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

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OPTIMISING RESOURCES FOR THE DEVELOPMENT OF INDIAN PHOSPHATE FERTILIZER INDUSTRY*

Prepared by

B. K. Jain**

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** Director (Technical), The Fertilizer Association of India, New Delhi, India

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SUMMARY

The fertilizer industry in India has come a long way. Presently there is an installed capacity of more than 5.8 mill. te N and 1.7 mill. te P205 in the country. The industry has made pioneering efforts in making use of indigenous phosphate rock. For meeting the growing needs of phosphatic fertilizers, a mixed strategy has been adopted. Because of very large dependence on imported raw materials, efforts to exploit the indigenous resources are being intensified. To ensure a fair return on investment, all fertilizers in India have been brought under statutory control. With proper policy support in terms of the end product, the objective of increased fertilizer production and consumption would be achieved.

I. Agriculture is the mainstay of the Indian economy and will continue to remain so. Fertiliser holds a key position in the system because of its accepted vital role in the growth of agricultural production. Since early 60s the Indian fertiliser scene has been continually expanding, embracing a whole range of fertiliser technology, using a wide spectrum of feedstock/raw materials and producing a vast array of products. The fertiliser industry occupies a pivotal position in the country. Presently India is the fourth largest producer and consumer of nitrogenous fertilisers and the sixth producer and consumer of phosphatic fertilisers in the world. The compound rate of growth in P2O5 capacity from 1960-61 to 1984-85 has been 10.9% per annum.

The build up in terms of P2O5 nutrient capacity over the years may be seen from Table I.

Table I: Growth in Phosphatic Fertiliser Capacity

Year	Straight Phosphatic -SSP/TSP		NP/NPK Complexes		Total	
	No. of plants	Cum. cap. '000 te P2O5	No. of plants	Cum. cap. '000 te P2O5	No. of plants	Cum. cap. '000 te P2O5
1950-51	9	86	-	-	9	86
1960-61	13	107	1	36	14	143
1970-71	27	232	5	214	32	446
1975-76	31	249	9	519	40	768
1980-81	44	538	10	810	54	1348
1984-85	59*	695	10	1027	69	1722

*Includes 16 small-scale SSP units having a total capacity of about 44,000 te P2O5

II. Mozaic of Product Pattern

Considering that both the principal inputs for phosphatic production, namely rockphosphate and sulphur had to be essentially imported and taking into account the compulsions to maximise foreign exchange savings during the early 60s, production of nitrophosphate was considered for minimising sulphur requirements and a nitrophosphate plant was set up at Trombay. Later in Trombay IV calcium nitrate freeze out method for furnishing nitrophosphate with 60% water-solubility was adopted. Another nitrophosphate plant,based on sulphate-recycle route has been set up at Haldia, which is being commissioned. Besides single and triple superphosphate, phosphatic fertilisers are produced in the country in various grades of ammonium-phosphate, urea-phosphate and nitrophosphates. The production pattern of phosphatic fertilisers in various forms is shown in Table II.

Table II: Production Pattern

Fertiliser	1982-83	1983-84	1984-85
I. Straight Phosphatic			
1. SSP (16% P205)	211.2	238.7	303.6
2. TSP (46% P205)	10.8	9.7	4.6
3. Total straight Phosphatic	222.0	248.4	308.2
II. NP's			
(APS) 16-20-0	19.8	25.7	11.5
(APS) 20-20-0	25.3	40.3	79.5
(DAP) 18-46-0	212.0	332.5	411.8
(UAP) 24-24-0	3.1	1.0	1.2
(UAP) 28-28-0	68.4	75.5	74.9
(Nitro Phos) 20.7-20.7-0	47.8	55.5	55.6
Total NPs	376.4	530.5	634.5
III. NPK's			
(nitrophos) 15-15-15	36.9	40.6	41.2
14-35-14	15.4	2.7	10.2
19-19-19	26.6	29.8	22.3
17-17-17	99.2	84.0	97.8
10-26-26	24.2	28.2	53.3
12-32-16	177.3	97.4	141.8
14-28-14	5.7	2.5	8.9
Total NPK's	385.3	285.2	375.5
Grand Total I + II + III	983.7	1064.1	1318.2

