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AMMONIA PRODUCTION BASED ON VARIOUS RAW MATERIALS[1]

by

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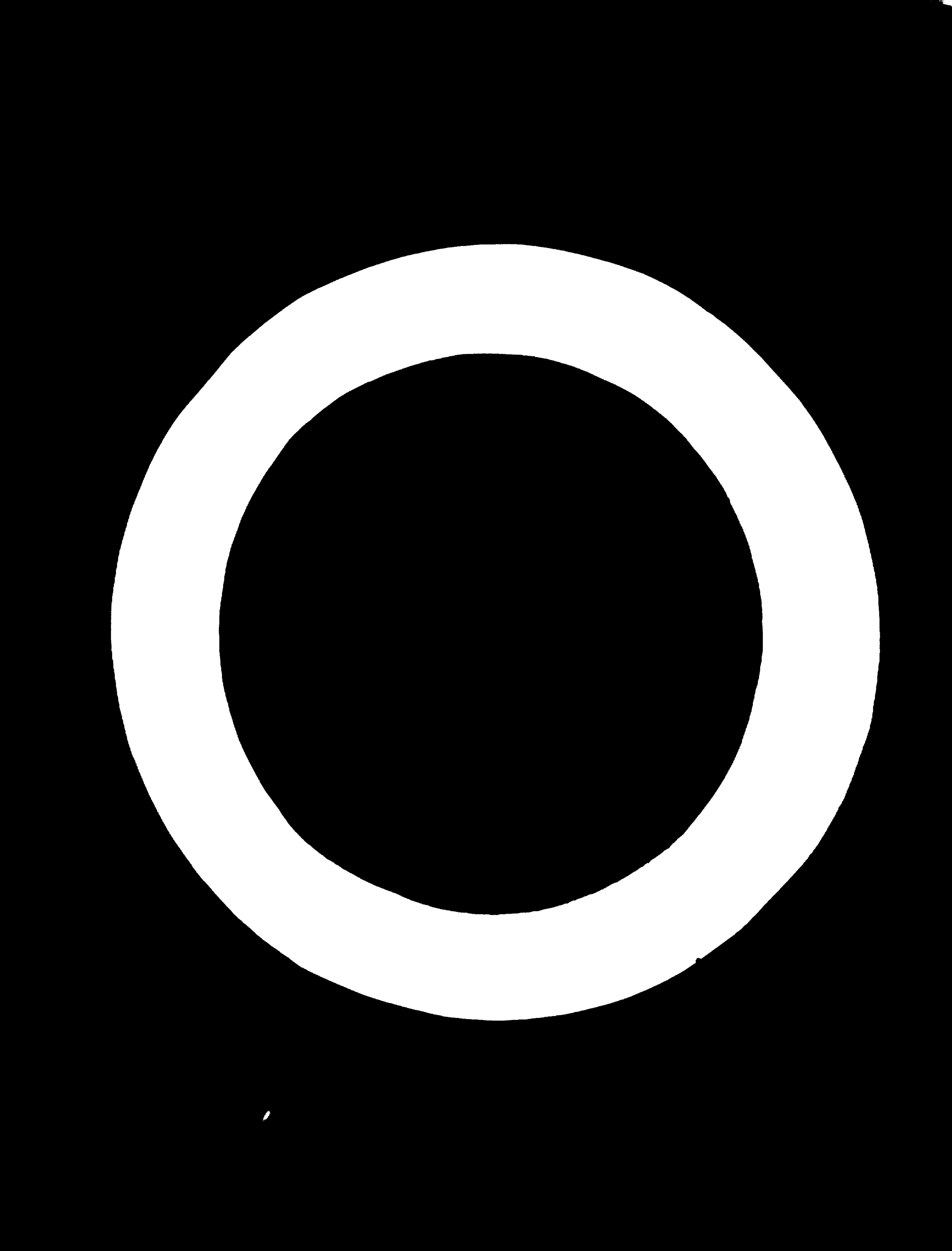

