrial companies be closed.

Design work on new types of machines would also be carried out in this section. While it is recommended that in general machines should be kept simple and sophisticated automatic controls avoided, nevertheless licences from foreign companies will be required and it will be the function of this section to negotiate for these.

The equipment needed for such a section is given below and it is estimated that it will cost some LE 260,000 (US$ 600,000):

1 lathe	4,000 mm.
2 lathes	2,000 mm.
3 lathes	1,000 mm.
1 planer	600 mm.
1 planer	1,500 mm.
1 planer with table	2,000 mm.
1 planer with table	4,000 mm.
1 milling machine (table)	500 x 1,500
1 copying milling machine	500 x 1,500
1 boring machine	500 mm. diametre
1 pentograph copying table	500 x 700 mm.
3 bench drills	½ inch
1 drilling machine with an arm	1.5 inch
1 surface grinding table	500 x 600 mm.

1 internal grinder	600 mm.
1 external grinder	6 inch diametre
1 screw turning lathe	3,000 mm.
1 head grinder, flexible	
1 hobbing press 1,000 tons	500 x 500 mm.
1 copying milling machine	2 inch diametre
1 high frequency treating	2 inch diametre
1 electro corrosion(plating)	500 x 500 mm.
1 furnace or hardening	3,000 mm.
1 furnace for tempering	3,000 mm.
1 oxy-acetylene welding equipment	
1 electrical welding equipment	100 amps
1 hard chrome plating equipment	
1 bath for Cu	2,000 x 1,000 mm.
1 bath for Ni	2,000 x 1,000 mm.
1 bath for Cr	2,000 x 1,000 mm.

2 polishing motors

1 set of diamond powders for smoothing different steels for moulds, dies and screws

The recommended staff would comprise:

From UNIDO:	Assignment
1 practical plastics engineer	3 years
2 designers	2 years
1 specialist in hydraulic systems	1 year
1 specialist in welding systems	1 year
1 electroplating specialist	1 year
1 master foreman	1 year

From Egypt:

2 mechanical engineers (Univ. qualified)

2 designers (with some qualifications)

1 master foreman

3 foremen

The above would be trained by the UNIDO staff, of these one of the mechanical engineers and the three foremen would be assigned to the factory for the regular production of mould equipment. The others supplemented by two electronics specialists (one engineer and one foreman) who would be trained abroad would represent the permanent staff of the training centre and would gradually take over responsibility from the UNIDO experts.

There would be some flexibility and interchange of staff between the training centre and the factory in the early stages.

Some 10 operatives, including potential foreman as required, would be trained simultaneously, this would take a year after which they would be transfered to the factory. Shorter courses would be arranged to train operators to use the equipment, some of these might be those already employed by existing manufacturing companies but who had had no training.

UNIDO would be responsible for:

a) installation costs

b) payment of experts

c) special running costs e.g. where expensive alloys were required.

(ii) <u>An Application Section</u>

This would have two main functions:

a) A mechanical and physical testing laboratory combined with a chemical and pilot plant laboratory. Standards could then be set up and maintained, comparions between Egyptian and competitive products be made and similar work carried out. An important aim for the chemical laboratory would be to formulate an improved adhesive for sticking plastic soles to shoes. The pilot plant section would be used for making up small quantities of compounds which could then be tried out in the various pieces of equipment to fabricate various products which could then be tested in the mechnical and physical laboratory.

The laboratory would also be used for training technical personnel who have to use similar equipment in their own factories.

It is estimated that the principal item of equipment, a list of which is given below, would be about L~ 200,000 (US$ 460,000):

Pilot Plant

High speed mixer with cooling vessel 20 litres
Weighing scales covering 20 g, 1 kg, 25 kg.
Drum mixer 50 litres
Injection moulding machine 50 g/shot, 200 g/shot
Extruder for pipes and profiles 60 mm screw
" " " " " 45 " "
Twin screw extruder 30 " "
Several dies for different pipe diametres
" " " film-blowing
" cooling rings
" moulds for blow moulding for bottles
Welding equipment for pipes and profiles PVC(hot air) and for PE
" " " sheets (high frequency and heat)
Scrap mill
1 - die 60 mm width with chill roll and cutting device
Pretreatment of PE-film for printing
Laboratory printing equipment with 1 roll
Deep drawing equipment

Laboratory for mechanical and physical tests (air conditioned 20°C)

Tensile strength and elongation
Shore harness A and D
Abrasive wear
Direct current stability
Break down voltage
Surface resistivity
Dielectric constant
Power factor

Laboratory for mechnical and physical tests (cont'd)