III. Productivity in Phosphatic Industry

Considering the various odds and constraints under which Indian Industry has to function,the performance of phosphatic plants,has been by and large satisfactory, barring a few plants. While the SSP industry and nitrophosphate plants have achieved an average capacity utilisation of around 75%, the performance of complex fertiliser plants based on imported phos-acid and ammonia has been much more impressive with an average utilisation rate of about 100% during the last five years. The main reason for lower capacity utilisation of the P205 industry, except for the year 1984-85 in which it attained 89% utilisation, had been virtually the inoperative capacity of phos acid-TSP plants which constituted about 31% of domestic phos-acid capacity and 16% of the total P205 installed capacity. The performance of domestic phos-acid plants had been unsatisfactory because of problems of corrosion, rubber-lining, other critical equipment and inadequate availability of sulphuric acid for reaction.

The capacity utilisation in various segments of phosphatic industry is shown in Table III.

Table III: Percentage Capacity Utilisation

Year	Phos-acid (domestic production)	SSP	Nitrophos-phate	Complex plants (based on imported phos-acid)	Total P205 (all plants)
1980-81	64.3	65	76	108.5	65
81-82	56.8	71	75	95.0	69
82-83	61.2	74	70	98.8	69
83-84	53.1	72	80	95.0	70
84-85	61.6	74	81	120.3	89

IV. Resource Optimisation

An interesting feature in the development of fertiliser production in India is the optimisation and use of indigenously available feedstock and raw materials.

(A) Rockphosphate

The first large deposit of phosphate rock was discovered in Jhamar Kotra (Rajasthan) in 1969. The rockphosphate in the country is mainly confined to sedimentary rocks as phosphorite. Out of about 150 million te of indicated phosphate reserve in the country, around 122 mill te of rock having widely ranging P205 content from 10 - 32% P205 would require beneficiation. Mainly run of mine grade of +31% P205 containing silica 7-11% as impurity is directly used by the fertiliser industry. With the increasing Ore:over burden ratio, the production has been pegged at about 0.5 mill tpy. The reactivity compared to Jordan rock is poor and fineness above 90% through 100 mesh and acidulation with acid of 66-68% strength at 62-65^{o}C and more retention time in the Den have to be maintained for SSP production. For phos-acid production a free SO3 level of 35-40 g/l and higher temp upto 70^{o}C and higher solid content in the slurry helped in getting uniform rhombic shaped easily filterable crystals.

Jhamarkotra rock having apatite as the main phosphate bearing mineral and dolomite constituting the main gangue has been successfully subjected to beneficiation in a 200 tpd (input) semi-commercial plant upgrading the feed from 18-20% P205 to +32% P205 and MgO within 1.5%. The process involves bulk flotation of carbonate and phosphate at an alkaline pH and depress the silica using a depressent followed by separation of high grade phosphate and carbonate at acidic pH. The experience will be utilised in optimising the process parameters for a commercial plant of 0.3-0.35 mill tpy concentrate capacity. Besides, a commercial beneficiation plant of 600 tpd to treat 20-25% P2O5 rock containing high silica from Maton deposits using froth flotation process is in operation since 1976. Currently about 0.7 mill te rock phosphate from domestic sources is usedin fertiliser production. Keeping in view the P2O5 content of the rock currently used in the phosphate industry and the grade of ore that can be subjected to beneficiation from the various deposits, the reserves could be broadly regrouped as:

i) Around 18 mill te of directly marketable grade having 30% P2O5 content and above of which abcut 17 mill te are in Udaipur(Rajasthan) and about one million te in Chattarpur & Sagar (M.P.).

ii) Around 32 mill te of rock containing 25-30% P2O5 (Rajasthan, M.P. & U.P.) may be considered as blendable grade. Small quantities of this grade is already being used after blending with high grade imported rock.

iii) Various grades of rock containing P2O5 upto 25% which would require beneficiation before use.

