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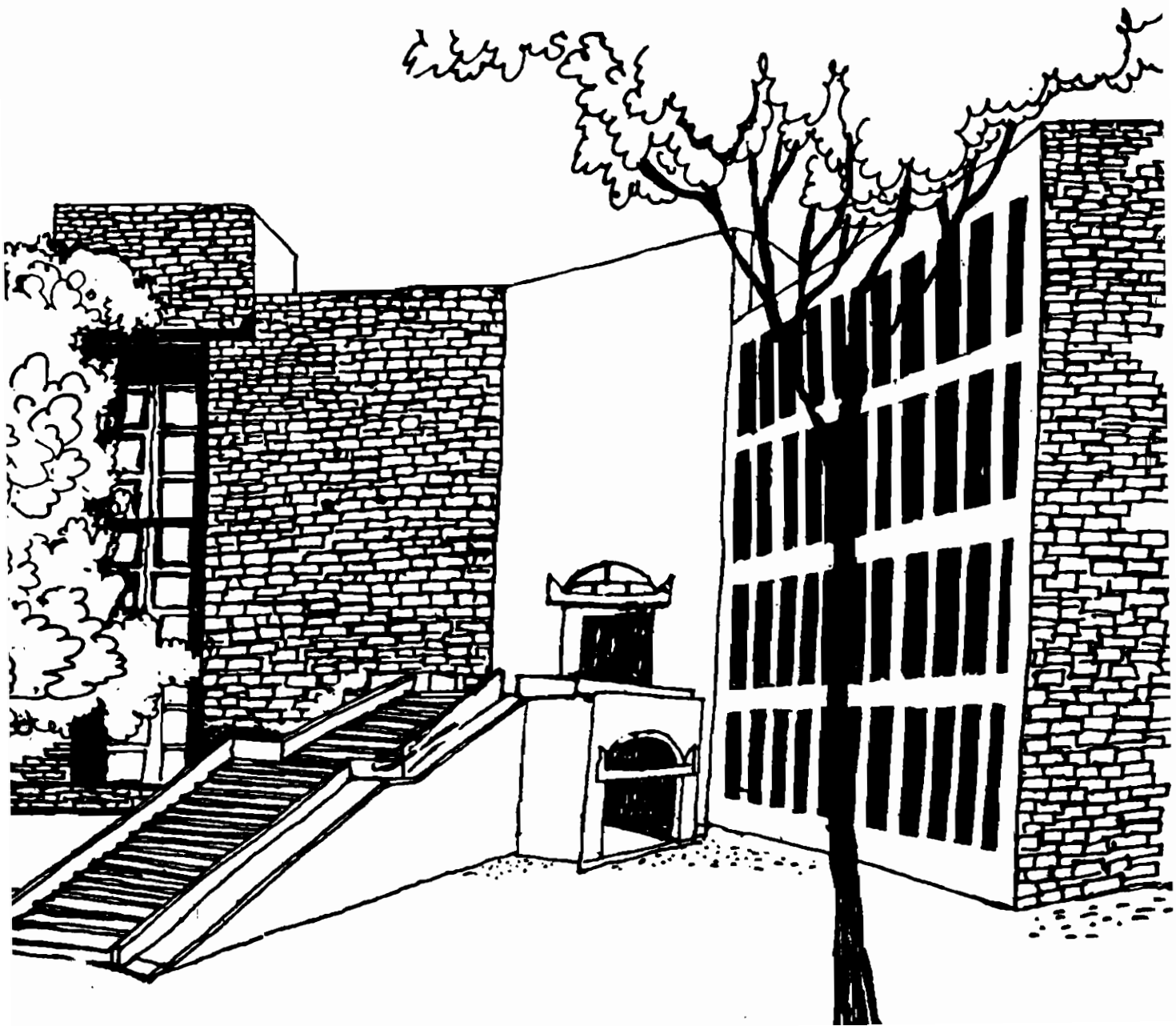

Searching for An Indian Niche in the International Petrochemicals Industry

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I Introduction

Some international and domestic trends seem irreversible in the foreseeable future. These include:

a. Liberalization of Indian Economy
b. Internationalization of Organizations and
c. Globalization of International Economies

