UREA FERTILIZER FACTORY LIMITED

COMPANY DESCRIPTION

Urea Fertilizer Factory Ltd (UFFL) is one of the oldest fertilizer plants in the country and a government-owned enterprise of Bangladesh Chemical Industries Corporation (BCIC) under Ministry of Industries. This factory is located at Palash, Narsingdi and was established in 1970 as a public limited company and its commercial production started on 4 September 1972. At present more than 1200 employees work in this factory and it produces high quality ammonia and urea fertilizer. As a continuous process, the unit operates 24 hours a day for 330 days per year. The overhaul of the factory is every two years and all kinds of major repair, maintenance and replacement works are carried out during that period.

The installed production capacity of the plant was 340,000 tons of urea per year and the renovated capacity is 470,000 tons per year. The present capacity utilization rate is approximately 80% and production for the base year 2003 was 340,223 MT and in 2004 it was 370,955 MT.

This plant started with installed capacities of 660 t/day of ammonia and 1137 t/day of urea fertilizer. Since then, it has implemented several programs to upgrade the plant. The Rehabilitation Scheme (RS) in 1985 changed the cooling water treatment system from a chrome based to a non-chrome based system, and to install new equipment, which enhanced their utility facilities. The next renovation was carried out during 1989-94, which reduced of natural gas consumption from 42 MCF/ton to 32 MCF/ton of urea and increased the production capacity to 470,000 MT/year. In 1999-2001 a 18 MW Gas Turbine Generator (GTG) was installed under the project “Energy Saving, Environmental Protection and Improvement of One-Stream Factor”. The company participated in the “Energy Management System” project in 2001 to improve their energy efficiency. The benefits from that project were instrumental in convincing the plant and corporate management to participate in the GERIAP Project. *(See case study “Story of a government plant”)*

PROCESS DESCRIPTION

Natural Gas (NG) is the main raw material of the plant. Production process involved two major processes: (1) Ammonia Process and (2) Urea Process. From NG, the plant produces liquid ammonia and then urea fertilizer, as described below and shown in figures 1A and 1B.

- ***Ammonia Process***

NG is desulphurized through the Desulphurization Vessel, which contains Zinc Oxide to remove sulphur. The refined NG then is chemically reformed in the First Reformer with steam through a nickel catalyst to produce H_2, CO and CO_2. Any unreformed process gas is further reformed in the Second Reformer and mixed with air. The following chemical reactions occur in the First and Second Reformers:

$CH_4 + H_2O = H_2 + CO + CO_2$

$H_2 + ½\ O_2 = H_2O + 57.8$ K.Cal/gm Mole

$CO + ½\ O_2 = CO_2 + 67.6$ K.Cal/gm Mole

$CO + H_2O = CO_2 + H_2 + 9.8$ K.Cal/gm Mole

$CH_4 + H_2O = CO + H_2 – 49.3$ K.Cal/gm Mole

$CO + H_2O = CO_2 + H_2 + 9.8$ K.Cal/gm Mole

Figure 1A

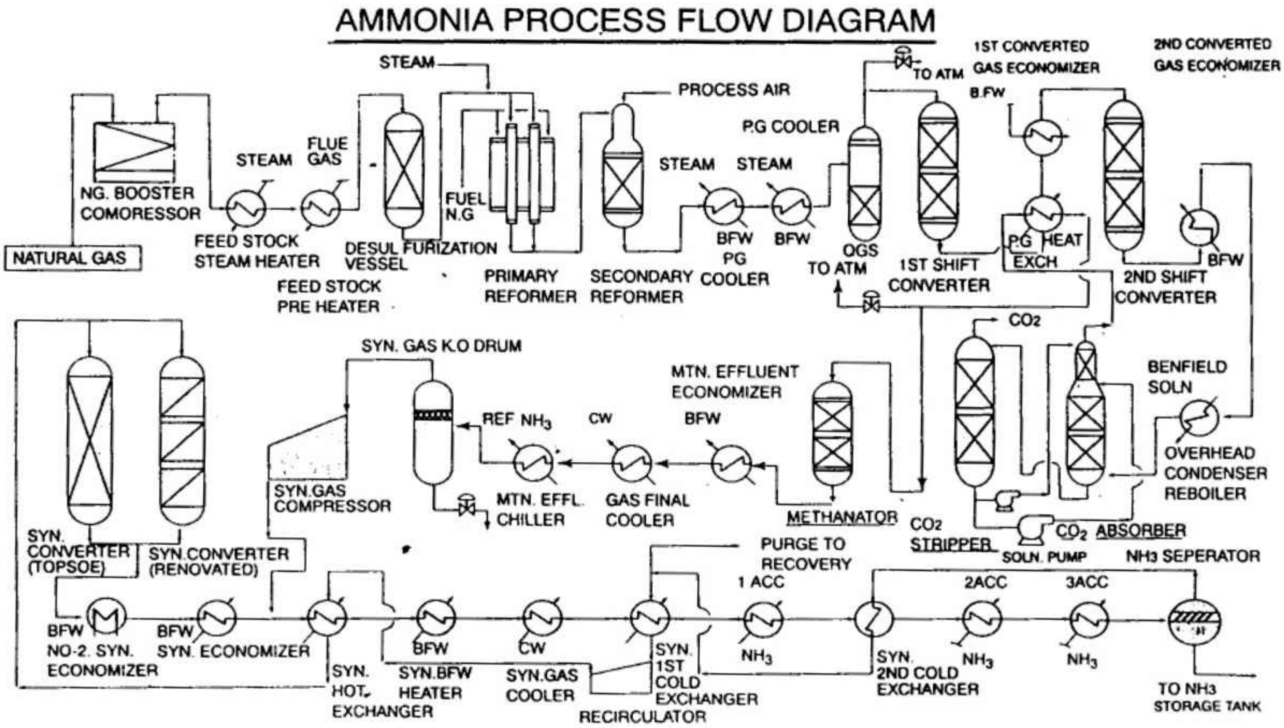
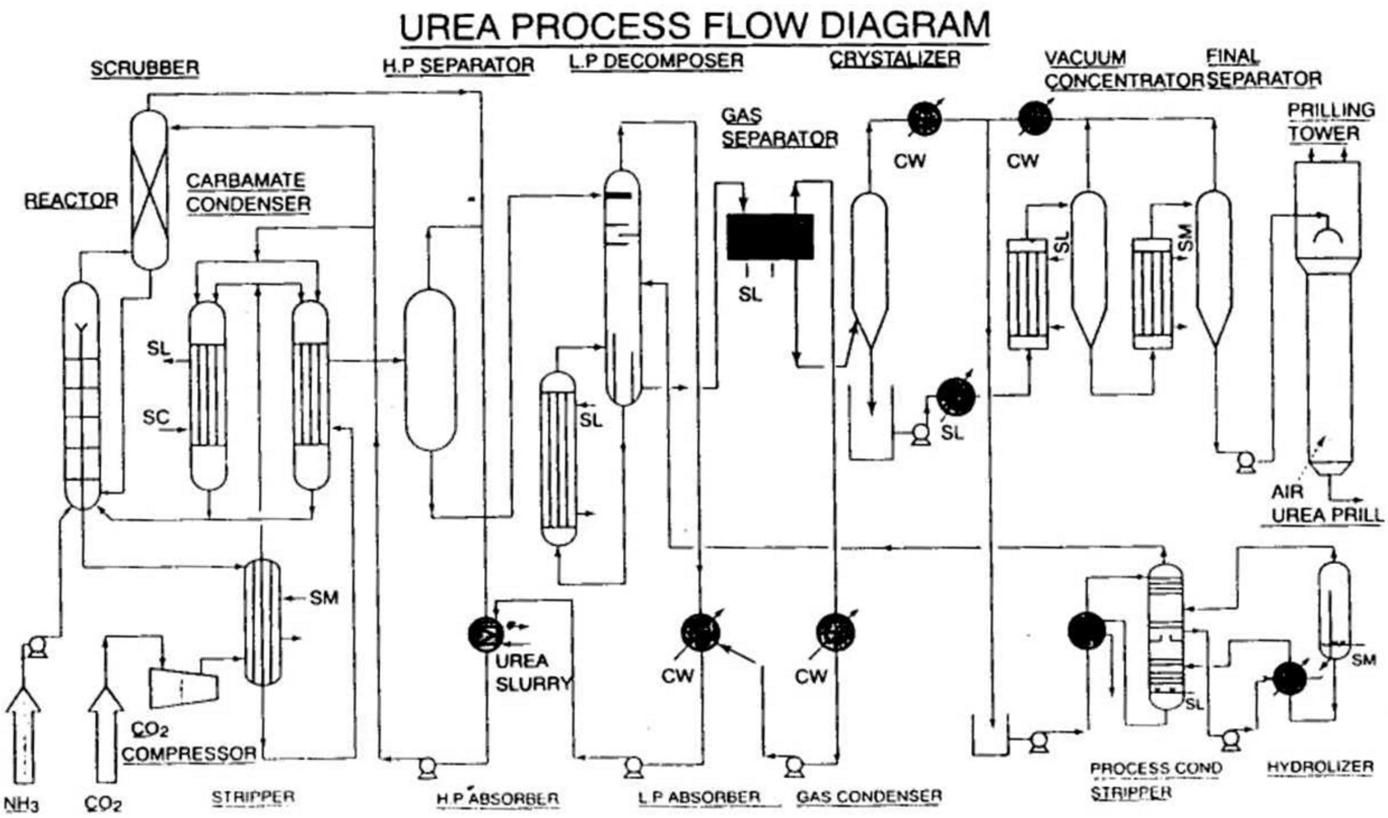


