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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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APPROPRIATE TECHNOLOGY FOR HEAVY INDUSTRIES

THE PETROCHEMICAL INDUSTRY

Background Paper

THE PETROCHEMICAL INDUSTRY

by

M. C. Verghese
UNIDO consultant

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PETROCHEMICAL INDUSTRY

1. INTRODUCTION

When one considers the installation of Petrochemical Plante in the context of today's developments whether it is Ethylene cracker or Petrochemical Refineriee. Ethylene Crackers 100,000 to 500,000 tons per year or more and Petrochemical Refineriee with a thorough put of 10 million tone of crude oil per year and the most sophisticated technology. This is because it is essential to get maximum economies of scale and adopt well proven technology in use in developed countriee.

Whereas such large plants and sophisticated technologiee are appropriate for some developing countries which have reached high levels of development and others which have large internal markets or those which have export potential based on large and cheap resources of raw materials, there are many developing countries particularly less developed land locked or island countriee where such scales and technologies are not appropriate. Further, even in large developing countriee which build 'Jumbo' size plants using modern technologies there is scope for dis-persed end product fabrication units using appropriate tech-nologies.

To quote the Aide Memoire for this meeting," It is imperative, that very close interlinkage is ensured betwsen the modern and the diepereed sectors, which should be viewed as integral parts of industrial growth processes. Unless an inte-

integrated two-fold approach is adopted concentrating both on the modern and dispersed or decentralized industrial sectors, the industrial growth pattern would continue to be confined to small urban enclaves and providing only limited benefit to the large rural communities in these countries.

The concept of appropriate technology needs to be considered both in the context of processes and techniques in the most sophisticated industrial sectors in these countries and in respect of a wide range of goods and services which can be produced through a more dispersed industrial sector, where manufacturing processes could be more directly related to meeting basic socio-economic needs and requirements of rural communities.

Technological needs for the decentralized or dispersed sector could vary significantly from those of the modern sector, though the basic principle of suitability and appropriateness would be equally applicable. In the two sectors, production scales and unit investment outlays would tend to be different according to local factor conditions, including human skills. In the dispersed sector, appropriate production processes could take the form of more labour intensive techniques or production technology either used formerly in industrialized countries or presently in developing countries or which may need to be developed through R and D processes. The identification of such processes and techniques would necessitate a systematic search for appropriate production technology in specific sectors or the development of such techniques through research efforts.

This paper examines possibilities of dispersed end product production fertilizer plants using intermediates or product from local 'Jumbo' plants or from imports. Such dispersion will promote the participation of rural populations and in making available timely inputs for agriculture. The experience even in developed countries such as U.S.A., U.K., France and others has proved that dispersed bulk-blending and liquid petrochemical formulation plants have helped a great deal in dispersion greater usage and as bringing appropriate technology to rural areas.

2. "JUMBO" PLANTS

Developing countries should not be isolated from the main stream of technological innovations and developments, ten years ago very ethylene cracker of capacities of 100,000 tons per year and above were mostly built in developed countries. But during last ten years many such plants have been built in developing countries in single streams. The concept of centrifugal compressors, Naphtha or natural gas reforming furnace technology, gas purification systems, the ethylene,propylene and batylene loop modifications and recovery systems reactor designs itself for LDPE and HDPC and other innovations have been adopted in developing countries and operated successfully. But there is still room for development of appropriate technologies peculiarly suited to developing countries especially energy conservation systsms, air-cooling methods, simply instrumentation techniques etc. processes which do not affect the environment.

These process innovations and technologies are more attuned to large scale production plants, for example centrifugal compressors need a minimum amount of synthesis gas to be hendled which determines the minimum capacity. Total energy concept is also best possible in plants of large capacities. Thus large scale plants and appropriate technologies some time go together.

There is need and scope for such 'Jumbo' Plants in many developing countries. They are located either market oriented or raw materials oriented. Thus where natural gas is flared or naphtha is cheaply available and can be obtained cheaply 'Jumbo' Petrochemical plants could be built for export purposes. Other in-frastructure facilities should also be available. Naphtha, based plants could be built in countries where there is a large market. In both cases the locations are mostly close to urban areas where in-frastructure facilities and technical man-power are available. Thus the tendency in countries with large markets or with abundant and cheap sources of raw materials is to isolate themselves from rural and consuming areas. This isolation leads not only to migration of workers but also tends to minimise dispersion of industries. But many countries are now making a concerted effort to disperse even 'Jumbo' plants to rural areas.