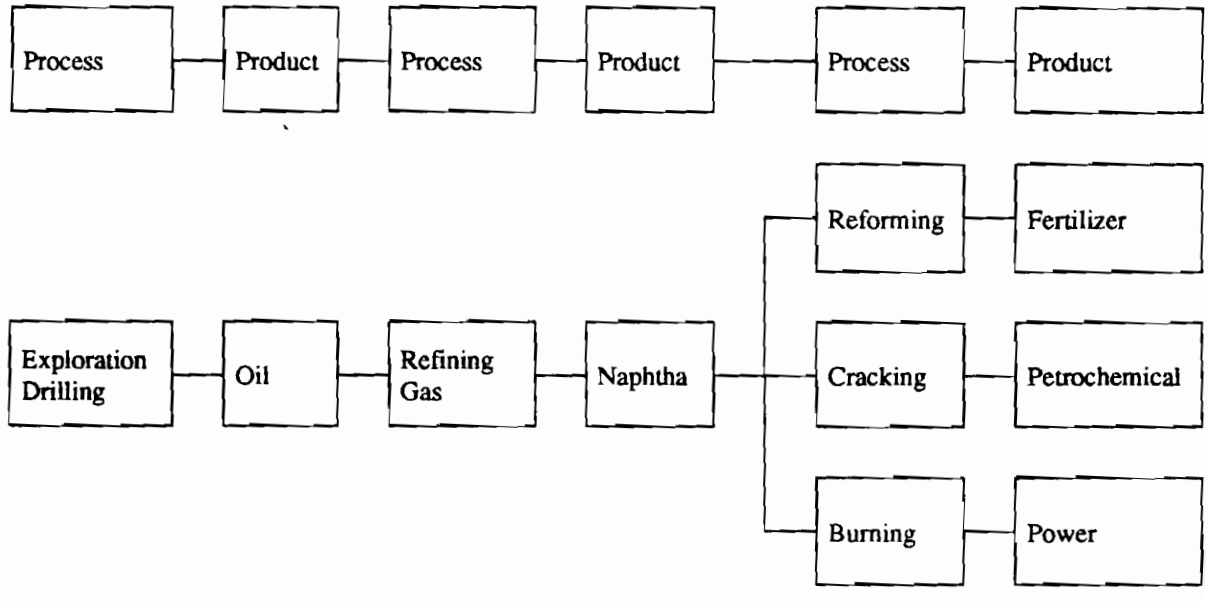
This provides a rare opportunity to Indian Industry to take stock of its situation; identify a niche in the Global Market and develop a strategy for growth. The purpose of this paper is to attempt identification of such a niche for the Indian Petrochemical Industry.

II Petrochemicals Industry

To a layman, it may come as a surprise that technically there is no single product as Petrochemicals, as it is an intermediate stage of processing natural oil, Gas and naphtha for its conversion into certain end products. All products based upon petrochemicals can be obtained from the natural sources and herein lies the strength of petrochemicals. Petrochemicals substitute a variety of precious natural resources ranging from metals to wood.

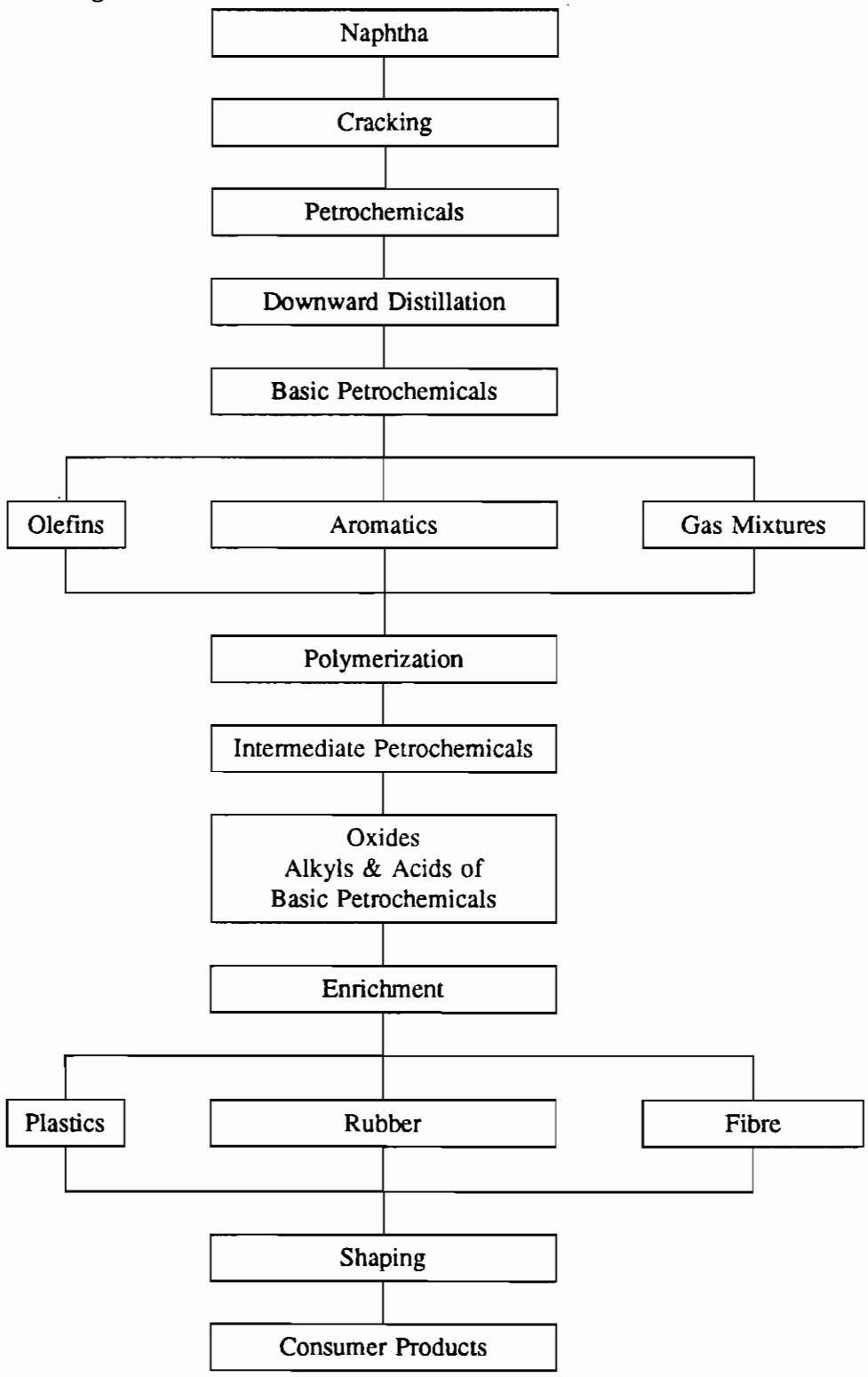
The industry chain for the production of petrochemicals begins with exploration and drilling for natural oil and gas. This, in turn is refined for obtaining Naphtha. Naphtha has three major uses namely, as a fuel for power generation, as a feed stock for fertilizer and petrochemicals. Diagram-1 below shows this industry chain starting with exploration and ending with petrochemicals.

