A new urea solution and UAN plant based on the existing standby facilities

Author
Mr. Rinat Anderzhanov
NIIK, Dzerzhinsk, Russia

Abstract
NIIK shares its experience of expanding urea production by construction of a cost effective Urea Plant. The plant is designed to produce 72% urea solution, which then converted into UAN. It means there is no need to install evaporation section, granulation unit and wastewater treatment section. Low energy consumption, low air emissions and wastes make the process environmentally friendly.

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RINAT ANDERZHANOV

NIIK

Dzerzhinsk, Russia

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1. INTRODUCTION

Inspite of urea price fluctuations all over the world, it is obvious that the market demand on this highly-efficient nitrogen fertilizer keeps always its constant positive trend. Likewise, over the recent years there is a growing demand for other urea-based products, such as urea ammonium nitrate (UAN), AdBlue etc. So, it is understandable why the mainstream manufacturers of nitrogen fertilizers consider further extension of urea production as one of the high-priority tasks. For this purpose, and most commonly, producers start with ammonium production scale-up, as far as this element is a critical raw material for all nitrogen fertilizers. Further conversion of the additional ammonium into urea can be performed in different ways and depends on the volume of ammonium produced and the company's goals.

2. DESCRIPTION OF PROPOSED TECHNICAL SOLUTIONS

Let us consider a specific case for the urea production scale-up through the construction of a small-scale plant with the use of only existing equipment and where the produced urea solution is supplied further to the urea ammonium nitrate unit.

In the summer of the upcoming 2018 NIIK will finalize the project for construction of urea solution plant with capacity of 600 MTPD in-equivalent to 100% urea. This large Russian company owner has already ammonium and urea units at site, so some amount of urea solution will be transferred to the UAN plant.

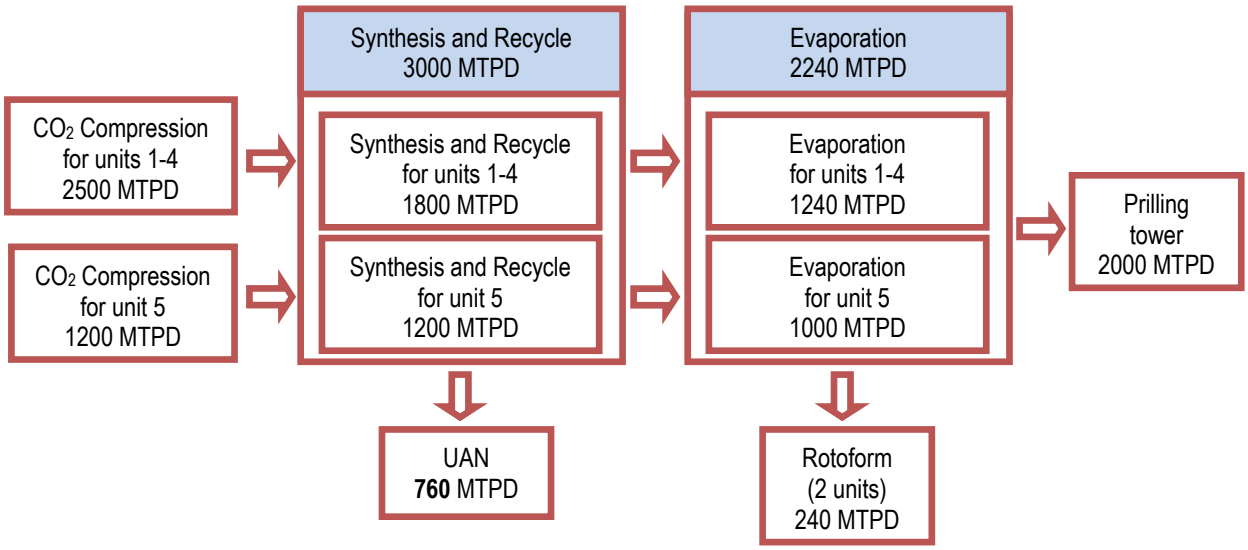

Fig. 1: Diagramm of existing urea production

Upon commissioning of a new ammonium unit the Customer came to a decision to expand the production of urea solution in order to increase in UAN output. NIIK suggested to get up a small-scale urea solution plant by NIIK's URECON 2006® process technology and using the existing equipment, for instance the CO_2 compression unit and urea synthesis reactor, in order to reduce significantly building costs and project execution time.

