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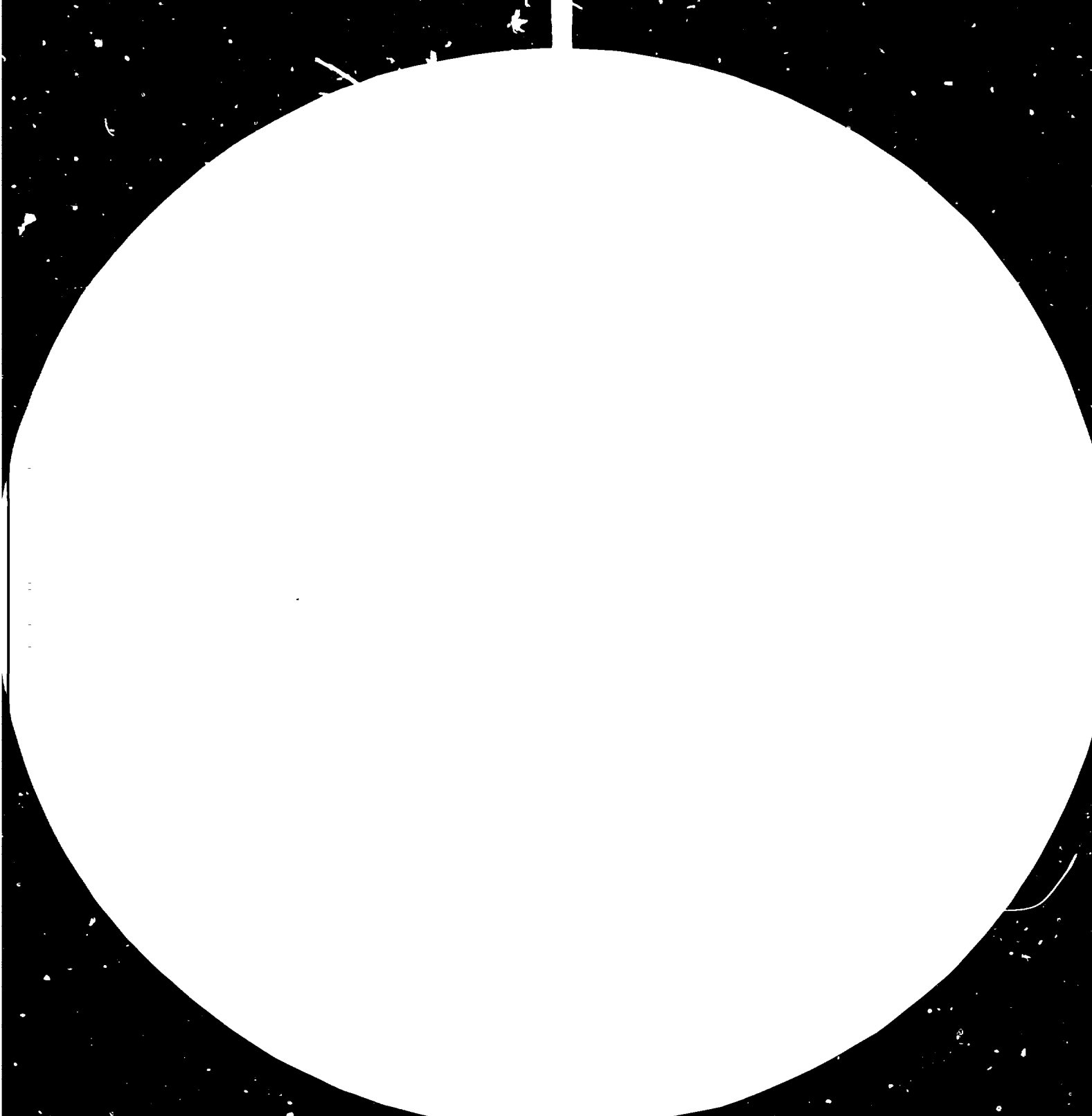