Figure 1: Petrochemicals: The Industry Chain



Petrochemicals so obtained through cracking naphtha are further processed for conversion into end use products through a process of downward distillation, polymerization and enrichment. Figure 2 below shows this chain:

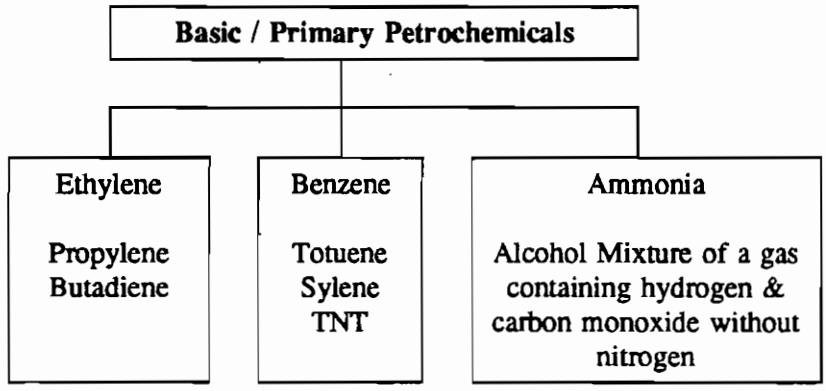
Figure 2: Conversion of Petrochemicals in to End Use Products



Thus, processed petrochemicals are available in three stages, namely Basics, Intermediates and End Use petrochemicals. The basic petrochemicals are based on Olefins, Aromatics and Gas Mixtures. Leading Petrochemical in the three categories are Ethylene, Benzene and Ammonia.

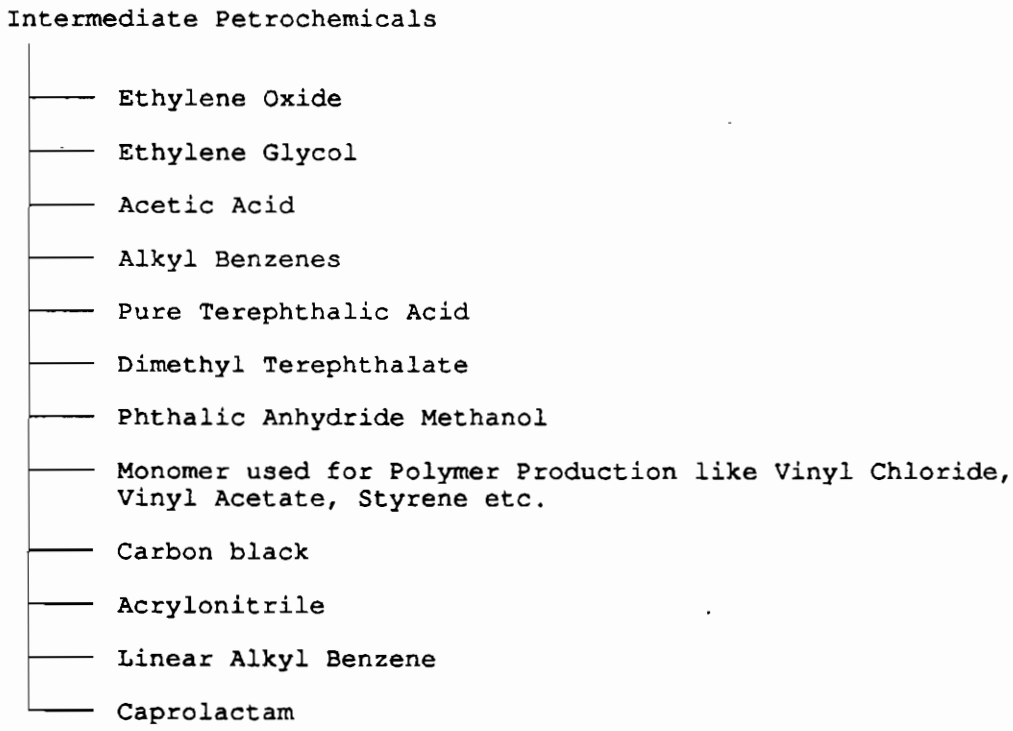
The diagram below indicates the basic petrochemicals which become the raw material for manufacturing of intermediates and end-use products.

Figure 3: Categories of Basic Petrochemicals



The Intermediates include Oxides, Alkyls and acids etc. of basic petrochemicals and comprise of ethylene, Oxide, Alkyt Benzenes, Terephthalates, Carbon black and carpolactum etc.
The diagram below lists various intermediate petrochemicals products.