3. MODEL APPROACH

To overcome such difficulties it is recommended that such 'Jumbo' plants should be used to feed satellite and product fabrication units located in the rural areas. We shall examine the mechanism of setting up such units, the advantages of this approach and its effects on economic and industrial developments in country concerned. Even if intermediates or finished products have to be imported in bulk, such end product fabrications plants located in rural consuming centres have certain advantages. such as polyethylene processing plants, PVC production plants, polyester fibre production units etc.

Central 'Jumbo' plants should participate in setting up such units. If a 300 mile radius is the economic distance to move finished on intermediate materials, such units could be set up within these limits. For example, a 'Jumbo' plant could select a region where requirements of packing materials using low density polyethylene exists. The granules could be sent to this region made locally. Similarly another region where uses of PVC pipes for drainage, conveying water and other agricultural uses exist air extrusion plant can be set up. In another areas where handlooms are located a polyester fibre unit can be set up using intermediates.

'Jumbo' plants should also make available to their satellite units technical know-how and appropriate technologies not only in production of end products but also in developing their uses, marketing and so on, products to local needs should be produced and for this appropriate technology will be needed. Thus rural areas benefit from the vast technological, marketing, extension services and other skills available in a 'Jumbo' project and in turn benefit from better sales.

Multiplier and demonstration effects of such schemes are obvious. A village or district benefitting from such satellite units and improving output and general conditions of living will automatically show to neighbouring districts on villages the advantages. Many others will voluntarily opt for coming into such arrangements as well as co-operating in the building of such satellite plants. Above all the input/output ratio has to be advantageous for such schemes to work.

4. PROCESS DESCRIPTION AND EQUIPMENT NEEDED

Let us now discuss the appropriate uses and physical facilities required for such satellite units:-

It would be appropriate to develop more extensively the use of plastics in agriculture; and at a later period to develop the industrial application of plastics, and identify the product areas for export promotion. Since the same expertise and equipment are also required to develop applications of plastics in rural development this market should be investigated as a priority area. In fact, taken as a subject heading, "Plastics in Rural Development" covers a much wider range of activities and can include agriculture as its largest component.

In this rural development area plastics can be used in a wide range of applications, covering pipe and fittings for potable(drinking) water supply, in drainage, for structures and particularly for roof units, water storage systems, pumps, grain storage etc. There is little doubt that suitable investigation will highlight other possible applications.

In the agricultural applications there are a large number of potential applications that can be developed and used to improve Indian agricultural outputs and efficiency. In other parts of the world, plastics are widely used in agriculture serving the following main areas of application :-

1. Growing
2. Disease and pest control
3. Water conservation, supply and drainage
4. Fertilizer, transport, storage and application
5. Crop conservation
6. Livestock rearing
7. Produce collecting, transportation and storage
8. Tools, machinery and equipment
9. Buildings and constructions.

In this context it should be pointed out that the word 'Agriculture' is taken in its widest meaning to include all things which grow and related areas. It therefore includes :-

1. Agriculture
2. Horticulture
3. Forestry
4. Produce handling, storage and pre-packing
5. Water-management & Fisheries etc.

The Indian Council of Agricultural Research(ICAR) has undertaken a number of its own, as well as sponsored programmes for the development of plastics in agriculture, as well as programmes undertaken by the plastics raw material manufacturers. Whilst this work is of a continuing nature, it is perhaps time to reflect on two specific indigenous Indian developments in the use of plastics in agriculture; namely combination canal lining and the Pusa Bin which both relate to the agricultural priorities of water conservation and crop storage.

Despite the fact that a volume of technical information has accumulated over the 20 year period, and the advantageous cost benefit ratio that can be achieved, yet only 60 to 70 kilometers of canals in India have been lined with plastics film in that period of time.

A similar picture is revealed in the case of the Pusa Bin. This was pioneered about 10 years ago at the grain storage Institure, Hapur, the Agricultural University Pantnagar and the Pusa Institute, Delhi.

It represents a classic example of excellent intermediate technology.

The traditional village mud brick grain storage bin, of about 2 ton capacity, is normally constructed by the farmer for storing grain for his own use. This bin suffers from the ingress of moisture and air which can lead to deterioration of the grain, and losses of upto 14% are known. In the Pusa Bin the traditional bin is interlined with polyethylene film sandwiched between the two layers of bricks. This ensures an hermetically sealed container and provided the lid is equally well secured, the losses are reduced to zero. Today's cost of such a bin is Rs 145/- (film cost Rs 50/-) compared to Rs 1200/- for an equivalent sized metal bin. Despite these obvious cost and performance advantages, very few Pusa Bins have been constructed in India, but there are a great many of these Pusa Bins in use in West Africa, particularly in Ghana and Nigeria. Food grain losses in India due to poor storage are estimated at 10 million tons per annum. The introduction of the Pusa Bin could greatly reduce the figure.

