Energy efficiency measures in fertiliser sites

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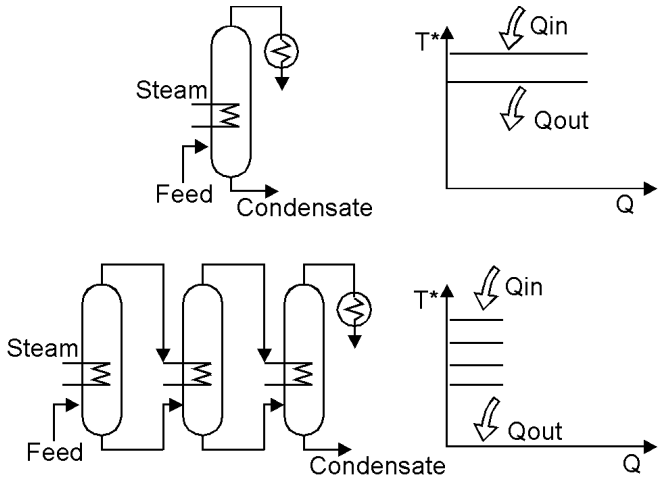
Outline

- Process integration in the fertiliser industry
  - Introduction to process integration
  - Site wise energy optimisation at Acron, Russia
    - Plant optimisation (Nitric acid)
    - Cogeneration (ammonia)
    - Heat export (ammonia, methanol, nitric acid, AN etc)
- International cooperation under IEA
  - Presentation of IETS
  - Opportunities for the fertiliser industry
    - Credibility

BAT
Evaporator thermal design



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Evaporator design for optimal energy efficiency

- "Golden rule for optimal energy use"
  - Use as many stages as possible
    - Reduced driving forces
    - Larger heat exchange area
  - Product properties may constraint number of stages
  - Trade off: Energy efficiency / capital costs
    - **1 stage** Energy: 100 Heat Exchange Area: 100
    - **2 stages** Energy: 50 Heat Exchange Area: 400
    - **3 stages** Energy: 33 Heat Exchange Area: 900
    - **Etc**
  - BAT technology for evaporators?
    - 3 stages?

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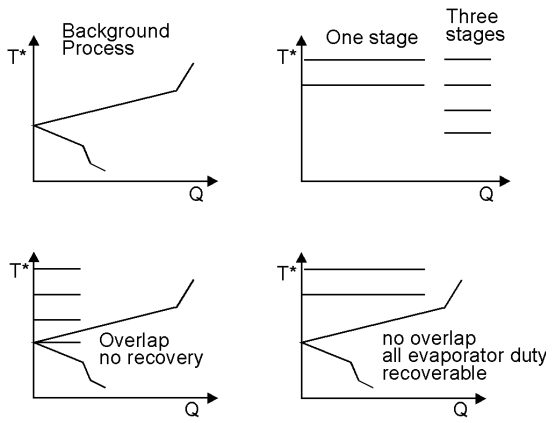
Integration of evaporator plants

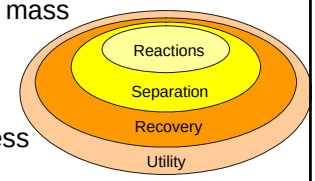
- Evaporators in site context



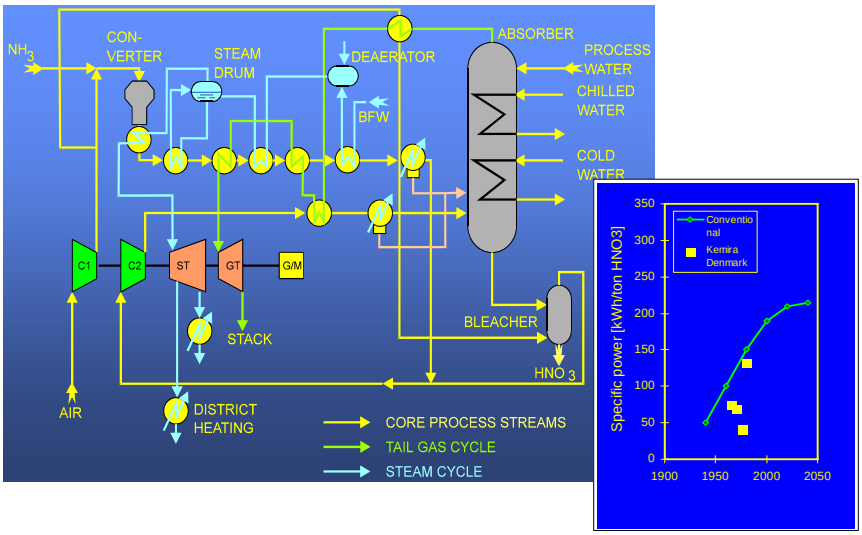
- BAT is context dependent

Process integration analysis (System analysis)