Figure 4: Major Intermediates

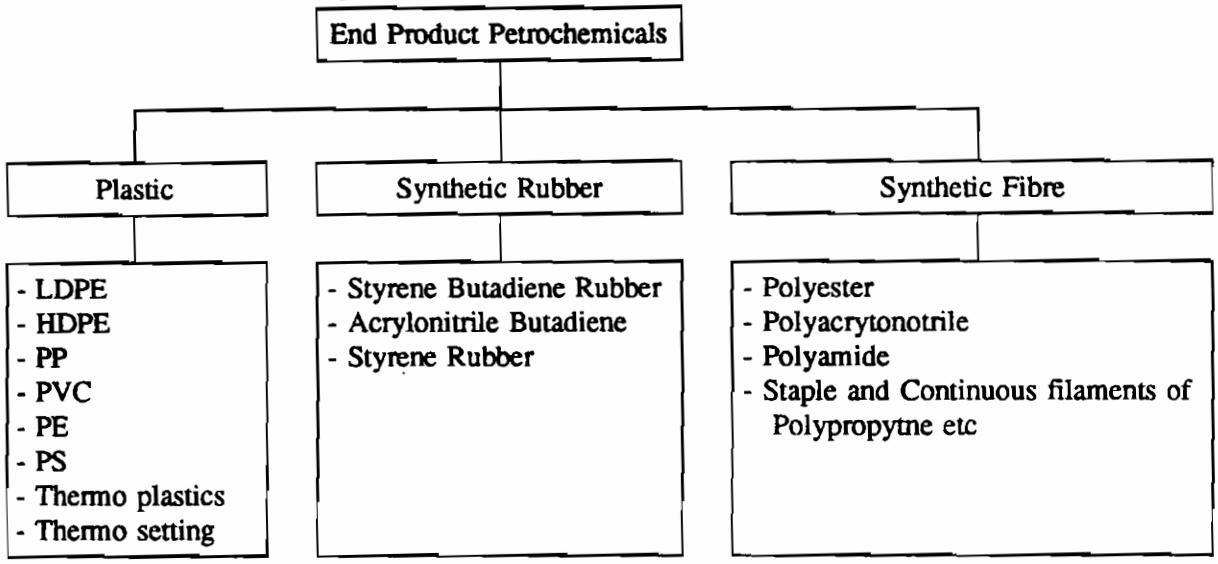


The End Use petrochemicals have added chemical properties and include various varieties of plastics, synthetic rubber and synthetic fibre.

Figure 5 shows the list of various End Product Petrochemicals.

As Figure 5 shows end product petrochemicals are classified into three categories, namely: Plastics, Synthetic Rubber and Synthetic Fibre. These end use petrochemicals are further converted into final products like sheets, buckets, engineering components, rubber alternative and synthetic yarn for cloth.

Figure 5: Major End Product Petrochemicals



III Feed Stock

Although India imports substantial quantities of oil for its needs; unlike Japan, Taiwan, Korea and some other new players in the petrochemical field, India has its own feed stock of oil, gas and naphtha.

The current oil output in India is around 24 MTs. This is lower than 1992-93 output and much below the peak output of 34 MTs in 1989-90. The import estimates for oil for the current year are around 30 MTs and are likely to go up further. Thus while India will continue to remain a net importer of oil for a long time, it need not be a constraint for the industry since the industry requires only about 5 - 8% of the national hydrocarbon capacity. This can easily be spared, particularly by improving transportation and logistics and by marginally reducing the flow to power generation, as alternative and non conventional sources for this sector are available. Resultantly, own feed stock can be a strength for the Indian industry vis a vis its competitors.

IV Capacity

Petrochemicals industry began in India with the setting up of Union Carbide Plant in 1965 near Bombay. This was followed soon by NOCIL in 1968 in Bombay and IPCL in 1968 near Baroda in 1973. IPCL set up the additional Nagothane complex in 1991. Barring Nagothane which uses associated Gas, other complexes use Naphtha as their feed stock. Historically these are the four major petrochemical complexes in India. Current capacities of these complexes varies approximately between 50,000 M.Tonnes of Union Carbide to 7,00,000 M.Tonnes of IPCL. (See appendix 1).

The national scenario changed vastly with the entry of Reliance in the petrochemical field and with approval of additional capacity in several places including Gandhar, Auraliya, Mangalore and Assam. The Hindu Survey of Industry with regard to surpluses/Gaps of major petrochemicals as of year 2000 A.D. shows that by the year 2000 India is likely to have an excess capacity in most major petrochemicals. (See appendix 2).

In Polythylenes, which are considered typical for polymers, India's capacity is likely to rise between 2.25 to 2.55 million tonnes by the year 2000 A.D. This is about 7 - 8% of the present world capacity. This percentage, however, may become smaller as further capacities get installed in the world. However estimated Asian Petrochemical capacity for year 2000 A.D indicates that India, Korea and China are likely to be the significant players in the Petrochemical market in future. (See appendix 3).

While the world capacity is rising between 13 to 69 % in various polymers (Economic Times, 7th November, 1991), India is lagging behind both in manpower employment as also in the turnover per employee in this field.

V. The Demand

Compilation of data from various sources shows that the demand for major basic petrochemicals, namely Aromatics, Propylene, Ethylene and Alpha Olefins in India is likely to increase between 40 - 65% (See Table-1 below). Only Benzene demand is expected to rise at a relatively low rate of 6 - 7%.

Table 1
Demand Forecast for Basic Petrochemicals

(In Thousand Metric tonne/Litres as app.)