On the basis of 1 million farmers using Pusa Bin, and calculating at a grain price of Rs 1000/- per ton with only 5% loss being saved, then the total value of grain that could be saved would be worth Rs 100/- million.

Both the combination lining and Pusa Bin are developments initiated and pioneered by Indian personnel. They involve the use of indigenously manufactured polymer, indigenously processed film on indigenously manufactured equipment. Both have excellent c cost benefit ratios yet the Indian farmer does not receive the benefit of these applications. There has obviously been a failure of technology transfer.

With 80% of the population living in rural areas, and who have benefitted the least in the previous development processes of the country it is the Government's intention to make special efforts to upgrade and improve the standard of living of this sector. One aspect of this programme is the development of Rural District Industrial Centres(DIC's). It is intended that the scheme should encourage unemployed educated youths to become entrepreneurs to start-up a business in the cottage industry (mini-scale industry) aided by generous incentives and through the assistance of a co-operative marketing organisation. By this means new areas of rural employment will be generated both directly and indirectly. When this programme is completed it will cover some 314 DIC's spread throughout the country.

Since the successful development of the use of plastics in agriculture will effectively mean that the plastics products have to be available for purchase at the village level then it is logical that consideration should be given to their on-the-spot production. This would involve the processing of plastics products as a cottage industry. Technically there are a number of plastics processes which could be utilised at this level, and these could include hand-operated injection moulding, pipe and film extrusion, hand-fabrications etc. If it becomes necessary for the process technology to be modified for operation at village level this is a task that would fall easily within the scope of activities to be undertaken by the PTC.

Based on day shift working only as a start, the capital investiment per person directly employed would be Rs 23,000/- for pipe extrusion(equipment cost Rs 92,000), Rs 16,000/- for film extrusion(equipment cost Rs 47,000) and Rs 3,500/- to Rs 15,000 for injection moulding (equipment cost Rs 3,500 to Rs 15,000) using indigenous equipment. These figures would be proportionately reduced when shift working is introduced. In addition, at least :· four other persons would be indirectly employed per person employed. In terms of annual production, these units would be capable of a one shift basis, of producing some 60,000 metres of plastics piping of maximum diameter 50mm, 30 tons of film, and between 100,000 to 250,000 small injection moulded items based on single cavity moulds. Taking an average of 30 gms per item, this would require 7.5 tons of raw material per year per injection machine.

To provide some indication of the number of production units that might be established these outputs need to be related to the applications. For example 30 tons of PE film would be sufficient for 12,000 Pusa Bins and there are 34,811 million farmers with one acre and more machine size limited by capital investment of DIC units only in the country. 60,000 metres of 50 mm pipe can be used in double or triple lay to provide the necessary volume of drinking water for a village rather than utilising a pipe of greater diameter which could not be produced by the cottage industry. Taking a triple lay this would be sufficient to carry water over a distance of 20 kilometers. There are 47000 villages still 3 kilometers from the nearest drinking water supply. This output would cover the requirements for at least 7 such villages. For injection moulded items these could include pipe fittings such as elbows T'e, end-stops, reducers etc.

There is also a need to design a suitable injection moulded plastics tap to replace the current expensive brass ones. Although there is a plastics tap on the market it is a copy of the brass tap and fails rapidly in use since it has not been designed from a knowledge of the performance of plastics. This is a particular example of the type of development which could be undertaken by the PTC to promote rural development. In addition to the above there are a number of industrial plastics items which could be identified as suitable for production at the DIC's. These could include battery caps, filters, electronic keyboard components etc.

Agricultural applications for plastics film include planting bags, grain storage such as Pusa Bins, wheat-seed storage(currently requiring 37 tons), for lining ponds in semi-arid zones to enable two crops to be grown instead of one and for pond linings for blue-green algae production. Mulching film for cotton, pineapples, vegetables etc. for moisture conservation and weed suppression; canal and channel linings, Khishii hose(Fluming) etc. for water conservation.

In the area of water conservation mention has not yet been made of trickle irrigation systems which enable at least twice the acreage to be utilised for a given volume of water. These systems can involve the use of both film, pipe and injection mouldings. Development work through ICAR is proceeding in India on these types of systems.

