Energy Efficiency and CO_2 Emissions in the Indian Ammonia Sector

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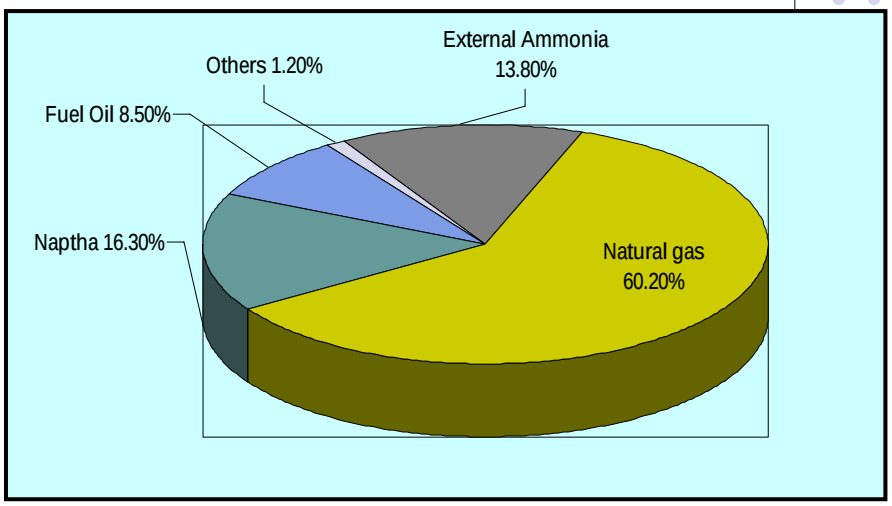
Overview

- India ranks second in the world in production of nitrogenous fertilizer.
- Ammonia is the basic building block.
- India produced 12.8 million MT of ammonia in the year 2005-06.
- The average energy consumption is 9.1 Gcal/MT of ammonia.

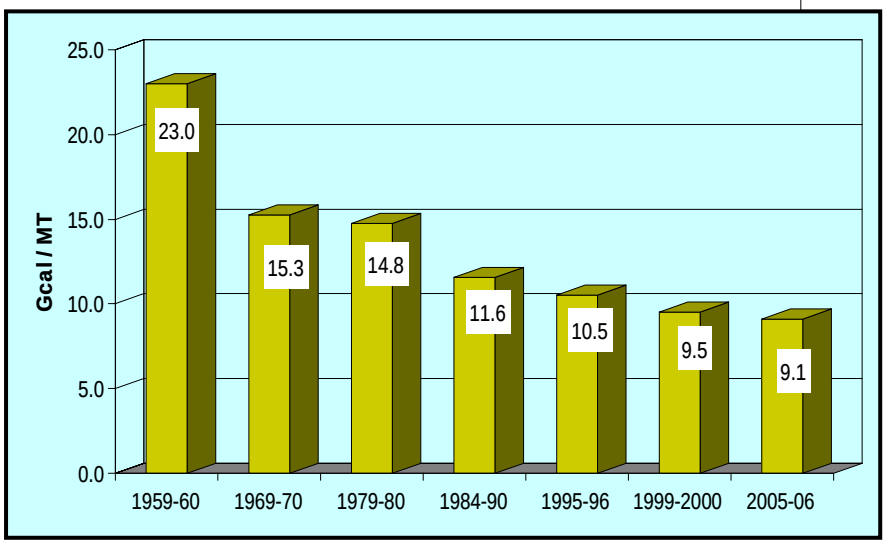
Feedstock wise capacity of Ammonia in India



Energy Trends

The average energy consumption per ton of ammonia has dropped from the highs of 23 Gcal that was prevailing in the 1960s to currently around 9.1 Gcal.

Ammonia energy consumption scenario in India



Energy Efficiency Measures

This has been achieved through:

- Switchover of feedstock;
- Advances in process technology;
- Improved catalysts;
- Better stream sizes;
- Increased capacity utilization and;
- Improved reliability.

Energy Consumption - Ammonia

PLANT TYPE	(Gcal/MT)
Gas based	7.56 to 9.90
Naphtha based	8.11 to 10.53
Fuel Oil based	11.45 to 20.81

Comparison of Energy Consumption of World Ammonia Plants

PLANT	AVERAGE ENERGY (Gcal/MT)
25% Most Energy Efficient Plants in India	8.41
25% Most Energy Efficient Plants in the World	8.49

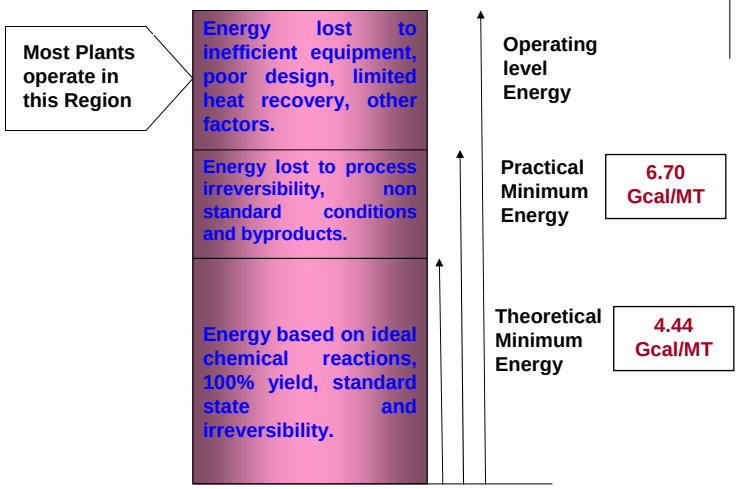
Source: Ammonia Plant safety, Vol 42, AICHE -2002 and FAI data for Indian Plants.

