Granulation processes in Azoty Tarnów, mechanical granulation of SALETROSAN

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Please cite as: CHEMIK 2012, **66,** 10, 1057-1070

Introduction

Zakłady Azotowe in Tarnów-Mościce S.A. is the oldest producer of nitrogen fertilisers in Poland. It is known as a mass producer of nitrogen fertilisers such as ammonium nitrate, CAN and ammonium sulphate.

Until the start-up of a modern mechanical granulation installation, Zakłady used prilling for the granulation of ammonium fertilisers. This is one of the oldest methods of fertiliser granulation which is being supplanted by mechanical or liquid granulation. A product manufactured using this method (*prilling*) has a porous structure, is characterised by a small diameter of granules and low (compared to other granulation methods) mechanical resistance.

Photo 1. Prilling

Photo 2. Mechanical granulation

Mechanical granulation of fertilisers – basic technology in the modernisation and development of fertiliser production in Azoty Tarnów

As early as in the 1990s, Azoty Tarnów conducted analyses of a possibility to construct a new centre for fertiliser granulation in order to increase the quality of fertilisers and to improve the entire fertiliser sequence. Various granulation methods were analyzed: mechanical, liquid or expanding granules from prilling.

Among several existing methods, mechanical granulation was selected in the modernisation of the installation. The main reason behind selecting the new granulation technology was the possibility of producing a broader range of fertilisers with improved mechanical properties compared to products created through prilling. The start-up of mechanical granulation in Azoty Tarnów allowed for adjusting the offer to the needs of modern farms, not only in terms of the chemical composition but also the type of granulation. A product from mechanical granulation is characterised by a larger diameter of granules and higher mechanical resistance.

Another advantage of this technology was the possibility of broadening the range by fertilisers containing sulphur. Due to the lack of sulphur in the soil occurring more and more often, the possibility of producing ammonium sulphate nitrate using mechanical granulation served as the response to its increasing demand.

An additional argument for starting up the production of ammonium sulphate nitrate was the fact that Azoty Tarnów produces large amounts of ammonium sulphate based on caprolactam. The possibility of producing a fertiliser with good agrochemical properties based on it favourably impacts the profitability of selling ammonium sulphate. Moreover, mechanical granulation allows for the use of ammonium sulphate with fine granulation, i.e. of lower quality.

Preparing the mechanical granulation investment

The project of modernizing the fertiliser production in Azoty Tarnów included the construction of a mechanical granulation installation which, apart from producing ammonium fertilisers (CAN and ammonium nitrate), would offer the possibility of producing ammonium-sulphate nitrate with a content of 26%N and 13%S.

The previous system was retained with regard to neutralisation and initial evaporation of the solution of ammonium nitrate. A solution of ammonium nitrate with a concentration of approx. 92%, needed for mechanical granulation is produced using the current installation in a vacuum evaporation centre and is delivered to a new granulation centre through a heated pipeline.

The use of an ammonium nitrate solution with a lower concentration than in prilling led to the possibility of excluding the film evaporator from exploitation, which caused a decrease in NH_3 and NH_4NO_3 emission from the CAN installation.

A **feasibility study** of the Construction Project of a Mechanical Granulation Installation of Ammonium Sulphate Nitrate (ASN), Calcium Ammonium Nitrate (CAN) and Ammonium Nitrate (AN) was the first stage when preparing a project of this investment. The aim of the study was to determine the possibilities as well as all technical and technological undertakings and financial outlays necessary for the purpose of executing the construction and starting up the installation. Production capabilities were determined and an initial selection was made of the production technology, as well as the location was determined for the new installation.

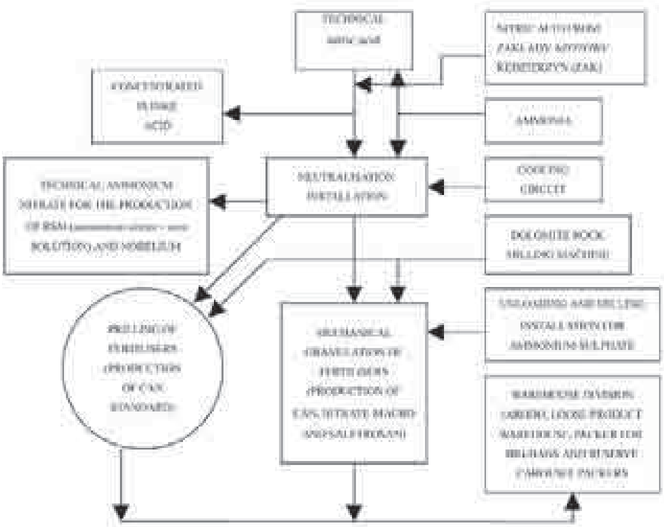

Fig. 1. Block diagram for the layout of the mechanical granulation installation for fertilisers in Azoty Tarnów

Technological production process of fertilisers through mechanical granulation

Generally, the granulation process involves preparing raw materials, creating a granule structure (granulation), drying, sorting, isolating, cooling and conditioning of the final product.