From the foregoing it will be noted that there are many market opportunities open for plastics processors at rural level. The practical problem is how to introduce the new entrepreneurs to the plastics processing operation and technology so that he may have the opportunity of assessing this as a viable business proposition. Like all rural communities throughout the world the most effective promotion is based on the old adage "seeing is believing". If plastics processing is to be introduced successfully at DIC level then the operation must be demonstrated and explained in the local language. As part of the communication activity of the PTC it is proposed that it should be equipped with facilities to mount a totally self-contained mobile demonstration unit which can visit selected DIC's. Initially, it is envisaged that this would take the form of equipment mounted on custom-built road vehicles so that they by dropping one or more sides, the equipment and processes can be practically demonstrated to the potential entrepreneurs at the District Centres. At a later stage, the use of a custom-built railway train could be considered instead of road vehicles. Such a train(s) could also be utilized for the demonstration of processes other than plastics, and it is possible to visualise a special train moving from the nearest railway station,centre to the next centre promoting a wide range of rural development activities.

Equipment:	Source	Cost in US $
1. 45 MM film extruder complete with take-off die, cooling ring, blowers, attachment and compressor & winding unit.	Brimco India	9,000
2. 45 MM pipe extruder with die sizing die, water bath and circulator, caterpillar take-off and wind up unit.	-do-	11,000
3. 2 Hand injection moulding units 50 & 15gm capacity, moulds.	-do-	2,000
4. Impulse heat sealer (bag making)	Various	1,200
5. Hot air welding tools with accessories and blower/compressor	various	1,000
6. Hot plate welding tool	various	1,500
7. Pipe welding equipment (Muffler and compression welder)	various	2,000
8. 3 granulators/chippers	India	900
9. Burst tester and accessories	Various	1,000
10. Go and no-go gauge for 1/2, 3/4, 1/1¼ and 2 inch pipe to ISI Standards	India	250
11. (2) Dial gauges and (3) Screw micrometers in metric.	Various	450
12. Strength tester-tensile equipment	Indian	4,000
13. Dart Impact Tester	Various	3,400
		37,700

Equipment for Processing Section.		Source.	Cost in U.S.$
1.	Hand operated injection moulding machine 50 Gm capacity.	India	600
2.	Hand operated injection moulding machine 75 Gm Capacity.	India	500
3.	Automatic injection moulder 60 ton clamping pressure 4 oz capacity	SPI Windsor India	15,000
4.	Hand operated blow moulding machine(0.25 Litre)	India	750
5.	Automatic blow moulding machine one Litre capacity with automatic parison control.	Fisher Bekum Germany.	60,000
6.	Dual purpose 45 mm extruder for blown film and for pipe, with take-off equipment, dies, cooling rings, blower, witnd up unit. Vacuum sizing dies, vacuum water bath, saw and caterpillar take-off and other accessories.	Brimco India	22,000
7.	Polypropylene film extrusion lant complete with dies, sizing rings chilling unit, and accessories.	Windsor India	36,000
8.	Film assembly unit with adjustable height, nip rolls, take-off unit for centre and surface windup and equipped with air blower unit.		
9.	Multipurpose 32 mm extruder with variably controlled screw spreed fitted with bottom fed, Cen re spiral mandrel die for film processing	Betol U.K.	17,200
			152,050

		Source.	Cost in U.S.$.
10.	Co-extrusion die with assembly trolley	Betol UK	6,200
11.	Supplementary multipurpose 32mm extruder for co-extrusion film processing and other extrusion developmental work.	Betol UK.	12,500
12.	Rotating die and trolley assembly.	Betol UK.	7,600
13.	Automatic bag making M/c.	Brimco India	6,000
14.	Mould cooling unit	India	4,000
15.	Film slitting equipment and re-rollers	India	8,500
16.	Four colour flexographic printing unit with automatic registration control, ink viscosity controllers, all accessories and spares.	Cosmo Plastics Italy.	150,000
17.	Stereo making equipment for flexographic printing Machine	Various	40,000
18.	Multipurpose coating machine with drying oven, including knife, reverse roll, blade and air-knife coating heads, and other accessories	Dizons UK	120,000
19.	FRP spray and chopped rovings unit with all accessories and spares		14,000
20.	Granulators(2)	Various	3,000
21.	High speed shearing film recompounder (Pelletises into water)	Germany U.K.	
22.	Temperature controlled fluidised bed for extruder screw and for dies etc.	Techne U.K.	12,000
23.	Automatic stretch-blow moulding m/c with all accesories	various	149.000
			522,800

