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EFFECTIVE WAY TO BOOST YOUR UREA PLANT CAPACITY - REVAMPING OF FERTIL UNIT

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Urea Casale's industrially proven technologies are being applied for a large capacity increase in the Urea Plant of Ruwais Fertilizer Industries (FERTIL) in UAE.

The Full Condenser™ design combines the mechanical advantages of the standard falling film configuration of the HPCC, with the very efficient bubble-flow condensation regime together with internal thermo siphon circulation.

The Split Flow Loop™ design takes advantages of the total condensation obtained in HPCC through Full Condenser™ design. These further increases the Reactor efficiency by splitting the vapours from HP Stripper so that the part that is required to be condensed is sent to HPCC while the rest to the Reactor. In this way only part of the inerts introduced in the plant reaches the Reactor, with a significant enhancement in the Reactor efficiency.

A Medium Pressure Split Flow Section has been added in order to achieve the target capacity.

The paper will give an overview of the application of these technologies to the specific revamping of the FERTIL urea plant and an overview of the project execution.

ABOUT FERTIL AND PROJECT BACKGROUND

Ruwais Fertilizer Industries (FERTIL) was established in October 1980 as a joint venture between Abu Dhabi National Oil Company (ADNOC) and TOTAL of France. Construction activities began in 1980 and production started in 1983. The prime objective behind establishing the company was to utilize lean associated gas supplied from onshore oil fields to produce Urea fertilizer and market it locally and internationally.The plant facilities are located in Ruwais Industrial complex (RIC) which is about 250 km west of Abu Dhabi City.

The existing facility comprises of 1050 MTPD, Haldor Topsoe designed Ammonia plant and a 1500 MTPD Stamicarbon designed urea plant. The plants have fully integrated utility units with storage facilities. The company has been continuously improving its technology and productivity. Presently, Ammonia and Urea plants are operating at 130% and 120% respectively of their original name plate capacities.

FERTIL Shareholders contemplated to install a Melamine plant in Ruwais to which feedstock and utilities were to be provided by FERTIL. The returning Carbamate stream from the Melamine plant was also to be processed in the FERTIL Urea plant. Further, it was desired to convert all available surplus liquid ammonia (about 100,000 MTPY) in to Urea.

With the above mentioned Objectives in view, FERTIL engaged Urea Casale to conduct a Technical Study which formed the basis of the Urea De-bottlenecking Project (UDP). The Urea De-bottlenecking project had three Components:

- Modifications to the Urea Plant to enhance its capacity from 1800 to 2700 MTPD (Synthesis section) enabling it to transform ammonia produced in excess in the ammonia plant into urea using the CO2 recovered from the flue gas of the reformer.
- Installation of a 400 MTPD CO2 Recovery plant utilizing Mitsubishi Heavy Industries (MHI)' proprietary KS-1 Chemical Absorption technology.
- Installation of 2500 MTPD Granulation unit using Uhde Fertilizer Technology (UFT)' license.

With processing of recycled Carbamate from Melamine plant, the revamped urea plant would have produced 2700 MTPD of Urea, out of which 800 MTPD would have been for the Melamine plant as raw material, while 1900 MTPD would have been granulated.

During Melamine plant shut down periods, the revamped urea plant would have produced 2300 MTPD of granular Urea.

In March 2008 however, the plan to install the Melamine plant in Ruwais was changed and proposed at another location close to Abu Dhabi. Although, equipment related solely with the Melamine Project was deleted from the UDP scope, the main equipment modifications within the Urea Plant were retained.

The Urea plant after UDP implementation shall now produce 2300 MTPD utilizing all excess ammonia presently available. This paper describes the modifications in the Urea Plant originally designed with a name plate capacity of 1500 MTPD, operated at 1830 MTPD and revamped for a target capacity of 2700 MTPD utilizing Urea Casale's proprietary technologies of Split flow and Full Condenser.

Apart from providing the Process Design Package of Urea Plant Modifications for the FERTIL UDP, Urea Casale also performed the Front End Engineering Design (FEED) and Detail Engineering.

EPC contract was awarded to Descon Engineering of Pakistan in July 2007 and the Project completion was in September 2009.

Pre-Commissioning, Commissioning and Start-up activities started in June 2009 and were completed in October 2009.