Resistance to water penetration

Screen analysis

Crushing strength of pipes

Microscope(binocular) with heated table and polarisation equipment

Bradender plastograph (plasticity at high temperatures)

Drop testing of hollow articles

Weather-O-meter (measurement of resistance to weathering)

Xeno test (light stability)

Refrigerator

Lab. press with heating and cooling plattens

Lab. turbomixer

Lab. mill 400 x 250 mm

Impact tester

Melt index measuring equipment

Viscosimeter Hoeppler with ultra thermostat

Note: Some of the pilot plant equipment might be made in the training centre, especially the injection moulding machine and the extruders. This possibility should be carefully considered before such equipment is ordered.

b) The market application department would have several aspects:

i) Demonstrations on equipment made in the training centres to processors or would be processors of products that could be made with raw materials from the Alexandria complex instead of from other raw materials, e.g. polystyrene.

ii) The design of new plastic products that can be made from Alexandria raw materials and the design of moulds to produce them.

iii) Demonstrations of new applications of plastics for the benefit of potential customers.

iv) Studies in some depth of particular plastics applications. As a first step it would include studies as to the best design of plastic crates, the best shapes and formulations for PVC bottles for various application. Food packaging would be dealt with in some detail, the use of split yarn considered and the effect of good packaging on the development of super markets examined. The department would be organized to give special technical assistance in other major potential applications such as drainage and irrigation.

The recommended staff would comprise:

From UNIDO	Assignment
1 Chemist, formulation specialist	6 months
1 Plastic application engineer	2 years
1 Designer	1 year

From Egypt

1 Chemical engineer

1 Mechanical engineer

3 Assistants

1 - 2 Designers

2 Marketing experts

4 Technicians (trained in the training centre)

The Egyptian staff would make up the permanent staff of the Application Centre and would be given general training by its UNIDO Experts.

UNIDO would be responsible for installation costs, payment of experts and small quantities of raw materials.

Overall Management

The whole Development Centre would be directed by a Council appointed by the Egyptian Government to which a senior UNIDO full-time expert would be seconded for a period of two years. He should be a plastic engineer with substantial experience and all the remaining UNIDO experts would report to him.

A chairman would be elected and amongst his responsibilities would be:

i) To report once a month to the General Organization for Industrialization

ii) To discuss with the UNIDO experts the plans for the training and application centres.

iii) To negotiate licences where appropriate for the designs of suitable machines.

iv) To plan a factory for the manufacture of plastics machinery and to decide what machinery is to be made, moulds to be given priority.

v) To decide on the specifications for machines to be made in the factory.

vi) To select suitable personnel to be trained.

vii) To organize appropriate language course for prospective trainees.

c) <u>Government Advisory Service</u>

As soon as the Alexandria complex is given the go ahead, it will certainly be necessary to import some and possibly a considerable proportion of the necessary processing plant, the actual amount depending on the stage reached by the Training Centre and the adjoining proposed factory for manufacturing equipment.

A team of UNIDO experts must be available to advise the Government on what machines should be imported to help locate suitable supplies and where requested, assist with the negotiations for machinery to make products to the desired specifications in quantity and quality.

The same team should draw up a critical path programme to follow up the recommendation made to the Egyptian Government.

The team should consist of:

	Assignment
1 Plastics engineer (extruder specialist)	1 year
1 Plastics engineer (injection moulding specialist)	1 year
1 Plastics engineer (calendering specialist)	1 year
1 Critical path technique specialist	2 years

d) Information Service

The Centre would include an information section which would include

i)	A selection of books on plastics valued at	$5,000
ii)	The principal plastics periodicals from UK, France, Germany and Italy	$1,000 per annum
iii)	A projector and a selection of slides	$1,000
iv)	Brochures from manufacturers of raw materials and equipment	$ 500

	Assignment
1 UN Information specialist to set up assistance	2 months

Egyptian Staff

1 Librarian

1 Clerk

13. RECOMMENDATIONS FOR ACTION BY THE EGYPTIAN AUTHORITIES BEFORE THE ALEXANDRIA COMPLEX COMES ON STREAM

It is strongly recommended that the whole complex be brought on stream simultaneously or the two stages should at least come into production within a year of each other.