(B) Sulphur

Sulphur is abother basic raw material required in the phosphate fertiliser industry. India has no source of elemental sulphur and there is no production of sulphur, except a small quantity produced as by-product from petroleum refinery and that obtained from fuel oil gasification in fertiliser plants. But the country is endowed with huge reserves of pyrites at Amjhore(Bihar) and Saladipura (Rajasthan). The reserve at Amjhore is more than 300 mill te expressed as pyrite containing 40% S and in Saladipura the reserve has been estimated at 120 mill te of pyrite containing 20% S. Further the reserve of pyrite ferrous shale containing 10% S is about 1500 mill te. Two sulphuric acid plants (400 and 880 tpd) had been put up but the acid plants encountered technical problems dueto impurity of pyrite feed and operation of these plants has since been stopped.

Sulphuric acid is also made in the country from sulphur bearing gases from zinc and copper Smelters. The six non-ferrous metal smelters have a cumulative capacity to produce 425,000 tpy of acid, however the production is limited to about 70,000 tpy of sulphur equivalent as acid.

V. Growth Strategy

The compound rate of growth in P2O5 consumption from 1960-61 to 1984-85 had been 15.6% per annum. The all-India ratio of N:P2O5 has been around 3.0. It is envisaged to achieve a ratio of about 2.5. Efforts are to be made to amend the imbalance and increase the consumption of P2O5. The planned capacity build up, estimated production, demand and gap in P2O5 up to the end of the decade are given in Table IV.

Table IV: Capacity Production and Demand Estimates of P_2O_5 ('000 te P_2O_5)

Year	Capacity	Production	Demand	Gap
1985-86	2013	1455	1955	(-)500
1986-87	2168	1625	2200	(-)575
1987-88	2733	1908	2353	(-)445
1988-89	2617	2109	2517	(-)408
1989-90	2891	2194	2687	(-)493

For meeting the growing needs of phosphatic fertilisers, mixed strategy has been adopted. The gap between the demand and indigenous production of P_2O_5 of around 0.5 million tonnes per annum will be met from imports. The indigenous capacity is based, partly on rockphosphate and sulphur and partly on imported phos-acid.

In order to meet the specific requirement of various crops with respect to essential secondary and micronutrients like sulphur, calcium, magnesium, copper etc, creation of substantial new capacity in the form of SSP has been undertaken. The SSP capacity would practically be doubled to 0.8 mill te P_2O_5 by 1989-90. To reduce country's dependence on imported sulphur, further production of nitrophosphate is also being considered. The total energy requirement for newer nitrophosphate processes is also claimed to be marginally less at 26.7 mill. KCal/te P_2O_5 as compared to 28.2 mill.KCal/te P_2O_5 based on ammonium-phosphate adopting sulphur route.

As a product DAP commands several advantages in manufacture, handling and storage. Very substantial expansion is planned in DAP capacity, mostly based on imported phos-acid at coastal locations to facilitate handling of imported phos-acid and ammonia. The % share of DAP in the total P_2O_5 capacity would increase to 38.5% by 1989-90. The planned expansion in the capacity of various phosphatic fertilisers is shown in Table V.

Table V: Expansion in capacity of various phosphatic fertilisers (P_2O_5)

Fertiliser	Grade	1984-85		1989-90	
		Capacity (in terms of P_2O_5) ('000 tonnes)	Percentage share of total	Capacity (in terms of P_2O_5) ('000 tonnes	Percentage share of total
1. SSP	16% P_2O_5	442.7	25.1	809.2	27.7
2. TSP	46% P_2O_5	252.2	14.6	252.2	8.6
3. Comb.Phosphates					
(a) Am.Phos. Sulphate	16-20-0 20-20-0	40.0	2.3	40.0	1.4
(b) Urea Amm. phos	28-28-0 14-35-14	104.0	6.0	104.0	3.6
(c) Nitro Phos	15-15-15 20.7-20.7-0	120.0	7.0	195.0	6.7
(d) Diammonium Phos	18-46-0	368.0	21.4	1130.0	38.5
(e) Other NP/NPKs		395.1	22.9	395.1	13.5
TOTAL		1722.0	100.0	2925.5	100.00

