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BILATERAL AND REGIONAL CO-OPERATION AMONG DEVELOPING COUNTRIES IN THE FERTILIZER INDUSTRY

EXPERIENCE OF INDIA *

by

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P.1.0 An appreciation of India's experience in all aspects of the Fertiliser Industry over the last 40 years in general, and 15 years in particular, is of relevance to have a proper understanding of the prospects and possibilities of bilateral and regional cooperation.

P.2.0 This paper, therefore, deals with two aspects.

P.2.1 The first part deals with India's Fertilizer Industry and the experience, inclusive of experience in Engineering and Construction of complete Fertilizer plants and manufacture of chemical plant and equipment in India.

P.2.2 The second part deals with experience of India and relates specific instances of bilateral efforts that have been made from time to time between India and the other countries.

P.3.0 India's Fertilizer Industry is indeed unique, like of which is not seen in any other country in the world.

P.3.1 In terms of production and consumption, India already ranks amongst the first four or five in the world.

P.3.2 In terms of feedstocks, India has experience of using a large number of feedstocks for ammonia production. Use of wood for generation of Hydrogen was practised commercially only in India. Large commercial plants have been built based on Coke, Coke Oven Gas, Electrolysis of water, Lignite Gasification, Refinery Gas, Naphtha, Heavy Fuel Oils and direct Gasification of low grade high ash coals.

P.3.3 The products manufactured have also a wide spectrum, namely Ammonium Sulphate, Ammonium Sulphate Nitrate, Calcium

Ammonium [illegible], Urea, Nitrophosphate, [illegible] Ammonium Phosphate and Ammonium Phosphate.

P.3.4 The plant capacities for Ammonia have varied between 5 tonnes per day of Ammonia in the early plants and successively increasing 50 tonnes per day, [illegible] tonnes per day, and thereafter single train plants based on new technology of 600 to 1100 tonnes per day. Currently, plans are to build 1350 metric tonnes per day Ammonia Plants based on Natural Gas.

P.3.5 Progressively, Design, Engineering, Fabrication, Construction, Inspection and Commissioning aspects are being increasingly undertaken by Indian engineering organisations.

P.3.6 In the field of usage development of fertilizers, significant work has been done by agricultural scientists, economists and Marketing specialists. A variety of techniques has been employed for education of farmers to use fertilisers to step up 'Yield per Hectare' from the land. A package of practices for obtaining optimum yield from the land is being introduced to fit in with the varying conditions of agriculture, inclusive of agro-climatic conditions.

P.3.7 Agricultural Economists are active in studying the impact of additional agricultural production, farm costs to the farmers, returns in financial terms, costs as well as benefits to the country, economic responses - cost benefit ratio - and other related matters.

P.3.8 An important policy issue in respect of vigorous fertilizer usage for obtaining additional agricultural production is the development of a system for effective marketing in time of the production of the farmers and to ensure that the farmer gets a remunerative price. Government's price support programme and guaranteed offtake are of relevance in this area. The Government have set up agencies, staffed with experts, to continuously review and advise the Government in all such matters. India's experience on fertilizer use development is of special relevance for other developing countries. Over the last 25 years, India has made rapid studies in this field in view of the variety of agro-climatic conditions that prevail in India, the variety of crops grown, the soil types [illegible] areas, the land tenure system, water management practices, development of newer varieties and the improvements in traditional varieties, high mechanisation to medium mechanisation [illegible] in agriculture, etc.

8.4.4 In sum, all kinds of situations do exist in India and different solutions have to be found in different situations for obtaining results. India is continuing to build up experience in these various fields.

PART - I

INDIA'S FERTILIZER INDUSTRY

I.1.0 India's Fertilizer Industry dates back to nearly 50 years when Superphosphate production started in a small way. The first synthetic ammonia plant was established in 1933. By 1952, India's production capacity was 80,000 tonnes of Nitrogen, all in the form of Ammonium Sulphate. Between 1954 to 1966, the Industry expanded. Both Sindri and FACT plants were expanded, and new plants came into production at Nangal, Trombay, Neyveli and Rourkela. The production capacity increased to 500,000 tonnes of Nitrogen. A number of feedstocks were employed, viz. wood, Coke, Coke Oven Gas, Electrolysis, Lignite, Refinery Gas and Naphtha. The product pattern was also diverse, viz. Ammonium Sulphate, Ammonium Sulphate Nitrate, Calcium Ammonium Nitrate, Urea, Nitrophosphates. The first large scale 500 tonnes per day capacity Total Recycle Urea plant - the largest in the world until then - was built in Neyveli.

I.1.1 Between 1965 and 1969, GSFC, Namrup, Gorakhpur plants came into operation and there had been further expansion of the FACT plant. This raised our capacity to nearly 760,000 tonnes of Nitrogen. Natural gas was used in the GSFC and Namrup plants.

I.1.2 In 1965-66, there had been a significant change in the development of the Industry. The Private Sector came into picture in a big way, and by 1972, production facilities were established at Indian Explosives, Shriram Chemicals (Kota) and Coromandel. Later, Zuari Agro-Chemicals came into the picture and the Joint Sector Project at Madras Fertilizers. During this period, a significant step was taken in adopting new Ammonia technology in the Public Sector in the plants at Durgapur and Cochin. At the same time, efforts were made to involve Indian Engineers to the maximum possible extent to master the fertilizer techuology. Although Durgapur and Cochin resulted in indifferent performance in the initial years, it did gave valuable experience to Indian Engineers. Subsequently, corrective steps have been taken and both these plants are now on way to full recovery.

I.1.3 A large number of plants were approved for construction between 1968 and 1970 at Barauni, Namrup Expansion, SPIC, Mangalore, GSFC Expansion, Kalol, Gorakhpur Expansion and Kota Expansion.

During this period, two major Phosphatic Fertiliser plants at Sindri and Khetri were also launched. Later in 1968-69, an important decision was taken to build major Fertiliser projects at Talcher and Ramagundam based on direct gasification of coal.

1.1.4 Further, with steep rise in crude oil prices by end of October, 1973, a new look on the feedstock was taken. A number of fuel oil based plants were approved for construction. Four major projects (Nangal, [illegible], Bhatinda and Panipat) are nearing completion, as on December, 1977, on fuel oil and Haldia is expected to become operational by 197[illegible]. A sixth one, with an Ammonia capacity of [illegible] tonnes per day has made a good beginning (Gujarat Narmada Fertilisers).

1.1.5 With the success of Bombay High, in finding crude oil and gas resources, the picture in feedstock has changed. The Trombay V and Phulpur projects, which were originally intended to use fuel oil, were changed to Gas and Naphtha respectively. Subsequent projects that are now being planned in South and North of Bombay, are based on Natural Gas.