Process stages:

1. Feeding raw materials.
2. Preparing the raw material mixture for the production of saletrosan.
3. Granulation.
4. Drying the granulate and air circulation.
5. Sieving and crushing granules.
6. Conditioning of air and product cooling.
7. Purifying the outlet air from the process and removing dust from the equipment.
8. Supplying energy media.

An ammonium nitrate melt with a suitable concentration and temperature is supplied to pulp reactors through a pump. The second basic raw material fed to reactors is ammonium sulphate which is properly prepared at the unloading and milling installation for ammonium sulphate. Saletrosan is produced also with the use of dolomite flour which is pneumatically transported from the milling installation to the flour container at the mechanical granulation section. Preparing a raw material mixture for the production of saletrosan 26 macro in the form of pulp involves mixing the solution of an ammonium nitrate melt with sulphate in reactors. The pulp fed to the granulator is precisely mixed with the return and dolomite flour. Fertiliser granules are created as a result of the mechanical work of the granulator blades and through the piling up of pulp and dolomite flour on the return particles. The obtained moist and hot granulate is fed to a granulation drum. There, the granules are shaped and hardened. Next, the granulate is poured from the granulation drum into the dryer. In the drum dryer, moist fertiliser granules are dried using hot air until obtaining water content below 0.8% (m/m). The air from the dryer (containing fertiliser dust) is directed to cyclone cells where gas is separated from the dust. The granulate is then transferred to a bucket conveyor which feeds the fertiliser to the sieve station. During this operation, 2÷6 mm thick granules are separated from the over- and undersize. The sieve station is divided into two identical lines: the oversize sieves separate oversize above 6 mm in diameter from the product flow. The oversize is fed into mills where it is reduced in size to a diameter below 5 mm, and then it is recirculated back to the granulator using a belt conveyor. The product sieves separate undersize fractions with a diameter below 2 mm from the product. The undersize from sieves is fed onto the belt conveyor of the return which directs it back to the granulator. The finished product is fed to a liquid cooler in which it is cooled down to a temperature below 30°C using dry air. After cooling down, the product is delivered to a powder machine where it is sprayed with an anticaking agent. Then, the product is transported to the warehouse in which it is seasoned before further confectioning.

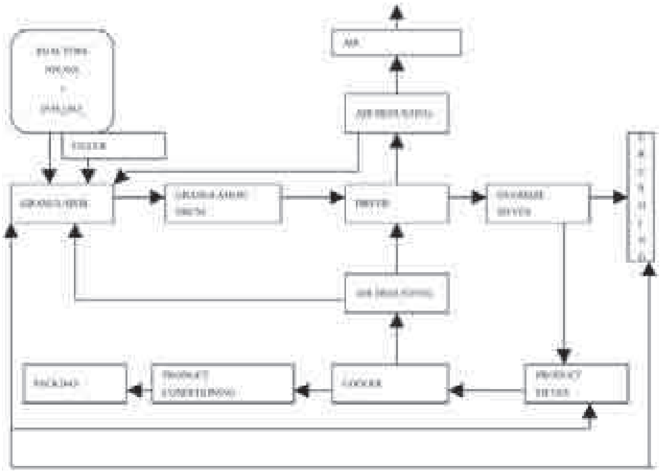

Fig. 2. Block diagram of the fertiliser production process using mechanical granulation

Realisation of investment

The aim of the investment was the construction and start-up of a mechanical granulation installation for fertilisers with an output of 1,200 t/day adjusted to the production of ammonium fertilisers, especially with the addition of sulphur.

The best technology available in Poland was selected – mechanical granulation held, implemented and perfected by Zakłady Azotowe Kędzierzyn. The basis for implementing it in Tarnów was the "Contract for the purchase of license, developing a basic engineering document, providing technical and training services for the mechanical granulation installation for ammonium fertilisers and cooperation at improving and implementing the production technology of ammonium sulphate nitrate" from 10/09/2004, concluded with Zakłady Azotowe Kędzierzyn.

