1,100 Metric Tons/Day Urea Plant
1,100 MTPD Urea Plant

Introduction
Designed by Stamicarbon, the Urea Plant was commissioned in 1982 and shut down in October 2002. The plant had an original capacity of 1,000 metric tons per day but has been upgraded to its current capacity of 1,100 metric tons per day. The plant has a prill tower and a Kaltenbach fluid bed Granulator.
Urea Manufacture using the Stamicarbon Recycle process

The chemical reactions that take place in the process guide the operator to concentrate on the key parameters to control the process.

Temperature and retention time determine the extent to which an impurity is formed, particularly the formation of biuret. Other compounds can be formed if the process gets out of control e.g. triuret and cyanuric acid. Water, carbon dioxide and ammonia form carbonates and bicarbonates which may affect the technical quality requirements.

**UREA PRODUCTION**

\[ 2\text{NH}_3 + \text{CO}_2 \leftrightarrow \text{NH}_2\text{CO}_2\text{NH}_4 \]

Exothermic Reaction

\[ \text{NH}_2\text{CO}_2\text{NH}_4 \leftrightarrow \text{NH}_2\text{CONH}_2 + \text{H}_2\text{O} \]

Endothermic Reaction

\[ 2\text{NH}_2\text{CO}_2\text{NH}_4 \leftrightarrow \text{NH}_2\text{CO} \text{HCONH}_2 + \text{NH}_3 \]

Biuret Reaction
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**High Pressure Condenser**
Ammonia (2 moles) and carbon dioxide (1 mole) react under pressure (147 bar) in the high pressure carbamate condenser where 90% of the feeds are converted to ammonium carbamate (1 mole) giving out heat (approx. 30 kcal per mole). The heat given out is used to generate steam.

**Reactor**
The process stream flows to the reactor where the carbamate decomposes to form urea (1 mole) and water (1 mole).
This reaction is endothermic and the required heat (approx 3 Kcals per mole) is supplied by the 10% of unreacted ammonia and carbon dioxide from the high pressure condenser.
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**Stripper**
The process stream flows to the stripper where any unreacted ammonia and carbon dioxide is stripped from the urea in water solution (liquid). The carbon dioxide feed to the high pressure condenser passes through the stripper on its way to the condenser and is the stripping medium. A film of urea solution flows down the inside wall of the several hundred tubes that are heated by steam on the outside wall. The carbon dioxide continues on counter flowing to meet the ammonia and recycled carbamate at the inlet of the high pressure carbamate condenser.

**Rectifying Column**
The urea solution leaving the stripper at 147 bar is reduced to 4 bar as it enters the rectifying column where the lower concentrations of ammonia and carbon dioxide are distilled over using steam feed to a heat exchanger at the base of the rectifying column.
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The pressure is dropped to ambient through the flash tank where more vapors are emitted and the urea flows to the urea solution tank at a concentration of 75% urea.

The biuret at this stage is about 0.6 - 0.7%. The vapors are condensed and retained in the ammonia water tank for treatment in the desorption hydrolysis system.
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**Evaporators**
There are two evaporators Evap.1 where the concentration of urea is increased from 75% to 95% urea and Evap. 2 where it is increased to 99.7%.
The water is condensed and passes to the ammonia water tank from where it is treated to remove and recover residual ammonia, urea and CO₂.

**Prilling**
The dried urea from the evaporators is now effectively molten urea with 0.3% moisture and about 1% biuret. The temperature is about 134°C.
The molten urea is pumped to the top of the prill tower (39 meter high) and into a prill bucket. The bucket is drilled with approx. 1500 holes in the wall. The base of which is solid and attached to a motor with variable speed to give it a rotational speed of approx. 230RPM. The stream of urea through the holes is broken into droplets that fall down the tower against an airflow of 335,000 m³ per hour.
Prilling continued

The air is drawn up the tower by six fans sitting at the top of the tower and the air enters the tower at the base through louvered slots.

To reduce the possibility of the prills super cooling and also to increase the impact strength of the prills a small quantity of very fine urea mixed with a flow aid (Calcium Stearate), particle size between 5 and 20 micron, is blown into the cooling airstream at the base of the tower. Each prill is hit by several particles and the crystallisation starts from each of these points to form a much stronger structure.
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**Desorption Hydrolysis**

The ammonia tank water is pumped to the top of Desorber 1 via a heat exchanger at the outlet of Desorber 2.

Ammonia is stripped from the water by the gases and steam leaving Desorber 1. The liquid from the base of Desorber 2 is fed to the bottom of the hydrolyser with live steam and flows upwards converting urea into ammonia and CO2. The liquid is fed to the top of Desorber 2 and the gases are stripped of ammonia and CO2 by steam.

All ammonia is condensed to ammonium carbamate and recycled by the high pressure carbamate pump to the plant feeds of the high pressure carbamate condenser.

The effluent from the Desorption hydrolysis section of the plant is discharged at 20ppm NH$_3$ and, 10ppm urea. Flow rate 25m$_3$ per hour.
Installed a new high pressure stripper in 1993
Installed a new high pressure condenser in 1993
Installed a new high pressure scrubber in 1993
Installed a new reflux condenser in 1993
Installed a new hydrolyser heat exchanger in 1993
Reactor with extra trays fitted and top dome relined
Desorption system upgraded and extra trays fitted
N to C meter fitted
Suction cooler fitted to suction of CO2 compressor
CO2 centrifugal compressor, Nuovo Pignone model no: 2MCL527, BCL305, BCL205, Siemens Turbine, ENK 32/36.
NH3 pumps, Worthington, UQE-H, 95*152, 230Kw, 136-146 RPM, 180 Bar.
Carbamate pumps, Worthington, UTE-H, 180*152, 140 Kw, 74-114 RPM, 165 Bar.
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Other Equipment-Turbines Covered

Absorber 101-E

Stripper 102-E
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Air Compressor 101-JA
part 1

Ammonia Compressor 1015-J

Synthesis Gas Compressor 103-J
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Secondary Reformer 103-D

Various Equipment

Various Equipment 105 CA/CB
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