The block diagram of the above mentioned urea plant after scale up looks as follows:

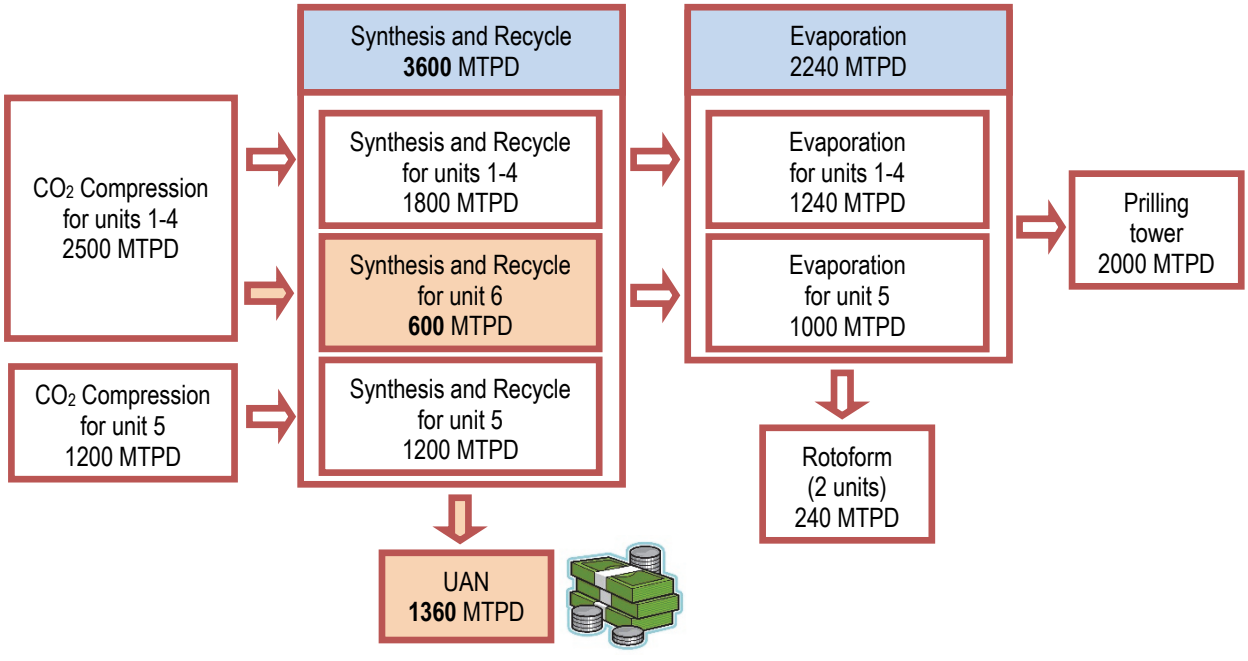

Fig. 2: Block diagramm of urea production after enhancement

As it can be seen from the below PFD, the multiunit production system opens powerful opportunities for variations of the total output and product lines.

In the long term the urea production can be even enhanced via construction of evaporation section and prilling or granulation unit for commercial output of a solid state end product. However, upon construction of the urea solution unit the Customer will be able to increase the UAN production and get an additional profit.

In this particular case the application of URECON 2006® technology by NIIK is the best option.