The **basic engineering document** based on the license documentation was developed by the Institute of Heavy Organic Synthesis "Blachownia" Kędzierzyn Koźle.

The **decision** regarding the realisation of the investment task "Construction of a Mechanical Granulation Installation for Fertilisers" was approved by the General Meeting of Zakłady Azotowe in Tarnów-Mościce S.A. on 25/04/2005.

In May, 2006 a Task Force was created for the realisation of the investment project entitled "Construction and start-up of a mechanical granulation installation for fertilisers in Zakłady Azotowe S.A.". Tomasz Kozioł was appointed Project Manager.

The technical project based on the process design was realized by the BIPROZAT design office. Documentations in the following branches: construction, assembly, electric, as well as inspection and measuring equipment were created gradually during the realisation of the construction.

The completion of equipment and instrument deliveries was performed until the end of 2007. Almost all instruments and equipment of the main installation and auxiliary installation devices were contracted independently. Special attention was paid to the quality and workmanship of key devices. The most important contracted devices include:

- a dual roll granulator, granulation drum, drum dryer
- a liquid cooler
- a crusher, oversize mills (2 pcs)

- ventilators (5 pcs)
- a bucket feeder
- a segregation system – oversize and product sieves
- a dust filter
- belt conveyors (3 pcs)
- a DCS control system
- ammonium nitrate melt pumps
- liquid ammonia pumps
- batching belt scales
- bucket and worm conveyors.

A contract was concluded with the Zakład Budowy Aparatury Chemicznej in Tarnów for the construction of 18 instruments included in the main installation. The most important of them include: cyclone cells, pumps of sulphate nitrate pulp, and air heaters. Air heaters were also constructed in ZBACH for the liquid cooler and drum dryer, and an additive tank.

The company Podlew from Warsaw served as the supplier of the system of pneumatic transportation of ammonium sulphate.

The realisation of construction and assembly works started in the third quarter of 2006. First, preparation works were done regarding territorial development for the main installation. In the second quarter, building foundations for the main building as well as constructing a drum dryer for the granulation installation were ordered. The works were commissioned to ZWRI. The foundations were finished in May, 2007.

Photo 3. Building foundations for the main building and construction of a drum dryer

Photo 4. Preparation works regarding territorial development for the main installation

Between September – October, 2007 the most important device of the installation – the drum dryer – was integrated and assembled. The assembly was performed by the company PROREM.

Photo 5. Assembly of devices

Photo 6. Assembly of devices

The assembly of the remaining instruments and devices was done according to the progress of constructing the installation building. Together with the assembly of instruments, the company STALBUD Tarnów Sp. z o.o. simultaneously executed construction works of the C-120 main building and the sulphate unloading centre. The scope of works included the creation of the main building, i.e. construction of the skeleton, ferroconcrete structures, heating, ventilation and air conditioning, water and sewage installation, thermal centre, as well as the assembly of devices and technological instruments. The piping of the installation was assembled by the companies ZWRI and PROREM.

The electric installation was performed by the ELZAT company, while inspection and measuring equipment installations and the system were installed by the company AUTOMATYKA.

Construction and assembly works were finished at the end of 2008.

Photo 7. Assembly of instruments and devices according to the progress in constructing the installation building

The selection of the team and training sessions were conducted during the final stage of construction. The practical training of the team was conducted at Zakłady Azotowe Kędzierzyn.

Starting up the production of CAN and ammonium nitrate

The mechanical inspection of machines and centres was conducted in October and November, 2008. All devices were inspected and started without loads. In October and November, 2008 also piping nodes were inspected and media were connected.

After mechanical start-ups, in the first half of December 2008 a complex trial was performed of the main installation.

In 2008, **the Technical Safety Committee** performed a safety evaluation and authorized complex trials on the installation.

Complex trials finished on 30/12/2008 with a positive result.

On 19/12/2009 the installation was subjected to assessment by representatives of the Licensor – ZAK – in order to confirm that it was created in accordance with the basic engineering project and process requirements. A Start-up Readiness Protocol was signed.

On 30/12/2008, the installation was handed over for Technological Start-up in Azoty Tarnów. Artur Kopeć was appointed manager of the technological start-up.