- Aim
  - To optimise process interaction in order to reduce total energy consumption
- Method
  - Setting up initial balances (energy- and mass balances, process modelling)
  - Screening of potential savings by heat recovery
  - Screening of potential savings by process changes and heat recovery
  - Realisation of targets
- Results
  - Improved insight in process interactions
  - An overall view of potential energy savings



Nitric acid process



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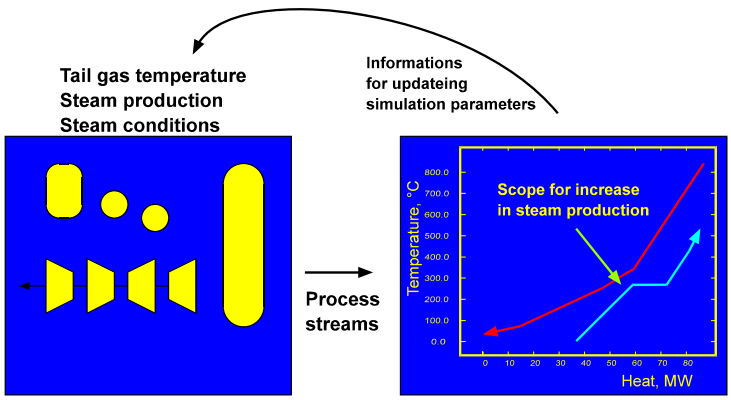
Process integration approach



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Nitric acid plant example
Process modifications

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- Process integration analysis provided insight
  - Bottleneck – tail gas flow rate
- Tail gas flow rate enhancement
  - Integrated tail gas humidification
- Consequences
  - Increased heat recovery to gas turbine cycle
  - Steam cycle can be omitted
  - Simplification of process lay-out

Nitric acid plant
Process comparison

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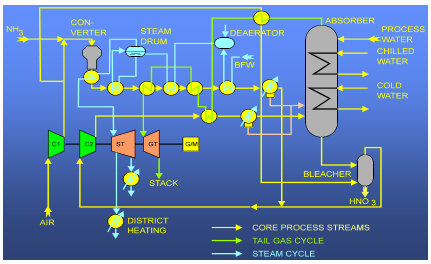
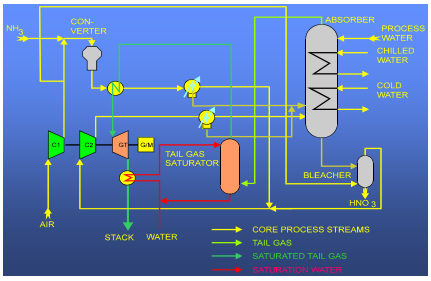
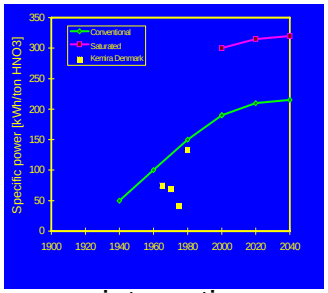




- **FIXED CAPITAL COST**
- **CONVENTIONAL**
  - 225 kWh/ton HNO3
  - COMPLEX DESIGN
  - PROVEN CONCEPT
- **SATURATED DESIGN**
  - 312 kWh/ton HNO3
  - SIMPLE DESIGN
  - NEW CONCEPT
  - BUT STANDARD EQUIPMENT



Process integration can help out of the box thinking!

Site optimisation at Acron, Russia

- Aim of analyses
  - Introduce process integration methods
  - Discover process improvement areas
    - Direct applicable solutions (pay back < 2 years)
    - Long term solutions (pay back > 2 years)
  - Combine expert knowledge of Acron and consultants
    - Exploit new opportunities

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Overview of primary analyses

- Nitric acid process
  - Gas reduction, power production
  - N_2O reduction
- Gas system
  - Gas expander
- Ammonia plant
  - Gas turbine system for power and steam production
- Methanol plant
  - Increased preheat (Reduced oxygen consumption)
- AN plant
  - Send condensate to the nitric acid processes (reduces steam consumption in the neutralisers)
- All processes
  - Recover waste heat for building heating purposes and/or heat export to Novgorod

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Nitric acid UKL

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- Base case simulation
  - Energy and mass balances
  - Identification of process equipment characteristics
  - Identification of inconsistencies
- Identification of potential improvements
  - Screening for improvements
  - Conceptual process simulation model
  - Identification of principal optimisation parameters
  - Evaluation of potential savings
- Actual design proposals

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Nitric acid
Short terms improvements

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- Solution carried out by Acron during the project
  - Improved preheat of process gas before NO_x reduction unit
  - Achieved improvement (per plant)
    - Natural gas reduction: 320 – 360 nm3/h (2.5-2.9 mills nm3/yr)
    - CO_2 emission reduction: ca. 5 000 tons/yr.
  - Pay back: Less than 2 years.
  - Detailed engineering carried out by Acron