UREA CASALE REVAMPING CONCEPT

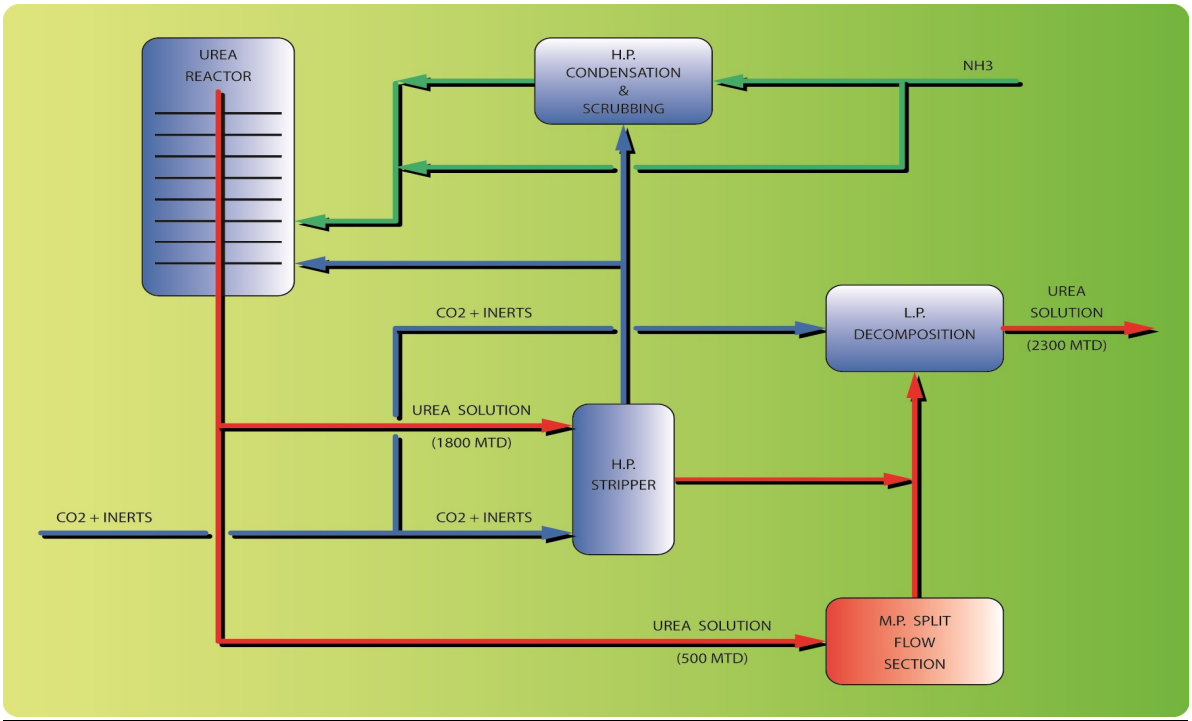
The modifications implemented in the Urea Plant to comply with the increased capacity are described as follows:

- Implementation of the technologies developed by Urea Casale, namely the Full Condenser™ and Split Flow Loop™ designs to upgrade Urea Plant Synthesis section from 1,830 up to 2,700 MTPD.
- Urea reactor performance improvement by adopting the Casale-Dente high efficiency trays which are the most efficient trays available in the market and are also an essential element to make Split Flow Loop ä as efficient as possible.
- To debottleneck the synthesis loop a Decomposer operating in parallel to the existing Stripper has been provided (MP Split Flow Section). The urea solution from the Reactor is split in two parts, one part to existing Stripper and other part to the new Decomposer. By condensing ammonia and CO2 at medium pressure it is possible to recycle to synthesis section a carbamate solution more concentrated, increasing the performance of the Reactor, with respect to the recovery of un-reactants at low pressure.
- The last important element of the Split Flow Loop ä process is the High Efficiency Hydrolyser that allows treating very efficiently the process condensate, eliminating all NH3 and Urea, so that it can be discharged without any environmental effects or it can be used as boiler feed water.