1.1.6 India's fertiliser industry today is second to none in the world in technology, scale of operation. It is unique in diversification in feedstocks and products, like of which is not adopted in any other country in the world.

1.2.0 <u>GROWTH OF CAPACITY</u>

1.2.1 The growth of capacity of the Nitrogenous and Phosphatic fertiliser industry over the last 40 years in India has been as below:

'000 Tonnes

Year	Nitrogen Capacity	P_2O_5 Capacity
1939-40	..	19
1947-48	10	48
1950-51	10	63
1955-56	85	63
1960-61	262	95
1965-66	549	228
1973-74	1938	500
1975-76	2509	692
1976-77	3020	1005

I.2.2 Since then, plans have been formulated for the 1982-83 programme. The Nitrogen capacity is to [illegible] million tonnes and P_2O_5 capacity to [illegible] million tonnes.

I.2.3 There are a total of nearly 70 fertilizer factories in India, of which 30 are major production centres of Nitrogenous fertilizers of world standards, and 11 of which are Nitrogen and Phosphatice complexes. All these are, in terms of capacity and scales of operations, compared to the groups of large plants that have been built elsewhere in the developed world.

I.3.0 <u>FEEDSTOCKS</u>

I.3.1 For Nitrogen fertilizer production, a variety of feed-stocks have been used. The table below provides the variety of feedstocks for the Nitrogen capacity as on April 1, 1977 and the capacity as is expected by 1978-79:

Feedstock	Capacity N as on 1.4.1977		Capacity N by 1978-79	
	'000 Tonnes	Percent	'000 Tonnes	Percent
1. Naphtha	2150	71.0	2138	46.9
2. Natural Gas	508	16.8	548	12.0
3. Electric Power	84	2.8	84	1.8
4. Coke/Coke Oven Gas	176	5.8	176	3.9
5. Lignite	70	2.3	70	1.5
6. Imported Ammonia	40	1.3	75	1.6
7. Coal	-	-	456	10.0
8. Fuel Oil	-	-	1014	22.3
Total	3028	100.0	4561	100.0

I.3.2 <u>New Gas Based Projects</u>

I.3.2.1 Since then, during the last four months (Sept.-Dec. 1977), the Government have formulated a comprehensive feedstock policy. Additional gas prospects have become clear in the Assam Region in North East India and a plant for the production of additional 150,000 tonnes of Nitrogen at Namrup is being approved.

I.3.2.2 Two major projects have been contemplated - one South of Bombay with a Nitrogen capacity of 690,000 tonnes Nitrogen (with a capacity of 2,700 tonnes per day of ammonia). This would be the single biggest project ever conceived in India until now. This would involve investment in excess of US $ 600 million. The project has been planned on most advanced lines, utilising the recent advances in Technology consistent with its soundness and reliability. The scale of operations has been kept in keeping with the recent trends in the world's advanced Nitrogenous Industry. Two trains each of 1350 tonnes per day ammonia capacity, and two trains of Urea each of 1800 tonnes per day capacity (Until now the largest capacity so far built in any place in the world) have been planned.

I.3.2.3 The second project on the North of Bombay in Gujarat area is also being planned on similar lines. This pattern would show clearly that with the prospects of availability of increasing supply of gas, a policy decision has been rightly taken to utilise this gas for Nitrogen production as a matter of national priority. The medium term outlook for production planning perhaps upto 1985-86 would, therefore, tend to indicate use of gas in the first instance as far as possible and thereafter consider use of coal.

I.3.3 Experience on Coal based Projects

Experience on two major coal based plants at Talcher and Ramagundam (with largest single unit capacity of coal gasifiers), which are expected to become operational in 1978, will indeed give India not only valuable technical experience but also would establish costs. In this respect, India's position in the world will indeed be unique. Concurrently, the Government have rightly taken steps in maintaining close follow up in keeping in touch with the newer developments in coal technology relevant to fertiliser production elsewhere in the world.

I.3.4 Shift in Pattern of Feedstocks Use

With these developments, it is likely that by 1982-83, there would be a significant change in the pattern of India's feed-stock for Ammonia production. The Naphtha based plants would roughly constitute about 35% of total from 71% now and the natural gas based plants from 16% now to more than 30% of total and Heavy Fuel Oil from nil to 25% and coal from nil to 7%.

I.4.0 Costs and Prices

I.4.1 A recent major policy change has taken place in respect of costs and prices. A rational pricing system has been introduced with a view to ensuring a reasonable return on investment and facilitate healthy growth of the fertilizer industry.

I.4.2 At the same time, a policy has been adopted to continuously review and adjust the cost of fertilizers to farmers to allow a reasonable return on its use at to optimise agricultural production. In addition, a system of subsidy which has recently been introduced for Phosphatic Fertilisers has played a significant role in increasing consumption of Phosphatic Fertilisers to ensure maintenance of adequate soil fertility on our agricultural lands.

I.5.0 PHOSPHATIC FERTILIZER INDUSTRY

I.5.1 In the Phosphatic Fertiliser Industry, has the following product pattern as on December, 1977 :

Product	Capacity as P_2O_5 '000 ts	Percentage
1. Single Superphosphate	221	17.0
2. Triple Superphosphate	257	19.7
3. Diammonium Phos	75	5.8
4. A.S.P.	37	2.8
5. Urea + Ammophos	100	7.7
6. Nitrophosphate	186	14.3
7. N.P.K.	426	32.7
Total	1301	100.0

I.5.2 The 1982-83 programme of development of Phosphatic Fertiliser Industry is being planned for setting up six major production centres with a total aggregate capacity of nearly 900,000 tonnes of P_2O_5. The scale of operations in each location is planned to be between 125,000 tonnes of P_2O_5 to 300,000 tonnes of P_2O_5. The product pattern is also varied. These are Diammonium Phosphate, Nitrophosphate, Triple Superphosphate and Single Superphosphate.

