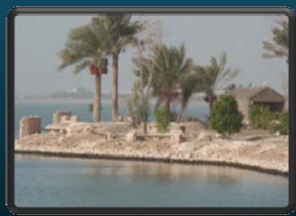
شركة الخليج لصناعة البتروكيماويات

Gulf Petrochemical Industries Company

IFA Benchmarking of Global Energy Efficiency



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PSI - **Plant Surveys International**

Agenda

- Introduction
- Importance of Benchmarks
- Energy & Emission Overview
- Key Finding
- Recommendations

IFA Technical Committee's Mission

- Actively promote the development of efficient, responsible production, storage and transportation of all plant nutrients in a sustainable manner.

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

Objective of Benchmarking Survey

- To assess the potential of IFA members to enhance their energy efficiency.
- To aid operators in assessment of their performance relative to others and in the identification of opportunities for improvement.
- To enable policy makers achieve energy and environmental policy objectives.

Why Benchmark Energy Efficiency

- Fertilizer production consumes 1.2% of the world's total energy annually.
- Ammonia production consumes 94% of the industry's total energy.
- For economic and environmental reasons – natural gas is the predominant hydrocarbon energy source for almost all nitrogen fertilizers.
- As a result, production processes that use less natural gas per unit of ammonia output reduces manufacturing cost and environmental impact.

IFA's First Energy Efficiency Benchmarking

- Energy Task Force established in 2003.
- PSI engaged to conduct the first benchmark survey.
- 2002-2003 operating period.
- Focused on energy efficiency and CO_2 emissions.
- 66 Ammonia plants participated.
- Benchmarking report issued Dec. 2004.

Benchmarking – Key Steps

1. Determine focus of benchmarking (for example – energy use).
2. Develop metrics.
3. Conduct comparisons.
4. Track performance over time.

Current IFA Benchmarking Status

- Step 1 & 2 completed – useful benchmark established.
- Now in a position to proceed with steps 3 & 4.
- Continuation will lead to reliable metrics so companies can use comparisons to assess their need for improvement.
- The next IFA ammonia plant benchmarking is planned to be conducted in 2008 based on 2006-2007 operating data.

Energy Efficiency

- Net energy efficiency includes all feedstocks, fuels, electricity, and "other energy" used by an ammonia plant.
- "Other energy" includes import steam and electricity as well as credits for energy exports such as steam and some off-gases.

$$\text{Net Energy Efficiency (GJ/mt } NH_3\text{)} = \frac{\text{Feed + Fuel + Other Energy (GJ)}}{NH_3 \text{ Production (mt)}}$$

Benchmarking Average Results

- Average energy efficiency for the 66 IFA ammonia plants is 36.9 GJ/mt NH_3.
- Average annual production is 395,900 tonnes/plant.

Table 1 – Net Energy Efficiency and Production Summary

66 Ammonia Plants	Average
NH_3 Production – mt as NH_3	395,900
Net Energy Efficiency - GJ/mt	36.9

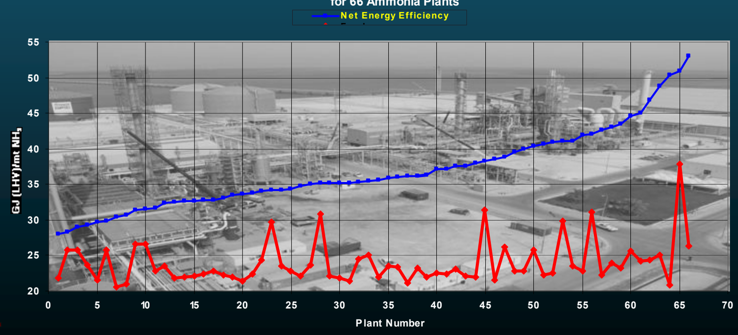
Net Energy Efficiency

The gap between “net energy” and “feedstock” is “fuel” and “other energy” usage.

- Higher net energy is caused by increased “fuel” and “other energy usage”.

Fig. 1 - Net Energy Efficiency

for 66 Ammonia Plants



Plant Capacity and Energy Efficiency

- Plant capacity and energy efficiency are related.
- The largest plants are the most efficient.

Table 2 – Net Energy Efficiency and Plant Capacity

Basis: Current rated plant capacity
66 Ammonia Plants
Net Energy Efficiency - GJ/mt NH_3

Capacity mtpd	No. of Plants	Average
< 1,000	19	40.0
1,000 – 1,500	25	37.0
> 1,500	22	34.0

Plant Age and Energy Efficiency

- Older plants are generally less efficient than new ones.
- Some older plants have excellent energy efficiencies.
- These are a result of improvements through revamps and equipment upgrades.

Table 3 – Net Energy Efficiency and Plant Age

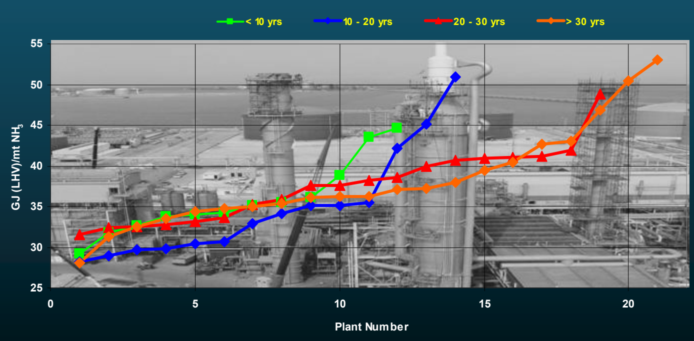
66 Ammonia Plants
Net Energy Efficiency - GJ/mt NH_3

Age – Years	No. of Plants	Average
< 10	12	35.8
10-20	14	34.9
20-30	19	37.6
> 30	21	38.2

Plant Age and Energy Efficiency (Cont'd)

- Many of the older plants have good energy efficiencies due to revamps, equipment upgrades and operational improvements.