Energy Consumption - Ammonia

The most energy efficient Ammonia plants in the world produce ammonia at 6.7 Gcal per MT.

Typical Energy break-up	
Feed	64%
Fuel	28%
Power	5%
Steam	3%
TOTAL	100%

Categorization of Energy



Ammonia Manufacturing Process

Possible areas of improvement

- **More efficient compressors and their drives.**
- **Improvement in CO_2 removal system.**
- **Introducing combustion air preheat.**
- **Lowering steam carbon ratio.**
- **Lowering pressure drop in front end.**
- **Purge gas recovery.**
- **Fuel gas expander.**
- **Generating High Pressure steam from waste heat.**

A case study

A 900 MTPD ammonia plant employing technologies of eighties was revamped in 2006, with following objectives:

- Reduction in the specific energy consumption;
- Improvement in reliability;
- To enhance capacity;
- Minimizing the downtime to incorporate the changes.

A case study

The following major modifications were selected and implemented:

- Up-gradation of primary reformer;
- Improvement in CO_2 removal system;
- Replacement of synthesis gas compressor.

Implementation : 24 months.

The cost of the above modification is about US$ 55 million.

Primary Reformer Upgradation

- **Rearranging the staggered row of reformer tubes into Single row of catalyst tubes for better distribution of heat.**
- **Increasing the reformer tube diameter.**
- **Installation of triple decker catalyst.**
- **Replacement of reformer burners by force draught type.**
- **Installation of combustion air pre-heater in reformer convection.**
- **Replacement of inlet distributors, pigtails and outlet hot collector.**
- **Modification of roof, floor and its refractory.**

Primary Reformer

Modification in Steam Superheater

Feed gas and combustion air preheat was provided in the convection section:

- **To reduce the Stack temperature from 465 degree C to 159 degree C;**
- **To improve thermal efficiency.**

Steam Superheater

Process Air Compressor

Compressor internals were changed:

- **To cater to increased requirement of air for secondary reforming;**
- **To improve the compressor efficiency.**

Condensate Stripper

Conversion of Low Pressure process condensate stripper to Medium Pressure:

- **Steam used for stripping is recycled back to reformer as process steam;**
- **Improved condensate quality, can be fed directly to polishing unit.**

CO_2 Removal System

- Improved tower packing.
- Hydraulic turbine in rich solution.
- 5 stage flash vessel.
- Steam compressor.

Synthesis Section

- Installation of S-50 Converter.
- A loop boiler.
- Replacement of the synthesis gas compressor that was inefficient and prone to frequent downtime.

S 50 Converter

Loop Boiler downstream - S50 converter

Energy Saving

Scheme	Gcal/MT
Primary Reformer	0.63
Aux. Steam Superheater	0.08
MP condensate stripper	0.25
Carbon Dioxide removal system	0.54
Other schemes (Synthesis, turbines, compressors etc.)	0.76
Total	**2.26**