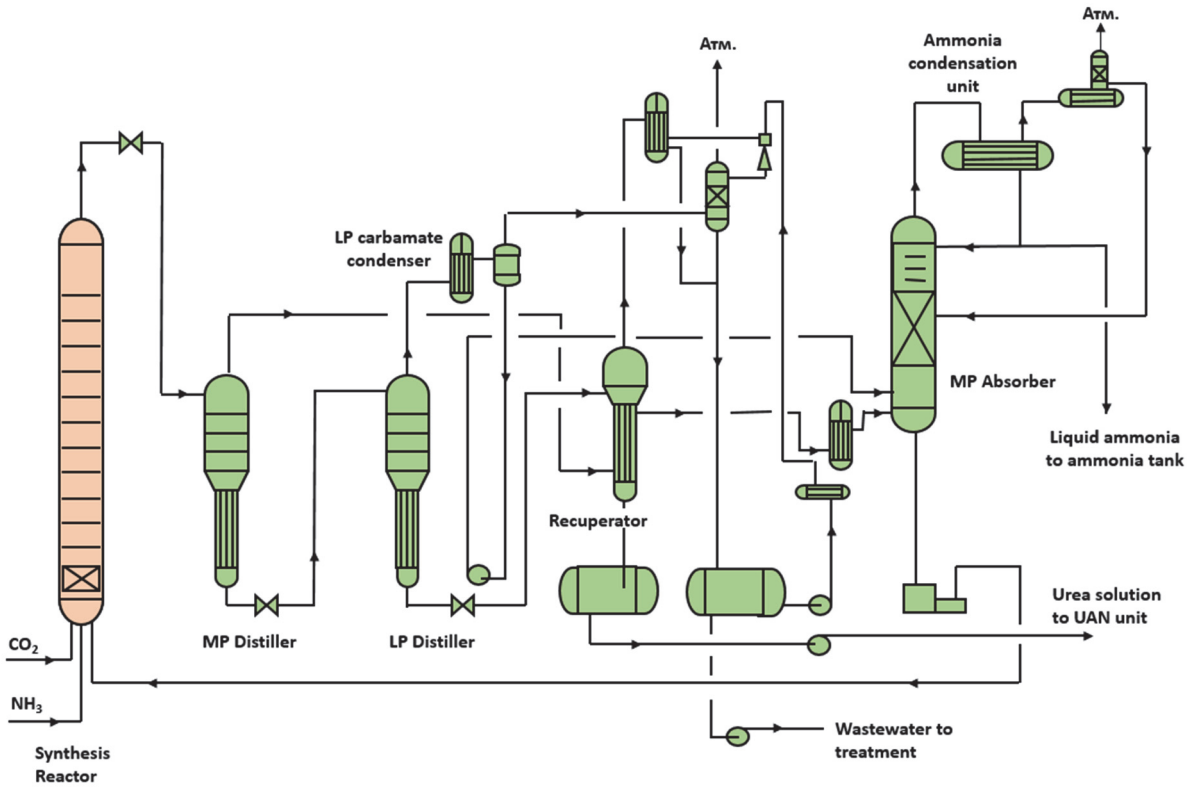

Fig. 3: PFD of URECON 2006® urea solution unit

The PFD shows the only one high-pressure vessel, i. e. synthesis reactor. It must be noted, that it is a stand-by vessel from the existing urea plant, which is used as a reactor. In order to increase its efficiency the reactor is additionnaly equipped by a special Set of Internal Devices (SID) by NIIK, which includes the following:

- Vortex mixer;
- Conversion booster;
- 10 sieve trays.

As a result of installation of the SID we achieved a very high reactor performance while retaining a comfortable conversion rate. Moreover, the existing stand-by reactor with the volume of 31 m^3 can be used with greater benefit at the urea solution plant with capacity of 600 MTPD (in-equivalent to 100% urea).