I.6.0 CONSUMPTION

I.6.1 The consumption of fertilise~ has also been expanding rapidly. The data relating to the recent five years are as below :

Consumption

'000 Tonnes

Year	Nitrogen	Phosphate
1973-74	1829	650
1974-75	1766	471
1975-76	2032	455
1976-77	2452	635
1977-78 (Projected)	3130	871

I.6.2 The outlook for the decade 1978-79 to 1987-88 for the Nitrogen and Phosphatic Fertilisers is as given below :-

'000 Tonnes

Year	Nitrogen	P_2O_5
1978-79	3400	870
1979-80	3700	1000
1980-81	4000	1110
1981-82	4300	1260
1982-83	4760	1485
1983-84	5200	1600
1984-85	5680	1790
1985-86	6050	2000
1986-87	6550	2240
1987-88	7075	2500

I.7.0 INDIA'S EFFORTS TOWARDS ATTAINING SELF-RELIANCE

I.7.1 India's efforts towards attaining self-reliance in the manufacture of chemical plant and equipment and Engineering and Construction of complete fertilizer plants had its beginning in 1959 when the Engineering, Construction of a major fertilizer project of 120,000 tonnes of Nitrogen or 600,000 tonnes of product was taken up entirely under the responsibility of Indian Engineers. This job was taken on the basis of competitive tendering in the year 1959 and in competition with a number of other well renowned firms from the developed world. The project was completed four months ahead of the schedule and with 75% of the estimated costs and 85% of the estimated costs in foreign currency. It had given confidence to the Indian Engineers to undertake full responsibility for complete building of projects of this magnitude and complexity. Indian industries in the field of Engineering, Fabrication had opportunities to undertake responsibility for handling such projects and in many instances for the first time in their history. It had given them opportunities for growth. Complicated chemical plant and equipment of stainless steel had been fabricated, in many instances for the first time in India; medium pressure vessels of carbon steel and certain other plant and equipment were fabricated by the Indian industries. Until then, these were regularly being imported from abroad.

Salient features of this project were presented in a meeting of the United Nations Economic Commission for Asia and the Far East, Committee on Industry and Natural Resources, in its Seminar on the Development of Basic Chemical & Allied Industries in Asia and the Far East, in October, 1962. A copy of this paper is at Annexure - I.

I.7.2 India has made rapid strides since then. In 1977, India's capabilities for production of hardware required for the chemical fertilizer industry have expanded tremendously, in performance, delivery and costs. The Indian industry competes with the world industry in the areas of highly sophisticated water treatment plants, steam generation, power generation, medium pressure equipment, electricals and practically all off-sites facilities. Centrifugal compressors and steam turbines are being manufactured in India under licence from well known manufacturers and are in commercial use in ammonia plants of capacities of 600 to 1100 tonnes per day. A beginning has been made in the fabrication of air separation plants, ammonia synthesis converter and urea converter under licence from well known manufacturers.

PART - II

Bilateral Relations Between India & Other Countries in the Field of Chemical Fertilisers

II.1.0 Until now, many proposals, either for Joint Venture Projects in foreign countries or giving Consultancy services in the matter of drawing up feasibility proposals for putting up fertiliser factories and for marketing of fertilisers, have been received by the Government of India and Companies concerning Chemical Fertilisers under their control. The progress made towards realisation of these efforts has been varied. The experience of India in each of these is described here.

II.2.0 IRAN

II.2.1 Following discussions at diplomatic levels, a joint Indo-Iranian Working Committee was constituted in July, 1969 comprising members from National Petrochemical Company of Iran and the Fertiliser Corporation of India, to prepare a Techno-Economic Feasibility Report on the setting up of a joint venture in Iran for the production of Ammonia. The object was that a greater part of its production could be supplied to India for use in its fertiliser industry. A preliminary feasibility report was prepared by the joint Indo-Iranian Working Committee and submitted to the respective Governments, in September 1969.

II.2.2 An investment decision on this has not been reached.

II.2.3 In recent years, the Companies of India and Iran are regularly collaborating in supply of sulphur, fertilisers and ammonia from Iran to India.

II.3.0 CEYLON

II.3.1 The State Fertiliser Manufacturing Corporation (SFMC), an organisation wholly owned by the Government of Sri Lanka, invited bids for ammonia/urea complex in 1969. Fertiliser Corporation of India was the only Indian firm which was prequalified for submission of a tender as prime tenderer. The Fertiliser Corporation of India submitted a bid in 1969, and negotiations was carried on with SFMC and the Government of Sri Lanka till 1971. In 1972, SFMC and the Government of Sri Lanka referred the Project to the Asian Development Bank (ADB) and at the suggestion of ADB, a review in the form of comprehensive evaluation study of the project was undertaken. To facilitate carrying out of the Project, SFMC decided to employ a Consulting firm from a Developed country to give consultancy services for selection of Engineering contractor, process and bidding specifications. Fertiliser Corporation of India was invited as one of the ten firms to submit a proposal, but due to heavy preoccupations in building their own plants, Fertiliser Corporation of India was not in a position at that time to furnish a bid. Another Engineering Company in India - Engineers India Limited - was chosen by M/s Kellogg as their partner to provide the Design, Engineering and Procurement services for the Project.

II.4.0 BULGARIA

II.4.1 Bulgaria has already assisted India in setting up of a pyrites based sulphuric acid plant of 800 te/day capacity at Sindri, Bihar. The plant is now under trial production. India has supplied to Bulgaria catalyst for steam reforming of natural gas and shift conversion. Further collaboration with respect to setting up of a fertiliser and other chemical complexes in India by Bulgarians is being discussed.

II.5.0 KUWAIT

II.5.1 A technical team of Indian delegation comprising members of Fertiliser Corporation of India, visited Kuwait on invitation from Kuwait Petrochemical Industries Company for examining the possibility of joint venture production of NP & NPK fertilisers using some of the raw materials and intermediate products available with KCPC. This was followed up by submission of a report captioned: "Kuwait Indian Fertiliser Project - Preliminary Feasibility Report". The report was scrutinised by Kuwaitees and commented upon suggesting alternative studies to be made. A questionnaire was sent by Fertiliser Corporation of

India to Kuwaitees which was also replied to by the Kuwaitees.

II.5.2 There was rethinking on this project as newer options developed, which appeared to be more economical than production in Kuwait itself.

II.5.3 In recent years, India and Kuwait have been collaborating in obtaining supplies of sulphur, fertilizers and ammonia from Kuwait and Kuwait has been obtaining jute bags for packing of fertilisers from India.

II.6.0 BAHRAIN

II.6.1 Following discussions at diplomatic level and on invitation from the Bahrain Government in February 1973, an Indian expert team visited Bahrain in March 1973, to explore possibilities of setting up a joint venture fertiliser project in Bahrain based on natural gas. This visit was followed by visits of teams of Engineers from Indian in June 1973 and again in July 1973 to study problems relating to the setting up of a fertiliser project and for collection of data. The Bahrain Government expressed their intention to support the Techno-Economic Feasibility Study of a fertilizer project.

The Feasibility Report was submitted in September, 1973. The Government of Bahrain sponsored an independent study to establish gas reserves and the possible utilisation pattern of the gas. World Bank's assistance was taken to make a study of the total availability of gas.

An investment decision on this Project has until now not been taken.

