

Urea Production Technologies "Urecon" Revamping and Grass-Root Construction

JSC "NIIK" – a reputable engineering company with about 60 years of experience on engineering services market dealing with urea and urea-based products offers state-of-the-art urea production technologies.

Almost all the urea plants in Russia and FSU (many of them are more than 30 years in operation) have been revamped by JSC NIIK's technology in the past years.

Technical solutions for revampings developed by JSC NIIK's specialists based on operational experience of urea plants and numerous researches are protected by international patents. JSC NIIK's specialists have developed and patented two urea production technologies for revamping of existing urea plants and grass-root construction of the new ones.

URECON-2006 ® – for plants with capacities upto 2000 tpd based on CO₂ stripping process

The key aspect of URECON 2006 ® technology is only one HP unit - reactor equipped with a set of internal devices, compact flow chart of two-stage distillation with the units of original design.

The key aspect of URECON 2007 ® is a reactor equipped with a set of internal devices, high-efficiency dispenser of stripper and submerged carbamate condenser.

All the urea plants by JSC NIIK design comprise prilling towers.

The proposed urea plants give high-quality products while feedstock and energy consumption is relatively low and secure environmental and industrial safety.

KARGAEVA NATALIA

International Business Manager
JSC NIIK
Russia

JSC "NIIK", A REPUTABLE ENGINEERING company with about 60 years of experience on engineering services market dealing with urea and urea-based products offers state-of-the-art urea production technologies.

Revamping and rehabilitation of urea plants have been carried out successfully in Russia and FSU countries. The revampings aim at capacity enhancement of existing urea plants, decrease of energy and resource consumption, reduction of environmental emissions and improvement of the final product quality.

"Turn-key" project: from engineering stage to equipment procurement, field and contract supervision, commissioning and guarantee testing or we can executed separate stages of the project.

Innovative Technologies of Urea Production Developed by JSC "NIIK"

All technical solutions used in our projects are developed by our specialists and patented. Based on our technical

developments two urea production processes are offered such as:

- ◆ URECON 2006® - total liquid recycle process with capacity of 500...800 TPD.
- ◆ URECON 2007® - CO₂ tripping process with capacity of 1000...2000 TPD.

Urea production by JSC NIIK's technology ensures the following:

- ◆ low feedstock and energy consumption;
- ◆ high quality of the finished product;
- ◆ environmental and industrial safety.

For the cases when you need to process small amount of ammonia to urea we are offering a small urea plant URECON 2006® operating with total liquid recycle process. Capacity of such a plant is 500-800 TPD.

The instrumentation of the process is

simple and safe. The main instruments have been proved by multiple tests of the plants revamped by our technology (Figure 1).

Technical solutions used in technology URECON2006® are patented.

Relatively low energy consumption is achieved due to utilisation of internal process heat (heat recuperation).

The advantage of the technology is only one HP unit in the process – synthesis reactor which reduces capital costs for assembly and equipment repair.

Urea production process is equipped with automatic process control system based on microprocessor technology of the leading producers such as YOCOGAWA, Honeywell etc.

The main indices of the process URECON 2006® are indicated in Table 1.

Parameter	UOM	Value
NH ₃ consumption	kg/t	570
Steam consumption for process	Gcal/t	0.85
Power consumption (inclusive of CO ₂ compression)	kWh/t	150
Cooling water consumption	m ³ /t	100

In the case when a large scale plant is required – from 1000 to 2000 TPD - JSC NIIK is offering URECON 2007®, a plant with CO₂ stripping process in which the technical solutions developed and patented by JSC NIIK are used (Figure 2).

The main peculiarity of the process is submerged carbamate condenser included in the process according to the PFD

patented by JSC NIIK. In the condenser of this type the steam with pressure sufficient for distillation and evaporation stages as well as for desorption and hydrolysis unit is produced.

Synthesis reactor is equipped with internal devices which ensure maximum conversion of original reagents to urea. Intelligent control system allows to perform the process control with maximum efficiency (to maintain the required mole ratios of substances, pressure and temperature).

In a condensation unit water ejectors are used to create vacuum. It reduces a load on desorption and hydrolysis unit. For manufacturing of all equipment advanced corrosion-resistant materials ensuring operation safety are used.

