Fertilizer Production in India

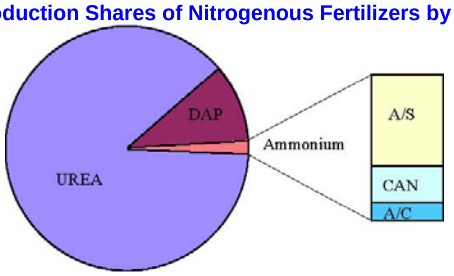
1. Fertilizer Production in India

Chemical fertilizers played a major role in the accomplishment of India's green revolution. India's fertilizer production increased in step with the green revolution. It achieved near self-sufficiency in its needs for nitrogen, and by 2002-03, India imported less than 1% of its nitrogen needs. It is currently the third largest producer in the world.

1.1 Fertilizer Industry Characteristics

Presently, there are 65 large-sized fertilizer plants in India. Of these, 32 units produce urea, 20 produce di-ammonium phosphate (DAP) and complex fertilizers, and 13 manufacture ammonium sulfate (AS), calcium ammonium nitrate (CAN) and other types of fertilizers. Indian nitrogenous fertilizers are mostly composed of urea (88%); the remaining share consists of the complex fertilizer di-ammonium phosphate (10%) and different types of ammonium fertilizers (2%). The output of nitrogenous fertilizers in India reached 10,590 tonnes by 2002-03.

Figure 4-1. Production Shares of Nitrogenous Fertilizers by Type, 2002/03



Note: DAP: di-ammonium phosphate, A/S: ammonium sulfate, CAN: calcium ammonium nitrate, SSP: single super phosphate

1.1.1 Energy Consumption

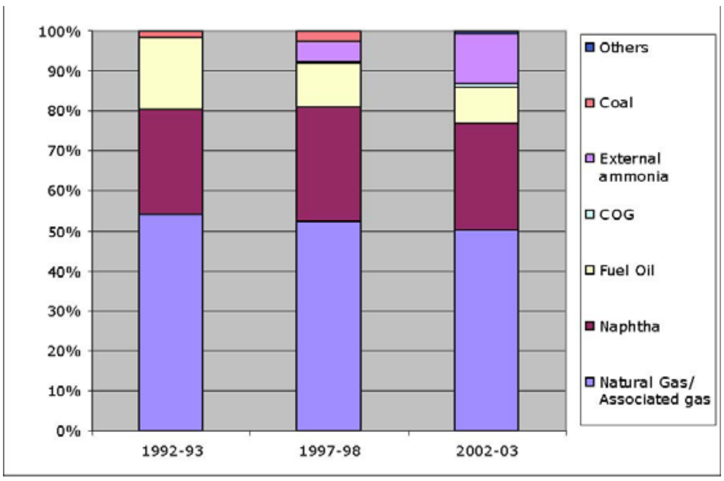
The production of fertilizers is one of the most energy-intensive processes in the Indian industry. Due to its large share, the production of nitrogenous fertilizers has the greatest impact on energy use. The major determining factors for energy efficiency in this industry are capacity utilization, feedstocks, plant age and technology.

The average fuel consumed per ton of fertilizer produced shown in Table 4-11 represents the energy intensity of the fertilizer industry. This indicator shows a decrease over time reflecting the progress in technology and the increasing attention paid to monitoring energy consumption.

Table 4-1. Energy Intensity in Fertilizer Industry

	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
GJ/t of total Fertilizer produced	49.06	44.07	44.44	44.74	43.06	41.00	37.15	35.51	34.20

Figure 4-2. Feedstock-Wise Share in Total Capacity of N (%)



Source: FAI, 2004; GOI, 2004.

The shift towards the use of natural gas as feedstock is an improvement in terms of energy efficiency as its conversion into nitrogenous fertilizer is considerably less energy intensive than for other types of feedstocks. Table 4-33 shows the specific energy consumption for the production of ammonia. Natural gas plants used 40.2 GJ/t of energy for the production of ammonia in 1990-91. Naphtha plants used 24% more, and fuel-oil based plants used 57% more energy per unit of output. The intensity of energy use declined by 1997-98 for the first three feedstocks by 8%, 8%, and 12% respectively, and that for the first two feedstocks declined further by 2000-01.