Efforts are also under way to increase the use of rockphosphate for direct application as phosphatic fertiliser. The fertility values of Mussoorie rockphosphate has been found comparable with SSP in acidic and near normal soils. Presently about 80,000 te of rockphosphate containing 18-24% P205 is used for direct application in the country and it is planned to increase it to 120,000 te in the next 2 years. Phosphatic fertiliser production in the country would involve large dependence on imported raw materials (rockphosphate/sulphur) or intermediates (phos-acid). The estimated import requirements of rockphosphate, sulphur and phosphoric acid upto 1990 are given in Table VI.

Table VI: Import Requirements of Raw Materials & Phos-acid

('000 te)

Year	Rockphosphate	Sulphur	Phos-acid (P205)
1985-86	2660	875	650
1986-87	2835	890	900
1987-88	3055	945	1020
1988-89	3280	1035	1200
1989-90	3425	1075	1250

With sulphur demand growing out of pace with supply at the International level, the price of sulphur is likely to harden. Already in the recent past there has been a spurt in the sulphur prices to the extent of 50%. At the current price of sulphur, production of sulphuric acid from pyrites could be an economic proposition. Technology is claimed to be available for conversion of pyrites to elemental sulphur by the hydro-metallurgy and pyro-metallurgy route. The production of sulphuric acid/cement from phospho-gypsum, can also be considered. Established process technology is available and sulphuric acid production may be economically viable from phosphogypsum as compared with the increasing prices of imported sulphur. Recovery of sulphur as acid from S02 bearing smelter gases from copper, lead and zinc smelters has also to be maximised.

Considering the large requirement of imported phos-acid it would be of advantage to tie-up supply of substantial quantities from firmed up sources on long-term basis. A beginning has already been made in the case of Senegal project where Indian companies have become equity partners in a phos-acid plant.

(VI) Tasks Ahead

A competent technological base has been progressively built up in the country in design, engineering, construction and operational management. Indigenous process technologies are available for acids, SSP/TSP and complex granulation plants. Latest technology like pipe reactor, pressure neutraliser and fluidised bed granulation etc are also being adopted. Auto-analyser for better quality control of various complex formulations have been widely adopted by the industry. Total effluent recycle for pollution abatement is practiced in several plants. However, fluorine recovery and utilisation of byproduct gypsum requires attention.

Although a few plants have achieved above 100% capacity utilisation, nonetheless, productivity in several phosphatic plants needs improvement. The on-stream efficiency and capacity utilisation of phosphoric acid plants in particular have to be improved by revamping. Various retrofit schemes are to be implemented to further improve energy efficiency and productivity.

Forecast of world phosphatic fertiliser supply/demand balance indicates a comfortable availability of phosphatic fertilisers upto 1994-95 but a country of India's size and resources cannot be dependent for 100% of its requirements of raw materials for production of essential commodities like fertiliser, and therefore efforts to exploit the indigenous mineral resources have to be intensified. Sources for imported raw materials have to be diversified to the extent possible.

A target of 185 mill. te of food grain production has been kept for 1989-90 and to achieve this target the fertiliser consumption is aimed at 14 mill.te of nutrients. The balanced use of nitrogen, phosphate and potash along with micronutrients will assume greater importance. Out of total Indian nutrient consumption of about 47.5 kg/ha during 1984-85, the P205 consumption of 10.5 kg/ha is far below the desired levels. Suitable product pattern has to be evolved keeping in view the appropriate use of nutrients, depending upon soil and crop requirements.

The message of economic benefits of optimim fertilisation has to be spread much wider. A minimum cost-benefit ratio which will induce farmers to increase the use of fertilisers, has to be ensured. In addition to providing for incentives in the fertiliser pricing system, efficiency in fertiliser production and use, as well as fertiliser distribution will have to be considered. With proper policy support in terms of pricing of the end product, the objective of increased fertiliser production and consumption should certainly be achieved.