Stripper is equipped with a patented distribution device which enables even distribution of flows along heat-exchanging tubes. It makes stripping process more efficient (Figure 3).

The main indices of process URECON 2007 are indicated in Table 2.

Parameter	EOM	Value
NH ₃ consumption	kg/t	568
Steam consumption for process	Gcal/t	0.65
Power consumption (inclusive of CO ₂ compression)	kWh/t	150
Cooling water consumption	m ³ /t	100

Process URECON 2007 ® can be successfully applied for revamping of existing urea plants with CO₂ stripping process.

CO₂ stripping process offered by JSC NIIK enables production of high-quality product with low feedstock and energy consumption, ensures high environmental and industrial safety.

All our urea plants are equipped with prilling towers in which commercial urea

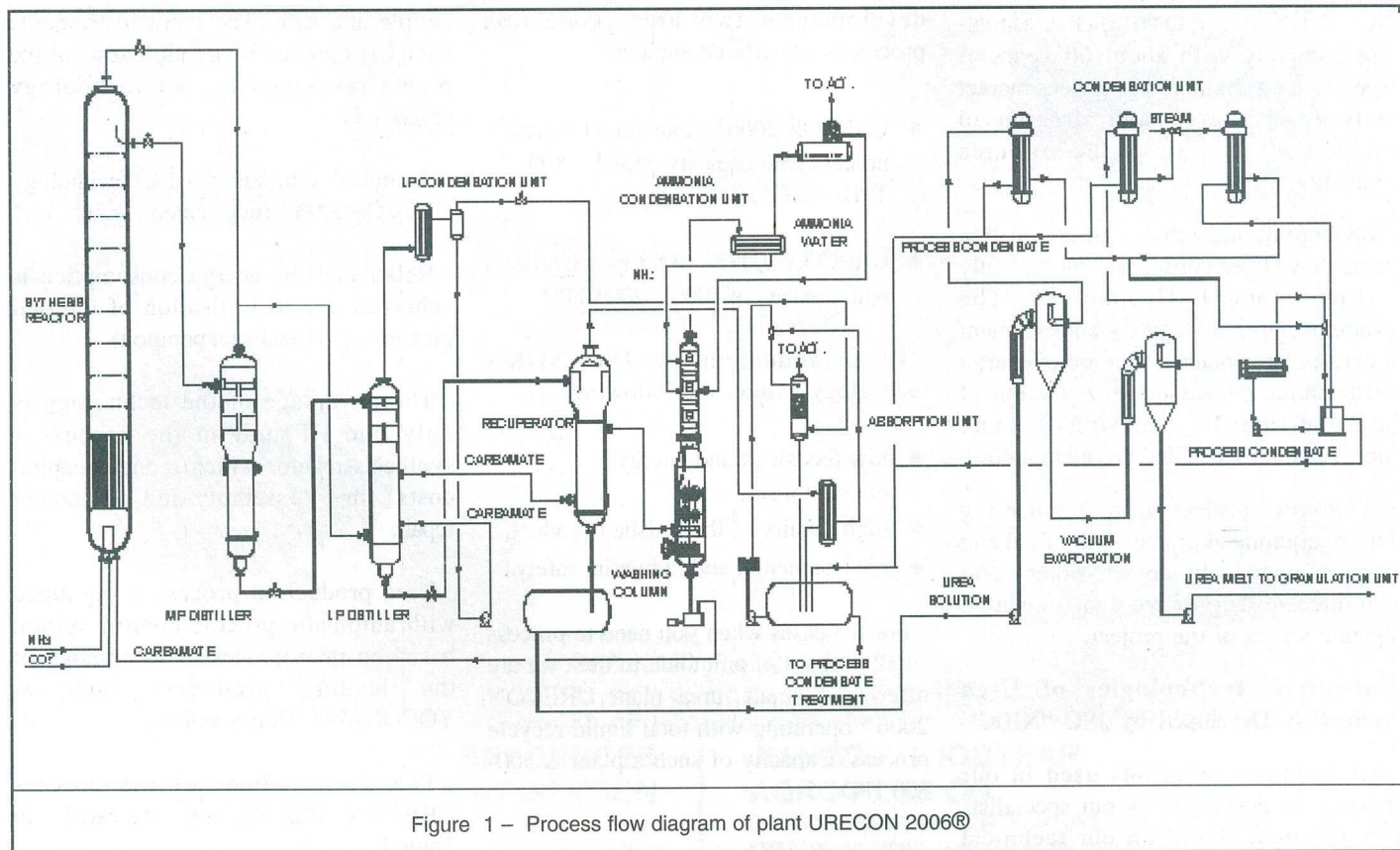


Figure 1 – Process flow diagram of plant URECON 2006®

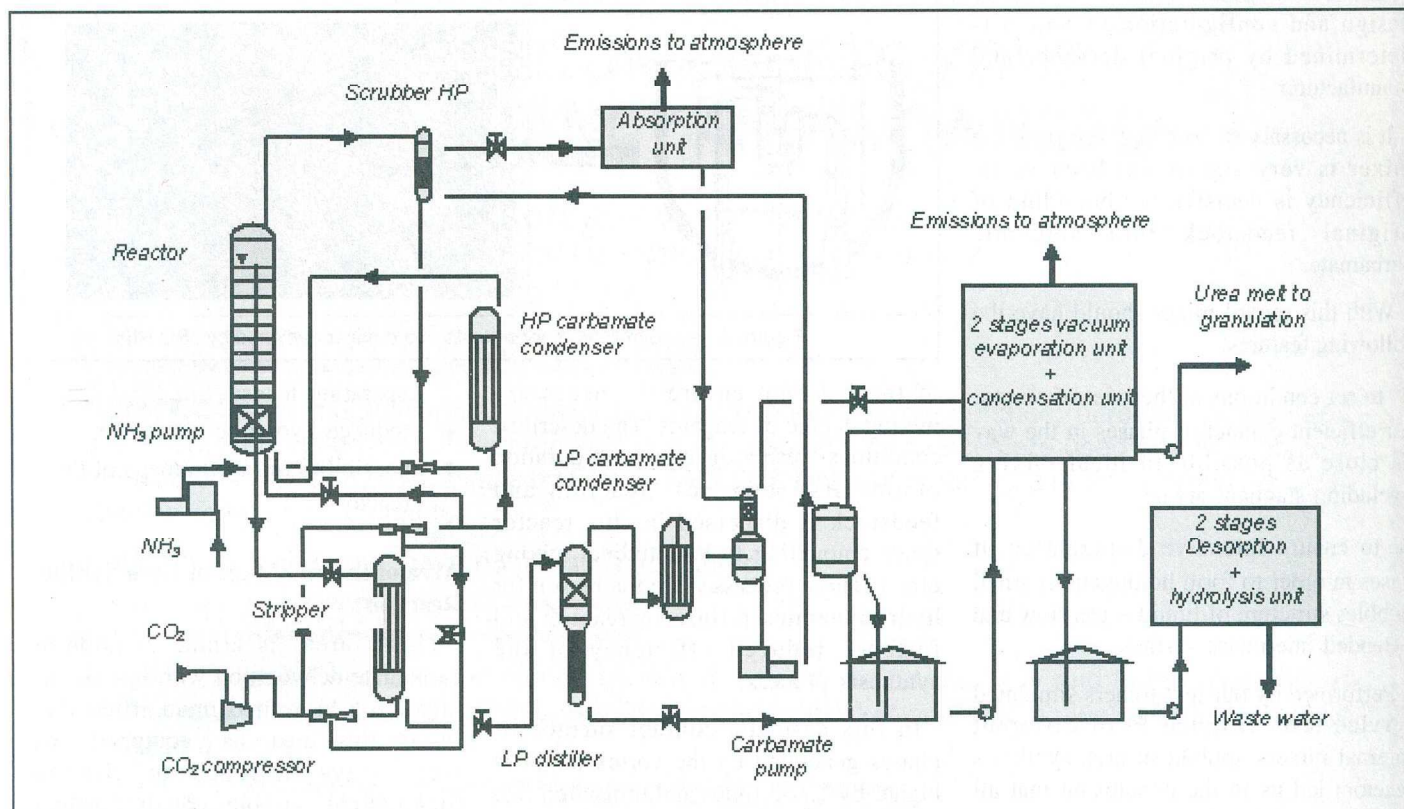


Figure 2 – Process flow diagram of plant URECON 2007 ©

is produced. A great number of the towers in Russia and FSU countries are constructed and revamped by JSC NIIK's design. The last tower was constructed last year for urea production in Algeria.

