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Stamicarbon's mega urea plant: 4500 mtpd in a single train

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1. Preface

Established in 1947, Stamicarbon is the wholly-owned licensing subsidiary of the Dutch chemicals and materials group DSM. Stamicarbon licenses proprietary processes, know-how and expertise developed and commercially proven by its parent company.

DSM NV is a private corporation headquartered in the Netherlands. DSM is active world-wide in a number of branches of the chemical process industry and has a workforce of 22.700.

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2. Stamicarbon's MEGA Urea Plant

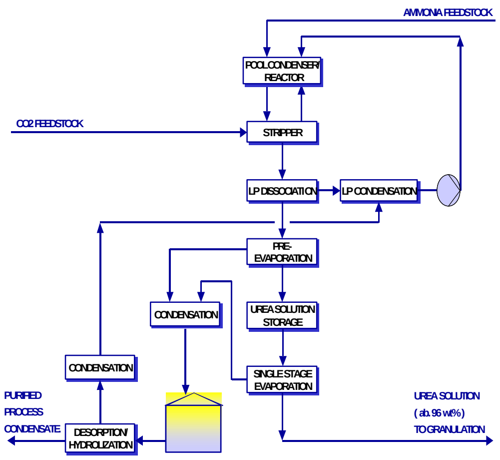
Single line capacities of urea units have increased since the urea industry exists. Were the largest capacities in the nineteen fifties and early sixties still below 100 mtpd, the tendency towards larger capacities has resulted in 2001, in contracts for units with giant capacities of over 3000 mtpd, the equivalent of over 1,000,000 tons per annum. Stamicarbon, the licensor of these large units, uses its Urea 2000plus™ technology to realize these enormous capacities in a single line.

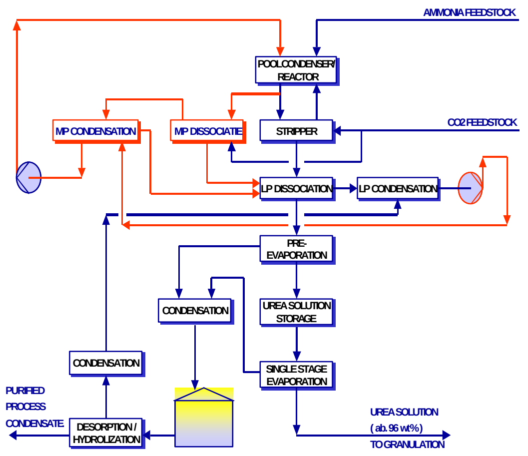
Ammonia licensors are presently developing single line ammonia plants with capacities far beyond the current maximum of 2000 mtpd. In conjunction with the developments in the ammonia world, Stamicarbon has developed a flowsheet for a single line urea plant of 4500 mtpd.

Large plant capacities require large sized high pressure vessels and apart from equipment upscaling constraints, it is certainly not easy to manufacture and transport such large and extremely heavy equipment. Stamicarbon's largest traditional single reactor plant, which is several years in operation, runs at a capacity of 3000 mtpd. Under implementation are single line units with capacities of 3250 mtpd based on Stamicarbon's Urea 2000plus™ process using a pool-condenser. A combination of know-how and experience of the large scale traditional plant with the know-how and experience of the large pool condenser plants paves the way for a new 4500 mtpd urea plant concept.

This new concept uses the Urea 2000plus™ pool condenser flowsheet as basis (figure 1), however in this new concept part of the liquid effluent from the reactor is diverted to a medium pressure recycle section (figure2).