The technological start-up of the mechanical granulation installation for fertilisers was carried out from 03/01/2009 to 30/04/2009. The operation was divided into two stages: the first stage – the start-up and test trial of the production of calcium ammonium nitrate 27 macro (CAN); the second stage – the start-up and test trial of the production of ammonium nitrate 32 macro (AN).

The first start-up period led to the obtaining of 156 tons of product which was stored in the warehouse as defective. It should be mentioned that the CAN obtained during the first start-up was characterised by very high quality and was qualified as defective only due to the decreased content of nitrogen. A product of full value was obtained for the first time on January 19, 2009. On January 19 – 21, 2009, the installation operated in a continuous mode. During that time, a total of 1,578 tons of CAN 27 macro were produced. Between January 22 – 28, 2009 works were carried out in the following fields: mechanical, electric and measurement in order to eliminate all defects revealed during the initial trial.

The test trial was carried out on February 9 – 12, 2009. The installation worked with loads varying between 90 – 105%. All technological parameters, consumption indexes of raw materials and energy media and indexes of emission into the atmosphere were reached according to plan.

Table 1

Product parameters

Item no.	Denoted parameter	Unit	CAN 27 macro	Nitrate 32 macro
1	Total content of nitrogen	%	26.85	31.80
2	Moisture content	%	0.47	0.28
3	Content of Ca dissolved in water expressed as CaO	%	2.70	1.80
4	Content of total Ca expressed as CaO	%	7.10	2.50
5	Content of Mg expressed as MgO	%	4.50	1.60
6	Particle size distribution (2 – 5 mm)	%	99.80	99.90
7	Granule hardness	kg	6.5	6.7
8	Granule diameter	mm	3.6	4.2

In March, 2009, before starting the proper test trial for ammonium nitrate, 82 tons of product were produced for testing. The first batch of ammonium nitrate was subjected to quality tests at the Fertiliser Research Institute in Puławy and at the Institute or Industrial Organic Chemistry in Warsaw for the compliance of fertiliser with requirements of Regulation (EC) No. 2003/2003 of the Parliament and Council from October 13, 2003 regarding fertilisers. After obtaining a confirmation by accreditation units on May 4, 2009, regarding the quality of nitrate, a 72-hour trial was carried out which ended with a positive result.

Photo 8. Product photos: CAN 27 macro

Photo 9. Product photos: Nitrate 32 macro

The Integrated Permit for the Mechanical Granulation Installation for Fertilisers, including gas and dust emission into the air, was obtained through a decision of the Marshall of Małopolska Province on August 5, 2009.

Developing a production technology of ammonium sulphate nitrate in Azoty Tarnów

Ammonium sulphate nitrate is one of the oldest fertilisers. The name "sulphate nitrate" refers to a mixture of three compounds: ammonium nitrate NH_4NO_3, ammonium sulphate $(NH_4)_2SO_4$ and double salt $(NH_4)_2SO_4 x NH_4NO_3$.

The first tests related to the start of this fertiliser's production in Zakłady Azotowe in Tarnów started in the 1970s. At the Research Facility of the Zakłady Azotowe in Tarnów, under supervision of Jan Turlej, MSc, Eng., experimental production was carried out using a test installation. The obtained product was studied and its physical properties were tested. Test results were published in *Przemysł Chemiczny 55/12 (1976)*. In subsequent years, further tests were conducted in order to examine the properties of dual salts of the NH_4NO_3-$(NH_4)_2SO_4$-H_2O system, and the results were also published in the *Przemysł Chemiczny* monthly, 1981, 7-8**,** 60. Its authors were Jan Turlej and Tadeusz Pieniążek.

In the following years, Zakłady still searched for possibilities of producing a fertiliser with good agrochemical properties, based on ammonium sulphate from the caprolactam sequence. One such possibility is the production of ammonium sulphate nitrate (ASN). The determining factor for starting production of such type of fertiliser was the construction of a new granulation centre because the existing method of prilling is not adjusted to producing ammonium sulphate nitrate. Together with the realisation of the mechanical granulation investment, works started on developing the technology. A team of specialists was created among the staff of Zakłady Azotowe in Tarnów and ZAK, whose aim was to develop the technology. The team was led by Andrzej Ochał.

On 15/09/2004 – 16/09/2004, a test production of ammonium sulphate nitrate was carried out in ZA Kędzierzyn. The purpose of the trials was to test the possibility of granulating a mixture of ammonium nitrate and ammonium sulphate in the existing granulator. As a result of the trials, necessary data and assumptions were obtained for designing a centre for preparing ammonium nitrate and ammonium sulphate pulp, which was added to the proper installation.