REVAMPING PROCESS DESCRIPTION

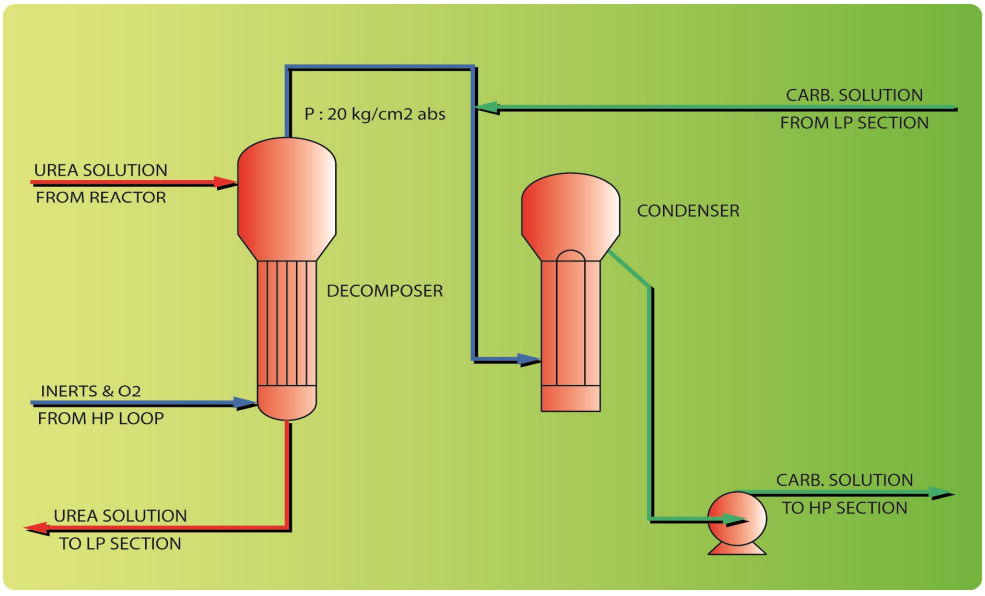
H.P. Section

Existing Reactor has been modified by replacing the existing trays with a set of new CASALE High Efficiency Trays.
After revamping, to cover the new demand of fresh ammonia both existing HP Ammonia Pumps are in operation. To have the necessary plant reliability, a new reciprocating pump identical to the existing ones has been added as spare.
Due to the increase in requirement of CO2 flow an additional CO2 compressor, reciprocating type, is installed, taking suction from CO2 recovery unit and feeding to discharge of existing CO2 compressor.
To cope with the new carbamate solution capacity for H.P. carbamate pumps new pumping capacity is being added.
Existing HP Stripper has been modified to fit the equipment to provide the new Split Flow configuration.
Existing HP Carbamate Condenser was replaced since the existing one was at the end of its working life. The new Full Condenser has been designed for the new plant capacity.