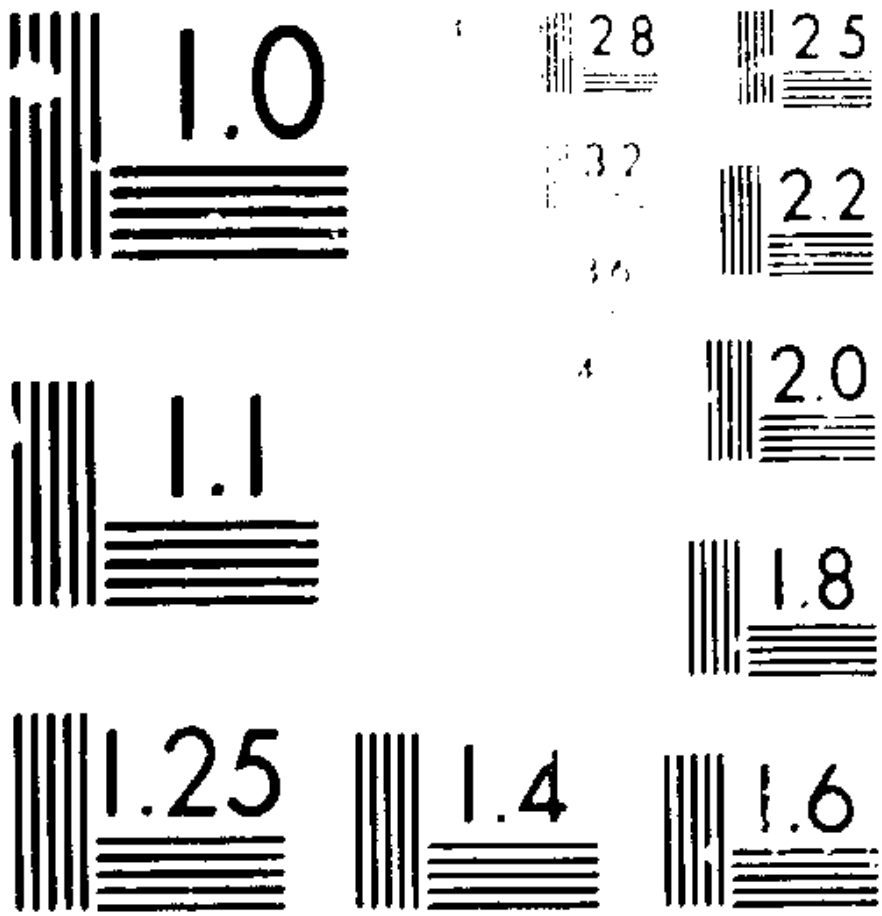
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AMMONIA INDUSTRY IN INDIA*

by

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PREFACE

The attached paper traces the development of the Ammonia Industry in India during the past 4 decades and highlights the action taken to achieve self-sufficiency in the matter of design, construction and operation of fertilizer plants. The paper also refers to the co-operation between Fertilizer Plant Designers and the Equipment Manufacturing Industry leading to a considerable increase in the ability of the Indian Engineering Industry to meet the requirements of the Ammonia and other industries.

THE AMMONIA INDUSTRY IN INDIA.

The synthetic nitrogenous fertilizer industry in India started with a 5 tonnes/day (tpd) ammonia plant based on electrolysis of water as a source of hydrogen, established in the State of Karnataka in the early forties. This was followed by a 40 tpd ammonia plant, based on fire wood as feed stock, established near Cochin in the State of Kerala. This plant went into production in 1947. However, plants of capacities comparable with prevalent international practice started only from the early fifties with the commissioning of a 270 tonnes/day semi water gas plant based ammonia plant at Sindri (in the State of Bihar) in 1951. All these 3 units converted the entire ammonia produced into ammonium sulphate, the use of which was very popular and continued to be so for a long time. Incidentally it may be mentioned that all these plants were set up with financing entirely or substantially by the State/Central Governments. Many of the plants constructed subsequently also were in the Public Sector. In 1980 the Public Sector accounted for about 61% of the total investment in the fertilizer industry, Private Sector 33% and the Co-operative Sector about 6%.