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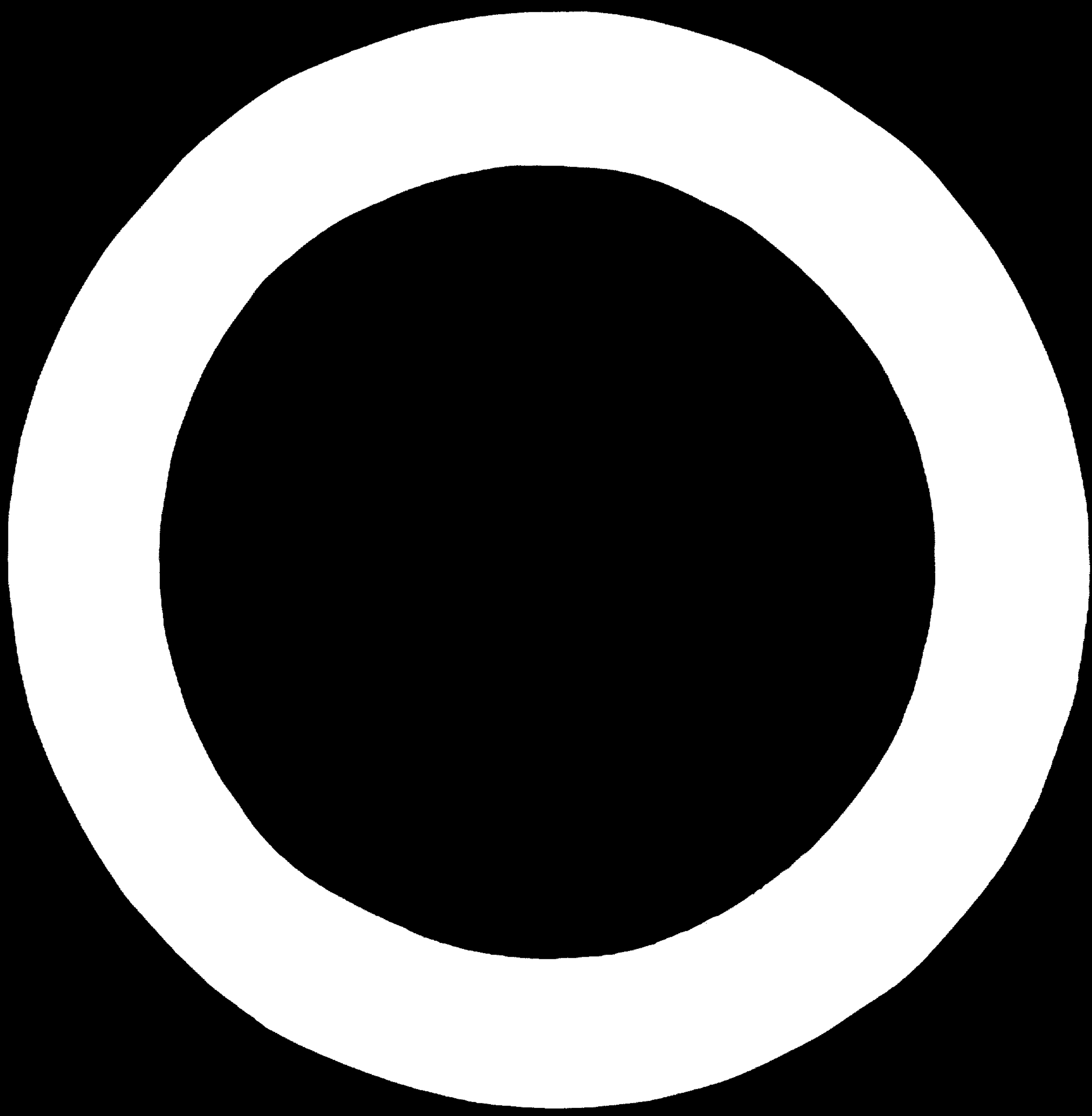

AMMONIA PRODUCTION
BASED ON VARIOUS RAW MATERIALS

I. FEEDSTOCKS USED FOR AMMONIA PRODUCTION IN INDIA

1. In India, the feedstocks that have been used/proposed for use, for the production of ammonia, include Lignite/Bituminous Coal, Coke, Coke Oven Gas, Electrolysis of Water, Natural Gas, Naphtha, Refinery Gas, Furnace Oil and Low Sulphur Heavy Stock.

2. The ammonia plants in India that are in operation and those under construction/advanced planning stage, along with the feedstocks in use/planned, are given in Table - I. The total capacity of all these plants amounts to nearly 5.6 million tonnes of Ammonia per annum.

TABLE - I

Ammonia Plants in India

Location	Ammonia Capacity Te/Annum	Feedstock
F.C.I. Sindri	153,500	Coke/Coke Oven Gas/Naphtha
Nangal	101,300	Electrolysis
Trombay	115,500	Naphtha
Gorakhpur	115,500	Naphtha
Namrup	66,000	Natural Gas
*Durgapur	198,000	Naphtha
*Barauni	198,000	Naphtha
*Namrup Expansion	198,000	Natural Gas
*Ramagundam	297,000	Bituminous Coal
*Talcher	297,000	Bituminour Coal
*Haldia	198,000	Heavy Stocks
Trombay Expansion 1/	200,000	Imported Ammonia
*Nangal Expansion 1/	297,000	Heavy Stocks
*Sindri Expansion 1/	2/ 297,000	Heavy Stocks
Sub-Total	2,731,800	
F.A.C.T. Alwaye	112,200	Naphtha
*Cochin-I	198,000	Naphtha
Cochin-II	55,000	Imported Ammonia
Neyveli Lignite Corporation	94,000	Lignite
New Central Jute Mills, Varanasi	13,200	Coke
Hindustan Steel Ltd. Rourkela	152,800	Coke Oven Gas/Naphtha
G.S.F.C. Baroda	313,500	Naphtha/Natural Gas
Coromandal Fertilisers	107,300	Naphtha
E.I.D.-Parry Ltd. Ennore	19,800	Naphtha
Shriram Fertilisers, Kota	148,500	Naphtha
Indian Explosives, Kanpur	274,000	Naphtha
* Madras Fertilisers, Madras	250,000	Naphtha
* Zuari Agro Industries, Goa	220,000	Naphtha
*I.F.F.C.O. Kalol	300,300	Natural Gas/Naphtha
Dharamsey Morarji, Shevanova	120,000	Imported Ammonia
* Southern Petrochemicals, Tuticorin	363,000	Naphtha
Malabar Fertilisers, Mangalore	198,000	Naphtha
Total	5,671,400	

1/ Planning Stage

2/ Of which, 90,000 te. capacity would replace existing capacity on Coke, which would be discontinued.

(*) Indicates plants based on Centrifugal Compressors.

2.1 The ammonia production capacity of the Fertiliser Corporation of India at approximately 2.73 million tonnes per annum accounts for 48% of the total production capacity in India. The daily production capacity amounts to approximately 8,000 tonnes per day ammonia.

3. The distribution of ammonia production capacity, according to the feed-stock used for all plants in India, for F.C.I. alone and for plants other than in fully owned Public Sector, is in Table - II.