BENEFITS

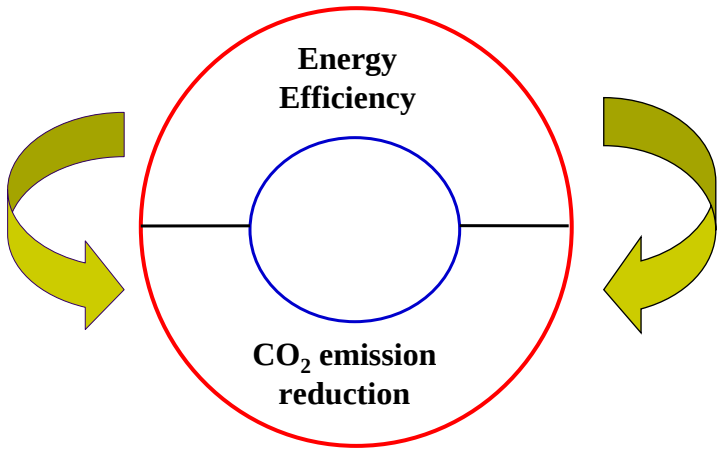
Before revamp ~ 11.0 - 11.2 Gcal/MT

After revamp ~ 8.7 - 8.8 Gcal/MT

Plus improved operability and reliability

Energy Efficiency and CO_2 emission

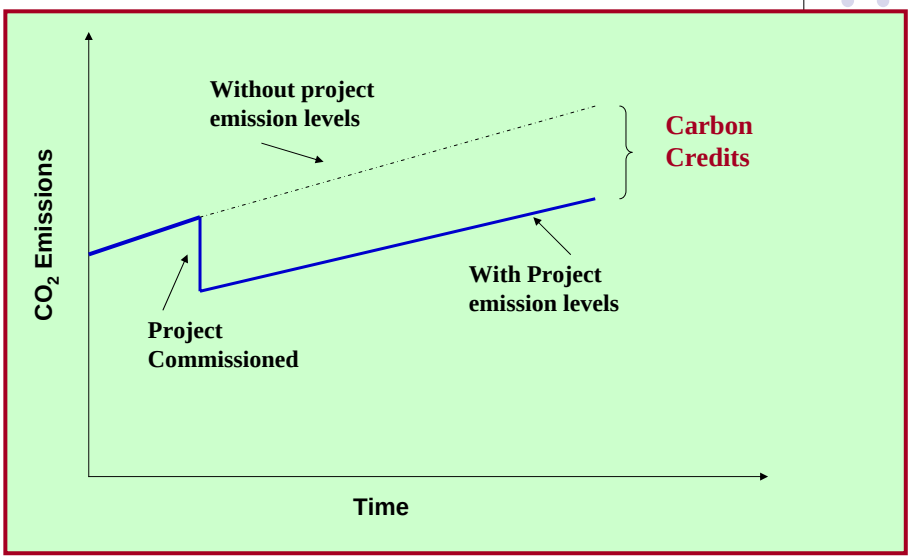
- Typically energy saving ultimately translates into reduction in fuel consumption.
- Reduced fuel consumption means burning of lesser quantity of fossil fuel and corresponding reduction in CO_2 emission.



Carbon Credits

- CO_2 is a greenhouse gas. Any project undertaken in a developing country causing reduction in greenhouse gas emission may qualify for Carbon Credits.
- An emission reduction of one MT of CO_2 qualifies for one carbon credit called Certified Emission Reduction (CER).
- These CER credits are tradable and can be used to contribute to the emission reduction commitment of industrialized countries under Clean Development Mechanism (CDM).

Generation of Carbon Credits



CDM - Additionality Criteria

All these projects should satisfy additionality criteria under Clean Development Mechanism (CDM).

Emission additionality:	**The project should lead to real, measurable and long term Green House Gas reduction.**
Financing additionality:	**The funding for CDM project activity should not lead to diversion of official development assistance.**
Technological additionality:	**Investments should be for newest and sound technologies.**

CDM Benefits

- As energy consumption pattern nears to its most efficient level it becomes increasingly capital intensive.
- Financial benefits from CDM improves the viability of a project.
- In many cases such benefits of CER credits under CDM is acting as a booster in pursuing a number of energy saving measures in ammonia plants.

Type of CDM projects

- **Energy Efficiency Improvement Projects.**
- **Feed Switch Projects.**
- **Carbon Dioxide Recovery (CDR) Projects.**
- **General Waste Recovery Projects connected with ammonia.**

Energy Efficiency Improvement Projects

- **The most common type applicable to ammonia Industry.**
- **Energy saving of 1 Gcal roughly translates into 0.2 CER.**
- **A 1000 MTPD ammonia plant with 2 GCal/MT reduction in energy is capable of generating approx. 132,000 CER per year.**
- **The methodology to be applied for such schemes under CDM is well established.**
- **Some ammonia plants in India have registered their project. Many other plants are on way.**

Feed Switch Projects

- Switching of feedstock from Naphtha to Gas leads to reduction in CO_2 emission and thus qualifies for CDM benefits.
- No approved methodology as yet. Some projects have progressed on this front and hopeful of getting registered under CDM soon.

Carbon Dioxide Recovery (CDR) Project

- **Ammonia plants in India are linked with urea production. There is a need to maximize CO_2 generation so that ammonia produced is completely converted to urea.**
- **One of the way to overcome shortfall in CO_2 production is putting up a CDR unit to recover CO_2 from Flue gases exiting the reformer stack.**
- **It is highly capital intensive and benefits derived under CDM will help to improve the financial viability.**
- **A methodology is in advanced stages of approval.**

General Waste Heat Recovery Projects connected with ammonia

General waste recovery projects associated with ammonia production facility is developed under this category. There are few approved methodologies, which can be adopted.

Basic Steps towards registration - under CDM

- Preparation of Project Design Document (PDD).
- Submission of PDD to UNFCCC through Designated National Authority.
- Use of approved methodologies for the project under consideration.
- Validation of CDM project Activity.
- Registration of the CDM project activity.

Conclusion

- Modern Indian Plants are at par with world class plants.
- The older plants have kept pace with the developments in technology and have put in serious efforts to bring energy efficiency to a comparable level.
- The way forward is to use clean feedstock and fuel like Gas and Liquefied Natural Gas, upgrade & modernize with respect to technology, equipment and machinery.
- While doing so avail the benefits under CDM for reducing green house gas emission.

THANK YOU