The nitrogenous fertilizer industry had a total installed annual capacity of only about 18,000 tonnes in terms of nitrogen (including by-product ammonium sulphate plants) in the year 1950. The present installed capacity is 4,586,000 tonnes of nitrogen per annum as on the first of April,1981 and India is rated as the fourth in the world in regard to fertilizer production capacity. The capacities of individual plants have gradually increased in line with the developments achieved by the fertilizer industry internationally. Starting

with a plant with a capacity of 5 tonnes/day ammonia 40 years back, plants under construction have a stream capacity of 1350 tonnes of ammonia per day with some of the projects under implementation having two such units at the same site with the entire ammonia being converted to urea.

Installed and planned capacity for nitrogenous fertilizers as on Ist April,1981.

	Te of N_2 per annum
In production	4,586,000
Under implementation	2,107,000
Approved in principle	313,000
Under consideration	2,120,000

FEED STOCKS.

One aspect of this industry in India for which there would be few parallels in the world is the variety of feed stocks used for the production of synthetic ammonia. While almost all over the world natural gas and liquid hydro-carbons have been generally used, with a few units using coal, India has had to depend on a variety of raw materials in view of the virtual non-availability of proven resources of liquid or gaseous hydro-carbons until recently. Thus the plants constructed were based on electrolysis of water where abundant hydro electric power was available, fire wood-believed to be the only plant using this feed stock for the production of ammonia-coke

through the conventional semi-water gas generators ,coke oven gas,naphtha, natural gas, fuel oil, low sulphur heavy stock and direct gasification of coal and lignite. It is doubtful whether any other country has had to contend with such a wide variety of feed stock, for plants with a wide range of capacities and producing end products varying from ammonium sulphate, calcium ammonium nitrate, ammonium sulphate nitrate, urea and several grades of NP and NPK fertilizers.

The synthetic ammonia industry which had its beginnings with an electrolysis unit as a source of hydrogen in the early forties has today plants using almost all the raw materials possible. The approximate percentages of production from different feed stocks as in 1980 are as follows.

Naphtha	-	52%
Fuel Oil/LSHS	-	21%
Natural Gas	-	12%
Coal	-	11%
Electric Power	-	2%
Coke/Coke Oven Gas	-	2%

A list of the existing ammonia plants indicating the capacities , feed stock, licensors and engineering contractors is attached at annexure-1 to indicate the variety of processes in use.

With the discovery of Hydro carbon resources in India during the seventies it is expected that in the immediate future efforts will be concentrated on exploiting the available associated and free gas with continued attention being paid for the development of coal based plants for ammonia as well as for the

production of methanol and other chemicals.

MANPOWER DEVELOPMENT.

India which always has had a large number of educated employable persons. utilised comparatively highly qualified staff for various operations although many of these jobs could be -and in many countries are being- done by less qualified persons. This has helped the country in developing operating personnel sufficiently rapidly to meet the requirements of the fast growing fertilizer industry, as these persons are able to understand the reasons behind the various procedures adopted and could,therefore, absorb and pass on the necessary knowledge in a much shorter time than would be possible with persons with comparatively limited educational background who can only follow specific instructions without really understanding the "why" of such procedures. The almost entire reliance on Indian personnel for operation and maintenance of such complex units from the very early days of the industry has been noted and remarked upon by visitors from other developing and developed countries.

RESEARCH AND DEVELOPMENT.

The Government of India had right from the beginning realised the importance of achieving self-sufficiency in the matter of technology to the maximum extent possible without at the same time losing the advantages possible by keeping up with modern trends in the industry. Consequently action was initiated 30 years back to establish the nucleus of a research and development wing. This wing has been working on several problems

connected with the industry and has also extended services to the industry by way of developing new materials, study of equipment failures due to mechanical, chemical and other reasons, suggesting solutions to problems, improvements etc. The R&D wing has also a fully developed catalyst research group working on the development of various catalysts indigenously for the synthetic ammonia and some other allied industries.

As an off-shoot of the catalyst development activities manufacturing facilities for different catalysts have also been established and today almost all the catalysts for the production of ammonia - except the ammonia synthesis catalyst itself- are being manufactured on the basis of processes developed by the R&D Division. This is in addition to another factory which produces catalysts. in collaboration with an internationally known company.