TABLE - II

Feedstock-wise classification of Ammonia Capacity in India

	All India		F.C.I.		Other than fully owned Public Sector Plants	
	Ammonia Te per Yr	%	Ammonia Te per Yr	%	Ammonia Te per Yr	%
Coke	103,200	1.8	90,000 1/	3.3	13,200	0.6
Coke Oven Gas	136,400	2.4	43,000 1/	1.6	-	-
Lignite	94,000	1.7	-	-	-	-
Bituminous Coal	594,000	10.5	594,000	21.7	-	-
Electrolysis	101,300	1.8	101,300	3.7	-	-
Naphtha	2,911,200	51.2	647,500	23.7	1,894,100	81.3
Heavy Stocks	792,000	14.0	792,000	29.0	-	-
Natural Gas	564,300	10.0	264,000	9.7	300,300	12.9
Imported Ammonia	375,000	6.6	200,000	7.3	120,000	5.2
	5,671,400	100.00	2,731,800	100.0	2,327,600	100.0

3.1 More than 50% of the country's production capacity for ammonia is based on naphtha; Furnace Oil/Heavy Stocks account for 14% of the capacity; Coal accounts for about 10% and Natural Gas for another 10% of the capacity. Imported ammonia represents roughly 7% of the capacity.

3.2 An analysis of the production capacity of F.C.I. shows that coal accounts for about 22% and naphtha 24%, Heavy Stocks 29% and Natural gas about 10%. All the three plants using Furnace Oil/Heavy

---

1/ Proposed to be discontinued and replaced by Naphtha Reformation/Partial Oxidation of Heavy Stocks

stocks are with F.C.I. as well as the two Coal-based plants.

3.2.1 Therefore, when all the plants that are under various stages of construction go into production, F.C.I. would be in a better position to more thoroughly evaluate the effect of the type of feedstock on plant performance.

3.3 Among the plants that are not in the fully owned Public Sector, more than 98% production capacity is accounted for by Naphtha and Natural Gas alone.

II. PROCESSING OF FEEDSTOCKS FOR SYNTHESIS GAS PRODUCTION

4. Table-III gives the production capacity distributed on the basis of process employed for gasification of the feedstock.

4.1 Two olds plants, viz. Sindri and Varanasi, use Coke as a raw material for semi-water gas generation for synthesis gas production.

4.2 Low temperature purification of coke oven gas accounts for a part of the synthesis gas production at Sindri (43,000) and for a substantial production at Rourkela (100,000).

4.3 Electrolysis of water is used in only one plant at Nangal. Adequate power availability and Heavy Water production were factors for adopting the electrolysis route.

4.4 Steam Reforming of Naphtha and Natural Gas account for a major portion of the ammonia capacity (3.15 million tonnes of ammonia per year) amounting to more than 60%.

4.5 Partial oxidation of oil accounts for (1.12 million tonnes of ammonia per year) about 21% of the capacity.

4.6 Plants based on Oxygen Gasification of Bituminous Coal/ Lignite account for about 13% of the capacity.

TABLE - III 3/

Process-wise Classification of Ammonia Capacity in India

	All India		F.C.I.		Other than fully owned Public Sector Plants	
	Ammonia Te per Yr	%	Ammonia Te per Yr	%	Ammonia Te per Yr	%
Semi water gas	103,200	1.9	90,000	3.6	13,200	0.6
COG Separation	136,400	2.6	43,000	1.7	-	-
Electrolysis	101,300	1.9	101,300	4.0	-	-
Steam Hydrocarbon Reforming	3,152,100	59.6	680,500	26.9	2,174,600	98.5
Partial Oxidation of Oil	1,115,400	21.0	1,023,000	40.3	19,800	0.9
Gasification of Bituminous Coal/Lignite	688,000	13.0	594,000	23.5	-	-
Total ...	5,296,300	100.0	2,531,800	100.0	2,207,600	100.0

5. Analysis of the capacity of F.C.I. shows that partial oxidation accounts for 40% of the capacity, steam reforming accounts for about 27% of the capacity and gasification of Bituminous Coal accounts for about 24% of the capacity.

6. The plants which are not fully owned Public Sector plants would obtain all their ammonia by Naphtha/Natural Gas steam reforming process.

III. TYPICAL SCHEMES FOR PROCESSING OF FEEDSTOCKS

7. Process schemes adopted for processing different feedstocks vary with the type of feedstock. The typical process schemes that are being adopted in the new plants are only being briefly outlined.. The possibility of use of coke/coke oven gas or electrolysis 5/ in large plants at this time is considered remote.

8. Natural Gas and Naphtha

8.1 Desulphurised Natural Gas is subjected to steam reforming at about 28-30 atm. This is followed by an auto-thermal secondary reformer

3/ Excludes Imported ammonia

4/ Proposed to be discontinued by 1975-76

5/ Electrolysis for hydrogen production in an agro-chemical complex centred around a large atomic power generation unit is currently being discussed.

where air is added to give the desired 3 : 1 hydrogen to nitrogen ratio in the synthesis gas. The reformed gases containing low methane content is subjected to two stage CO-Conversion to reduce the CO content to low levels. The gases are subsequently freed from carbon dioxide either by MEA wash or by scrubbing with activated potassium carbonate solution. The final removal of residual CO and CO_2 is accomplished by methanation. The purified synthesis gas is subsequently compressed and introduced at the appropriate stage in the ammonia synthesis loop.

8.2 The newer large capacity plants are in single stream and employ centrifugal compressors for major services.

8.3 The process sequence in the case of naphtha feedstock is the same as that for natural gas except that the raw naphtha is subjected to a preliminary hydrodesulphurisation step to remove the bulk of the sulphur. The naphtha reforming catalyst is different and the purification section is larger due to the higher carbon content in naphtha. A typical process block diagram is shown in Fig. 1.

9. <u>Heavy Stocks</u>

9.1 The heavy oil is subjected to partial oxidation with oxygen. Pressure varies between 30 to 90 ata. Most of the old plants are designed for 28-30 ata pressure, whereas the new plants are being designed for 55 ata pressure. Operations at 80 ata pressure and above has been suggested and one or two plants of large capacity at higher pressure are on stream but experience is still limited.

