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Energy Efficiency and CO_2 Emissions in Ammonia Production

2008-2009 Summary Report

International Fertilizer Industry Association (IFA)

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The fertilizer industry's commitment to continuous improvement in the efficient use of global energy resources

Fertilizer production consumes approximately 1.2% of the world's total energy on an annual basis. Since ammonia production accounts for some 87% of the industry's total energy consumption, the fuel and feedstock used to produce ammonia are by far the main energy requirements.

For both economic and environmental reasons, natural gas is the primary hydrocarbon feedstock used in ammonia synthesis (from which almost all nitrogen fertilizers are derived). Therefore, production processes which use less natural gas per unit of ammonia output reduce manufacturing costs.

Energy efficiency in the manufacture of nitrogen-based fertilizers has significantly improved since the early 20th century. Modern plants are rapidly approaching the theoretical minimum energy consumption for ammonia production. Nevertheless, a number of plants are not yet equipped with the most advanced technologies, suggesting that global energy consumption in the industry could be significantly reduced through the adoption of new technology in the coming decades.

To assess this potential, the International Fertilizer Industry Association (IFA) periodically conducts an industry-wide benchmarking survey which is used to estimate energy efficiency in the ammonia sector. This survey is designed to improve IFA producers' knowledge of plant performance; to assist operators in assessing plant efficiency relative to industry averages; and to help identify opportunities for continual improvement. The results are also valuable to policy makers, as they can serve as a basis for well-adapted policy analysis and implementation.

Summary of the findings of the 2008 benchmarking survey

The 2008 IFA benchmarking survey included participation by 93 plants located in 33 countries, representing approximately one quarter (40 million tonnes) of total world ammonia production.

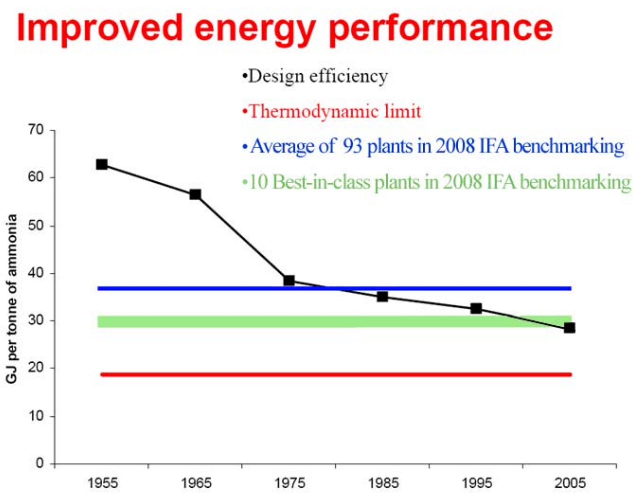
The survey gathered information on participating plants' *average net energy efficiency* during the year, based on the following calculation:

Net Energy Efficiency = Feed + Fuel + Other Energy / NH_3 Production

Energy includes that required to produce ammonia, as well as that used in operations, e.g. startups, shutdowns and catalyst reductions. Offsite emissions related to energy imports were also calculated in order to reflect operations' overall energy and environmental footprint more accurately.

On an annual basis, plants generally do not operate at their design energy efficiencies, which are based on continuous operation with equipment and catalysts in good condition. During certain years they may operate at energy efficiencies approaching this level. However, energy use in plants with frequent outages, inefficient equipment or poor catalyst activity is much higher. Along with inherent differences in plant design energy efficiencies, this accounts for the wide variations in the efficiency of energy use in different plants.

Due to the variety of manufacturing methods and raw materials, no single process can be identified as a Best Practice Technology (BPT) for ammonia production. Except in China (which uses coal for almost all ammonia production), natural gas is a raw material for the vast majority of the ammonia produced worldwide.



Average net energy efficiency in the 93 ammonia plants surveyed in 2008 was 36.6 GJ/mt NH_3 (ranging from 27.0 to 58.2 GJ/mt NH_3). The top quartile performed in the range of 28 to 33 GJ/mt NH_3. These figures are comparable to theoretical design efficiencies and are near the optimum efficiency level, for a new plant, of approximately 28-29 GJ/mt.[1]

Overall, a plant built today uses some 30% less energy per tonne of ammonia produced than one constructed 40 years ago. Technological advances have accompanied economic changes, and restructuring has rewarded more efficient producers. In Europe and North America, where energy costs are high, average energy consumption has been drastically reduced through the revamping or closing of inefficient plants. Energy costs have also led to the construction of new state-of-the-art units in regions including North Africa and the Middle East, where there are abundant supplies of affordable natural gas.

The move towards higher capacity plants has helped to implement more efficient technologies. Capacity upgrades offer a cost-effective opportunity to install better performing technology. Comparisons of current performance against Best Practice Technologies (BPTs) indicate that there is still room for improvement. The BPT energy requirement for the top ten percentile natural gas-based ammonia production facilities operating today is 32 GJ per tonne of ammonia (net energy consumption). This suggests that revamping less efficient existing plants would increase energy efficiency and decrease CO_2 emissions by some 10%. The cost would be significant, sometimes exceeding USD 20 million per site.

Shifting production from poorly performing plants to new production sites with Best Available Technologies (BATs) would improve overall energy efficiency by up to 25%, with a corresponding decrease in GHG emissions of about 30%. But this is a long-term scenario, stretching over decades.

Finally, per tonne of ammonia the energy requirement for coal-based plants is significantly higher than that for natural gas-fired facilities. A coal-based unit also produces roughly 2.4 times more CO_2 per tonne of ammonia than a natural gas-based unit.

[1] For more detailed information on the 2008 IFA benchmarking survey, please contact the IFA Secretariat (for contact information, please go to www.fertilizer.org).

In view of the availability and relative costs of energy sources in different regions, and the policy imperative in China to achieve food security through ensuring domestic fertilizer supply, coal-based ammonia synthesis is expected to increase in coming years. Carbon Capture and Storage (CCS) could be an important means of minimizing emissions from coal-based production.

"Our goal is to make energy efficiency improvements a matter of course in everything we do."

Abdul Rahman Jawahery
General Manager
Gulf Petrochemical Industries Inc. (GPIC)

Chairman of the IFA Technical Committee

The IFA Technical Committee encourages the development and adoption of technology improvements that lead to greater production efficiencies and reduced emissions and discharges, as well as better health and safety standards throughout the fertilizer industry. The Committee's mission is to actively promote the development of efficient, responsible production, storage and transportation of all plant nutrients in a sustainable manner. For more information, please visit IFA's website (www.fertilizer.org).