Petrochemicals	Current	2000	% Variation
Alpha Olefins	88	144	63.64
Ethylene	137	202	47.45
Propylene	600	884	47.33
Butadiene	130	177	36.15
Aromatics	106	151	42.45
Benzene	828	885	6.88
Totuene	62	76	22.58

World demand of Ethylene, which is typical of the group, is estimated to increase by 6% between now and 2000 A.D. Although the domestic demand is rising at a higher rate, it must be remembered that there is a vast difference in the per capita use of Petrochemicals in India and abroad. Thus the scope for the industry growth, both in the domestic and international markets, is very large.

Studies shows that the demand for intermediates is likely to rise between 20 to 72% by the year 2000 A.D. (See appendix 4). The Demand supply gap is likely to further increase anywhere between 50 - 300% depending upon the product. Like in the basic petrochemicals, the scope for growth in the intermediates is also very large.

Demand for end Product Petrochemicals, in all three categories, namely plastics, synthetic rubber and fibre (See appendixes 5 & 6) are bound to follow the same pattern as both basics and intermediates must be converted into end-product petrochemicals for final conversion into consumer products.

The Domestic consumption of Synthetic Rubber is estimated around 108 Thousand Metric tonnes per annum. This is roughly 20% of the total rubber consumption of 553 Thousand Metric Tonnes inclusive of the natural and reclaimed rubber. As per the IDBI Industry and Finance Record (News Digest, May, 1992) the consumption of synthetic rubber in India is expected to rise from the current level of about 20% to about 60 to 65% of the total rubber consumption by May, 1996.

The world demand of synthetic rubber is over 10 Million Tonnes and growing at around two to three percent per year. The table below shows the estimated demand growth of synthetic rubber in the world.

Comparison of per capita consumption of plastics and synthetic rubber shows that there is a vast potential market in India which can range anywhere between the world average and the U.S. level of consumption. Table-2 below provides data with regard to both these products.

The plans for synthetic rubber production in India are primarily aimed at increasing SBR capacity. It is planned to achieve a target of 280 Thousand Metric Tonnes per annum (In Rubber and Plastics Age, May, 1992). Additional plans include installation of 50 Thousand Metric Tonnes per annum of TDI.

Table 2
Per Capita Consumption of Plastics & Synthetic Rubber

(In Kgs.)

Consumption	Plastic	Synthetic Rubber
India	0.7	0.08
Japan	58	7.60
W.Europe	63	6.10
U.S.A	89	9.00
World Average	13	1.90

As can be seen from the above table, reaching the world average of plastics consumption would mean a fifteen-fold increase while reaching the U.S. level will mean a 100 times increase. Difference in the Indian and World consumption of synthetic rubber is also enormous and similarly shows the huge potential market that India holds within its own boundaries. The current Synthetic Fibre Production in India is around 2000 Tonnes (Economic Times 26 June, 1991). As estimated by the Committee on perspective plans for petrochemicals, demand for synthetic fibre yarn is expected to double for each variety of yarn by the year 2000 A.D. The world production of synthetic fibre was estimated at 15.66 million tonnes (IDBI Industrial News Digest, May, 1991). Of these, USA accounted for barely 20%, West Europe 15%, and Japan 10% of the total production. Thus, with less than half a million tonnes of production, India accounts for barely 3.5% on the world production. The table below gives the estimate of the demand for synthetic fibre yarn in India by the year 1999-2000.

Table 3
Estimate of Demand for Synthetic Fibre Yarn

(Fig. in kilo tonnes)

Fibre Yarn	89-90						
PSF	124	200	230	300	250	300	450
PFY	100	130	150	200	168	200	350
NFY	70	80	90	120	125	150	170
AF	40	60	70	80	95	120	120

Source: Report of Committee on Perspective Planning for Petrochemicals

It is widely known that the domestic manufacturers of synthetic yarn find the domestic market somewhat more profitable than the international market. Thus, there is no incentive for the manufacturers to address themselves to the global market. However, this may change with the

increasing liberalization and reduction of import controls. The margins for the Indian manufacturers in the domestic market are bound to reduce. It is also known that while synthetic fibre can earn about four dollars per Kg. in the international market, the Grey Cloth can earn about eight dollars per Kg. and Garments can earn about 12 dollars per Kg. in the international market. Thus, there exists a large incentive for conversion of fibre into Yarn, Grey cloth, and Garments, a step that textile industry has recently started taking.

Thus even without any data with regard to the demand for the synthetic fibre in India, one can certainly foresee a hugh potential domestic market with the rise in the earning capacity of the Indian household. India has a long way to go before it can expect a middle class citizen to casually pick up a garment off the shelf because it excites his fancy. Thus the scenario that emerges in the field of synthetic fibre is once again of a large potential market within the country.

Together, this poses the crux of the dilemma for the petrochemical industry. Should it try to enlarge and meet the domestic demand or should it focus on the international market and avail of the export incentives?.

VI. The Competition

Worldwide, with approximately 3000 active projects in petrochemicals, the competition is tough and becoming tougher. A report by Hydrocarbon Processing in June 1992 indicates that there were 829 active projects in this field in refining alone. This is an increase of 62 projects over the previous year. Europe accounts for approximately 30 to 40% of the total global production. Table-4 below gives information in this regard.