II.7.0 ABU DHABI (United Arab Emirates)

II.7.1 Following discussions at diplomatic level and exchange of visits of Indian delegation to UAE, an expert team of India visited Abu Dhabi to study infrastructure facilities and collect data for the preparation of a Techno-Economic Feasibility Report. The report was submitted in June 1975. Discussions followed on setting up of a joint venture between UAE and India. The UAE Ministry of Industry set up a company under its auspices - Abu Dhabi National Oil Company - to undertake this project. Agreement on a joint venture of this project could not be reached.

II.6.0 IRAQ

II.6.1 Bilateral relations with Iraq started with Indo-Iraqi economic cooperation in pursuant of which an Indian delegation was sent to Iraq in December 1971. The subjects covered were: crude supplies, joint venture refinery in India, joint venture fertiliser factory in Iraq and rendering technical engineering services to Iraqi Government in fertilizer industry. This was followed by an official delegation of Iraq in September, 1972 to India and an official delegation from India to Iraq in August, 1973 when these points were further discussed. There was already a contract entered into between ONGC and INOC for exploration, production and marketing of petroleum by ONGC from specific areas In Iraq. Some specific proposals were made as part of joint venture fertiliser projects in Iraq by India which were discussed also with the Iraqi authorities but the project did not proceed further.

II.6.2 As per the programme for providing assistance to Iraq, an agreement was entered into between Fertiliser Corporation of India and SOIDC of Iraq, for deputation of technical experts on short term basis towards February, 1974. Accordingly, experts in Mechanical, Instrument and Process Engineering were sent to Iraq. These experts assisted the Iraqi authorities in evaluation of the tenders they received from various parties for their new projects. They have also rendered assistance in operating plants. Subsequently, more experts were deputed to Iraq to assist them in evaluation of the bids for the fertiliser plants. A further number of experts were deputed to Iraq in February, 1977 for assisting them in commissioning of their ammonia and urea plants. Proposals are under consideration to assist Iraq in setting up of Research & Development Centre in Fertiliser field.

II.7.0 EGYPT

II.7.1 As part of Indo-Egyptian cooperation following projects were identified by end of 1972:

> A Joint Venture Project in Egypt for production of Phosphorous/Phosphoric Acid, based on Egyptian Rock.

However, there was no progress in this direction. In early 1975, another suggestion was made to explore the possibility of setting up a fertiliser project in Egypt based on gas and oil reserves. A detailed questionnaire was sent to the Egyptian authorities requesting information on feedstock, utilities site, meteorological data, communication facilities, construction facilities, manpower availability, etc. etc. No further progress has been attained.

II.8.0 PHILIPPINES

II.8.1 In response to global invitation to bid for preparation of a Techno-Economic Feasibility Report (including site selection feedstock selection and capacity selection) and marketing study (covering forecast of demand, method of marketing and distribution, establishment of storage facilities, etc.) for a Nitrogenous fertiliser complex in Philippines, Fertiliser Corporation of India submitted an offer in March, 1975. Five to six other international parties also quoted for the job. After evaluation, Government of Philippines selected Fertiliser Corporation of India for the final negotiation of the offer. Contract between Fertiliser Corporation of India and the Fertiliser Industry Authority of Philippines was concluded on June, 1975.

In pursuance of this contract, a team of Fertiliser Corporation of India engineers visited Philippines for collection of local data. The draft of the Techno-Economic Feasibility Report was submitted to FIA in end December, 1975 for their scrutiny as per contract. A second team of Fertilizer Corporation of India engineers visited Philippines in January, 1976 for discussion on the draft report. On the basis of these discussions, the final Techno-Economic Feasibility Report was submitted to FIA in March, 1976.

II.9.0 BRAZIL

II.9.1 Towards the end of 1976, Petro-Bras approached through Government of India for the deputation of an expert from Fertiliser Corporation of India to come to Rio de Janeiro, for one week for evaluating the work done by Brasilians in the field of coal gasification and advise them about future course. They also expressed interest to enter into an agreement for providing them consultancy service in the field of coal gasification. This was followed up by visit of a Fertiliser Corporation of India expert in the month of December, 1976. M/s Petro-Bras advised the Fertilizer Corporation of India to enter into an agreement with them for giving overall consultancy from the project feasibility stage upto commissioning and training of personnel for coal based ammonia plant. Accordingly, Fertiliser Corporation of India sent an offer to M/s Petro-Bras for consultancy and project management services in April, 1977. On receipt of the Fertiliser Corporation of India's offer, M/s Petro-Bras informed that they would require assistance of experienced Engineers to help evaluation of licensors proposals in Brasil; later on, they would formalise a contract based on the Fertiliser Corporation of India's offer. A team of Fertiliser Corporation of India was in Brasil between September and October, 1977, to assist them in evaluating the offers of various licensors. A formal contract for Phase - II services i.e. for selection of engineering contractor, selection of critical equipment, scrutiny during project implementation stage, assistance during commissioning of the plant and training of Petro-Bras personnel in the Fertiliser Corporation of India's projects is currently under active consideration.

II.10.0 <u>TURKEY</u>

II.10.1 Towards the beginning of 1977, M/s Azot Sanayii T.A.S. of Turkey invited the Fertiliser Corporation of India's cooperation and collaboration with them on process selection, licence, engineering services, supply of machinery and equipment and manufacturing technology and ammonia production from Lignite. A delegation from Turkey visited the coal based fertiliser projects in India and held discussions with Indian organisations. An understanding was reached between Azot Sanayii and Fertiliser Corporation of India, by which the Fertiliser Corporation of India expressed readiness to extend cooperation and render assistance in project planning, consultancy in overall projects and review of detailed engineering, procurement assistance and commissioning of the projects, training of Azot Sanayii personnel in plants in [illegible] Bangladesh's desire to build a new fertiliser project. Negotiations are in progress for training of engineers of Arab Council in Design and Engineering. [illegible] considering utilising the services of Fertiliser Corporation of India as consultant for the establishment of the fertiliser project.

11.[illegible] Turkey, on the other hand, is also extending cooperation to India. A group of [illegible] Indian engineers of the Fertiliser Corporation of India has taken specialised training in their lignite gasification plant in Operation and Maintenance.