Additional laboratory data regarding the preparation of a raw material mixture for the production of sulphate nitrate in the mechanical granulation installation were prepared by the Wrocław University of Technology in a work created by Andrzej Biskupski, PhD, Eng. In the tests, conditions were specified for obtaining a suitable fluidity of the raw material mixture as well as basic parameters such as: the required temperature of the mixture of reacting substances in mixers, the minimum time of the mixture in reactors, the size of ammonium sulphate particles (granulation) and its temperature, the size of dolomite flour particles (granulation) and its temperature.

Moreover, a quality assessment was performed of the crystalline ammonium sulphate in terms of its suitability for producing ammonium sulphate nitrate. The tests were carried out by Andrzej Biskupski, PhD, Eng. at the Wrocław University of Technology.

The summary of the actions of specialists from Zakłady Azotowe in Tarnów and ZAK was Patent Application P-380727 entitled "The manner of producing ammonium sulphate nitrate". The project was submitted to the Patent Office of the Republic of Poland on 02/10/2006. By decision of the Office, on 24/06/2010 a patent was granted for this process. The subject of the invention is the manner of producing ammonium sulphate nitrate from a solution of ammonium nitrate, crystalline or milled ammonium sulphate and dolomite in a continuous production process, in which the final product is obtained using mechanical granulation with an isolation stage on sieves of proper fraction which is cooled down and conditioned, while the isolated undersize and crushed oversize are returned to the granulation process; the reaction of creating dual salt occurs in a multistage reaction system consisting of a mixing centre and a multistage granulation system.

Implementing the production of the new ammonium sulphate nitrate fertiliser SALETROSAN

After finishing the start-up of the mechanical granulation installation on calcium ammonium nitrate 27 macro (CAN) and ammonium nitrate (AN), actions were undertaken to implement a third product of ammonium sulphate nitrate with the trade name Saletrosan. The production of this fertiliser occurs with the use of two additional technological centres: a centre for preparing ammonium sulphate and a centre for mixing ammonium sulphate with ammonium nitrate and dolomite flour.

Complex trials of additional technological centres were carried out in April, 2009 with a positive result.

The first production of Saletrosan was conducted in June, 2009 in batches using one of the reactors with the aim of checking the granulation parameters of the new fertiliser. As a result of several hours' work, approx. 21 tons of product were obtained, containing 27% of nitrogen and approx. 6% of sulphur.

Continuous production was undertaken for the first time on 04/06/2009. During a dozen or so hours of the installation's operation, a product was obtained containing approx. 10% of sulphur. The aim of those trials was to check the operation of the reactor-mixer and the capacity to granulate sulphate nitrate pulp consisting of a mixture of ammonium nitrate melt, milled ammonium sulphate and dolomite flour.

The operation of the installation was unstable which was due to mechanical problems related to the smooth pneumatic transportation of sulphate flour. Problems occurred also with the suspension of milled ammonium sulphate in warehouse containers. The start-up ended with an emergency shut-off of the installation due to the clogging of the chute of pulp from the granulator to the granulation drum. Because of the failed trial production, a series of design changes were made in the centre of preparing sulphate nitrate pulp and in the centre of feeding and refining ammonium sulphate. The scope of works included the assembly of additional nozzles for clearing ammonium sulphate chutes from containers, the assembly of an additional safeguarding system against temperature increase in reactors, the change of the geometry of the reactor's mixers, and changes in the installation's dedusting system, among others.

Moreover, it was stated that suitable mixing of ammonium sulphate with ammonium nitrate and dolomite flour is an important technological element of the process. Because of this, in order to optimize this technological centre cooperation was undertaken with the Institute of Mining Technology for the purpose of performing a variant analysis of the mixing process, thanks to which the most optimal mixer geometry was selected.

After making changes and corrections in the installation, technological start-up was once again undertaken on 05/08/2009. The installation was stable for a dozen or so hours. The performed works considerably increased the process conditions, especially with regard to maintaining technological parameters of preparing the pulp in reactors. As a result of the carried out start-up, approx. 200 tons of fertiliser were obtained containing approx. 27% of N and almost 11% of sulphur. From August 17 to 21, 2009, the installation worked continuously with a load of approx. 25 tons/h. The product had a suitable composition but the production was shut down due to the fertiliser's high susceptibility to caking.

