# Experience as an advantage

Galina Pechnikova of JSC NIIK, Russia, discusses her company's design and equipment solutions for the nitrogen fertilizer industry.

*Production facilities at JSC Acron.*

JSC 'NIIK' (Research and Design Institute of Urea and Organic Synthesis Products) – is a full scale engineering company with experience and competences in renovation and construction of grass-roots production and engineering facilities for the chemical industry. The engineering activities of JSC 'NIIK' have focused most recently on technologies concerning the production of urea, melamine and its derivatives (melamine cyanurate, melem). In addition to this, they are also active in sharing best practice in production of cyanides, isocyanates, phosgene and related compounds.

The company was established based on the Dzerzhinsk branch of the state-owned (in Soviet times) Institute of the Nitrogen Industry (more widely known by the acronym GIAP). Since its foundation in 1952, the joint experience of GIAP-Dzerzhinsk and later JSC 'NIIK' have been employed in the development of almost 100 production units built and still serviced by the company in countries such as Russia, Ukraine, Lithuania, Byelorussia, Uzbekistan, Estonia and Algeria.

The 300 staff and their skills and qualifications enable the company to provide qualified engineering services via several departments organised to provide services from concept development to 'turnkey' project realization. JSC 'NIIK' has the following departments:

## Scientific department

This is responsible for the development of concepts and technologies concerning both processes and equipment. Scientific department includes laboratories for engineering; inspection; analysis; and diagnostics of equipment, pipelines, corrosion and welding faults.

## Design department

The design department is responsible for project management and development of design documentation. It includes divisions covering all aspects of the engineering profile: economic and business planning, technologies and processes, control systems, civil works, equipment and pipeline design, environmental protection and industrial safety.

## Equipment delivery and turnkey project management

This department is responsible for the manufacturing and packaged delivery of equipment and other materials necessary for project realisation.

All of the departments are provided with the programming tools necessary for high quality engineering in design, planning and control.

NIIK's main building.

## Competences

The key competences of JSC 'NIIK' are based on a combination of long-standing experience and a management policy which focuses on development. Currently JSC 'NIIK' mainly provides a complete range of engineering services for urea and melamine production, including:

- process monitoring and equipment conditions assessment,
- development and realisation of revamp concepts for urea production facilities with capacity increases and reduction of energy consumption,
- inspection of process piping and vessels,
- development and delivery of equipment,
- development and implementation of 'turnkey' projects,
- business planning, feasibility studies, investment estimation,
- comprehensive engineering of commercial production plants,
- facilitating of environmental protection issues when implementing developed projects.

JSC 'NIIK's knowledge and experience is sought-after in projects in Russia, Ukraine and Lithuania, in which they work together with other urea process licensors, and the participation of an established Russian engineering company can be advantageous for licensors when bidding for projects in the region. JSC 'NIIK' is aware of the idiosyncrasies of Russian construction regulations, environmental protection and industrial safety norms which can help minimise risks in implementation of projects already at the design stage.

Clients can also benefit from the development and delivery of new equipment for concepts and technologies conceived by JSC 'NIIK' and the comprehensive approach to the services offered, 'from concept to start up'.

## Innovations

Cooperation with leading Russian and European steel and equipment manufacturers has allowed JSC 'NIIK' to develop and deliver high pressure equipment which ensures reliable operation in the severe operating and climatic conditions which can experienced in Russia, including:

- pressure up to 320 bar;
- process temperature up to 400 °C;
- toxic, acid, corrosive, explosion- and fire-risk media.
- ambient temperature from -50 °C up to +50°C;
- seismicity up to 9 balls as per MK-1964 scale;

The guarantee of equipment operability is achieved by professional control of special grade steels at the delivery stage, as well as by supervision during manufacturing and acceptance.

The range of traditional engineering services offered is further complemented by new and unique products such as: a system of optimized process control (the software product 'Smart Operator'), and a PC-based complex 'process simulator' designed for personnel training with integrated models animating all known urea production processes.

## Revamping

Energy saving is the rationale behind JSC 'NIIK''s developments, and this can achieve its most significant return on investments in the revamping of urea units. In recent years JSC 'NIK' has achieved the following significant references: a third urea unit at JSC 'Achema' (Lithuania), a prilling tower for 'Fertalge Industry' (Algeria), and revamps of urea production facilities at 'Odessa Port Plant', 'Eurochem' ('Nevinnomysky Azot', NAK 'Azot' Novomoskovsk), 'Agro Cherepovets', 'Akron' (Novgorod), 'Nitrofert' (Kohtla-Yarve, Estonia), 'Salavatnefteorgsyntez' (Salavat), 'Azot Kemerovo', 'KuybyshevAzot' and 'TogliattiAzot' (Togliatti).

The introduced technical solutions resulted in:

Synthesis column in Novomoskovsk.

- increases in capacity of the urea units by 20–40%,
- reduction in energy costs by ~ 20%,
- improved environmental performance,
- improvement of production reliability.

The urea revamp concept offered by JSC 'NIIK' is based around the principle of improvements to equipment and process efficiencies which result in energy savings, as well as enhancement of production safety in all aspects; technical, environmental and health and safety. The efficiency of the JSC 'NIIK' revamp approach is best illustrated by figures which show up to an 80% reduction in the investment required to increase each tonne of urea production capacity compared to that of constructing a new plant.