Table 4-3. Specific Energy Consumption (GJ/t NH3) for the Production of Ammonia

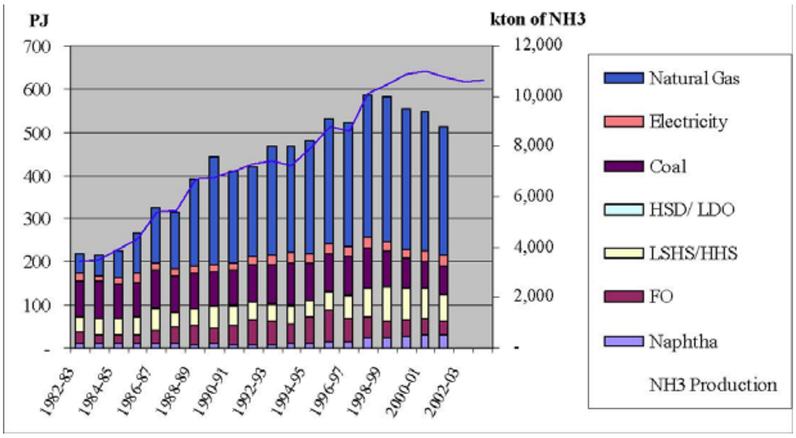
	1990-91	1997-98	2000-01
Gas	40.2	37.1	36.5
Naphtha	49.9	45.8	39.9
Fuel Oil	63.1	55.7	58.4
Coal	163.8	201.5	NA

Source: 1990-91 and 1997-98, TERI, 2003; 2000-01, Anonymous, n.d.; Ashraf, et al., 2003;

1.1.2 Energy Consumption

Energy consumption in the fertilizer industry grew as fast as the production of fertilizer during the 1990's and then declined continuously as the fuel mix changed and plants became more efficient.

Figure 4-3. Energy Consumption in the Indian Fertilizer Industry and Production of Nitrogenous fertilizers.



Source: Central Electricity Authority, 2003; India Ministry of Coal, 2003; India Ministry of Petroleum and Gas, n.d., TERI, 2004. Note 1: FO: Furnace oil; LSHS/HHS: Low Sulfur Heavy Stock/Hot Heavy Stock; HSD/ LDO: High-Speed Diesel/ Light Diesel Oil Note 2: these figures include energy products used for electricity production

Figure 4-3 shows the total energy consumption in the fertilizer industry over the last 10 years; it includes fuel used as feedstock as well as that used for energy purposes. The figure shows simultaneously the production of nitrogenous fertilizer on a second axis. With the limits on the domestic availability of natural gas, its total consumption has stagnated since the late 1990s, while that of naphtha has increased since the early 1990s. From the late 90s up until now, energy efficiency has improved despite the increased use of naphtha, a more energy intensive fuel. This may be explained by the focus on energy efficiency techniques encouraged by the BEE and new policies that promote higher capacity utilization and efficiency.

2 Potential for Energy Efficiency Improvement

As mentioned earlier, the biggest drawback of the Indian fertilizer industry is its reliance on non-natural gas-based plants. If we consider only the natural gas based plants, Indian plants compare very favorably with international practices (see Table 4-5). The figures in brackets are the improvement potentials if plants were to reach best practices available in India. The highest energy saving potential is observed with fuel oil based plants.

Table 4-5. Specific Energy Consumption by Feedstock Type (GJ/t NH3)

Feedstocks based plants		**India Average**	**India Best (Improvement Potential)**	**World Average (1998)**	**World Best**	**China Average (2000)**
Gas based plants	Ammonia	36.5	30.3 (17%) TCL Babrala	36.6	28	36.7
	Urea	26.5	22.5 TCL Babrala (15%)	25.8	20.9	26.3
Naphtha based plants	Ammonia	39.9	34 (15%) CFCL Kota			38.7
	Urea	29.1	24.3 CFCL Kota (16%)			28.3
FO based plants	Ammonia	58.4	47.9 GNFC (18%) Bharuch			
	Urea	40.5	31.3 GNFC (23%) Bharuch			

Source: Anonymous, n.d.; Ashraf, et al., 2003; Kongshaug G., 1998; GOI, 2003; EFMA, 2000; Worrell E., et al., 1997.
Note: The urea figures include the embedded energy in the production of ammonia.