Table 4
Count of Total Active Projects in the World

Country	Rfg.	P'Chem	Gas	Other	Total
USA	223	209	40	107	579
Canada	20	18	17	29	84
Other W.Hemi	114	168	16	42	340
Europe	180	243	26	103	552
Africa	46	35	13	5	99
Mid East	62	131	24	22	239
Far East	202	578	43	86	909
Australasia	43	62	17	11	133
World, this issue	890	1442	196	405	2935
World, Year ago	828	1548	210	350	2936

Source: Hydrocarbon Processing, June 1992.

Focus recently, however has recently shifted to Asia particularly due to the western policies of phasing out of environment and health hazardous industries and the encouraging other newly developing countries for taking up of these projects. The competition, nevertheless, is expected to be high in the world market.

Thus India has the option of going it alone with a small speciality niche on its own or join hands with other Asian players and stake a claim in the global market. If it chooses to be a speciality niche player, the niche must be economically significant in the global market to be able to make a mark. If however, it chooses to join hands with the Asian players, a politico-economics question, it can emerge as a key partner in the fourth transnational group in the world market in addition to the existing three consisting of North American, European and South East Asian Countries. The option of having its own production base for a sub-continental size market will always be available. Thus while the basic choice remains between going alone and creating and joining a new alliance, India, nevertheless can still gainfully examine the possibility of making a mark in the global market.

VII Prices

Petrochemical prices in India, exclusive of taxes, in comparison to the world market are higher by anywhere between 25% to 400%. Table 5 below provides the comparative information in various petrochemicals.

Table 5
Petrochemical Comparative Prices in India (Mid 1991)

Petroproduct	International US $ / MT	India US $ / MT (excl.taxes)	% Increase
Ethylene	450	540	20.00
Propylene	400	600	50.00
Butadiene	425	800	88.24
Benzene	325	595	71.43
Toluene	280	480	164.29
Ortho-Xylene	350	925	80.00
Ethylene Oxide	1000	1800	300.00
Phenol	400	1600	50.00
Acetone	550	825	82.50
Methanol	200	365	233.33
Phthalic Anhydride	540	1800	

Source: Chemical Business, October 5-19, 1991.

Major reasons for the high price differential are:

a. Relative price of the feed stock.
b. Dependence on collaborators for technology.
c. Relative profit margin due to market protection policies in the past.

The profit margins, however, are likely to come under severe strain due to the increasing competition in light of the liberalization policies of the government.

Based on the above information it can be inferred that the relatively high price of its petrochemical products will pose a significant barrier for India in its entry in the world market.

VIII. Niche Identification

Niche identification is a matter of product/market choice in light of strengths and opportunities that best fulfil the interests of industry. Based upon the foregoing analysis and interviews with selected top executives in the industry, the following strengths, weaknesses and opportunities can be identified for the Indian Petrochemical Industry.

Strengths: Technical skills for installing and operating plants
Managerial Skills of running large organizations
Own raw material/feed stock

Weaknesses: Capital inadequacy
Dependence on overseas technology
Low absorption rate of new technology
Low research and development
Low product/process development/innovation
Low concern for quality
Low productivity

Threats Ecological and environment Pollution Concerns
Non availability of latest technology
Emergence of giant regional trading blocks (North American, EEC and ASEAN)
Use of social/ideological concerns as Business barriers.

Opportunities Large unutilized scientific,technological and managerial manpower.
Large skilled and semiskilled manpower.
Large potential domestic market.
Perception of India as best investment opportunity.
Acceptance of India as a potential player in world economy.
Unutilized/misutilized associated gas in Assam & other areas.
Shifting focus on Asia.

Large potential global market in and outside the trade blocks.

Let us also briefly examine the product and market range to be able to delimit niche choice.

Market Range

The market for petrochemicals ranges from the current domestic, to the potential, on to the global existing and potential. A brief look at these markets shows that the two markets are somewhat different in character and in their product need. While domestic market has a larger potential for consumer products,the international market has prime need for the engineering components and high tech performance products. While potential for the engineering components, exists in the domestic market, some degree of active promotion will be required with adequate development back-up. This, in some ways suits the present situation as it provides flexibility for making the market choice.

Product Range

The petrochemical chain has already been identified to include four major segments namely Basics, Intermediates, End product petrochemicals and End Products. End-Products can further be classified into Commodity Polymers based mass consumption items and Performance polymers based engineering components and high tech items. Since basics cannot be transported far from the point of manufacture and must be converted into intermediates within reasonable geographical distance, the choice is reduced between:

a. Basics and Intermediates
b. End-product Petrochemicals
c. Engineering components and High tech products.
d. Mass Consumption commodity products.

It is known that the refining and cracking task is a capital intensive segment. It is also known that this end of the industry chain is technology intensive. The market for these products is basically the industry which processes the bulk material for subsequent stages. Between the two category of products, the performance polymers consisting of engineering components and high-tech products, ranging from gears to space research oriented carbon-filled polymers, require a very high level continuous research, something that Indian Petrochemical Industry has shied away from. As a result, the petrochemicals consumer products industry in India has left the high-tech products untouched and concentrated on mass consumption commodity polymers. The mass consumption polymers, although relatively low capital and technology intensive, also provides relatively low value addition. Having a larger domestic market, for whatever quality, has, in a way, proved a disincentive for the industry to keep pace with the world market.

A good option for the Indian petrochemical industry will be a two pronged strategy which aims to fulfil the domestic consumer market need while simultaneously diverting a significant part of capacity to the international market with a specialized focus. Starting from this the petrochemical industry can move backwards from the end product petrochemicals to the intermediates and thereby gradually increasing the capital intensity and technology.