Thus, the urea solution from the reactor is distilled in two stages (medium pressure stage and low pressure stage) with unreacted ammonium and CO_2. After that this urea solution is exposed to the pre-evaporation phase where its concentration reaches minimum 72 % by means of the heat from the medium pressure distillation gases. Some small amount of resulting emissions is transferred to the new waste-water treatment unit designed for several plants and which is under construction now.

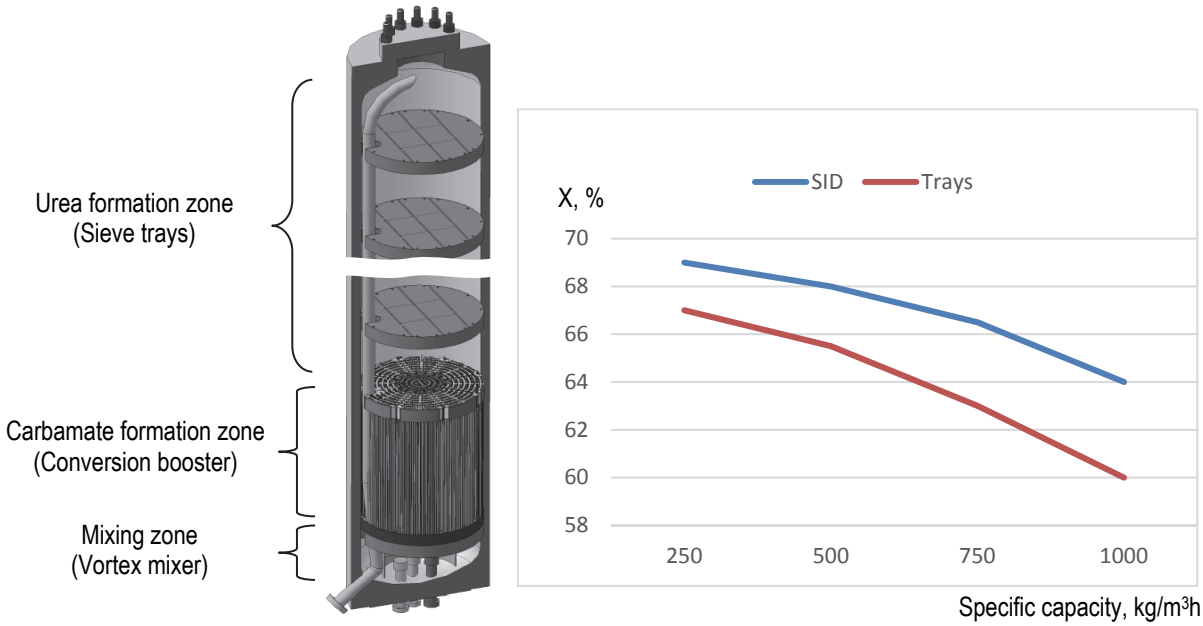

Fig. 4: Efficiency upgrading of the urea synthesis reactor

The urea solution distillation is performed into the distillators represented by special vessels containing a tray-type fractionating column and film heater. By combining of multiple processes in a single vessel their efficiency increases significantly, while the space required for the unit and number of pipelines are reduced on the contrary. Added to this is the fact that the equipment corrosion wear is also notably decreased.

One of the most important distinguishing features of the proposed process flow diagram as compared with a traditional total liquid recycle process consists in the medium pressure condenser unit. Here we use a vertically-mounted condenser with U-tubes where the solution is circulating outside of tubes. At the same time this design provides a closed cooling water (CCW) suitable for adjustment of the water temperature. As a result the condenser's efficiency increases and potential carbamate solution crystallization outside of tubes becomes practically excluded.

Besides that, in the process described the internal heat release (heat from the medium pressure ammonium carbamate formation) is used for the pre-evaporation of urea solution up to the concentration of minimum 72 %. The heat recuperation is carried out into a special vessel which is called heat recuperator and performs functions of the film-type evaporator and medium pressure carbamate condenser.