The raw gas is freed from carbon formed during the gasification step by scrubbing with water. The raw gases are then subjected to desulphurisation using Rectisol process. The final purification for CO removal is accomplished by liquid nitrogen wash. After the addition of pure nitrogen for correcting the hydrogen nitrogen ratio, the synthesis gases are compressed and introduced into the synthesis loop. A typical process block diagram is shown in Fig. 2.

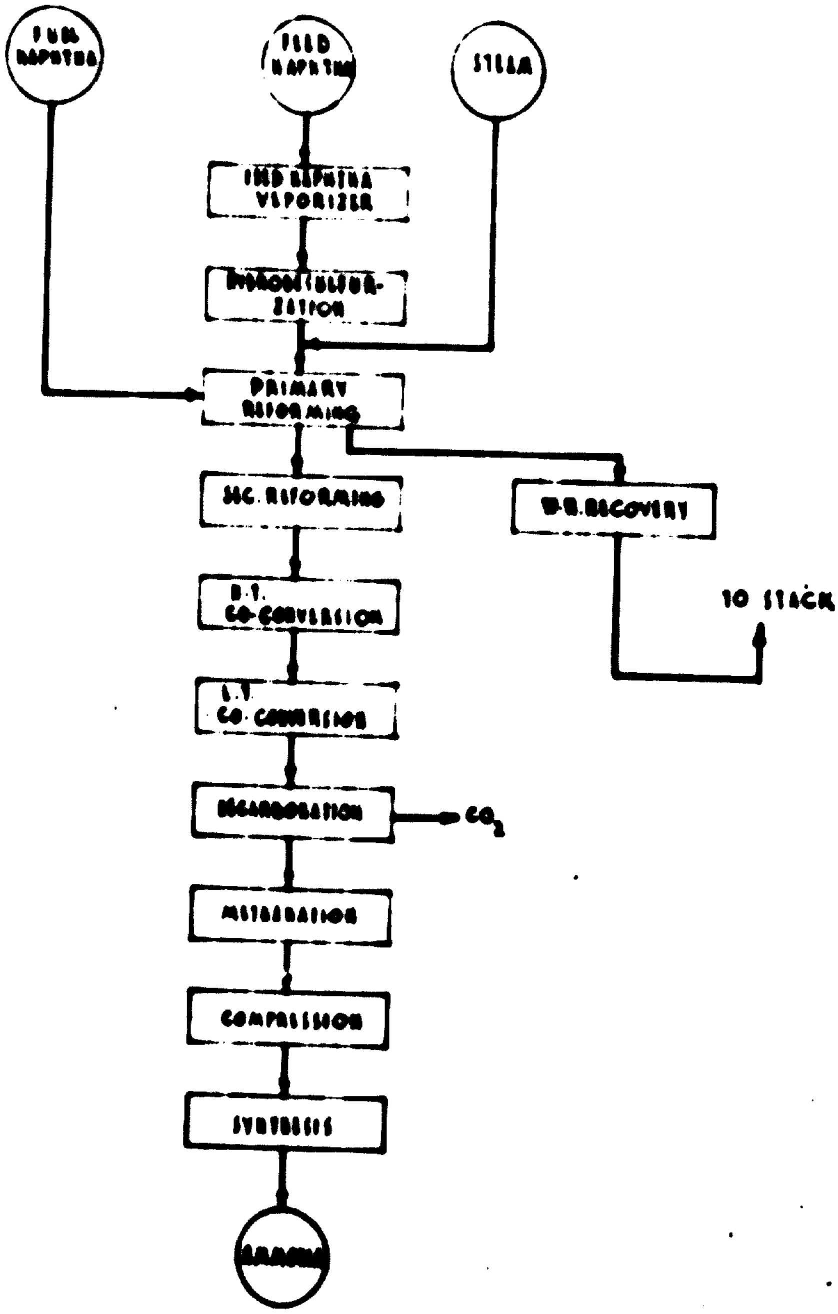

FIG-1. NAPHTHA BASED AMMONIA PLANT

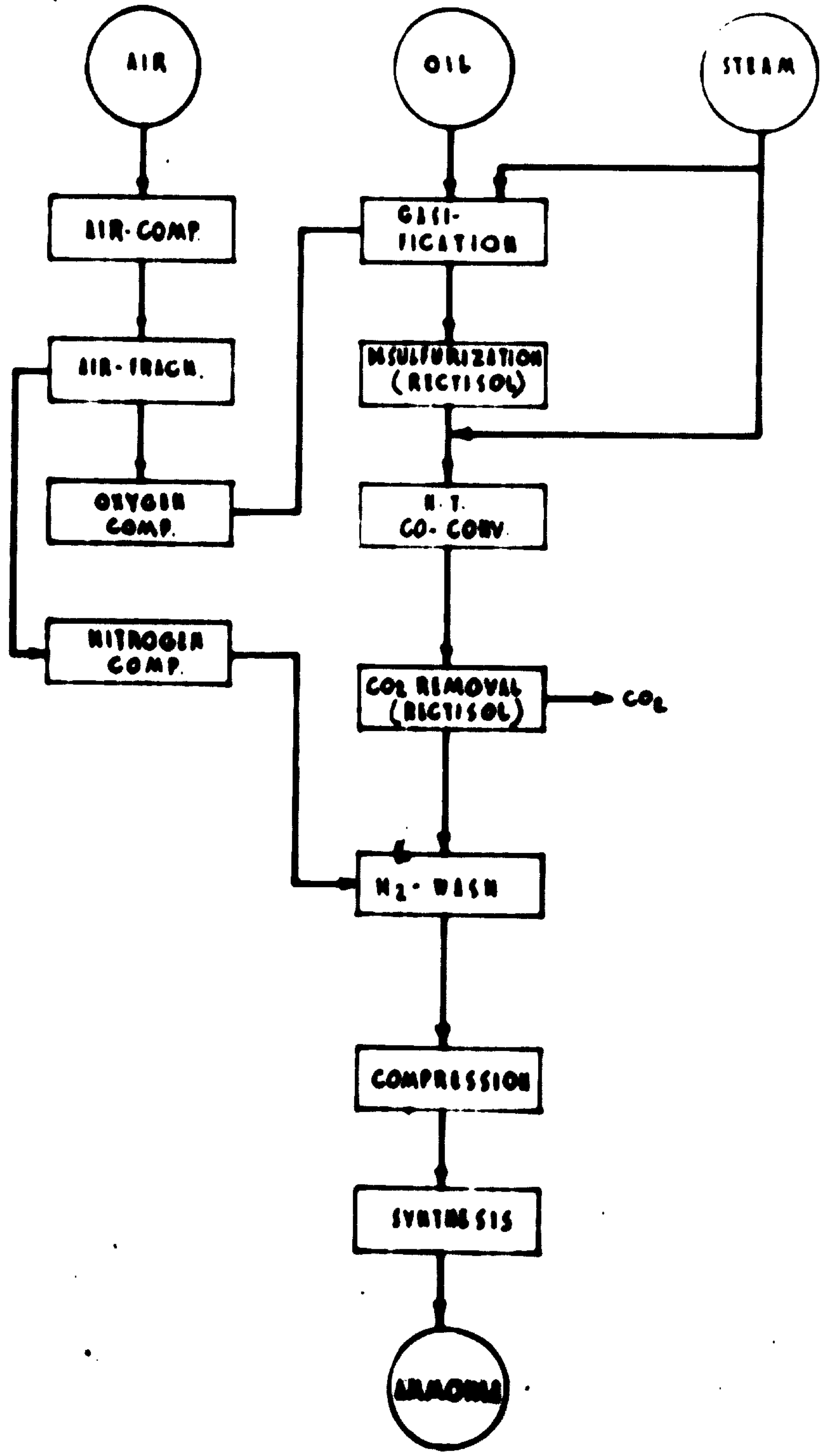

FIG-2. FURNACE OIL BASED AMMONIA PLANT

9.2 Except for the gasifiers, the plants are largely to be in single stream with centrifugal compressors. The planned capacity is 600/900 te ammonia/day.

9.3 The main difference compared to the naphtha steam reforming plants are -

(i) Large air plant required for the production of 98% oxygen and pure nitrogen.

(ii) Auto-thermal non-catalytic single stage gasification step; and

(iii) Bigger capacity purification unit.

10. Coal

10.1 Pulverised coal in suspension is gasified with oxygen at slightly above atmospheric pressure. Koppers-Totzek gasifiers are being adopted. The raw gas after heat recovery is subjected to a purification step which finally includes an electrostatic precipitator to reduce the dust content.to low levels.

The raw gas is compressed to about 28 atm. and desulphurised using the Rectisol process. The subsequent process steps are similar to that described for the partial oxidation of furnace oil. A typical process block diagram is shown in Fig. 3.

10.2 Except for the gasifiers, the plants are to be in single stream, using centrifugal compressors. The capacity is 900 te ammonia/day.

10.3 Compared to the partial oxidation of furnace oil under pressure, the main differences are:-

(i) The provision of coal handling and grinding facilities.

(ii) Gasifier operation at atmospheric pressure;

(iii) Elaborate raw gas cleaning facilities including an electrostatic precipitator; and

(iv) Raw gas compression from about atmospheric pressure to the gas purification pressure.