11.41.0 BURMA

11.41.1 Towards the beginning of April, 1977, World Bank invited the Fertilizer Corporation of India to submit a proposal excluding cost estimates for undertaking a study on fertiliser marketing and distribution system as part of a pre-investment study for a urea fertiliser plant in Burma. The Bank is the executive agency for the programme, which is being financed by UNDP. Accordingly, FCI submitted the proposal to the World Bank excluding cost estimates, which found the basis of negotiations with World Bank, for which two representatives of the Fertiliser Corporation of India were in Washingtin in July, 1977. The contract document for award of the job to the Fertilizer Corporation of India was signed by World Bank on 25.7.1977. Seven FCI experts in the field of Market Research and Soil Sciences & Agronomy paid a visit to Burma in September/October, 1977. The Report is to be submitted very shortly. The scope of study encompassed the following:-

- Forecast of fertilizer consumption
- Import requirement and export possibilities
- Handling of imported and domestic products
- Bagging and Bag specifications
- Seasonal and monthly demand of fertilisers and their movement
- Transportation of fertilizers
- Warehousing
- Pipeline storage including inventory at the retailer end

- Price structure
- Marketing [illegible] Distribution Channel
- [illegible] organisation.

II.12.0 TANZANIA

II.12.1 At the instance of the Minister for Energy of Tanzania who was on an official visit to India in October, 1977, it was agreed between him and the Government of India that India will undertake the preparation of a Feasibility Report for building up an Ammonia/Urea complex in Tanzania based on free gas found there. The terms of the work to be undertaken by the Fertiliser Corporation of India have been finalised and a team of the Fertiliser Corporation of India engineers will shortly pay a visit to Tanzania to collect data information.

II.13.0 LIBYA

II.13.1 An understanding has been reached between the Government of India and the Libyan Arab Republic for cooperation in several fields. Specific areas in the field of fertilizers have been identified as below:

i) Providing technical assistance for meeting the technical manpower needs of the Ministry of Petroleum (Operation and Maintenance staff requirement for Ammonia and Urea Plants)

ii) Joint Venture company for Design, Engineering, Construction of Petroleum and Chemical Projects in Libya.

iii) Joint Ventures in setting up petrochemical projects.

II.14.0 ZAIRE

II.14.1 In March, 1977 Zaire had requested for training facilities in India for Electrolysis of Water for their experts. This training was requested in the context of plans by Zaire for putting up an ammonia plant based on Electrolysis of water. The Fertiliser Corporation of India has been asked to coordinate the training programme and other facilities.

II.15.0 SYRIA

II.15.1 The General Establishment of Chemical Industries, Damascus invited tenders for seleting consultant engineering services for fertilizer projects in Syria. The Fertiliser Corporation of India submitted an offer for the consultancy services in October, 1977 last. Response from Syria is awaited.

II.16.0 PEOPLES DEMOCRATIC REPUBLIC OF YEMEN (PDRY)

II.16.1 The Ministry of Economy & Industry of Peoples Democrafic Republic of Yemen (PDRY) and the Ministry of External Affairs of the Government of India agreed during the visit of PDRY delegation to India in March, 1974 that India would depute experts to prepare feasibility studies for industries on Soda Ash, Caustic Soda and Nitrogenous Fertilisers in that country. As a follow-up measure, a team of Indian delegation went to PDRY in September, 1974. On the basis of information collected from the PDRY, it was revealed that PDRY has no source of feedstock for feeding the fertiliser plant. They have to depend upon either naphtha to be made available by the refinery owned by British Petroleum in Aden or by fuel oil from outside source for feeding the fertiliser plant. None of these alternatives appeared to be attractive. The conclusion arrived at was that it would be preferable for PDRY to await the outcome of the developments on the present exploration for crude and associated natural gas so as to derive the advantages involved in the use of gas as fertiliser feedstock.

II.17.0 COLLABORATION WITH ANDEAN PACT COUNTRIES

II.17.1 Under the cooperation programme between developing nations supported by UNIDO Industrial Board and reiterated by in "The Lima Declaration and Plan of Action on Industrial Development and Cooperation" adopted at the 2nd General Conference of UNIDO in March, 1975 and Round Table Ministerial meeting on Technological and Industrial Cooperation among Developing countries held in New Delhi in January, 1977, there was exchange of experts between India and the Andean Pact countries. As a result, certain projects were identified for setting up in the Andean Pact countries in which India could render active assistance. In the field of fertilisers, the projects identified are for Bolivia on (i) Detailed geological prospecting of rockphosphate deposits and (ii) setting up a large fertiliser complex. The Bolivian authorities have invited the Fertiliser Corporation of India for assistance in setting up of a fertiliser plant. The matter is under active consideration.

ANNEXURE - I

RECENT DEVELOPMENTS IN THE MANUFACTURE OF CHEMICAL PLANT AND EQUIPMENT IN INDIA - AND ENGINEERING AND CONSTRUCTION OF COMPLETE FERTILIZER FACTORIES

Part I

BACKGROUND OF ENGINEERING, FABRICATION AND CONSTRUCTION INDUSTRIES IN INDIA

Carbon Steel Fabrication

Medium Pressure Chemical Plants

1. In recent years, considerable development has taken place in engineering, fabrication and construction industries in India. Design and fabrication of structural steel of practically any description, of carbon steel plate upto a thickness of about 30 mm and carbon steel vessels of practically any shape and volume for normal pressure service is quite common. In more recent years, several factories have now been equipped to handle carbon steel plates upto 80/90 mm thickness. Workshops equipped with modern shearing, bending, edge preparation and ancillary equipment for handling such thick plates are available. These shops are equipeed with modern tools for welding and could adopt rigid standards of inspection of weld for class I service with facilities for X'Ray and other means of non-destructive inspection. Chemical plants, vessels and heat exchangers for operation upto 20 atm. service could now be produced in these shops. Shops equipped for manufacture of complete high pressure boiler plant and equipment upto 40 atm. service and upto 300 tons per hour steam raising capacity are already on production lines.

Machinery for Chemical Plants

2. In the field of machinery, Indian-made centrifugal water pumps of capacity upto 7500 gallons per minute with 140 ft. head, and alloy steel pumps for chemical plants built out of very high ("R 55" metal)nickel content alloys for service in ammonium sulphate plants are already in service; fans and blowers for dust control, and air-conditioning systems in chemical plants

are becoming increasingly available; small **air compressors** for use in construction industries are available; and production of **ammonia compressors** for refrigeration service are due to start soon. Schemes are under active consideration for the production of **high pressure air and gas compressors** in collaboration with experienced firms from other countries.

Heavy Machinery and forging for chemical Plants

3. Although capacity is limited to meet the ever expanding demand, a significant beginning has been made in the **steel castings** industry. Several large units are now being set up for production of **heavy machines** and components of heavy plant and equipment. Large foundries and capacity for **heavy forgings** are being established with the primary object of producing ultimately complete equipment for integrated iron and steel works. These factories would also be capable of production of components for super high pressure chemical plant service such as those used in the field of ammonia synthesis and other petro-chemical fields.