DESIGN AND ENGINEERING.

As in the case of R&D activities action was initiated as early as the mid-fifties to lay the foundations for a design, engineering and project management group. The first opportunity came in connection with the expansion of the ammonium sulphate manufacturing facilities in Sindri by about 30% and also the design and construction of auxiliary services for the expansion of the fertilizer producing facilities. On the successful completion of this, a plant for the production of 2000 tonnes per day of calcium ammonium nitrate along with the required nitric acid plant was designed and constructed for a steel plant compex towards the late fifties/early sixties. Since the completion of the plant several ammonia, urea , nitrophosphate and other plant units have been designed ,constructed and commissioned with the Indian organisations playing an important part with the

assistance of well-known foreign Engineering companies; the extent of participation by the foreign firms depending on the knowledge and past experience available in India, the complexity of the process etc. For example, currently a large ammonia-urea complex is being constructed with almost the entire technical contribution coming from Indian Engineers. Simultaneously some still larger units for the production of ammonia and urea are being constructed with the licence and basic know-how from well-known foreign companies, all other activities being performed by Indian Companies.

EQUIPMENT MANUFACTURE.

Apart from the development of designs and project management capabilities for work directly connected with the establishment of fertilizer factories the engineering organisations dealing with this industry also put in considerable efforts to develop indigenous facilities for the manufacture and supply of equipment for the plants to increase the extent of self-reliance. The first two small fertilizer units commissioned during the forties depended entirely on imported equipment including such simple items as low pressure gas mains, fabricated and process equipment valves etc. The Indian contribution to these plants was practically limited to the concrete and masonry work in foundations and buildings. The country has presently reached a stage when almost all the equipment can be made in India including high pressure vessels for ammonia synthesis, high capacity high pressure centrifugal compressors for air and gases, pumps to meet the various requirements of ammonia and other plants and a substantial

part of the control and instrumentation equipment. The engineering industry as it existed about 30 years back was capable of fabricating structural steel work, manufacture of simple plate work and similar jobs. As the fertilizer industry was, for all practical purposes, the earliest process industry to take up design and construction of plants indigenously the engineers engaged on the design and construction of these units had to put in enormous efforts to develop facilities for the manufacture of plant and equipment to meet the requirement of the process industry. A close collaborative effort developed between the pioneers in the fertilizer field and various manufacturing units which existed already as also which were being set up resulting in the steady increase in the capability of the Indian Engineering Industry to produce sophisticated equipment to International Standards, as required by the Fertilizer Industry.

From this brief note it will be seen that by a conscious effort to develop indigenous talent in regard to all aspects of the fertilizer industry which is vital for a country like India it has been possible to achieve a considerable extent of Self Reliance. This has been done without overlooking the need to keep abreast of the developments in this fast growing industry. While,therefore, it is possible to design and construct a plant for the production of ammonia without seeking technical assistance from other agencies, the industry continues to draw on the experience and developments abroad to ensure that advantages arising of these are not lost to the country and the expertise developed over the years is constantly upgraded to contemporary levels in the world.

With this background Indian Companies are offering their services to other developing countries either in the role of a prime contractor or as associates working with contractors from developed countries to take advantage of the availability of services to international standards at competitive rates from India. Indian engineers have already undertaken jobs connected with the preparation of Techno-economic feasibility reports and other documents. Assistance during commissioning and operation of fertilizer plants are being rendered through the deputation of trained Indian engineers to other countries. There are hopeful signs of Indian Companies with expertise in the fertilizer field being awarded jobs connected with the construction of fertilizer plants based on conventional processes and also based on know-how generated in India for special products or for the use of raw materials not conforming to generally accepted standards.

PROBLEMS.

The demand for fertilizers in India is comparatively large and keeps steadily increasing. To meet this demand a much larger investment than is made available at present is required but due to the resources available having to be utilized for many other important sectors also the indigenous production of fertilizers has not been able to keep up with the demand. This has made India a major importer of fertilizer in the world in spite of continued increases in production.