Fig. 3 - Net Energy Efficiency vs. Plant Age
66 Ammonia Plants



CO_2 Generation and Emissions

- **Ammonia plants have 2 CO_2 emissions sources.**
  1. Process CO_2 Emissions - from the CO_2 recovering system.
  2. Flue Gas CO_2 Emissions - from combustion.

Reducing CO_2 Emissions

- Recover and use process generated CO_2 for other chemical products such as urea production.
  - This is the most utilized method.
- Recover CO_2 from combustion flue gas for use in other chemical products.
  - Technology exists to do this, implemented on a very small scale.
- Improve ammonia plant energy efficiency. Less CO_2 is generated and therefore emissions are reduced.
  - Many ammonia producers have done this.

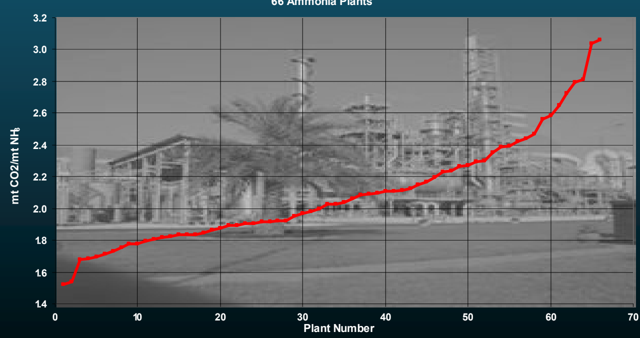
Summary of CO_2 Emissions

- 33% of the total CO_2 generation is from combustion of fuels.
- 38% of the all CO_2 generation is recovered.
- 57% of process generated CO_2 is recovered.

Total CO_2 Generation

- Total generation varies widely.
- Net energy efficiency accounts for most of the variation. Processing heavier hydrocarbons also plays a role.

Fig. 4 - Total Generated Carbon Dioxide
66 Ammonia Plants



Key Findings

- Average net energy efficiency for the 66 IFA ammonia plants is 36.9 GJ/mt NH_3.
- The highest capacity plants are the most energy efficient.
  - Some of the best performing plants have a capacity less than 1,000 mtpd.

Key Findings (Cont'd)

- Newer plants have the best energy efficiencies.
  - Many older plant have improved their efficiencies through revamps and equipment upgrades.
- Ammonia plants built today use 30% less energy per tonne NH_3 than one built 30 years ago.
  - Current BAT for new plants is 28 GJ/mt NH_3 – just 30 years ago newly designed plants used 40 GJ/mt NH_3.
- Universal BAT application would reduce energy usage by 40% and reduce greenhouse gas emissions by 58%.

Key Findings (Cont'd)

- The least efficient ammonia plant uses about 90% more energy to produce a ton of ammonia. Most of this inefficiency is due to high fuel usage. This presents an opportunity for improvement through technology and equipment upgrades and other means.
- The 66 ammonia plants generate an average of 2.07 mt CO_2 for each mt of NH_3 produced. Of this ratio, 2/3 is process generated CO_2 and the remaining 1/3 is from fuel burning.

Key Findings (Cont'd)

- More than one-third (38%) of the generated CO_2 is not vented to the atmosphere because it is recovered for other uses (primarily urea production).
- Generated CO_2 in the 66 ammonia plants ranges from 1.5 to 3.1 mt CO_2/mt NH_3. Most of the variation is due to differences in energy efficiency where low energy usage ammonia plants generate less carbon dioxide per unit of ammonia production.

Recommendations

- Continue primary focus on energy and CO_2.
- Enact ways to enlarge participation - advertise IFA benchmarking in IFA newsletters and in other trade publications, involve IFA membership to solicit participation from their companies and other non-IFA organization, such as, AFA, EFMA, FAI, etc.

Recommendations (Cont'd)

- Continue to track influence of plant capacity and plant age on energy efficiency.
- Begin tracking trends of "same" plants – those that have participated in past benchmarkings as well as the current benchmarking.
- As participation increases, the number of regional comparisons also increases.

Recommendations (Cont'd)

- Consider adding other metrics that may have an impact on energy efficiency or CO_2 emissions. Examples:
  - Process technology, improvement projects, best practices, etc.
- Governments should foster an enabling environment for investment in cleaner, more efficient technologies through financial incentives and stable, long term environmental policy.
- Governments and industry have an important role in facilitating the adoptions of BATs.
  - Parallel funding technology transfer.
  - New market mechanisms such as carbon financing.

Recommendations (Cont'd)

- The IFA Technical Committee should continue to encourage the development and adoption of technology improvements that can lead to greater production efficiencies, better health and safety standards and reduced emissions and discharges.

Thank You