Mechanical Handling for Chemical Plants

4. **Complete mechanical handling plants** for raw materials and product handling in heavy chemical factories could now be engineered, fabricated and constructed within India. Components such as for example, rollers, idlers, conveyor belts, head and tail pulleys and more recently, reduction gears are available from Indian industries. Complete bucket elevator equipment designed and fabricated in India are in use for service in chemical industries.

Electrical Equipment for Chemical Industries

5. In the field of electrical equipment and accessories, a significant progress has similarly been made. **Cables for high tension and low tension** service and **motors upto 250 HP** are commonly available; steps haverecently been taken for the production of **flame-proof and explosion-proff motors**; **transformers and switch gears** are being produced, although presently with considerable imported components, and steps have been taken for the production of **large induction and synchronous motors** in the factories that are now being set up for the production of heavy electrical equipment inclusive of turbo-alternators for power generation.

Instruments for Chemical Process Industries

6. Development in the field of chemical process instruments has so far not been significant, but progress is being made in that direction.

Construction Services for Chemical Factories

7. In the field of construction, a good many competent design firms are available for complete design and supervision of construction for industrieal buildings and foundations. There are number of contracting firms specialised in reinforced concrete and structural steel work. Specialised types of construction, such as thin shells, pre-stressed and pre-cast in reinforced concrete, are becoming increasingly popular. Steps have also been taken for the production of high tensile steel wire required for pre-stressed concrete jobs. In a recent application, in conjunction with the Rourkela Fertilizer Plant - one of the largest fertilizer plants in the world which we shall presently describe - two large silos (approximately 700 ft. in length, 120 ft. width and 75 ft. height) for storage of fertilisers have been built with thin shell construction by Indian design and construction firms at a cost which is nearly half that of similar structures built earlier with designs from abroad.

Water proofing

8. Materials and specialist service are available for water-proofing and handling problems in connection with water-seepage, etc. Polyethelene films are being increasingly used for such jobs.

Paints for Chemical Industries

9. Corrosion and heat resistant paints are available to meet the many demands for application under corrosive condition in chemical industries.

Insulation in Chemical Plants

10. Efficient insulation materials for both low and high temperature service are being produced from mineral slags. Synthetic materials of the polyestyrene group of polymus are being increasingly use for cold insulation to substitute cork which until now has been imported in large quantities for such jobs. Specialist Indian firms are now available to execute insulation jobs for any service encountered in chemical plant operations with highly rigid specifications and standards.

Plastic Piping Materials for Chemical industries

11. Newer developments in piping materials such as for example polyethelene, P.V.C. etc., are also becoming increasingly available.

Production of alloy steel, aluminium and other materials of construction for Chemical Industries.

12. In the field of materials of construction, large projects are under way for production of special steels, corrosion resistant alloy steels, aluminium and other non-ferrous metals, copper and plastic materials, etc. Small diameter carbon steel pipes are being produced as also valves and pipe fittings for water services. Pipes, valves and pipe fittings, for rigorous chemical plant service for gas, air chemical fluids and slurries are however, yet to be developed in specialist factories.

Complete Auxiliary and Ancillary Plants for Chemical Industries

13. Auxiliary and ancillary plants for operation in conjunction with chemical industries, e.g.:

a) Demineralisation plant for water treatment,
b) Induced draft, forced draft and natural draft, cooling towers,
c) Complete mechanical handling plants for raw materials and product-handling,
d) Air-conditioning and refrigeration plants,
e) Complete sulphuric acid plants,
f) Complete cane sugar plants,
g) Complete cement plants

are being designed, engineered and offered under one responsibility by competent Indian firms as package units against outline specifications, to meet any customer demands for chemical industries.

Consulting Engineering Services

14. Consulting engineering services are also beginning to develop in India. An organisation with specialists for engineering of integrated iron and steel plants and alloy steel plants and other metallurgical industries has been functioning with success. This firm has recently been commissioned by Pakistan in connection with establishment of a steel plant there. The author is in charge of the Project Division of the Fertilizer Corporation of India who has been commissioned for furnishing Technical Consultancy Service to the Federation of Malaya for setting up an urea fertilizer plant in Malaya. Earlier the author - as an expert chemical engineer, member of the FAO-United Nations Team - had acted as adviser to many governments for chemical fertiliser projects.

PART II

COMPL..E PROJECTS FOR CHEMICAL INDUSTRIES

15. With general background of the stage of development of the engineering fabrication and construction industries in India as outlined above, it should now be possible to have a fuller appreciation of the role that could now be played for engineering, procurement and construction of large complete chemical and allied projects. The author's specific experience has been in the field of chemical fertilizer industry, and in more particular, in the field of nitrogenous chemical fertilizers. The development that has taken place in this field during the last several years in India is quite significant. This paper would describe the experience in engineering, procurement & Construction of a complete fertiliser project of one of the world's largest chemical fertilizer projects with an annual production capacity equivalent to 600,000 tons of nitro-lime fertilizer. The project now nearing completion for Hindustan Steel Ltd. at Rourkela is being built as a "turn-key package" contract by the Fertilizer Corporation of India through its Project Division entirely under the responsibility of Indian Engineers.

Rourkela Fertilizer Plant

6. The plant is adjacent to a large integrated iron & steel works. The feed stock is coke oven gas from the steel works, nitrogen from the oxygen plant of the steel works (oxygen being used for steel making processes) and limestone rejects from quarries for primarily meeting the requirement of the blast furnace plant. The high pressure plant upto the production of the intermediate product - anhydrous ammonia (464 tons per day) is being engineered and constructed by an experienced firm from Western Europe. The Fertilizer Corporation of India through its Project Division is responsible for the complete factory for the production of nitric acid (nearly 1,700 tons of 53 per cent acid per day) and nitrolime (nearly 2,000 tons of product containing 20.5% N per day), and associated auxilliary and ancillary facilities e.g., electrical distribution system, water treatment plant with demineralisation, cooling tower and water circulation system, limestone unloading, handling, reclaiming and grinding facilities (000 tons per day), air-conditioning system, with a total capacity of 1200 tons of refrigeration per day, product storage (150,000 tons capacity), reclaiming, handling & bagging facilities (5,000 tons of bagged product per day).

Indian goods and services for the Rourkela Project

17. This gigantic project has been built entirely under the responsibility of Indian engineers and with a considerable percentage of Indian goods and services. An experienced firm of Western Europe has acted as process consultants for limited services for highly specialised sections in which India until now does not have adequate experience. Instruments, machinery, large synchronous and induction motors and other miscellaneous components have been imported of a total value equivalent to less than half of that spent in other comparable projects built earlier in India. With the background of development that have been outlined earlier it would be possible, in course of next few years, to considerably reduce this expenditure of imported components and build chemical plants largely from within the resources in the country.