Figure 1: Proven Pool condenser concept **Figure 2: New concept with MP stage**



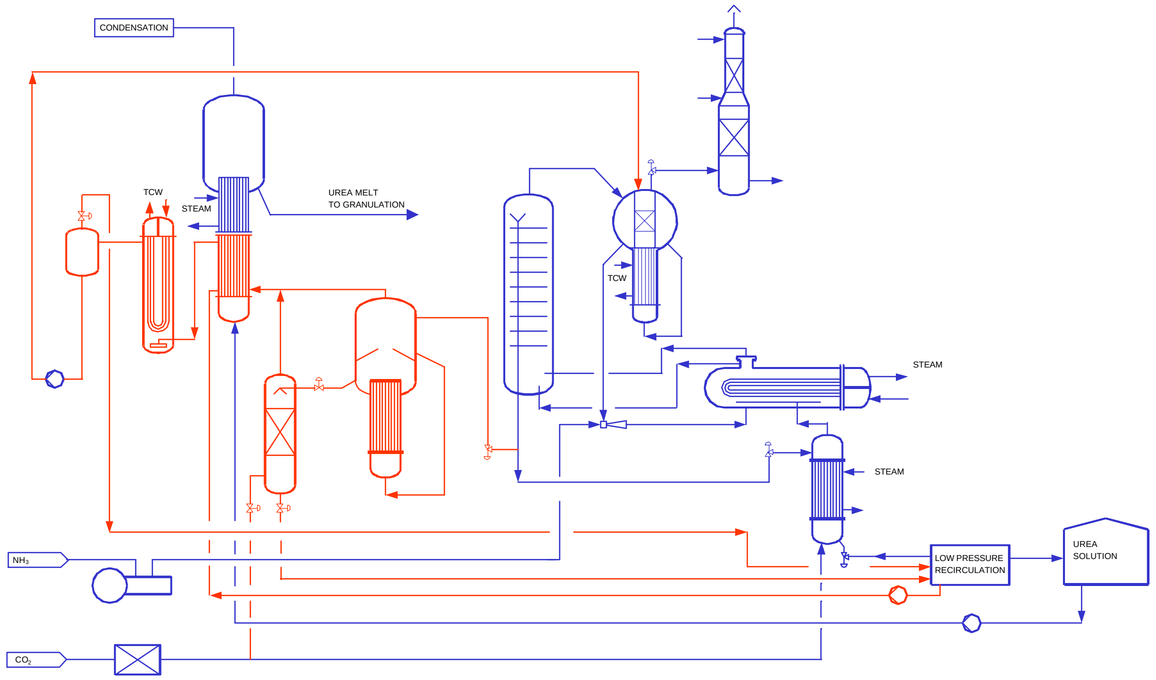


3. Brief Process Description.

The urea solution leaving the urea reactor flows for about 70% to the high pressure CO_2 -stripper. The remaining solution is fed into a medium pressure recycle section. The reduced liquid feed to the stripper results in a reduced stripper size, a consequently reduced amount of off gasses from the stripper results in a smaller pool condenser. The stripping efficiency is chosen in such a way that enough low-pressure steam is produced by the carbamate reaction in the pool condenser as needed in the downstream sections of the urea plant.
About 30% of the urea solution leaving the reactor is expanded into an add-on medium-pressure recycle stage without the usual ammonia recycle and ammonia hold-up. The operating pressure in this section is about 20 bar. The urea solution is heated to some 165 ^{o}C by 12 bar steam whereby the non-converted carbamate is dissociated in ammonia and carbon dioxide. The urea solution leaving the MP dissociation separator flows to an adiabatic carbon dioxide stripper in which the solution is stripped in order to reduce the ammonia to

carbon dioxide ratio in the liquid leaving the MP section so facilitating condensation of carbamate gasses in the next step.

Figure 3 Flowsheet of 4500 mtpd urea plant



The vapors leaving the MP separator together with the gasses leaving the adiabatic carbon dioxide stripper are condensed together with low pressure carbamate in a MP carbamate condensation system consisting of the shell of the evaporator followed by a carbamate condenser with pump vessel. The formed MP carbamate containing only 20 to 22-wt% of water is pumped from this pump vessel to the scrubber part of the urea synthesis
In the MP condensation system the released heat is used for concentrating the urea solution in the lower part of the evaporator. For further concentrating this solution, low pressure steam produced in the pool condenser is used.

The urea solution leaving the adiabatic carbon dioxide stripper , together with the urea solution leaving the high pressure stripper is expanded into the low pressure recycle section which operates at a pressure of 4 bar. The formed low pressure carbamate of this section contains about 30-wt% of water and is pumped to the MP condensation section to avoid crystallization of MP carbamate without the addition of other process water.

4. Features of this Mega Urea Plant

- Because only 70% of the reactor liquid is fed to the high pressure stripper the size of such stripper in a 4500 mtpd plant is similar to the size of stripper in a 3150 mtpd urea plant. This plant size is currently under implementation.
- As the off gasses from the stripper will be only 70 % of those of a 4500 mtpd plant designed in a traditional way, the size of the pool condenser is similar to a condenser in a 3150 mtpd plant.

- A pool condenser achieves already 60% approach to equilibrium in its urea reaction. The required additional approach to equilibrium is provided by the urea reactor. As a large part of the conversion already takes place in the pool condenser the size of this reactor can be smaller and will be similar to the reactor size presently used in the traditional 3000 mtpd plant already in operation.
- All MP stage process steps are well known and proven technologies.
- The plant does have an increased flexibility because a relative small high pressure stripper is used which allows for a higher turn down ratio.
- Energy consumption per ton product is very competitive because the absolute water recycle towards the section synthesis via the carbamate for a new 4500 mtpd plant is similar to todays recycle in a 3250 mtpd plant. Additionally the heat integration between medium pressure condensation section and the evaporation section reduces the energy consumption.
- Investment per ton product is once again reduced because the additional tonnage achieved above todays 3150 mtpd capacity requires no additional investment in high pressure equipment.

Conclusions: Stamicarbon provides a 4500 mtpd urea plant design whereby process steps and high pressure equipment size are not experimental.

5. Conclusion

Technology can always be improved upon.
Stamicarbon has again proven that mature technology can be innovated, while retaining all process advantages of the CO_2 stripping process at the same time increasing plant reliability and substantially reducing the investment cost of the synthesis section.

Stamicarbon's target is to remain, the world leader in Urea technology. With its Urea 2000plus™ technology, Stamicarbon can license state-of-the-art urea plants with capacities upto 4500 mtpd for dependable service for many years to come.

Clients opting for Urea 2000plus™ technology will be ready for the challenges of the future.-