This having been accepted the following, is a possible time table of the various actions to be taken:

Zero Year (means the year in which the Alexandria complex is on stream)	Action
Zero minus 5 years	Allow unrestricted imports of polypropylene to encourage its use. Set up a council for the Plastics Development Centre and a committee for exports Obtain quotations, delivery dates for all the equipment and machinery necessary for the actions detailed in later years to be carried out. Order PVC compounding plant
Zero minus 4 years	Bring PVC compounding plant on stream and allow unrestricted imports of ingredients into the country up to the demand. Remove tariff on plasticisers altogether. Ban imports of H.D.P.E. and polystyrene except where their use can be shown to be essential in the national interest. Allow imports of L.D.P.E. up to capacity of existing plants. Bring on steam one quarter of the capacity of the PVC insulated cable extension. Bring the Plastics Development Centre into operation

Zero minus 3 years

Bring on steam one half the capacity of the P.P. battery case plant also half the P.P. split film plant for woven sacks and the whole of the L.D.P.E. sack-making machine (from lay-flat tubing).

Allow applications from existing companies who wish to extend their plant to absorb more tonnage of the three thermoplastics concerned.

Allow unrestricted imports of L.D.P.E.

Ban the import of PVC compounds.

Ban the import of thermosetting resins and all plastic products except where any of these can be shown to be essential to the national interest. (Such exceptions might include the import of products when it could be shown to be necessary for building up a market for a plant coming on stream within the following two years.

The factory for making plastics processing machinery, mould making machinery, etc. must be on stream.

Zero minus 2 years

Bring on steam a further quarter of the capacity of the PVC insulated cable plant, one half the bottle-blowing plant and half the corrugated pipe plant.

The PVC and P.P. pipe extruders should also be brought into operation.

Zero minus 1 year

All equipment for producing containers, crates and film (up to the forecasted demand) should be in operation.

Bring on stream the other half of the battery case plant.

Erect, equip and bring into operation the pilot plant laboratory.

Zero year	Bring on stream the other half of the bottle blowing plant, the other half of the corrugated pipe plant and the other half of the PVC insulated cable extension. Implement remaining changes in tariff. ALEXANDRIA COMPLEX ON STREAK.

It must be borne in mind that, from the time of placing an order to the time of the plant going on stream, 18-24 months may elapse, or even longer for the more difficult pieces of equipment e.g. calenders. A very strict time schedule has to be set up on a critical path basis so that it can be seen at once exactly what the consequences will be if any of the steps in the whole plan falls behind hand. In fact such a plan can only really be worked out when the offers for the necessary equipment, the delivery dates etc. have been obtained and the means of finance settled irrevocably

In order to help pay for the foreign exchange needed to purchase the equipment, it is necessary that producers are instructed that they must make available not less than one third of their output made from new equipment at an ex-works cost low enough for the Export group (see under Exports) to sell it abroad.

APPENDIX I

Discussions have been held with the following:

UNDP

Mr. V.P. Pavicic, Resident Representative

Mr. A.A. Vassiliev, Deputy Resident Representative and UNIDO Senior Industrial Development Field Adviser

Mr. Tharwat Sabry, Programme Officer

Ministry of Industry General Organisation for Industrialisation

Dr. Taher Amin, Chairman

Mr. Ibrahim Charkass, General Manager

Dr. Mustafa Shaaban, Consultant

Dr. M.A. Oraby, Head, Petroleum and Petrochem. Dept.

Dr. Youssef Mohamed Youssef, Head, Chemical Department

Mr. S. Tribey Ragaey, Building and Construction Department

Mrs. Sawsan El Kasaby, Architect

Mr. Fouad Gabriel, Vocation Training and Small Industries

Mr. A. Mehelmy, Manager, Food Department

Mr. M. Mansour Zein El-Din, Petroleum and Petrochem. Dept.

Mrs. Samia Ahmed Abdel Migid, Petroleum and Petrochem. Dept.

Ministry of Irrigation

Mr. Saad El Din El Gindy, Deputy Minister and Under-Secretary of State for Lower Egypt

Appendix I (continued)

	Dr. Mounir Zaki, Deputy Minister and Under-Secretary of State for Upper Egypt Mr. Osman Elghamry, Director, Technical Office, Nile Delta Authority for Tile Drainage
Ministry of Land Reclamation	Dr. Osman Badran, Minister Mr. Mahmoud El Gawish, Chairman, Egyptian General Development and Planning Reclaimed Lands Organiz. Mr. Zaki Arnaout, Director General for Planning and Projects Mr. Ali Labib Wasfy, General Director of South Tahrir
Ministry of Housing and Construction	Mr. Mohamed Elmosallamy, General Director, Department of Research and Central Laboratories Mr. Zawif Bishay
Ministry of Agriculture	Dr. [illegible] Attiase, Research and Soils Dept. Dr. Y.A. Hamdi " " " " Dr. Sami Halim Abdel-Malik, " " " "

PUBLIC SECTOR (Companies)