	Item	Source.	Cost in U.S.$.
24.	Rotational costing machinesingle station	U.S.A.	10.000
25.	Ultrasonic Welder	Various	5,000
26.	Radio-frequency welder 3KW output capacity	India	7,300
27.	Pyro-portable surface temperature measuring pyrometers(2) 0-300°C	Various	1,200
28.	Plasticater for re-cycling plastics waste.	FN Herstal Belgium	25,000
29.	Magnetic separation	various	2,500
30.	Corona discharge print treater with attachments and accessories.	Pillar treaters UK.	8,000
31.	Moulds for injection, blow moulding and casting.	Various	10,000
32.	Impulse heat sealer	Various	1,200
33.	Hot air welding tools with accessories.	various	450
34.	Hot plate welding tools	Various	1,500
35.	Pipe welding equipment (Muffler and compression welder).	Various	2,000
36.	Power tools; drill, saw sander, buffer, grinding wheel and accessories	Various	2,500
37.	Continuous heat sealer	Doughboy U.S.A.	6,000
38.	Applicator of compound sealing of film, and supply of compound	Expandite Ltd.U.K.	1,300
39.	T-die for sheet extrusion	Johnson Belgium	15,000
			98,950

		Source	Cost in U.S.$.
40.	Adjustable slot film cooling rings two pairs for 32 mm extruder die position and in bubble length, plus two rings diameters to be specified later.	Betol U.K.	9,000
41.	Kanix static mixer (for extrusion)	Gloenco U.K.	2,000
42.	32 mm extruder screws for HDPE,PVC,BBS,PP and nylon extrusion (6 screws)	Betol U.K.	9,000
43.	Miscellaneous minor items and spares.	Various	5,000
			25,000
		Total	875,000

5. **Financial Implications**

Although a complete satellite plant including P.E. film making P.V.C. pipe making and bag making plants with printing facilities is costed for $ 875,200 depending on the requirements of the village or district these facilities can be divided into smaller components and adjusted to local needs. Each unit may not then cost more than $ 200,000/-

6. **Employment opportunities**

The following figures indicate the possibilities of employment if the facilities are separated :-

	P.E.Film making	PVC Pipe extrusion.	Printing	Bag making
Manager	1	1	1	1
Supervisors	2	2	1	1
Operators	3	3	2	2
Mechanics	2	2	1	1
Electricians	2	2	1	1
Helpers	10	10	5	15
Total:-	20	20	11	21

If the facilities are combined, the total requirements will be reduced. The numbers indicated are for two shift operations.

7. Management and Training

The supervisors and operaters and mechanics are to be trained in existing similar plants for at least 3 months each. The operators and mechanics preferably should be trained in a plastic training and repair institute which has facilities for making and repairing moulds. They should have practical experience both in a general workshop as well as a workshop dealing with equipments for plastics processing.

It will be very useful for such village and district industries to employ a market development man who can demonstrate polyethylene films for lining grain storage bins, for covering seed beds etc. and PVC pipes for drainage water, for irrigation etc. He should also demonstrate the use of packing materials and polyethylene and polypropylene bags for grain and agricultural products. Once villagers are convinced of the lower cost and better packing qualities of such materials compared to jute bags, use of these new materials is bound to grow.

It is in this area where 'Jumbo' plants can supply raw materials for intermediate and even end-products can assist the village or district 'satellite' plants in extension work. This in turn will help the mother plant to produce its maximum installed capacity.

8. Inputs and participation of rural and agricultural sectors.

As stated before, polyethylene granules, or PVC granules, can be supplied to satellite plants for the production of end-products. The participation at the village or district level could be on a co-operative basis or the satellite plants could be set up by the government concerned or by the mother plants themselves. However, it is is essential that the local population be involved in setting up, running and utilizing the products of these satellite plants. The products manufactured will improve water supply, drainage, grain storage and grain delivery to market. The losses will be minimized in storage and transport. However, the results of modern technology and new products are extended into the village for their use and their benefit.

9. <u>National and inter-country benefits</u>

The national benefits enumerated before are :-

a) involvement of village and districts in industrial development.

b) extension of appropriate and modern technology for the benefit of rural population.

c) fuller use of capacities of large petrochemical complexes.

In case one country has the natural resources to produce large spectrum of petrochemical products but has no markets, it can either sell or come to an agreement with a country with a large market to set up such end-product plants.

The products and intermediates which can be supplied from a producing country to a large consuming country are as follows :-

a) Ethylene (ETHYLEN) monomers or polymers to make high or low density polyethylene sheets.

b) PVC granules.

c) Urea/Formaldehyde resins for plywood manufacture.

d) DMT or Terephthalic acid and ethyleneglycol to produce polyester fibres which can be blended with cotton fibres in the ratio of 65 : 35 and can be spun into yarns, suitable for making cloth in handlooms.

Such an arragement of importing intermediate or end-products and setting up satellite plants in another country will benefit both countries. In the producing country the cheap raw materials are converted into petrochemical, intermediate and end-product and in the consuming country, the large demand can be met and employment potential satisfied.

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