Figure 1B



Next, CO_2 is recovered from the mixed gas of H_2, N_2 and CO_2 ($H_2+N_2+CO_2$) by the Benfield Process and is sent as a raw material to the Urea Plant. To save the Synthesis Catalyst, CO and CO_2 is then converted to CH_4 and inert gas through Methanation Process as follows:

$$CO + 3H_2 = CH_4 + H_2O + 21.66 \text{ K.Cal/gm Mole} \qquad CO_2 + 4H_2 = CH_4 + 2H_2O$$

Next, purified H_2 and N_2 are compressed by the Synthesis Gas Compressor at a pressure of 150Kg/cm^2 at a ratio of 3:1 and then sent to the Quince type Ammonia Converter. In this stage, the temperature of the process gas reaches at 470-500^{0}C. The ammonia synthesis reaction is as follows:

$$3H_2 + N_2 = 2NH_3 + 22 \text{ K.Cal/gm Mole}$$

This ammonia gas is then liquefied by the mechanical refrigeration cycle and is stored in ammonia storage tank before it is sent to the urea plant for urea production.

- ***Urea Process***

Urea is produced by liquid ammonia and CO_2 gas by the Advanced Cost & Energy Saving (ACES) process in the Synthesis Reactor. In this Urea Synthesis Process, the temperature of the ACES loop is kept at 190^{O}C and a pressure of 175 Kg/cm^{2}g with an ammonia & CO_2 ratio at 4:1. Urea is produced from the ammonia and CO_2 by an exothermic reaction through the following two steps:

$$\text{(a)}\ 2NH_3 + CO_2 \rightleftarrows NH_2\,COONH_4 - 38.06 \text{ K.Cal/gm Mole}$$

$$\text{(b)}\ NH_2\,COONH_4 \rightleftarrows NH_2 - CONH_2 + H_2O + 5.22 \text{ K.Cal/gm Mole}$$

Liquid Ammonia is directly sent to the reactor and CO_2 through Stripper. The converted urea solution (urea) along with excess ammonia, ammonium carbonet and water are also passed through the Stripper. It is then sent via the Gas Separator, Vacuum Concentrator and Final Separator to the Head Tank of the Prilling Tower. Next, the concentrated urea is sprayed through an Acoustic Granulaor on a Fluidized Bed in the Prilling Tower, and turns prill upon contact with air blowing from the bottom. Prilled urea is then sent to packaging and storage.

METHODOLOGY APPLICATION

The draft Company Energy Efficiency Methodology was used as a basis for the plant assessment to identify and implement options to reduce energy and other materials and wastes. Some of the interesting experiences are:

- ***Task 1a–Meeting with top management:*** From a first meeting with plant management it became clear what the constraints and benefits were that would influence an energy assessment and should be considered:
  - Constraints: old plant, lack of capital, low energy costs, Government owned plant with possible slow decision making, less economic incentive than commercial plants to reduce costs, and need to ensure that safety environment and production are not affected
  - Benefits: sound process design, an expert team within the plant, supportive site management, low labor rates

Lesson learnt: A first meeting with top management will help understand what factors will make an energy assessment easier or more difficult, which will need to be considered in the planning as part of preparing an assessment proposal.

- ***Task 1e – Prepare assessment proposal for top management approval:*** The pre-assessment showed that huge potential savings exist for this fertilizer plant. Despite this knowledge, it took several months to get the energy assessment started at this plant because the plant it Government owned and has a complicated management structure with many layers. Approval from site management was not sufficient and a lot of time had to be spent to get the approval from top management.
Lesson learnt: when dealing with a Government owned plant or a plant that is part of a larger conglomerate a lot of time may be needed to get approval for an energy assessment because of the more layered and bureaucratic management structure.