The urea produced in the towers designed by JSC NIIK is of high quality

and has even granulometric composition and high strength.

Efficiency Enhancement of Synthesis Reactor

Efficiency of synthesis process influences much efficiency of the entire urea plant, thus we decided to review the

reactor structure and internal devices – in particular.

In order to ensure maximum efficiency of urea synthesis process, the synthesis reactor is equipped with internal devices of special design (Figure 4).

Bases on JSC NIIK's concept synthesis reactor can be divided into three operation areas depending on the process (Figure 2).

1. Mixing areas of original reagents.
2. Area of the 1-st stage of urea synthesis.
3. Area of the 2nd stage of urea synthesis.

Mixing area of original reagents

In the mixing area the initial dispersion of gas takes place as well as formation of liquid – gas mixture. This area includes existing feeding nozzles and mixing device,

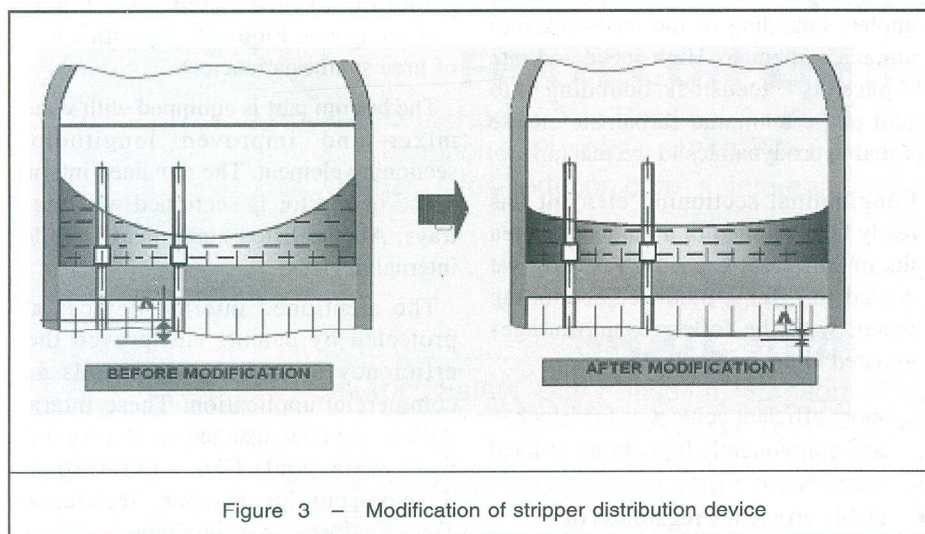


Figure 3 – Modification of stripper distribution device

design and configuration of which is determined by original designer and manufacturer.

It is necessary to note that design of the mixer is very significant because its efficiency is decisive for bounding of original feedstock into ammonia carbamate.

With this regard mixer should have the following features:

- ◆ to set conditions at the inlet of reactor for efficient contact of phases in the way as close as possible to ideal mixing excluding stagnant areas;
- ◆ to ensure intensive dispergation of gases in order to form homogenous small bubbles structure of liquid – gas flow and extended interphase surface.

Performed by our researchers simulated service tests (Figure 5) of different internal mixers applied in urea synthesis reactors led us to the conclusion that all