Photo 10. Saletrosan 26 macro – without defects

Photo 11. High susceptibility to caking

Exploitation experiments and improvement of SALETROSAN

After the first production, the most important task was the pressing necessity to explain the reasons behind the unfavourable phenomenon of the fertiliser's strong susceptibility to caking despite being protected with an anticaking agent used previously for the old product, i.e. for CAN standard.

In order to prevent this phenomenon, activities were undertaken in two directions: selection of an anticaking agent which would fully protect the product against caking as well as testing the product in order to determine the reasons behind the susceptibility to caking and to prevent this phenomenon.

Selection of an anticaking agent

A series of technological trials was carried out for selecting anticaking agents used in this type of fertilisers, offered by suppliers. 14 anticaking agents were tested over a period of two years from the start-up. The most effective agent proved to be one with the symbol A-PN3/1 which fully protects the product against caking.

The photographs illustrate the effectiveness of various anticaking agents.

Photo 12. The effectiveness of the best anticaking agent A-PN-3/1

Photo 13. Photos of loose product: poured from the car and *bigbag* packages

Testing the properties of product granules

In order to determine the reasons behind the caking susceptibility, a series of tests was carried out of the physiochemical properties of ammonium sulphate nitrate.

1. For the purpose of determining the granule structure, the product was tested using electron microscopy:

Fig. 3. Images from electron microscopy

On the surface of granules crystals may be observed in the form of needles which were interpreted as a mixture of dual and triple salt of the ammonium nitrate and ammonium sulphate $2NH_4NO_3x(NH_4)_2SO_4$, $3NH_4NO_3x(NH_4)_2SO_4$.

2. The degree of conversion of ammonium sulphate and ammonium nitrate was assessed by comparing DCS analyses of saletrosan and CAN: no changes were stated in saletrosan samples which proves the lack of free ammonium nitrate at the moment of testing the sample.

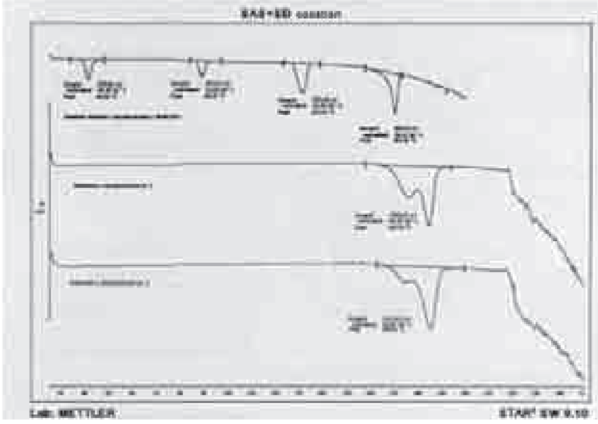

Fig. 4. Comparing DCS analyses of saletrosan and CAN

3. X-ray analyses were performed of saletrosan granules: the necessity of the product's tempering was explained due to excessive susceptibility of the fresh product to caking. The tests were performed by Sylwester Żelazny, PhD, Eng. at the Cracow University of Technology.

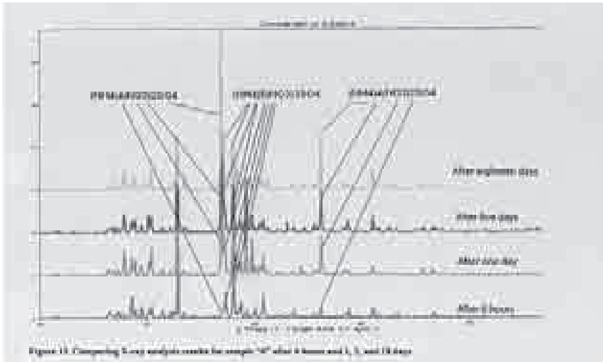

Fig. 5. X-ray pattern of changes in the sample's phase composition

X-ray patterns show changes in the sample's phase composition after one, five and eighteen days from the moment of production which proves that directly after production crystallographic changes occurred in the granule.

These results were used in further modifications of the fertiliser's production technology. Several agent formulas were specified which influence the stabilisation of granules. These are additives to the ammonium nitrate melt which impact the rate of crystallographic changes. The best effects were obtained by the B-PN-3/1 agent. The effect of the additive was observed while testing the fertiliser sample with the additive under a roentgen apparatus and the improvement of the product's quality was observed.