The best practice energy intensity worldwide is 28 GJ per ton of ammonia, and is a result of auto-thermal reforming technology process. Auto thermal reforming process is a mixture of partial oxidation and steam reforming technology.

Tata Chemicals owns and operates one of the more energy-efficient plants for the production of ammonia and urea in India with an energy intensity of 30.3 GJ/t of ammonia and 22.5 GJ/t of urea. These energy intensity values are among the lowest recorded internationally. Manufacturing facilities at Babrala comprise an ammonia plant of 1350 TPD and a urea plant of 2250 TPD capacity which were implemented and commissioned in December 1994. Even though the plant currently uses natural gas, it has been designed for full flexibility in the use of natural gas and naphtha as a feedstock and fuel.

When only natural gas-based plants are considered, India appears to maintain very competitive plants compared to the world average (see Table 4-5). However, this conceals the fact that only 50% of the plants in India uses natural gas whereas worldwide the average is close to 80%.

Table 4-6. Average Specific Energy Consumption by Country/Regions (GJ/t of NH3)

Process	India average (2003)	World (1998)	Europe (1997)	US average (1995)
Ammonia	41.8	36.6	35.5	37.1
Urea	28.4	25.8	24.5	30.4

Source: Kongshaug G., 1998; GOI, 2003; Worrell E. et al., 1997 and 2000.

Due to the low share of natural gas based plants, Indian national average figures of specific energy consumption shown in Table 4-66 are far from best practices abroad. In a competitive environment, with energy cost representing between 55% to 80% of total production cost depending on the type of plant companies will be compelled to gradually switch over to natural gas in order to have an energy consumption per ton of output closer to world average and as a result become more competitive in the international market.

2.1 Categories of Energy Efficiency Improvement

Over the past 30 years, induced by major technological improvements and by a better energy management, the energy used to produce each ton of ammonia has declined by 30 to 50%. Technology-wise, three different process stages can be distinguished where energy improvements are possible.

Steam reforming phase: This is the most energy intensive operation, with the highest energy losses. Different methods are available to reduce losses that occur in the primary reformer: installing a pre-reformer, shifting part of the primary reformer to the secondary with installation of a purge gas recovery unit, and upgrading the catalyst to reduce the steam/carbon ratio. It is possible to reduce energy losses by 3-5 GJ/t of NH3.

CO_2 removal phase: The removal of CO_2 from the synthesis gas stream is normally based on scrubbing with a solvent. A reduction of the energy requirement for recycling and regeneration of the solvent can be achieved by using advanced solvents, pressure swing absorption or membranes. Energy savings are on the order of 1 GJ/t NH_3.

Ammonia synthesis phase: A lower ammonia synthesis pressure reduces the requirement for compression power, but it also reduces production yield. Less ammonia can be cooled out using cooling water so more refrigeration power is required. The recycling power increases also, because larger gas volumes have to be handled. The overall energy demand reduction depends on the situation and varies from 0-0.5 GJ/t NH_3. Another type of catalyst is required to achieve the lower synthesis pressure. Furthermore, adjustments have to be made to power system and the recycle loop.

Additionally, energy price escalation and growing concerns regarding pollution have intensified the attention on energy conservation at all levels. Improving energy efficiency does not necessarily require investment and can result from a better balancing of energy flow along the process. The optimization of operations and maintenance practices, by reducing waste heat and capturing excess heat to channel it back into the system, allows a better energy distribution and constitutes major energy efficiency improvements.

Some plants in India have realized considerable energy savings by increasing awareness at all levels in the plant, monitoring energy consumption during production, and identifying potential energy-savings opportunities. During the fiscal year 2001-02, Rashtriya Chemicals & Fertilizers Ltd. (RCF) achieved energy savings worth Rs. 63 million by reducing its electricity consumption by 16,292 MWh and natural gas use by 674,000 m3 without investing extra money on any of the different energy efficiency schemes, see table below. This kind of energy improvement can be accomplished by using benchmarks and careful audits to identify and analyze primary energy users in a plant. See Table 4-77 for examples of energy efficiency schemes applied by RCF.