The emerging scenario shows that niche choice for India is between:

a. low capital intensity versus capital collaboration.

b. low technology intensity versus technological collaboration.

c. serving domestic versus global market.

The overriding concern in making the choice is to capitalize on strength. Thus, niche identification should be such that fully exploits the managerial, scientific, technological and skilled manpower available in the country.

Let us however examine some key considerations in making the final choice.

Key Consideration

Three key issues need to be considered for exercising this option.

a. Does Indian petrochemicals industry have enough capacity to divert a part to the international market.

b. Does India have the capability for producing high quality, high precision products, e.g., like engineering components with which it can compete in the international market.

c. Can the industry make these at a cost to suit the international prices.

The answer to the first question is perhaps a hesitant 'may be'. As of today, India does not have the capacities to make a mark on the world market. However with arrival of Reliance in the petrochemicals and allied fields and other players actively contemplating major expansions, five years down the line, India should be in a position to make a significant entry in the global market. As of today only some capacity diversion is possible. Additionally, one can explore the option of importing

the raw material and converting it into consumer products. The answer to the other two questions is perhaps "a hesitant yes".

It is known that India has enough capabilities to fulfil the domestic consumer goods market although there is a lot of scope for improving the quality. If skilled manpower is a strength, it should be possible to make high quality engineering components. The industry will, however need to examine costs and productivity very carefully. This will require a concerted effort by the industry as part of implementation plant. Meanwhile, should Industry wait till Basics Capacity is installed and production standard or should it examine the possibility of focusing on the Consumer Products end and move backwards with its own capacity for End-Product Petrochemicals, Intermediates and Basics. By the time it reaches the basics end it may even be examining the possibility of copying western strategy of retaining only environmental friendly industry. The unanswered question pertains to the choice between commodity polymers and performance polymers. For entry into performance polymers investment in research and development is inescapable, something that the industry has not paid much attention to. Meanwhile, time bound technical collaboration may be inescapable.

IX. Action Plan

Globalization of the world market is a net result of the shrinking of space and time barriers in our every day life. However, in industrial terms globalization means several things. It includes, among other things, free flow of:

Communication
Technology
Investments
Trade

These four factors have to be taken into account by the national economies for interaction with the large business blocks.

To be able to make significant mark in the global scene one must have a competitive advantage. In real terms the competitive advantage has always involved consumer concern in terms of value for the price. This clearly requires some home work on part of the industry and the government in the form of same initial steps.

Step 1 - Productivity & Quality Improvement

India employs 165,000 persons in the plastic manufacturing industry compared to 136,000 in France and 425,000 in Japan. Turnover per employee is lowest at US $ 14,900 in India in comparison to US $ 16,200 of France and US $ 171,300 for Japan. Turnover, of course, is a combination of technology and manpower productivity and it clearly points to a substantial scope both for technological upgradation and improvement in manpower productivity.

Implied but not specified in this is the concern for productivity is the concern for quality and value to the consumers, since mere improvement in quantity cannot take us far.

Step 2 - Product Innovation

Not specified in the concern for consumer is the concern for product innovation where a concerted effort by the corporate world is required. The industry must try and fulfil not only the existing felt needs but also the unfelt needs of the consumer. This is particularly so since new markets can be created overnight by identifying any specific act. This was exemplified by the Japanese industry when they came out with the watch-pen, while separate market existed both for the

watches and also for the pens. The watch pen not only tried to serve these two needs but also catered to an entirely different need by tapping the gift market.

Step 3 - Policy Changes

Clarity with regard to two major policy issues is required on part of the government. These are:

a. Feed-stock policy for petrochemical industry.
b. Import policy.

The feed stock policy must ensure that adequate feed stock is available for the use of petrochemical industry even if it means diversion of some Naphtha from power to petrochemicals. This should be possible since the industry's requirement of the feed stock is rather low being just 6% to 8% of the domestic production of oil and gas. This diversion should be possible as alternative sources for power generation are available, while for petrochemicals this is the only raw material. Only lately has some progress been achieved by experimenting with ethane cracking in place of naphtha.

Similarly a policy which allows imports at a sliding scale starting perhaps from zero duty on imports of raw materials like Naphtha and aims at successively increasing level of duty for import of Basics, Intermediates, End Product Petrochemicals and for Consumer products will automatically lead to higher value additions both for the industry and the country.

The Long Term Need: Research & Development

The single major failure of the petrochemical industry in India has been its lack of sufficient effort for research and development. As a result, the industry does not own any worthwhile technology. This lack has often been justified in the name of insufficient finance in face of the large sums required for Research in today's context. This may be true as long as we follow the Russian model of research through public owned laboratory. The alternative American model of supporting research through the academic institutions and the Japanese model of undertaking cooperative research by pooling industry resources have both gone unexplored. Perhaps the time is ripe to take the step seriously, unless we wish to be a permanent backbencher in the international community.

NOTE: The research for this paper was sponsored by IIM Seed Money Project.