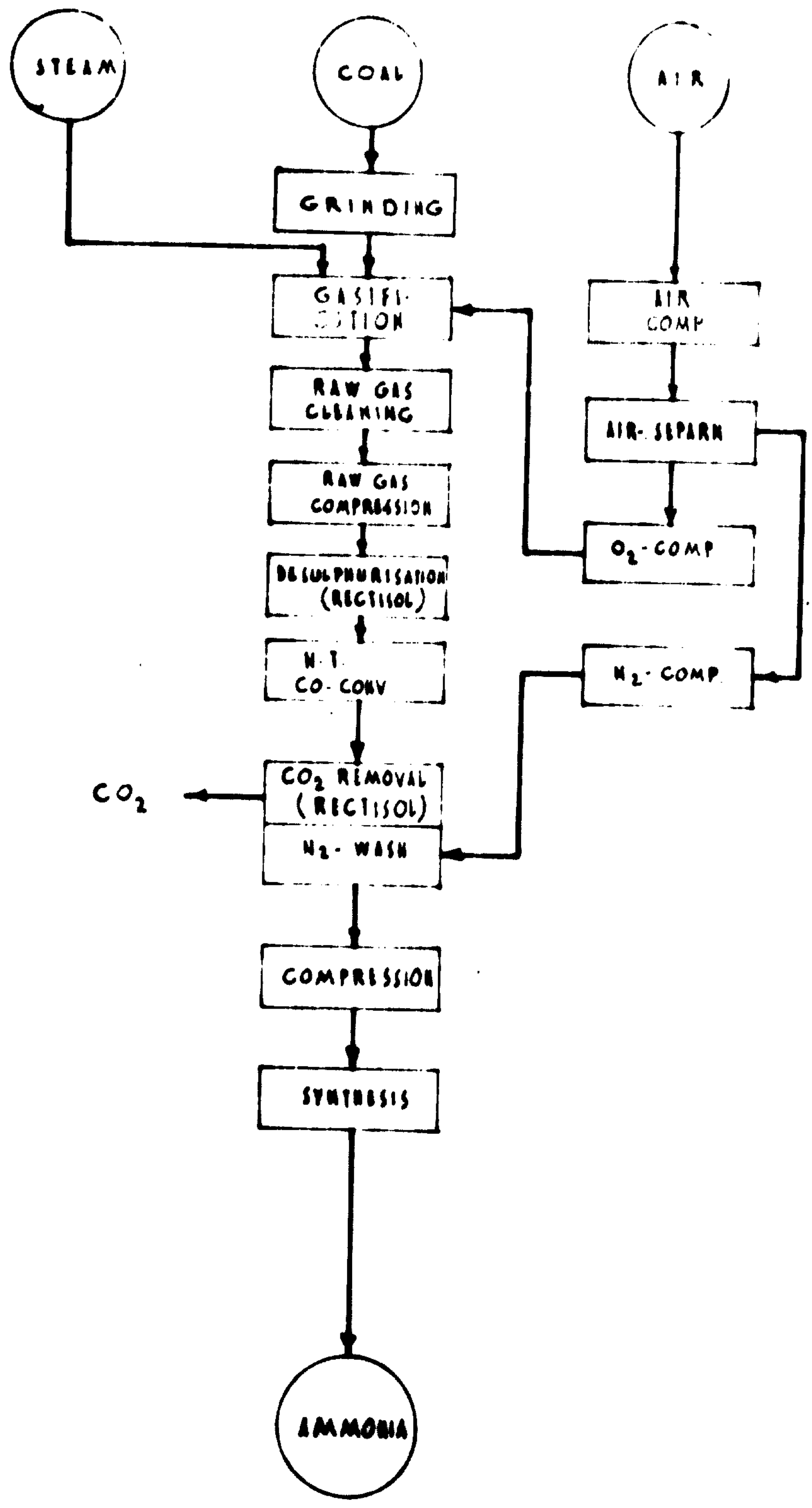

FIG.-3. COAL BASED AMMONIA PLANT

IV REQUIREMENTS OF FEEDSTOCKS, UTILITIES, INVESTMENT COSTS, PRODUCTION COSTS, ETC. FOR AMMONIA PLANTS, USING VARIOUS FEEDSTOCKS

11. The typical ammonia plants that are being subjected to the analysis in the following paragraphs form part of fertilizer complexes; the end products are either urea alone, or urea and NPK products. Five typical plants have been taken for an analytical study.

11.1 PLANT A: The plant is located inland near natural gas fields and natural gas is the feedstock for the reformer. The plant capacity is 910 tonnes per day and in single stream using centrifugal compressors. The process scheme is similar to that in Fig.1. The plant is expected to be commissioned in mid-1974.

11.2 PLANT B: An inland location and the feedstock naphtha is piped to the plant. The plant is in two streams using reciprocating compressors and is based on steam naphtha reforming. The process scheme is similar to that in Fig. 1. The capacity is 830 te/d ammonia. The plant is in operation for about one year.

11.3 PLANT C: is in a coastal location and is based on naphtha steam reformation. The plant uses centrifugal compressors and is in single stream. The process shceme is similar to Fig. 1. The capacity of the plant is 660 te/d ammonia. The plant is expected to be commissioned in mid-1973.

11.4 PLANT D using partial oxidation of heavy stock is at a coastal location. The plant uses the single stream concept except for the gasifiers, which are in multiple units. Centrifugal compressors are used for all services. Fig. 2 gives the process scheme. The capacity of the plant is 600 te/d ammonia. The plant is expected to be commissioned in 1975.

11.5 PLANT E using suspension gasification of powdered coal with oxygen is located inland practically on the coal mine. The plant is single stream except for the multiple gasifiers. Gas/air compression is done in centrifugal compressors. Fig. 3 gives the process scheme. The plant is expected to be commissioned in Mid-1975.

12. Feedstock requirement for the plants illustrated above in terms of their heat value, along with their cost in 1971 and their probable cost in 1975, is shown in Table-IV.

TABLE - IV

Feedstock requirement with their costs in 1971 and 1975

Plant	Feedstock	Feedstock requirement KCal/Te NH_3 x 10^6	Cost in 1971		Probable Cost 1975	
			Rs./10^6 KCal	Rs./Te NH3	Rs./10^6 KCal	Rs./Te NH_3
A	Natural Gas	9.95	15.1	150	22.6	225
B	Naphtha (Reciprocating)	8.50	20.4 6/	173	27.4	232
C	Naphtha (Centrifugal)	10.45	15.6	163	21.9	229
D	Heavy Stocks	8.20	13.4	110	18.8	152
E	Coal	11.10	6.9	77	8.6	95

12.1 The costs for petroleum based feedstocks have been computed on the basis of the price of the crude oil at $ 1.28 per barrel prevailing in January 1971. Recently, there had been an increase in crude price and it has generally been agreed that the same is to go up further. The feedstock costs in 1975 include an estimated increase due to the rise in the crude price to $ 2.05 by 1975. For coal, the cost at Rs.38.7 per tonne in 1971 has been assumed at Rs.50/- per tonne in 1975.

12.2 It will be observed the feedstook cost for coal is the lowest followed by heavy stocks.

12.3 The cost of utilities and fuel for the various plants is given in Table-V.

6/ Includes pipeline transport costs

TABLE - V

			PLANTS				
			A	B	C	D	E
1.	Power	Rs./MWH	120.0	49.4	95.0	85.0	52.0
2.	Water	Rs./M^3	0.12	0.03	0.3	1/	0.01
3.	Coal	Rs./Te	-	-	-	55.0	38.7

13. The investment costs for the ammonia plant alone and ammonia plant with the auxiliary facilities (proportionate costs) contingency, financing charges, pre-operating expenses, etc. are shown in Table-VI, for various plants.