Table 4-7. Energy efficiency scheme in RCF Ltd., Trombay, (2001-02)

	Actual achievement of energy savings per year basis.			Investment incurred on the project
	Power		Gas	Total
Project Description	MWh	kNM3	Rs .Million	Rs. Million
Ammonia I Diverting of excess air in Ammonia V PAC to Ammonia I for operating Inert Gas Plant thus shutting one air compressor Cooling water line hooked up from Nitric Acid Plant cooling water header facilitating closure of cooling tower in Ammonia I Connecting Grid air in Ammonia Storage thus stopping Air compressor in Storage Area. Excess 4 data steam from synthesis section is diverted to gasification section thus decreasing the steam import from grid	1,980 2,659 103 -	---674	7 10 0 2	0 0 0 0
Ammonia V Change over of Benfield pump from Motor drive to Steam driven	11,550	-	44	0
Total	16,292	674	63	0

Source: RCF report submitted to the BEE for National Energy Conservation Awards – 2003 4-10

Appendix 4 shows examples of energy efficiency schemes applied by three different plants in India. The table illustrates the investment, the energy saved, and the corresponding monetary savings as well as the pay back periods for each energy efficiency investment.

3. Scenarios of Future Energy Use

3.1 Future Trends in Fertilizer Production

Country's endowment of feedstock: The major difficulty of the sector is the uncertainty surrounding the availability of raw materials in India. Although natural gas is the preferred feedstock, due to dwindling supplies, some natural gas based units have been forced to partially use naphtha instead. During FY 03-04, RCF: Trombay-V unit produced only 8.1 kton of nitrogenous fertilizer (5.3% capacity utilization) due to non-availability of natural gas. IFFCO: Kalol was originally a natural gas based plant, where it was decided to install a naphtha unit for pre-reforming to be able to operate the plant as a dual feedstock unit. Table 4-88 shows clearly the trend since 1996 of adding new ammonia/urea plants that have dual feedstock capacity.

Maintaining self-sufficiency and at the same time moving towards more efficient natural gas based plants implies that new domestic or imported sources of natural gas will need to become available. In order to overcome the constraints in domestic availability of natural gas in India, the government is looking at the possibility of developing infrastructure to import LNG. The government is also encouraging joint venture projects in countries where feedstocks and raw materials are abundant and relatively cheaper.

Table 4-8. Capacity of Ammonia/Urea Plants

	1996	2003
Gas	47%	41%
Naphtha	27%	31%
Fuel Oil	11%	9%
Coal	3%	0%
Ext. Ammonia	5%	5%
Coke Oven Gas	1%	0%
Dual Gas/Naphtha	6%	15%

Source: GOI, 2004.

3.2 Future Trends in Energy Efficiency

In terms of energy efficiency, the new policy is sending the right signal by inducing a changeover from naphtha/fuel oil based plants to LNG/natural gas, as might be expected in a more open fertilizer market. Natural gas is the most energy efficient and economical feedstock for urea. The new urea policy will induce manufacturers to revamp their plants and place energy efficiency at the top of their priorities. In order to stay or become competitive in a decontrolled market, significant efforts will be needed.

The changeover of feedstock from naphtha to LNG or dual feedstock in general requires limited changes to the existing process equipment. For Naphtha based plants, it is recommended to install a new heater preheating the LNG in parallel with the existing heater preheating the naphtha. For FO/LSHS based plants, since they operate on partial oxidation, they can change over to natural gas feedstock through auto thermal reforming rather than conventional reforming of gas.

Furthermore, the progressive shift to an open market will sharpen competition. As energy cost represents between 55 to 80% of total production cost, it is to be expected that an increasing number of plants that want to stay competitive will try to reduce their energy intensity.

4. Summary and Conclusions

In a more competitive market, it is expected that most of the production of nitrogenous fertilizers will occur where raw materials are the cheapest and that countries with scarce natural gas resources like India will import most of their needs. However, fertilizer production has been a priority for India during its development, and it is now an important part of the local industry. The prospect of making available the infrastructure to import and use LNG will allow this industry to reduce its energy intensity and become competitive in an international market. Moreover, increased attention towards saving energy is essential for an energy intensive industry. The former RPS policy allowed inefficient processes to linger, but this opens the possibility for large energy savings today.

Reference:

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