The revamp concept developed and patented by JSC 'NIIK' for units with total liquid recycle has given such units a second lease of life. These facilities, mostly build in the 1960s, have typical capacities of 250 t/d and represent about 30% of the total production capacity of the former USSR, all of it requiring revaming. These units are characterized by high energy consumption (1.2–1.3 Gcal per ton of product) and low relative productivity per unit of process equipment volume. To adequately face this challenge, JSC 'NIIK' has developed and implemented at some of urea plants a new revamp concept for distillation units with a short pay-back period and reduction

of energy consumption down to 0.8 Gcal per ton of final product.

This concept is realised through increasing the efficiency and capacity of the synthesis unit by installation of internal components aimed at improving the conversion rate, and reducing energy consumption as well as arranging for the synthesis section to be optimised through better process control. There is also significant efficiency increase in the first stage distillation unit by introducing:

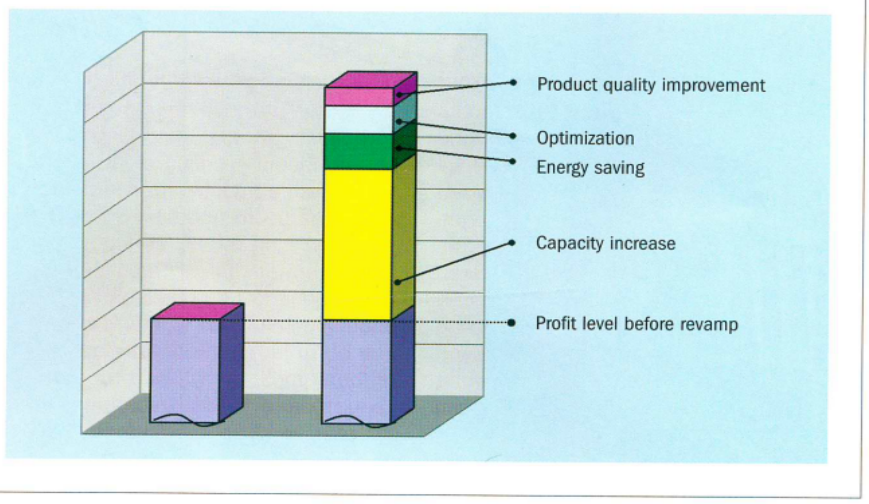
- an improved distillation column equipped with novel trays where there is sufficient mass and heat exchange between the incoming melt flow from the synthesis section and the outcoming hot distillation gases from the separator.
- a stripper-distiller which is a substitute for the heater and separator and is designed for decomposition of ammonium carbamate and separation of non-reacted ammonia from the melt in the stream of $CO_2$. The increased rate of deammonisation and the reduction of steam consumption at this stage ensure enhanced efficiency for the whole urea unit.
- utilisation of the heat of the second-stage distillation gases for pre-evaporation of the urea solution. For this purpose recuperative heat exchangers based on an original JSC 'NIIK' design are used. These have a tray type bubbling shell side for condensation of the distillation gases, with film evaporation of the urea solution on the tube side. These concepts have been successfully used in the urea units at JSC 'KuybyshevAzot' and JSC 'NevynnomyskyAzot', botyh of which were revamped in 2006.

While carrying out this concept JSC 'NIIK' managed to develop design documentation within a very short time period (less than six months) and arranged packaged equipment delivery within a simile time frame. Highly qualified field supervision was also arranged and a system of post-project services was developed.

The following improvements have been achieved:

- capacity increases up to 500 t/d and more,
- reduction of energy consumption by 25%,
- stable and reliable operability of equipment.

Fig. 1: **Advantages of the JSC NIIK concept for urea unit revamps**




The pay-back period for such projects is less than 1.5 years, and the expected design life of revamped units is increased by 15 – 20 years.

JSC 'NIIK' has also approved procedures, methodologies, technical and equipment solutions that have already been successfully trialled at some urea plants with stripping technology. This approach has become the stable basis for new revamp concepts aiming at increasing the capacity of existing urea units by 40–50%, from a starting level of 1,000 –1,200 t/d up to 1,500 t/d and above. The most attractive features of this approach are: increased efficiency (because energy consumption is reduced by 20 – 40%), a stable environmental performance, and customer oriented activity as well as lower cost (up to 50% of that offered by foreign engineering companies).

## New constructions

In spite of these activities in revamping, JSC 'NIIK' does not limit its activity only to dealing with the rehabilitation of ageing production facilities, but is now also ready to offer the packaged delivery of a new urea unit with a capacity of 1200 – 1500 t/d, operating by technology based on a traditional stripping process which has been modernized by JSC 'NIIK' by utilising its extensive experience in revamping of a great number of stripping units in the former USSR. JSC 'NIIK' is also ready to satisfy the growing demand for low capacity urea units (500 t/d), offering its own technology operating on the principle of an updated total liquid recycle with critical parameters similar to those of a stripping process.

## Melamine

Another prospective field of activity of JSC 'NIIK' is the design of melamine units. The demand for this product in Russia is measured in tens of thousands tons and all of the volume consumed is imported. The high pressure synthesis melamine production technology offered by JSC 'NIIK' today is based on a more efficient, energy saving method compared to prior developments. JSC 'NIIK' is ready to offer melamine production units based on urea with a capacity of 20,000 t/a. The relatively low price of such a project, its attractive environmental performance and reduced power consumption make it very competitive to those offered by other melamine technology licensors.

The recent run of high prices in the nitrogen fertilizer market has allowed JSC 'NIIK' to further invest in its development activities, focusing on acquiring the most modern equipment, know-how and, of course, on personnel to work not only with domestic but also with international clients.

We believe that our ideas and innovations will contribute a lot to global progress in the nitrogen industry and be recognised by our customers and the international community of world-scale engineering companies. ■