TABLE - VI

	Investment per annual tonne of ammonia					
	Battery Limits Plant Costs:			Total including facilities and financing charges		
	As per Project Estimate	Common Basis		As per Project Estimate	Common Basis	
		Rs.	R.I. 2/		Rs.	R.I. 2/
	1	2	3	4	5	6
A	702	702	100	985	985	100
B	649	810	115	842	1052	107
C	812	910	130	1106	1240	124
D	1172	1120	160	1738	1520	154
E	1656	1585	226	2050	1979	201

13.1 Columns 1 and 4 give the figures as calculated from the respective project estimates. However, as these estimates have been made at different times and under different credit systems and fiscal policies and thus are not strictly comparable. An attempt has been made to bring these figures on a "common basis" as far as time and fiscal policies are concerned. The adjusted figures are given in columns 2, 3, 5 and 6.

1/ Water will be obtained from tubewell located within the factory
2/ Relative indices

13.2 Plant A based on natural gas has the lowest investment; others follow expected pattern depending upon feed stock and plant size. However, as the design and supply of equipment are from different countries and organisations and strictly not on competitive basis, these figures are not strictly comparable. But the figures do provide a broad yard-stick for evaluation.

13.3 Plant D based on partial oxidation of heavy stocks requires about 24% more investment than the comparable Plant C based on naphtha steam reformation. The reasons are mainly due to the requirement of a large air plant and a large steam generation plant. In addition, more processing steps like desulphurisation of raw gas are also involved.

13.4 The plant E based on powdered coal gasification with oxygen requires the maximum of investment. The investment required for coal based plant works out to about 88% more than a comparably sized plant based on naphtha steam reforming and about 30% more than a comparable plant based on partial oxidation of heavy residues.

13.5 The reasons are a still larger sized air and steam generation plants compared to the plant based on partial oxidation of heavy stock and coal handling/preparation facilities required. Since the gasification of coal takes place at atmospheric pressure, in addition to low pressure gas cleaning equipment, raw gas compression facilities are also required. Large capacity plants like Plant E based on single stream concept are so far not in operation. But there had been a number of plants based on the powdered gas coal gasification of smaller capacity.

14. Estimated cost of production of ammonia, with the 1971 and 1975 feedstock prices, are shown in Table-VII for the plants A, B, C, D and E.

TABLE-VII

Cost of Production for the Plants A, B, C, D & E

Cost Element		PLANTS				
		A	B	C	D	E
		Rs. per tonne ammonia				
1. Feedstock	- 1971	150	173	163	110	77
	- 1975	225	223	230	152	99
2. Utilities	- 1971	9	38	14	46	71
	- 1975	9	38	14	53	80
3. Consumables and Maintenance Materials		45	79	51	57	76
4. Labour and Overheads		10	11	11	11	13
5. Insurance, Local taxes, general expenses, interest on working capital and contingency		20	27	20	25	30
6. Credit for steam		-	34	-	-	-
7. Cost of production before depreciation and interest	- 1971	234	294	259	249	267
	- 1975	309	344	326	298	298
8. Depreciation		99	105	124	152	198
9. Cost of production after adjusting depreciation and interest	- 1971	333	399	383	401	465
	- 1975	408	449	450	450	496

14.1 The relative indices for the cost of feedstocks and the costs of production of ammonia before depreciation and interest and after depreciation and interest are shown in Table-VIII.

TABLE-VIII

Relative Indices for Cost of Feedstocks and Cost of Production for various Ammonia Plants

		PLANTS				
		A	B	C	D	E
1. Feedstock		Natural Gas	Naptha - Reciprocating	Naphtha Centrifugal	Heavy Stock	Coal
	- 1971	92	106	100	67	47
	- 1975	98	97	100	66	43
2. Cost of Production						
i. Before depreciation and interest	- 1971	90	113	100	96	103
	- 1975	95	105	100	92	92
ii. After depreciation and interest	- 1971	87	105	100	105	121
	- 1975	91	100	100	100	110

14.1 As discussed earlier, the cost of feedstock alone is the lowest for the coal based plant E, followed by heavy stock based plant D and the natural gas based plant A. Situation is more favourable for the coal-based plant with the probable feedstock price in 1975 as the cost of naphtha is likely to go up. We have estimated that the price rise of naphtha would be proportional to the rise in crude price. In fact, the world-wide demand for naphtha for petrochemicals is likely to further harden the naphtha price in international trade. Developing countries of Asia, Africa and Latin America are likely to be the worst sufferers as far as Ammonia production is concerned.

14.2 The cost of production of ammonia before depreication and interest is more or less same for the feedstocks naphtha, heavy stocks and coal in 1971 but is likely to be lower by about 8% in 1975 in the case of heavy stocks and coal-based plants compared to that for naphtha based ammonia.

14.3 The cost of production of ammonia after depreciation and interest is higher by 20% in the case of heavy stocks based plant and for plant B and by 34% in the case of coal based plant with 1971 feedstock prices. With the 1975 feedstock prices, the ammonia production cost based on heavy stocks is expected to remain about the same and that based on coal might be 22% higher than that based on naphtha. The major reason for competitiveness of heavy stock and coal in 1975 is that the effect of higher investment for these plants is neutralised by the likely higher price of naphtha.