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Nitric acid
Long term opportunities

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- Significant potential for energy savings
  - Improved heat recovery
  - Power production
- Energy saving potential
  - Natural gas savings up to 11 mills. Nm3/yr. (per plant)
  - Possible CO_2 reduction (21 000 tons/yr. per plant)
- Currently too long pay-back period
  - 4 – 10 years pay back at current energy costs
- Strategic planning
  - Change in energy costs
  - Plant upgrade
  - Integration of environmental protection systems

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Selected other saving potentials

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- Gas expander
  - Produce power by expanding high pressure n-gas
    - 3 MW electricity
    - Pay back period 2-4 years
- Methanol plant
  - Improved process integration
    - Reduced power – oxygen generation (5 100 MWh/yr)
    - Decreased steam demand (up to 49 000 MWh/yr)
- Ammonia plant
  - Power production
  - Reduction of steam consumption
- Heat export potential (80 - 140 C)
  - Significant potential for heat export from Acron
  - 150 MW waste heat

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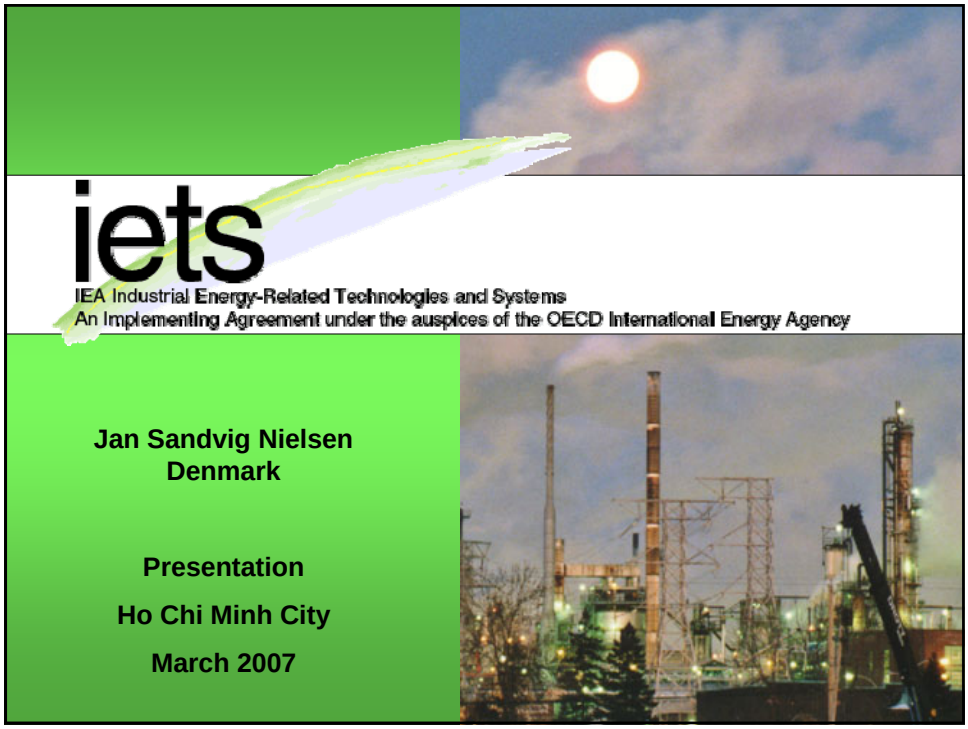
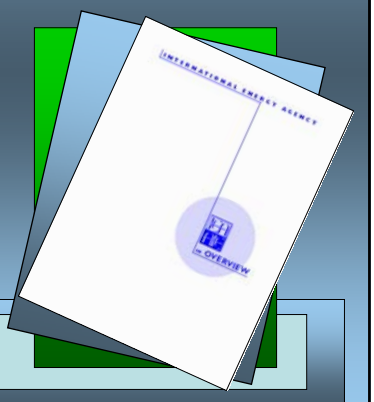


What is the IEA?

The International Energy Agency (IEA) was founded by the OECD countries in 1974 to reduce dependence on imported oil.

The shared goals of IEA members today are **energy security, economic growth and environmental protection**.

Energy technology innovation and widespread deployment of more economical and environmentally benign technologies are central parts of the IEA's work.



For more information about the IEA:

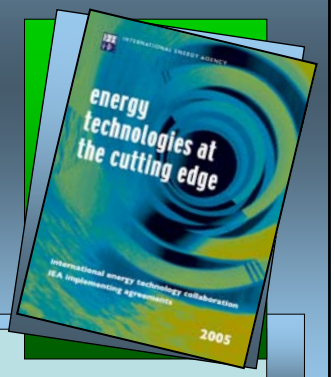
http://www.iea.org/Textbase/about/docs/Overview.pdf

What is an IEA Implementing Agreement?