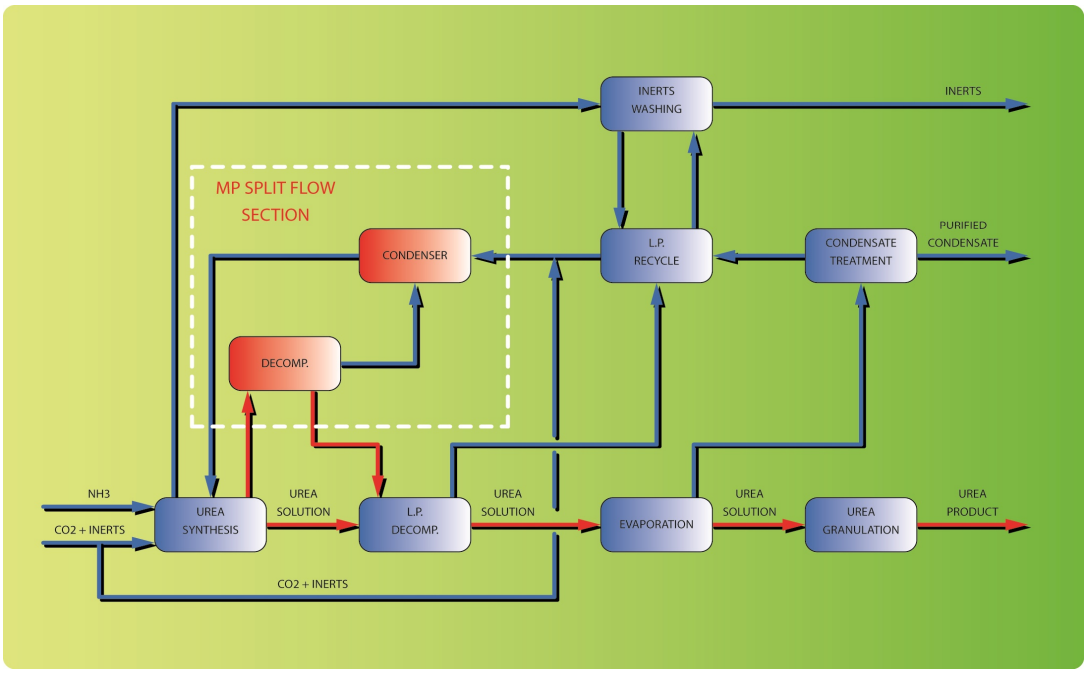
MP Split Flow Section

In order to achieve the capacity increase up to 2'700 MTD a new decomposition section operating at 18-20 kg/cm2 is installed in parallel to the existing Stripper.
The urea solution coming from the Reactor is split part to the existing Stripper and minor portion to the new Decomposer.
The vapors from Decomposer are condensed in the new Condenser with the help of carbamate solution coming from Level Tank for Carbamate Condenser through the new M.P. Carbamate pumps.
The solution coming from Decomposer joins the solution exiting the HP Stripper to feed a common new LP Flash vessel.



L.P. Section

Urea solution, both from the Stripper and the MP Decomposer, are fed into the new LP separator where the gas/liquid separation is achieved.
Therefore only the liquid phase is sent to the existing rectifying column, where the liquid distribution is improved by new internals of more efficient concept.
The vapors from the top of rectifying column, together with the vapors from new LP separator join a stream of CO2 from the compressor that is being added in order to guarantee optimum condensation into the existing and new LP Condensers. The liquid from new LP separator enters top of rectifying column which in turn enters into Recirculation heater for further decomposition.



Vacuum Evaporation and Condensation Sections

Due to the fact that this section has almost the same design capacity of the Granulation Unit (2500 MTPD) a new bigger evaporator is installed and flanged to the existing separator.
Inside this separator, special internals designed by CASALE are installed, to avoid urea carry-over problems.
The urea solution 96% wt is sent from separator to the new granulation section by means of new urea melt pumps.

Hydrolysis / Desorption Section (Waste Water Treatment)

The function of the revamped Waste Water Treatment section is to deeply treat the process water produced in the urea plant (recycle water plus formation water) in order to obtain water containing about 1 ppm of urea and NH3 (suitable to be used as BFW) before it is discharged from the urea plant.
A new Distillation Column, is being introduced in order to achieve the process condensate quality to be suitable for BFW utilization.
This column is divided in two parts thanks to a chimney tray that split the column in the desorption section (upper part) and stripping section (lower part).
Upper part removes most part of NH3 and CO2 by means of vapors coming from the lower part through the chimney tray.
The water from the chimney tray of this column feeds the existing hydrolyser, which will be modified according to CASALE High Efficiency Hydrolyzer technology thus reducing the urea content in the treated water down to about 1 ppm.

Urea Debottlenecking Project (UDP) Process Performances

Capacity after Revamping

After the revamping the design capacity of 2450 MTD has been achieved.

Turn-Down and Operation

Nevertheless the plant, thanks to the presence of the MP Split Flow Section, is having increased plant flexibility. In fact the plant is operating in steady conditions at very low capacity with MP Decomposer not lined up, as well as at higher capacity with MP Decomposer in line. The range of plant operability is varying between 1350 mtpd up to the maximum achieved capacity.
MP Decomposer is lined up or is excluded from the plant operation when it is necessary to raise or to decrease the capacity of the plant.
All the operations are very simple and within a couple of hours the plant capacity is adjusted to the desired value.

Gaseous and Liquid Emissions

The following granular product characteristics have been achieved during a controlled run performed in August 2011:

1. NH_3 emission from 4bar absorber vent to atmosphere:
   - NH_3 less than 1 kg/h
2. NH_3 emission from atmospheric absorber to atmosphere:
   - NH_3 less than 4 kg/h
3. NH_3 and Urea emission in the treated process condensate from Waste Water Treatment section:
   - NH3 less than 1 ppm
   - Urea less than 5 ppm