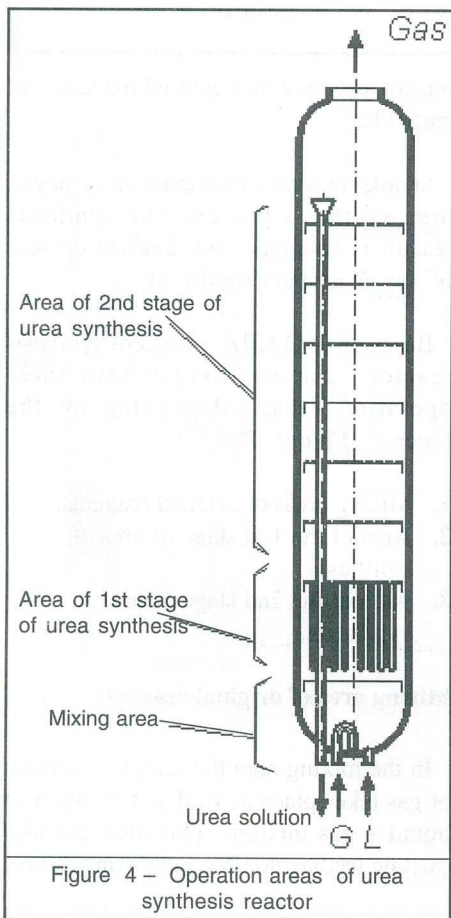


Figure 4 – Operation areas of urea synthesis reactor

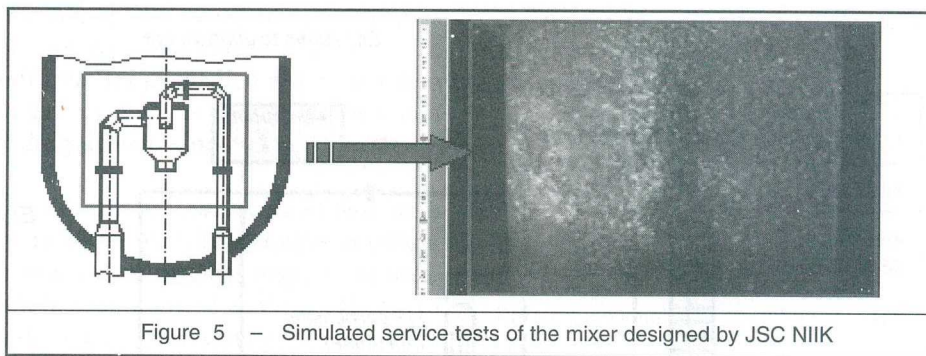


Figure 5 – Simulated service tests of the mixer designed by JSC NIIK

of them do not ensure the necessary mixing degree of reagents. The described conditions result in increased duration of the first stage of reaction and feedstock is dispersed in the reactor space amounting to longitudinal mixing effect. These processes are the reason for hydrodynamics failure in reactor and further reduced efficiency of the synthesis process.

In this case the contact surface of phases generated by the vortex mixer is higher by 1.5 -2 times and utilisation rate of mixing column volume reaches 90% (against 30% for standard mixers.).

Area of the 1st Stage of Urea synthesis Reaction

Area of the 1st stage of urea synthesis reaction is aimed at ensuring maximum reliable bounding of the original components into ammonia carbamate.

While revamping this area is equipped with longitudinal sectioning element of our own design. This element ensures complete bounding of the feedstock into ammonia carbamate. High speed and rate of gaseous feedstock bounding into liquid phase ammonia carbamate ensure optimal hydrodynamics in the reactor.

Longitudinal sectioning element has already been applied in a number of urea units of different capacity. Recently we are glad to offer a modified sectioning element with the following advantages compared to the original one:

- ◆ more efficient contact of feedstock and consequently higher rate of local conversion;
- ◆ stable efficiency regardless of

operating loads;

- ◆ reduced hydraulic resistance;
- ◆ possibility of fast drainage of the reactor.

Area of the 2nd Stage of Urea Synthesis Reaction

This area is aimed at ammonia carbamate dehydration with formation of urea. To achieve maximum efficiency of reactor this area is equipped with sieve trays designed to eliminate longitudinal mixing, equalize velocity profiles of ascending movement of phases and to increase interphase surface.

In each particular case trays are calculated considering achievement of uniform velocity profiles in both longitudinal and horizontal sectioning of reactor because these measures ensure hydrodynamics in reactor close to optimal.

Thus, JSC NIIK offers the following principle of urea synthesis reactor sectioning (see Figure 4, Operation areas of urea synthesis reactor).

The bottom part is equipped with vortex mixer and improved longitudinal sectioning element. The remained internal space of reactor is sectioned with sieve trays. All the listed equipment is called internal devices.

The mentioned internal devices are protected by patents and proved their efficiency in experimental trials and commercial application. These internal devices are now installed on 18 urea units in Russia and CIS operating by Snamprogetti, Stamicarbon, Technimont, Toyo Engineering technologies.