IEA Implementing Agreements offer the **framework** for collaborative projects.

Interested countries join together to study applications of existing technologies, research new technologies, co-ordinate national research programmes or share information.

Today there are 40 collaborative projects in the following areas:
End-Use; Fossil Fuels; Renewable Energies and Hydrogen; Fusion Power; Cross-sectional Activities.



For more information about the Implementing Agreements:

http://www.iea.org/textbase/nppdf/free/2005/IAH2005mep_Full_Final_WEB.pdf

The IETS Implementing Agreement

The IETS is an Implementing Agreement under the IEA, focusing on **energy efficient industrial technologies and systems**.

The Programme was established in 2005 as the result of merging, revamping and extending activities formerly carried out by separate industrial IEA Programmes.

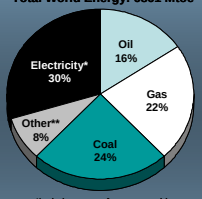
The IETS currently has ten member countries: Finland, USA, Canada, Denmark, Sweden, the Netherlands, Norway, Portugal, Mexico and Brazil.

For more information about IETS:

http://www.iea-iets.org/ Information Brochure “About IETS”

Energy use in industry

Figure 1. Industry Energy Worldwide: 2059 Mtoe: Total World Energy: 6861 Mtoe



*includes power from renewables
**combustible renewables & waste

Today, industry accounts for about **one-third of total global energy use**.

The sector is responsible for about **22% of worldwide CO_2 missions**, of which:
26% are from the iron and steel industry,
25% from non-metallic minerals and
18% from petrochemicals.

Source: IEA

Energy efficiency potential

Overall, industry offers a **significant savings potential** at low or even negative cost.

As a result, there is a greater potential for reducing greenhouse gas emissions at a lower cost than could be achieved in other sectors. A long-term potential for CO_2 emission reductions in this sector is 25-30%.

This potential deserves more attention than it has received so far.

Source: IEA

Energy efficiency opportunities

Some examples:

• In primary steel production, efficiency improvements on the order of 20 to 30% are available based on existing technology;

• Improvements to steam supply systems and motor systems offer efficiency potentials on the order of 15 to 30%;

• Combined heat and power generation can bring 10 to 30% fuel savings over separate heat and power generation;

• CO_2 capture and storage (CCS) could be applied to several industries on a gigatonne-scale, especially in the production of chemicals, iron and steel, cement and paper pulp.

Source: IEA

Identifying opportunities in industry

Identifying opportunities in industry is complex due to the great diversity of processes and products.

Moreover, evaluating the techno-economic aspects and reliability of those opportunities can be time-consuming and difficult.

Much more research, development and demonstration (RD&D) and international co-operation will be needed to successfully identify and capture the world-wide opportunities for industrial energy efficiency improvement.

Mission of IETS

To foster international co-operation among OECD and non-OECD countries for accelerated research and technology development of industrial energy-related technologies and systems.

Strategic Objectives of IETS

- To strengthen international cooperation on energy saving and GHG mitigation in industry;
- To facilitate cooperation between different industrial R&D disciplines;
- To improve knowledge transfer and information between countries, researchers and industries;
- To provide IEA and the G8 countries with energy consumption data and energy efficiency opportunities.

IFA aspects

- Benefits
  - Cooperation with energy technology experts
    - Share knowledge with other industries
  - Added credibility by working with IEA
- Potential working packages
  - Energy management guidelines
  - KPI's
  - Best practice
  - Benchmarking

More information about the IETS

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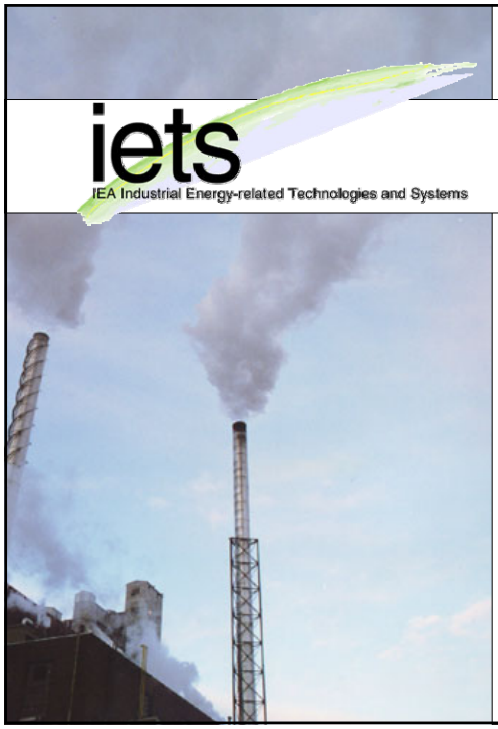

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