National Plastics	Mr. M.I. Barghout, Technical Manager Mr. Atef El-Mewaled, Manager, Shobra Factory Mr. Said Massar, Technical Manager, Shobra Factory Mr. M. Lashier, Manager, Giza Factory Mr. Mansour, Technical Manager, Giza Factory

Appendix I (continued)

Canaltex Company	Mr. M. Galal Sidky, Chairman, and Managing Director
	Mr. Shaheen, Technical Director
	Mr. Alfred Jones, Representative of Semtex Ltd. Licensors of the process
Medical Packaging Co.	Mr. Gamal El-Din Ghali, Production Manager
Nasr for Bottling Co.	Major-General Taha Hussein El Zeney, Chairman
Misr Dairy and Food Company	Dr. Ahmed Safwat, General Manager
	Mr. Mostafa Sobhi, Production Manager
The General Jute Products Co.	Mr. A. Kadry, Chairman
	Mr. Gamgoum, Production Manager
The Delta Industrial Co.	Mr. Ahmed Sadek Saad, Plant Manager
Electrocable Egypt	Mr. Hosny Hafez Amer, Chairman
	Mr. Samir Fawzy, Chemist
El Nasr Automotive Manufacturing Co.	Mr. Sami Abdel Wahab, Production Mgr.
	Mr. Omar Amin, Director, Buses and Lorries
Nasr Company for Television	Mr. Ali Ismail, Planning Manager and Acting Chairman
Egyptian Plastics and Electrical Industries	Dr. Farouk Garrana, Chairman and Managing Director
	Mr. Aly Zaky El Badry, Plant Manager
Sugar and Distillery Company of Egypt	Mr. I.M. Ismail, Vice-President
	Mr. H.A. Mohie El-Din

Appendix I (continued)

Egyptian SAFA Company	Mr. Tawfik H. El-Meligi, Chairman
	Mr. Mahrahi Meleta Min, Cost Accountant
	Mr. Morsi Mahmoud, Technician
Transport Engineering Co.	Mr. A. Shehata, Production Manager
Paper Converting Company 'Verta'	Mr. Aly M. Hanna, Chairman and Managing Director
	Mr. M. Aladdin Elhadid, Plant Manager
Egyptian Vineyard and Distilleries Co.	Mr. Ibrahim K. Khiralla, General Plant Manager
The Egyptian Company for setting Fruit and Vegetable	Mr. Ahmed M. El Shayeb
Tractor and Engineering Co.	Mr. Ahmed El Hamamy
The General Company for Trading and Chemicals	Mr. Badie El Rihani, General Manager (Chemicals and Dyestuffs).
	Mr. Kamal Hussein, In-charge of plastics
	Mr. F. Hussein, Export Manager
Egyptian Petroleum Corporation	Dr. Maher Arafa, Research Manager
	Mr. M.P. El Warraky, Market Research
Nasr Petroleum Company	Mr. M.H. El-Hifnawi, Chairman
	Mr. Ahmed Nour Eldin, Vice President and Technical Director
	Mr. S.S. Kandil, Chief Technologist
Water Wealth Organization	Mr. Anwar Bahai El-Din, Chairman

Appendix I (continued)

PRIVATE SECTOR (Companies)

El-Masri Shoes Factory	Mr. Kamal Hafez Ramadan
Middle East Plastics Co.	Mr. Zaki Farrag, Managing Director and Chairman
	Mr. Kamal Farrag, Director, Production and Sales
	Prof. Youssef Guindi, Consultant
Arab Plastics Company	Mr. Hekmat Bakir
	Mr. Moahmed Hashem
	Mr. Talaat Youssef
	Mr. Farouk Ibrahim
Helbawy Plastics Factory	Mr. Helbawy
Ramadan Chehata Ahmed Factories	Mr. Ramadan

OTHER ORGANIZATIONS AND INDIVIDUALS

German Embassy	Dr. Klaus Eckhard, Commercial Attaché
	Mr. von Behsten, Statistics
British Embassy	Mr. M.J. Wilmhurst, Commercial Attaché
Federation of Egyptian Industries	Mr. Wafik El Guindi, Director of the Chemical Chamber
	Mr. Hasem Abdel Latif, Head of the Plastics Section
	Mr. Mohamed Hafez, " " " Leather Section
	Dr. Lotfy Abdel Azim, Managing Editor "Al Ahram El Ektisadi"
	Mr. George Zaidan, Technical Adviser
Bayer Service Company	Mr. George A. Cassis
	Mr. Paul Lorenz

Appendix I (continued)