Almost all the elements of the above PFD have been tested many times within other urea reconstruction projects with total liquid recycle process technology and proved their high efficiency.

As for the CO_2 compression unit, in this particular case we used the existing compressor equipment reserves. These reserves revealed earlier after a partial replacement of old piston compressors for new centrifugal-type compressors of greater capacity.

If such reserves are unavailable, a new CO_2 compression unit will be required. This issue can be resolved in different ways depending on the existing configuration of compressor equipment, its current physical condition and available financing.

Of course, the environmental aspect merits a special attention. Due to the small volume of waste water and efficient gas scrubbing system the described unit meets the most strict environmental standards.

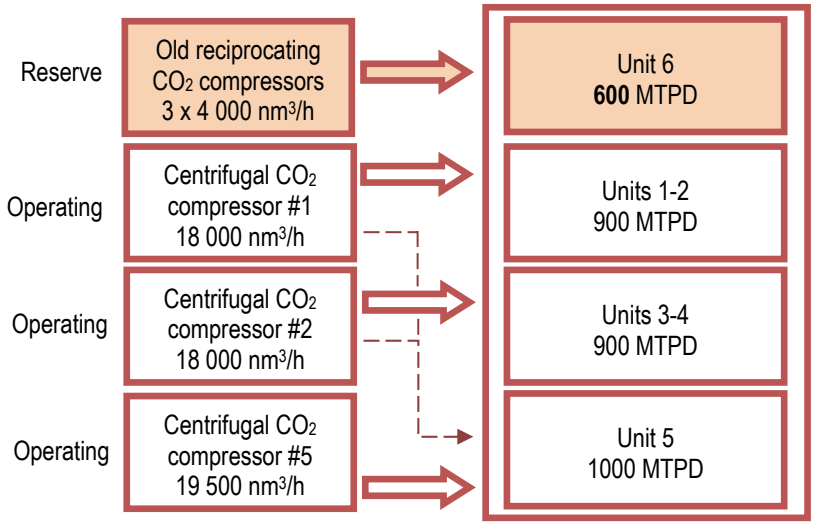

Fig. 5: Distribution of CO_2 compressors by urea plants

The expected performance indicators of the urea solution plant are shown in the Table 1:

Table 1
Basic parameters of the urea solution plant

No.	Parameter	Value
1	Capacity in-equivalent to 100% urea, MTPD	**450-700**
2	Steam consumption for industrial requirements, Gcal/t	**0,7**
3	Power consumption for industrial requirements *	**50**
4	Cooling water consumption*	**90**
5	Composition of urea solution, % wt. • Urea • Ammonium	 **≥ 72** **≤ 0,3**

** Consumption of utilities for CO_2 compression is not included*

3. PRIMARY BENEFITS FOR CUSTOMER

The main advantages of the proposed urea solution plant design are the following:

- Low investment costs and significant reduction of the project execution time due to re-use of the existing CO_2 compressor equipment and synthesis reactor, which are ususally top-priced and take much time for manufacturing and procurement. Besides that, there is no need to provide an additional infrastructure for interconnection of the new plant, because it already exists at site.
- Staff training is not required inasmuch as the process technology of the new plant remains similar to the existing units on stream. Thus, the breaking-in period will be also notably reduced.
- Good efficiency and space saving design of the new plant are guaranteed by NIIK's best practices in operating and revamps of urea units all over the world.
- The multiunit process technology assures a great flexibility of manufacturing activities, so depending on the market conditions the customer has always a good opportunity to produce different types of fertilizers: not only solid urea, but also UAN, AdBlue etc.

4. CONCLUSION

In spite of the existing global trend towards the capacity scale-up of urea plants, sometimes there is a need to build up a small-scale urea unit or a urea solution plant for further production of UAN. To do this NIIK proposes its own urea technology URECON 2006®, which makes it possible to significantly reduce investment costs and project implementation period via the use of existing or stand-by process equipment.