Appendix

Appendix 1: Major Petrochemical Complexes in India

Company	Location/Year/ Feed Stock	Major Products	Capacity (MT/Year)
Union Carbide (now Oswal Petrochemicals)	Near Bombay 1965 Naphtha	Ethylene Propylene Benzene LDPE	20,000 8,000 5,000 20,000
National Organic Chemicals Ind. Ltd. (Royal Dutch/Shell Joint Venture)	New Bombay 1968 Naphtha	Ethylene Propylene Butadiene Benzene EG Acetone Oxo-alcohols PVC HDPE (through J.V with Hochest)	63,000 37,000 7,200 17,000 10,000 14,000 16,000 22,000 50,000
Indian Petrochemicals Corporation Ltd. (IPCL)-Govt. Company	Baroda 1973 (Aromatics) 1978 (Olefins) Naphtha	Ethylene Propylene Butadiene Benzene O-Xylene P-Xylene DMT EO/EG Acrylonitrile LAB LDPE PP PVC PBR Acrylic Fibre	1,30,000 81,000 22,000 23,000 45,400 48,600 30,000 20,000 30,000 43,500 80,000 55,000 55,000 20,000 24,000
IPCL	Nagothane 1991 Associated Gas	Ethylene Propylene EO/EG LLDPE, HDPE LDPE PP	3,00,000 60,000 55,000 1,35,000 80,000 60,000

Source: Chemical Business, October 5-19, 1991, Page 6.

Appendix 2: Surpluses/Gaps of Major Petrochemicals in 2000 A.D.				
Product	Demand	1991 Capacity	Additional Capacity Expected by 2000 A.D	Excess Gap
Ethylene	1570	950	2254	1634
Propylene	719	505	794	580
Butadiene	154	117	272	235
LLDPE & LDPE	450	382	415	347
HDPE		235	440	275
PP	300	221	575	496
PVC	640	392	300	52
PS	125	60	176	111
Benzene	641	308	304	0.29
Styrene	150	117	262	229
P. Xylene	390	214	272	96
O. Xylene	151	55	60	-36
DMT	181	181	-	-
PTA	419	200	400	181
Source: The Hindu Survey of Indian Industry, 1993.				

Appendix 3: Estimated Asian Petrochemical Capacity for 2000 A.D. ('000 Tonnes/year)						
Chemical	India	Korea	Indonesia	Malaysia	Thailand	China
Ethylene	2290	3505	375	500	564	2995
Propylene	1045	1817	322	200	269	606
Butadiene	190	538	-	-	17	594
Benzene	858	854	528	-	121	608
Methanol	286	330	330	660	-	629
LDPE	308	812	-	-	399	647
LLDPE	130	113	-	-	50	140
HDPE	555	710	420	160	290	425
PP	420	1210	520	240	340	430
PS	120	564	61	30	171	105
ABS	17	242	454	-	40	10
Polyester	247	565	283	41	213	1074
PVC	713	610	164	119	249	917
SBR	95	182	50	-	13	281
Source: Industry, trade and finance division, Asia Technical Department, World Bank.						

Appendix 4: Forecast Demand for Some Petrochemicals

(Fig. in TPA)

Item	1994-95	1999-2000	% increase
Linear Alkyl Benzene	1,85,000	2,95,000	59.46
Ethylene Oxide	24,000	30,000	25.00
Mono Ethyl Glycol	1,99,800	2,68,000	34.13
Vinyl Chloride	3,20,000	5,50,000	71.88
Plasticizer Alcohol	57,000	83,600	46.67
Alpha Olefin	64,800	1,20,000	85.19
Acrylonitrile	1,28,600	1,76,400	37.17
Propylene Oxide	58,300	89,600	53.69
Phthalic Anhydride	75,740	1,13,365	50.23
Maleic Anhydride	10,500	15,000	42.86
Acetaldehyde	1,23,000	1,65,700	34.72
Acetic Acid	77,000	95,000	23.38

Source: Chemical Business Annual - 91, 65-84.

Appendix 5: Demand Supply Scenario of Major Plastics by Year 2000

('000 Tonnes)

Product	Year	Demand	Availability	Gap
IDPE	1989 - 90	200	80	120
	1994 - 95	482	420	62
	2000	708	-	-
HDPE	1989 - 90	160	40	120
	1994 - 95	378	225	123
	2000	555	-	-
PVC	1989 - 90	280	130	150
	1995 - 95	484	287	198
	2000	713	-	-
PP	1989 - 90	70	55	15
	1994 - 95	286	255	31
	2000	-	-	-
POLYSTYRENE	1989 - 90	45	22	23
	1994 - 95	82	71	11
	2000	120	-	-

Source: Chemical Weekly Annual 1991.

Appendix 6: World Demand for Synthetic Rubber					
Year	SBR	PBR	Butyl	Other SR	Total SR
1994-95	84110	32530	23010	19040	158690
1999-2000	170210	47899	33810	27980	279800
2000 A.D	180420	50670	35840	29655	296585
Source: Chemical Business, November 5 - 19, 1991.					

Appendix 7: Manpower and Turnover in the Plastic Manufacturing Industry					
Country	No. of Firms	Employees	Turnover Mio US $	Percentage	Turnover per Employee US $
USA	12,000	595,300	72,750	+ 1.3	122,200
Japan	19,076	425,100	72,801	+ 3.6	171,300
Germany	2,457	301,000	36,842	+ 10.8	122,400
France	4,130	136,600	14,760	+ 6.5	116,200
Italy	5,100	118,000	13,773	- 1.8	116,700
India	18,000	165,000	2,466	+ 35.1	14,900
Source: IPAD Facts for You, January ' 93.					