V. FEEDSTOCKS FOR FUTURE PLANTS FOR AMMONIA PLANTS

15. Petroleum Crude

15.1 A scheme has been studied to utilise 1.25 million tonnes of crude per annum for the production of one million tonnes of fertilisers Nitrogen by subjecting the crude to a simple distillation step in a topping unit so that the distillation products would provide feedstock for 4,600 tonnes of ammonia per day as below:

(i) Feed. naphtha requirements of a 600 te/d ammonia plant based on steam reformation;

(ii) Feed naphtha and fuel (light distillates) requirements of a 1000 te/d ammonia plant based on steam reforming; and

(iii) Residual heavy stock requirements of three 1000 te/d ammonia plants based on partial oxidation.

15.2 The economics of the crude topping unit and the associated ammonia plants appear attractive and would be preferable to the use of crude as such, as a feedstock in all the four ammonia plants. Such one million tonne nitrogen production facility from a group of four units could be duplicated to attain the targeted requirements for nitrogenous fertilisers.

16. Heavy Stocks

16.1 Heavy stocks are available at about the same price as crude oil (weight basis) and their import (if not available indigenously) could be considered for the production of ammonia. Specially for inland locations, transport of fuel oil would be cheaper than that of naphtha.

17. Coal

17.1 Suitable coal is available indigenously in adequate quantities in several specific locations. An essential pre-requisite for the success of a coal-based plant would be a thorough investigation to ensure that not only the supplies of coal would be available from the mines for a specified number of years, but the quality of coal including the ash content and ash characteristics, must not widely vary during the useful period of plant life. Thorough investigations, therefore, are called for, inclusive of extensive bore hole tests over wide areas before investment decisions for a coal-based plant could be considered. It is necessary to emphasise that more abundant availability of coal from a number of sources of varying quality would not necessarily contribute to the success of a coal-based plant.

17.2 Normally, coal based plants should be situated near the mine head to avoid bottlenecks and double handling of coal. Minimum re-handling of coal will lead to a smoother operation. Further transport and handling costs must be kept to the minimum. Under such circumstances, developing countries would do well to consider coal as a suitable alternative for ammonia production. It should, however, be recognised that on-stream time of coal-based plants might be lower as the maintenance requirements are heavy. Therefore, adequate provision for spare equipment is essential, and this would contribute to higher capital investment. The sections relating to gas cleaning should be adequately designed in order that the dust content could be brought down to a negligible value to provide reasonable trouble-free operation of the compressors.

18. **Foreign Exchange requirement for Feedstocks**

18.1 This analysis is restricted to the feedstocks coal, naphtha, heavy stocks and crude, as these are the likely raw materials on which the future production of ammonia would be based in India.

18.2 Indigenous naphtha would not be available after meeting the requirements of the naphtha-based plants, and, therefore, if any future ammonia capacity is to be based on naphtha, it would require import of naphtha.

18.3 Heavy Stocks and crude petroleum might be obtained both from indigenous and imported sources.

18.4 The annual foreign exchange outgo would comprise of -

(a) Importing the feedstock;
(b) Servicing of foreign exchange capital and loan; and
(c) Buying spares and catalysts requiring import.

Table-IX shows the foreign exchange requirement for feedstock and servicing of foreign exchange capital and loan along with the requirement for spares and catalysts requiring import. In computing the servicing of foreign exchange capital and loan, it has been assumed that the repayment would be effected in ten equal annual instalments after an initial period of three years. Interest has been computed at 8% per annum from the dates of drawal. The total foreign exchange outgo over the ten year period for repayment of capital inclusive of interest and for yearly purchases of feedstocks and imports of spares, catalysts and chemicals has been computed for the six different alternatives in Table-IX. The total production of ammonia during the ten year period has been estimated and the foreign exchange outgo per tonne of ammonia has been computed on this basis:

TABLE - IX

Foreign Exchange Outgo - Rs.per tonne ammonia

Feedstock	Feedstock Cost-1975 Rs.	Capital, interest repayment, spares & catalysts (Rs.)	Total
1. Crude (Indigenous)	-	120	120
2. Heavy Stock (Indigenous)	-	115	115
3. Coal (Indigenous)	-	128	128
4. Crude (Imported)	93	120	213
5. Heavy Stock (Imported)	92	115	207
6. Naphtha (Imported)	230	133	363

18.5 The foreign exchange requirement for the production of ammonia is lowest in the case of indigenous feedstocks. The petroleum feedstocks based ammonia require lesser amount of foreign exchange than the coal based ammonia.

The foreign exchange requirement is the highest in the case of imported naphtha based ammonia. Imported Heavy Stock based ammonia is about same as the imported crude based ammonia.

19. The current position in India in respect of choice of feedstocks in the expanding nitrogen fertilizer industry is somewhat complicated. It has earlier been shown that of the 5.6 million tonnes of ammonia capacity, about 50% is already based on naphtha. This programme itself would call for import of substantial quantities of naphtha, probably at least of the order of 1 to 1.5 million tonnes by 1975 or so. India's Nitrogen requirement by 1985 would call for nearly doubling the ammonia capacity that has already been approved for construction. The question of further imports of naphtha or petroleum feedstocks for the new capacity that has to be installed between 1975-85 would have to be viewed in this context.

19.1 Until now, the crude reserves have proved inadequate to meet our demand of petroleum feedstocks. Until more crude oil reserves are, therefore, proved, it would be risky to continue to depend on petroleum feedstocks for our expanding nitrogen programme from the long term point of view. The position in this respect, however, is far from clear. There are some indications of large reserves of crude oil being found off-shore on the Gujarat coast. It is, therefore, possible that the off-shore crude may provide enough not merely to meet India's petroleum demands, but also some surplus to meet at least a part of the nitrogen demands. If that happens, the adoption of coal technology for nitrogen programme in a big way would no longer be required.

19.2 However, in the event of the expectations of off-shore crude proving disappointing, the coal based projects would provide adequate experience and data for consideration of further expansion of the industry on coal for the 1978-79 programme and beyond.

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