Chemical Plants and Equipment for the Rourkela Project

18. A few illustration of critical chemical plants and vessels and particularly those of Stainless Steel that have been produced for the first time in India for the Rourkela Project are given in the paragraphs below.

The nitric acid plant is of conventional medium pressure type and designed for an operating pressure of 4.2 atm. absolute. The product acid is obtained at 53 per cent concentration and is used to neutralise anhydrous ammonia in the ammonium nitrate plant. The resultant neutralised liquor is concentrated to 95 per cent and therefore mixed with powdered limestone for granulation. Practically the entire plant equipment and accessories coming in contact with nitric acid vapours (below the dew point) nitric acid solution and ammonium nitrate are of stainless steel. The equipment which handle wet granulated product e.g., pug mills, granulating drums and dryers, are lined with stainless steel.

Special Stainless Steel for Nitric Acid and Ammonium Nitrate Plants at Rourkela

19. Of the three alternative possibilities for nitric acid and ammonium nitrate service, niobium stabilised stainless steel as per American standard AISI 347 is most suitable, but generally most expensive. The carbon content should preferably not exceed 0.07 per cent maximum (in actual practice forRourkela this was of the order of 0.04 to 0.03 per cent), and a completely austenite structure is essential i.e, if the chromium content is increased the nickel content must also increase proportionately. The stabiliser element niobium and tantalum must be

present to the extent of 10 times the maximum carbon content for complete stabilisation. Apart from corrosion resistance, the stabilised steels are relatively easier to handle for fabrication than the extra low carbon steels, which are also equally suitable from the point of view of corrosion resistance. The Rourkela Project was built entirely with AISI 347 niobium stabilised stainless steel., although this steel is normally most expensive than other varieties.

19.1 A total of 650 tons of stainless steel plates and sheets between thickness of 2 mm to 7 mm were procured from Europe; in addition fabricated dished ends, heat exchanger tubes, pipes upto 200 mm internal diameter, valves and pipe fittings, and bolts and nuts, for an approximate total weight of 200 tons were also procured from abroad. Apart from some special design stainless steel coolers made out of thin sheets (1.5 mm thick), and two sets of shell and tube heat exchangers (feed water heaters, and cooler condensers), the <u>entire plant and equipment in stainless steel was fabricated in India.</u> The total tonnage involved is approximately 850 (of which about 650 tons are stainless steel plates and sheets between 2 to 7 mm thick), which is roughly equivalent to 3500 handling tons of carbon steel tonnage in the normal thickness that are used in industry.

19.2 Great care was taken in specifying the stainless steel inclusive of tests on physical properties, chem'cal composition, corrosion resistance etc. The welded specimen from each heat had been subjected to boiling 65 per cent nitric acid test and only such steels as do not show any weld decay lines or any other granulating attack is approved for use for fabrication. A rate of corrosion at less than 0.018 inch per year when tested repeatedly 5 times for 48 hours period each in boiling 65 per cent nitric acid solution is the limit of tolerance. Great care was taken to plan the procurement of sheets and plates in width such that the number of welded joints in the fabricated equipment is reduced to minimum. Since this involved procurement of sheets over 2 metres in width, the choice was restricted to only a few firms in the world who could produce stainless steel sheets in such widths.

Shop Fabrication in Stainless Steel in India for Rourkela Nitric Acid and Ammonium Nitrate Plants.

20. The fabrication of different plant and equipment and pipes and fittings was undertaken by a number of fabricators in India from detailed drawings furnished to them. Most of the fabricators did not have any experience of such jobs in the past and only some of them had some experience of relatively small jobs. Rigid fabrication standards were, therefore, set up by mutual discussion with the fabricators. Continuous independant inspection of the welds was undertaken by the Project Division's own competent welding supervisors and experts in the field. The European process consultants made available the services of an expert inspector on stainless steel welds, who continuously visited the different fabricating firms in India alongwith Indian welding supervisors and kept a continuous check on them. The Indian supervisors and welders in different factories thus gained considerable knowledge and expereince on the control of welds. Arrangements were also made for non-destructive inspection tests such as X'ray and radiography. Such routine inspection tests also helped incidentally to improve the general standards of workshop practices. The welders improved progressively during preliminary trial welds and ultimately produced welds which are of very high standards and comparable to the best that have been produced in the industry in advanced countries. Only such welders were allowed to work on fabrication of critical chemical plant and equipment and regular inspection of the welds were also conducted thereafter to ensure continuity of quality work. Argon arc welding was employed for these sections.

Site fabrication and Erection and Stainless Steel at Rourkela Fertiliser Project

21. Apart from shop fabrication a considerable quantity of welding work had to be done at site, particularly, in connection with assembly of large vessels, assembly and erection of tanks, and erection of pipe lines. In the latter, the thickness of the material handled was of the order of 2 mm and sometimes less and these presented special problems.

Site Radiography [illegible] Rourkela Fertilizer Project

21.1 To keep a continuous check on practically 100 per cent of the critical welds at site a special unit was developed by the project to undertake radiographic examination of welds. With establishment of the nuclear reactors in India, cheap GAMMA ray sources are available from the Atomic Energy Establishment, for gama ray radiography. The technique and equipment for the inspection tests have also been developed by the Atomic Energy establishment in India. Under their guidance, a special Unit was set up at site and technicians trained to handle radiography equipment. Iridium 192 isotope was used for the radiographic work. The field radiography unit is also equipped with an air-conditioned dark-room for processing and developing films immediately after the test so that any fault could be detected and corrected on the spot, before the work could proceed further. The welders had also been kept alert as a result of such continuous tests, which were very effective to maintain quality of work. The net result had been that the completed plants and equipment have shown very few minor leaks in the final pressures. The rigorous quality control at the time of fabrication and erection helped to ensure a good weld without cracks, blow holes or other faults.

Examples of Types of Stainless Steel Chemical Plant and Equipment - Tanks Towers for Rourkela Nitric Acid and Ammonium Nitrate Plants

22. Typical examples of important plant and equipment fabricated out of stainless steel in this project are:

(i) Product acid storage tanks for storage of 53 per cent nitric acid (4 Nos.) - each 10.5 m. h x 8.94 m. dia. each having approximately 20 tons of stainless steel plates between thickness 3 mm to 7 mm. The plates were rolled to size in the shops and the assembly and erection were done at site.

(ii) Storage Tank for Ammonium nitrate melt (4 Nos.) - Each 2.5 m h. x 1.8 m. dia. for storing 80 per cent ammonium nitrate.