The absence of sufficiently large resources of a single or at least a limited number of feed stock materials has necessitated the use of a wide range of processes with consequent increase in the number of types of plants and processes. The technological aspects of this have been well understood and adequate solutions have been arrived at but the capital costs involved in establishing ammonia plants based on heavier hydrocarbons and solid raw materials reduce the extent to which the capacity could be increased for a given quantum of financial resources. This also introduces a variety of types of plant and equipment preventing rationalisation of the type of equipment, standardisation of spares etc.

Some of the other problems are due to inadequacy in some of the facilities which are required to promote the growth of the fertilizer industry. For example while the capacity for the manufacture of a wide range of equipment used in the synthetic ammonia industry has been established much of the raw materials such as low and high alloy steel plates, tubes etc. are still being imported as some of these are not indigenously available or where available not in sufficient quantities. The production of equipment , therefore, depends to a certain extent on imported raw materials.

Similarly the operation of the fertilizer plants is affected occasionally by inadequate or irregular power supply- particularly in dry years in areas where the power supply is dependant on hydro electric generating stations.

These aspects have been identified and action is being taken to make good the deficiencies in a phased manner.

TRAINING FACILITIES.

Many of the major fertilizer companies have facilities for training of personnel in the operation and maintenance of fertilizer plants. In addition organisations like the Fertilizer (Planning and Development) India Limited also train engineers for taking up work in design, technical services and other aspects. In view of the facilities available and experience gained in the training of engineers and technicians Indian Companies are rendering assistance in the setting up of training facilities in another country. It would be possible to provide training for a certain number of people from developing countries in the training organisations in India if required.

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ANNEXURE-I

LIST OF AMMONIA PLANTS, FEEDSTOCK, CAPACITY & LICENSORS.

Sl. No.	Name of Plant	Feed stock	Capacity T/day	Licensor			
				Gasification	H_2S, CO_2 Removal	Synthesis	Detailed Engineering.
1.	Fertilizer Corporation of India						
a.	Sindri (M)	Fuel Oil	900	Shell-Partial Oxidation	Lurgi-Rectisol	Topsoe	The Fertilizer (P&D) India Ltd. Sindri (FPDIL)
b.	Gorakhpur	Naphtha	550	Shell-Partial Oxidation	Hot Potash MEA Benfield	Chemico/ YEC	TEC / FPDIL
c.	Ramagundam	Coal	900	Krupp-Koppers Coal gasification	Lurgi-Rectisol	Montedison	FPDIL
d.	Talcher	Coal	900	Krupp-Koppers Coal gasification	Lurgi-Rectisol	Montedison	FPDIL
e.	Korba	Coal	900	-do-	-d0-	-do-	
2,	Hindustan Fertilizer Corporation.						
a.	Durgapur	Naphtha	600	ICI Steam Reforming	Vetrocoke	Montedison	Fact Engineering & Design Organisatin (FEDO) /Cochin FPDIL
b.	Barauni	Naphtha	600	Selas -Steam Reforming	Vetrocoke	Montedison	FPDIL

Sl.No.	Name of Plant	Feed stock	Capacity T/day.
1	2	3	4
c.	Namrup I	Natural gas / Associated gas.	200
	Namrup II	Associated gas/ Natural gas	600
	Namrup III	Natural gas/ Associated gas	600
d.	Haldia	Fuel oil	600
3.	Rashtriya Chemicals & Fertilizers. Ltd.		
	Trombay	Natural gas	350
	Trombay V	Natural gas	900
	Thal-Vaishat 2 Plants	Associated gas	1,350 each
4.	National Fertilizers Limited.		
a.	Nangal	Water electrolysis	300
	Nangal Expansion	Fuel Oil	900