Farbwerke Hoechst	Mr. Lutz A.W. Mann
	Mr. Manfred Knoll
	Mr. Gohargh i
Klein Schanzlin and Becker	Mr. Heinz H. Wieland
Siemens A.G.	Mr. Reinhard Gross
BASF	Mr. Siegle
Friedr Uhde GmbH	Mr. Rudi Stärker
Goethe Institut	Mr. Siegfried Reite
Deutsch-Arabische Handelskammer	Mr. Klaus Balzer

APPENDIX II

Consumption of Polyethylene and P.V.C. resin in Arab countries in 1970 and estimates for 1975 and 1980

Polyethylene (LD and HD)	1970	1975	1980
Morocco	3,100	6,900	12,200
Algeria	4,000	9,000	15,900
Tunisia	13,000	2,900	5,100
Libya	900	1,900	3,400
Egypt	7,700	15,800	28,506
Sudan	500	1,000	1,800
Jordan	700	1,500	2,600
Syria	5,510	11,600	20,500
Iraq	3,700	7,800	13,800
Kuwait	200	400	700
Lebanon	2,400	5,000	8,800
P.V.C. resin			
Morocco	6,000	9,000	13,200
Algeria	7,500	11,300	16,600
Tunisia	1,550	2,300	3,400
Libya	1,500	2,500	3,700
Egypt	11,500	19,400	28,500
Sudan	950	1,600	2,400
Jordan	1,000	1,900	3,700
Syria	6,800	13,100	25,200
Iraq	4,400	8,500	16,300
Kuwait	300	600	1,200
Lebanon	2,000	3,900	7,500

This information was provided by IDCAS

APPENDIX III

The duty on plastic products from Egypt entering industrial countries is as follows:

Austria	30 % reduction of normal tariff
France) Belgium) Holland) FRG) Italy)	Duty free up to a ceiling */
Japan	Duty free up to a ceiling */
Denmark	Duty free
Norway	" "
Finland	" "
Sweden	" "
Switzerland	30 % reduction of normal tariff
U.K.	Duty free

The above information is taken from an UNCTAD letter dated 12 October 1972 and it should be noted it applies also to PVC polymer and compound, polyethylene and polypropylene provided the monomers are produced in Egypt.

*/ Attempts to obtain a definition of "ceiling" have not been successful.

It must be emphasized that, apart from tariffs, most countries levy taxes on imported goods to compensate for the taxes already paid by corresponding goods manufactured in the countries concerned.

APPENDIX IV

COST OF CONSUMING 1,000 TONS OF PLASTIC RAW MATERIAL IN TERMS OF FOREIGN CAPITAL EXPENDITURE

It is assumed that in an early stage, at least, equipment will have to be purchased from overseas. The equipment costs which are needed before various end products can be made varies greatly. Under circumstances where two end products are roughly equally useful a decision may have to be made on which of the two will take the lower outlay in foreign exchange.

The table given below gives this information in terms of how much foreign capital is required to process a thousand tons of a plastic raw material to a finished product. Two words of warning are however necessary: first these figures have nothing whatever to do with the profitability of the production and secondly the quantity of a product to be produced has been based on the estimates already given in this report and are therefore not on an equal basis. In general, if more of a product were to be produced the capital costs per thousand tons would fall and vice-versa if the quantity was less, again fewer sizes would mean fewer moulds, more different sizes, more moulds.

Product	Foreign investment in US$ to process 1,000 tons of raw material
P.V.C. corrugated pipe	59,000
P.V.C. insulated cable	75,000
P.V.C. straight extruder pipe	96,000
L.D.P.E. extruded film	101,000
P.P. extruded pipe	138,000
L.D.P.E. heavy duty bags from lay-flat film	154,000
L.D.P.E. extruded pipe	160,000
L.D.P.E. blow moulded bottles	187,000
L.D.P.E. Light duty bags	190,000
P.V.C. bottles	212,000

Appendix IV (continued)

Product	Foreign investment in US$ to process 1,000 tons of raw material
P.P. injection moulded chairs	252,000
P.P. heavy duty sacks	253,000
P.V.C. all plastic shoes	297,000
P.P. lavatory seats	340,000
P.P. ropes and fishing nets	460,000
P.P. luggage	471,000
P.P. battery cases	491,000
P.P. crates	496,000
P.V.C. shoe soles	619,000
L.D.P.E. injection moulding, fish trays	643,000
L.D.P.E. injection moulding, general	1,265,000
P.V.C. injection moulding, general	1,725,000
P.P. jerry cans	1,925,000
P.V.C. calendered sheet, rigid	2,810,000
P.V.C. calendered sheet, flexible	4,860,000

N.B. This Appendix was drawn up by ECH but H.H. has reservations.

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