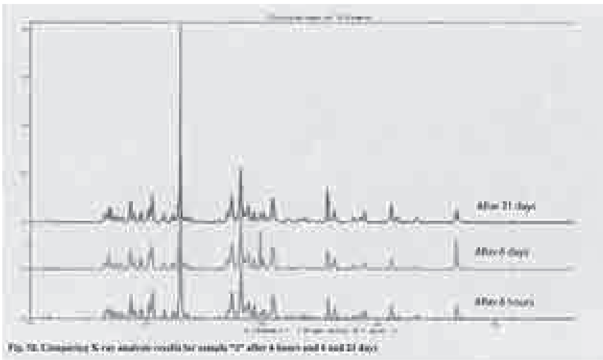

Fig. 6. Comparing the results of an X-ray analysis for the sample after 6 hours and 6 and 21 days

The X-ray pattern does not show changes in the phase composition of the sample produced with the B-PN-3/1 additive.

Assessment of the effectiveness and benefits of using the saletrosan fertiliser (ASN) in agriculture in crops especially prone to the deficiency of sulphur in soil

Azoty Tarnów cooperates with the Agricultural University of Cracow where studies were conducted on the impact of Saletrosan on the size of maize crops as well as on the quality properties of the grain. The tests were carried out in a three-year cycle in the experimental station of the Department of General Soil and Plant Cultivation in Cracow.

Test conclusions indicate that in places where Saletrosan 26 macro was used, the highest crops of maize were obtained, higher by 10 – 20% than in places where only nitrate fertilisers without sulphur were sowed.

Moreover, similar tests are being conducted on the benefits of applying the ASN fertiliser in winter wheat and winter rape. Tests are carried out in a three-year period but are not finished so the results cannot be published yet. The tests are conducted by a team led by prof. Barbara Filipek-Mazur, PhD, Eng., Agricultural University of Cracow.

Summary

The realisation of the investment entitled "Construction and Start-up of a Mechanical Installation for Fertilisers" in Tarnów has strengthened the position of Azoty Tarnów as a producer of ammonium fertilisers in Poland. Possessing a technology of mechanical granulation has allowed for the implementation of a new fertiliser with high sulphur content in production. From the moment of starting production in the second half of 2009, the installation worked with maximum load; so far, approx. 480 thousand tons of saletrosan have been produced and sold. Works are underway on the product's continuous development. The presented facts prove that the new fertiliser was well accepted by the market.

Tomasz KOZIOŁ - M.Sc., is a graduate of the Faculty of Chemical Engineering and Technology at the Cracow University of Technology (1992). He finished his postgraduate studies on "Industrial Process Safety" at the Lodz University of Technology (1998). He works at Zakłady Azotowe in Tarnów-Mościce S.A. Currently, he is the Production Manager at Zakłady Nawozów in Tarnów. He is co-author of patents on fertiliser production: "Manner of producing fertiliser containing ammonium nitrate and boron", PL187029; "Manner of producing ammonium sulphate nitrate" P 380727, as well as on purifying process condensates containing ammonium nitrate: Deutschen Patent "Verfahren zur Trennung von ammoniumnitathaltigem Kondensat-Abwasser in zwei wiederverwendbare flüssige Anteille", Akt. 199 01 571.6.

Artur KOPEĆ - M.Sc., is a graduate of the Faculty of Chemistry at the Wrocław University of Technology (2002), a manager school organized by the Rudzka Agencja Rozwoju and Training Partners (2008), as well of postgraduate studies in the field of entrepreneurship run by the Cracow University of Economics and the Cracow School of Business (2008). In 2010, he finished a course for members of supervisory boards of State Treasury companies. He has worked at Zakłady Azotowe in Tarnów-Mościce S.A. since 2003. As the start-up manager, he actively participated in starting up new installations in Tarnów, such as mechanical granulation of fertilisers and hydrogen production installations. He is co-author of a patent on the technology of producing ammonium sulphate nitrate. Currently, he is the head of the Department of Ammonia and a member of the board of the Azoty Tarnów Capital Group.

Daniel SZCZERBA - M.Sc., is a graduate of the Faculty of Materials Science and Ceramics at the AGH University of Science and Technology (2009). As the controller, he participated in starting up the mechanical granulation installation of fertilisers. He works at Zakłady Azotowe in Tarnów-Mościce S.A., currently, as an independent technologist at the Department of Fertilisers.