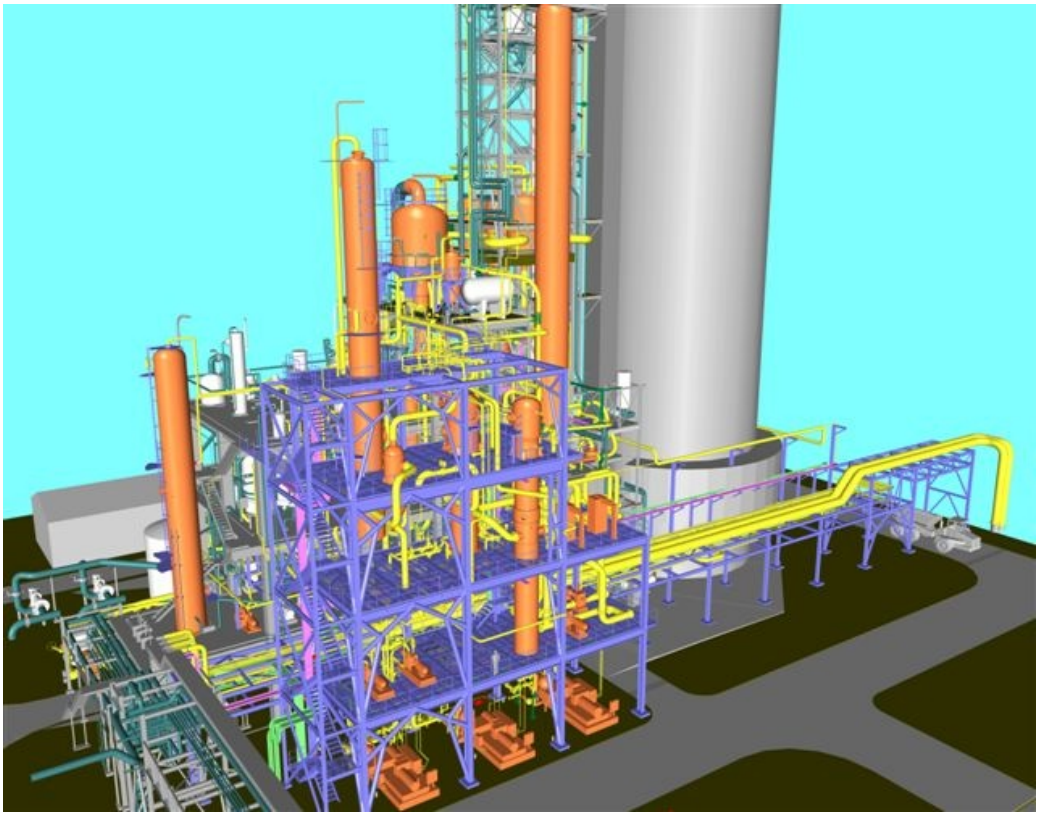
Granular Product

Biuret	0.84 %wt
H_2O	0.22 %wt
HCHO	0.49 %wt
+ 4.00 mm	0.83 %wt
+ 2.00 mm	92.92 %wt
- 2.00 mm	6.25 %wt
Crushing Strength	4.10 kg/prill

Project Implementation

The Urea Debottlenecking Project has been developed through the following main steps:

- Feasibility Study by UCSA
- FEED (Front End Engineering Design) by UCSA
- Detail Engineering of Urea Plant modification by UCSA and including:
  - Laser scanning of the existing plant (see figure below)
  - 3D modelling (see figure below)
- Supply of UCSA proprietary equipment (High Pressure Carbamate Condenser, HP Ejector, High Efficiency Trays, MP Section equipment)
- UCSA assistance to FERTIL for the procurement of Long Lead Item (CO2 Compressor, High Pressure Ammonia and Carbamate Pumps)
- Construction, erection and installation with UCSA assistance
- Pre-Commissioning, Commissioning and Start-Up with UCSA assistance



3D view of FERTIL revamped plant

MP Decomposer corrosion problem

After the start-up of the revamped plant MP decomposer suffered some tube corrosion phenomenon which was detected by sampling the carbamate solution at inlet at outlet of the equipment.
The reasons of the problem have been identified in:

a. lack of passivation agent
b. quality of SS316L UG material used for the tubes
c. inlet carbamate solution not evenly distributed over the tubes (due to the overdesign of the equipment)

In fact, as described above, the original design capacity of the new MP Split section was of about 900 MTD in view of the revamped capacity and Melamine unit integration. After modifying the project scope to "only" 2300 MTD overall production capacity, the relevant MP Split section load was decreased to about 450 – 500 MTD.
As first temporary measure to mitigate the problem, a temporary line of passivation air (coming from the Air Compressor of the NH3 plant) has been provided and some tubes have been plugged allowing the plant to operate at full load with very minimum loss of production. During this period the plant flexibility was limited by the fact that the new MP Section had to be maintained at high load in order to minimize the corrosion phenomena.
To definitively solve the problem, Casale and Fertil agreed to replace the MP Decomposer with a new one re-designed for the actual plant capacity, with higher quality of material used for the exchanger tubes (i.e. Duplex material instead of SS).
The new decomposer has been installed in November 2012; after the replacement of the equipment the corrosions problems have been completely solved with the full satisfaction of Fertil.