Licensor			Detailed Engineering.
Gasification	H_2S,CO removal	Synthesis	
5	6	7	8
Chemico Steam Reforming	Hot potash MEA	Chemico	Chemico/FPDIL
KTI Selas	Vetrocoke	Montedison	FPDIL
Haldor Topsoe	Benfield	Haldor Topsoe	FPDIL
Shell-Partial Oxidation	Lurgi-Rectisol	Montedison	FPDIL
Shell Partial Oxidation	Benfield MEA	Chemico	Chemico
Topsoe-Steam Reforming	Benfield	Topso	FPDIL
Topsoe steam Reforming	Benfield	Topsoe	FPDIL
DeNora-Electro-lysis		Grande Paroisso	Sant Gobain
Shell Partial Oxidation	Lurgi-Rectisol	Topsoe/ Uhde.	FPDIL

1	2	3	4
	b, Bhatinda	Fuel Oil	900
	c. Panipat	Fuel Oil	900
5.	Indian Farmers & Fertilizer Cooperative		
	a. Kalol	Natural gas	910
	b. Phulphur	Naphtha	900
	c. Hazira(2 Plants)	Natural gas	1,350
6.	Fertilizers & Chemicals Travancore.		
	a. Alwaye	Naphtha	350
	b. Ambalamadu	Naphtha	600
7.	Coromandal Fertilizers Vishakapatnam	Naphtha	357
8.	EID Parry Madras	Naphtha	66
9.	Gujrat State Fertilizer Co.	Nat.Gas	950 (in two streams)

5	6	7	8
Shell Partial Oxidation	Lurgi- Rectisol	Topsoe	Engineers India Ltd. New Delhi (EIL)
Shell-Partial Oxidation	Lurgi-Rectisol	Topsoe	EIL
Kellog-Steam Reforming	UCAR-MEA	Kellogg	Kellogg
Kellogg-Steam Reforming	Benfield	Kellogg	Kellogg
-do-	-do-	-do-	FEDO
Texaco-Partial Oxidation	Hot potash MEA	I.C.I	PGC
ICI-Steam reforming ICI Steam reforming	Vetrocoke	Montedison	FEDC/FPDIL
Kellogg-Steam reforming	Dow Chemical MEA	Kellogg	Kellogg
Shell-Partial Oxidation	Hot Potash MEA	Casale	Simon Carves
ICI-Steam Reforming	Vetercoke	Casale	Toyo

1	2	3	4
10.	Indian Explosive.		
	Kanpur	Naphtha	830
	Expanded	"	415
11.	Madras Fertilizers Ltd.		
	Madras	Naphtha	750
12.	Mangalore Fertilizers & Chemicals Ltd.		
	Mangalore	Naphtha	600
13.	Neyveli Lignite Corporation		
	Neyveli	Fuel oil	300
14.	Sriram Fertilizers (Chemicals)		
	Kota	Naphtha	600
15.	Zuari Agro Chemicals		
	Goa	Naphtha	660

5	6	7	8
ICI-Steam reforming	Vetrocoke	ICI	ICI
-do-	-do-	-do-	Humphray & Glasgow(India)
Topsoe-Steam Reforming	Catacarb	ICI	Chemico
ICI-Steam Reforming	Vetrocoke	ICI	Humphray & Glasgow(India)
Shell-Partial Oxidation	Benfield	Montedison	FPDIL
Topsoe-Steam Reforming	Benfield	Topsoe	Chiyoda
ICI-Steam reforming	Benfield	TEC	TEC.

1	2	3	4	5
16.	Southern Petrochemical Industrial Corpn.			
	Tuticurin	Naphtha	1100	ICI-Steam reforming
17.	Rourkela Fertilizers Ltd,			
	Rourkela	Naphtha coke oven gas	463	Topsoe - Steam Reforming
18.	Gujarat Narmada Valley Fertilizer Co.			
	Baruch	Fuel Oil	1350	Texaco-Partial Oxidation
19	Nagarjuna Fertilizers & Chemicals			
	Kakinada	Fuel Oil	900	Texaco-Partial Oxidation
20.	Deepak Fertilizers & Petro Chemicals Ltd .	Nat.Gas	273	Selas-Steam reforming

Source: Fertilizer Association of India.

6	7	8
Vetrocoke	ICI	Davy Power Gas
Benfield	UHde	Uhde.
Linde-Rectisol	Topsoe	Linde
Linde-Rectisol	Topsoe	Fosterwheeler EIL
UCAR-MEA	Topsoe	EIL