- ***Task 4a – Technical, economic and environmental feasibility analysis:*** The Team identified that one of the main barriers to implementation of options was obtaining the investment capital, because the plant is Government-owned and has a complex and bureaucratic approval system. When the Team brainstormed about a solution it was found that several of the proposed options could be paid for by the maintenance budget, such as the insulation and repair of broken insulation on steam pipelines, valves and fittings, and the reparation and replacement of steam traps, valves and flanges.
Lesson learnt: Investment costs for some options can be sourced from existing allocated budgets, such as regular maintenance budgets.

- ***Task 2d – Quantify inputs and outputs and costs to establish a baseline:*** Management mentioned at the first meeting that inefficiencies are mostly happening because the plant it old, and that new technologies rather than improvements to the existing processes were needed to improve the plant's energy efficiency. An international consultant assisted the plant's Team and external Bangladeshi facilitators with the collection of baseline data for the plant and compared these with specific resource and energy consumption data of other similar fertilizer plants. Upon showing the results to site management, he convinced management that improvements in resource and energy efficiency of at least 20% would be possible by improving the existing production process without purchasing new technologies.
Lesson learnt: quantifying inputs and outputs and costs can be important to convince management of the potential to improve energy efficiency, which in turn will help in getting their support to implement options at a later stage

- ***Step 6 – Continuous improvement:*** The barriers to energy efficiency that were identified at the start of the project have not changed. This Government owned fertilizer plant has very good technical staff, but has a complex management structure, bureaucratic processes and less economic incentive compared to a commercial plant. Therefore improvement in energy efficiency will very much depend on top management driving this, rather than by staff's technical skills and motivation.

OPTIONS

- The focus areas selected were: (1) Water distribution system, (2) Steam system, (3) Electricity consumption (4) Ammonia.
- A total of 5 options were identified (several are cluster options i.e. many small options combined), of which 4 were partially implemented and 1 remains to be implemented
- For the 4 partially implemented options, investment costs were none because existing maintenance budgets covered equipment and labour. Annual savingswere US$ 469,830
- For the 4 partially implemented options, electricity savings were 5,991 MWh, Natural gas 2,333,307 NM^3; Water savings 159,600 t
- GHG emissions were reduced by 8,286 tons, which represents 2.2% of the plants total emissions (371,611 tCO_2 in 2003)

Table: EXAMPLES OF OPTIONS IMPLEMENTED

FOCUS AREA/ OPTION	CP TECHNIQUE	FINANCIAL FEASIBILITY	ENVIRONMENTAL BENEFITS	COMMENTS
Water Distribution System / Water and energy conservation in water distribution system *(see case study)*	Good housekeeping	▪ Investment: not determined ▪ Cost savings: US$ 85,985 ▪ Payback period: immediate	▪ Water savings: 159,600 t/yr ▪ Electricity savings: 17 MW/yr ▪ GHG emission reduction: 9 tCO_2/yr	Valves, flanges and insulation materials were in stock option implemented under maintenance budget so investment costs could not be determined
Steam system / Insulation, steam traps repair and condensate recovery for boiler and steam system *(see case study)*	Good housekeeping	▪ Investment: not determined ▪ Cost savings: US$ 85,165/yr ▪ Payback period: immediate	▪ Natural gas savings: 2,333,307 NM^3/yr ▪ GHG emission reduction: 5,052 tCO_2/yr	Valves, flanges and insulation materials were in stock and option implemented under maintenance budget so investment costs could not be determined
Electricity consumption / Installation of capacitor bank to improve power factor and replacement of motors and pumps *(see case study)*	Good Housekeeping	▪ Investment: not determined ▪ Cost savings: US$ 298,680 ▪ Payback period: immediate	▪ Electricity savings: 5,974 MW ▪ GHG emission reduction: 3225 tCO_2/yr	Motors, pumps and other parts and were in stock and option implemented under maintenance budget so investment costs could not be determined
Water Distribution System / Cooling water conservation through reduced water drainage, blow down and evaporation *(see case study)*	Good housekeeping Process / equipment modification	▪ Investment: US$ 91,667 ▪ Cost savings: US$ 140,000/yr ▪ Payback period: 8 months	▪ Electricity savings: 1030 MW/yr ▪ GHG emission reduction: 556 tCO_2/yr	Option only partially implemented so savings are projected savings for full implementation only
Ammonia / Repair of leaks in ammonia pipelines *(see case study)*	Good housekeeping	▪ Investment: US$ 25,000 ▪ Cost savings: US$ 23,334/yr ▪ Payback period: 13 months	▪ Natural gas savings: 646,470/yr ▪ GHG emission reduction: 1400 tCO_2/yr	Option to be implemented during shutdown end 2005 so figures are expected savings only

FOR MORE INFORMATION

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