(iii) Oxidation tower (4 Nos.) for allowing retention time for oxidation of NO to NO_2 - Each 11.4 m h. x 2.7 m dia. and weighing 6.4 tons - Shop fabricated with plate thickness ranging from 4 to 6 mm.

(iv) Absorption towers for absorption of gaseous oxides of nitrogen in circulating dilute acid of varying concentration (24 Nos.) with dished ends with internal grids of stainless steel to act as supports for ceramic raschig rings packing material, inlet and outlet nozzles for gas and liquid inlets and outlets, Stainless Steel Sprays, each 20.4 m.h. and 2.7 m dia, weighing approximately 17 tons each of stainless steel material made out of plates between 4 to 7 mm thick.

(v) Bleaching tower (4 Nos.) for bleaching of brown acid with air to obtain water white acid by expelling oxides of nitrogen (9.2 m x 1.3 m weighing 7 tons).

(vi) A number of stainless steel tanks for miscellaneous services e.g.

Make up condensate (4 m h x 3.8 m, - 2.5 tons).
Degassing tanks (1.5 m x 0.4 m).
Nitric acid tanks (2.8 m h. x 2.2 m).
Neutralised liquor (4.4 m h. x 3.8 m - 3.5 tons).
Level tanks for evaporators (1.4 m h. x 1.6 m -
Drip acid tanks (3.1 m x 1.2 m).
Acid balance tanks (3.2 m x 1.3 m).
and many other miscellaneous vessels and tanks.

Stainless Steel Shell and Tube Heat Exchangers
FOR Rourkela Nitric Acid and Ammonium Nitrate Plants

23. A number of shell and tube heat exchanger for different services had been fabricated in India for the project. Typical examples are:

(a) Condensate coolers 3.6 m l, 0.6 ID having 312 tubes weighing 3.5 tons (2 Nos) stainless steel.

(b) Nitric acid pre-heaters for pre-heating 53 per cent nitric acid, - 3.6 m l., & 0.5 OD with 178 tubes - weighing 2.9 tons (4 Nos) - stainless steel.

(c) Neutraliser vapour condenser - 3 m h. x 0.8 m ID containing 454 tubes, weighing 16.52 tons (4 Nos). - stainless steel.

(d) Tail gas heater for pre-heating tail gas with outgoing hot gases from the ammonia oxydation section operation at 4.2 atm. absolute, - 6.8 m. h x 0.9 m ID containing 608 tubes and weighing 17.8 tons (4 Nos.)

and a number of other shell and tube heat exchange equipment.

Stainless Steel Reactors and Concentrator of special designs for Rourkela Ammonium Nitrate Plant

24. The reactors and concentrators of special design in the ammonium nitrate plant are as below:

(i) Evaporators 10.8 m n. flash type dia., 2 m OD, weighing 19 tons (4 Nos.)
(ii) First stage neutraliser complete with flash chamber and mist separator overall height 10.3 m x 1.3 m dia., - 5.3 tons (4 Nos.)
(iii) Second stage neutraliser complete with agitator height 2.2 m dia., 1.5 m, 2.3 tons (4 Nos.)

Field Welds on Vessels and piping Radiographed at Rourkela Fertilizer Project Site

25. The field welds for assembly of the vessels (either due to limitations imposed by transport or for convenience in erection) had to be conducted under rigorous inspection and the entire welds radiographed. The piping work and installation of supports for the piping had also to be conducted under rigorous conditions of inspection with radiographs.

Argon Arc Welding for thin Shell piping and fittings

26. For working on thin sheets such as vessels and piping with 2 mm thickness, Argon Arc Welding was employed.

Care in Handling Electrodes

27. The electrodes (AISI 347 type) were partly available from a manufacturer in India, but due to inadequate supply in time had also to be imported in part were carefully stored in a hot dry atmosphere and only absolutely dry electrodes were used on the job.

Rotary Drums, Cooler Drums, Coating Drums and Granulating Drums for Rourkela Fertilizer (Nitrolime) Plant.

28. Apart from the critical stainless steel plant and vessels described above, a number of other heavy critical equipment of large dimensions were fabricated for the first time in India

for services in Chemical fertilizer Plants.

Typical examples are:

(a) Rotary granulating drum of carbon steel sheet (length 8 m x dia. 3.5 m lined with AISI Type 347 - 2 mm thick weight 15 tons stainless steel plates equipped with girth gears, reduction gears and pinions for a speed of rotation at 4.5 r.p.m.) for granulation of ammonium nitrate and powdered limestone mixed material containing approximately 3 per cent moisture.

(b) Rotary cooler drums of carbon steel (dia. 2.6 x length 14 m, each weighing about 29 tons with internal lifter plates) for cooling granulated nitro-line product fertilizer with conditioned air at 16.6°C. 100 per cent R.H.

Each Drum is equipped with girth gears, reduction gears and pipions, for driving at 4 r.p.m. for cooling the product from 60°C temperature to 45°C temperature.

(c) Rotary coating drum of carbon steel weighing about 14 tons (dia. 2.5 m x length 9.0 m) for coating on Nitrolime fertilizers with finely powdered limestone to ensure free flowing characteristics, equipped with girth gears, reduction gears and pipions for operation at speed 4 r.p.m.

There are 4 Nos. of each of these drums i.e, a total of 12, and each granulating drum is capable of handling 40 tons/hr. and the coating and cooling drums 22 tons per hour of material (gross) for a net output of about 20 tons per hour capacity of finished fertiliser from each of the four streams. These equipment are all fabricated in engineering firms in India.

PART III

OUTLOOK

29. With the general background of engineering, fabrication and construction industries in India that have been briefly outlined in Part I and with the knowledge and experience gained in engineering, procurement and construction of one of the largest chemical nitrogenous fertilizer plants in the world in Rourkela, India as outlined in Part II, it should be possible to undertake to build complete projects for chemical fertilizer and allied industries in India under the entire responsibility of specialist Indian Engineers organised specifically to engineer, procure and construct different groups of industries, e.g., chemical fertilizers and other petro-chemical and chemical industries. Such specialists organisations could undertake to build projects largely from the goods and services that are available in India and that are likely to be available in near future from the projects that are now being developed in the engineering and construction fields. As a result, complete fertilizer projects should now be possible to build with limited imports of specialised machinery and know-how. With this background of experience gained in building the Rourkela nitric acid, ammonium nitrate and granular nitrolime fertilizer plants, India would be in a position to plan, engineer, procure and build complete chemical fertilizer projects, with the service of Indian Engineers and goods of Indian origin, for neighbouring developing countries in Asia, Middle East and the Far East.

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