Rotoform Urea Pastilles

The Sustainable Premium Urea product

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Summary

The Rotoform process offers high flexibility in urea production and opportunities to add value to your existing urea products, with low investment and operational costs, low energy consumption, negligible emission figures and premium product quality. One or more Rotoform units can be added in parallel to the existing finishing system at any time. The Rotoform process is a good technical and economical method of debottlenecking or revamping existing urea finishing units.

Furthermore, it's possible to add value to the product by producing specialty fertilizers in a parallel line.

For new grass root urea plants Rotoformer technology offers besides the significant advantages such as negligible emission figures and low investment and operational costs, also other advantages such as no risk for large scale applications as it is simply several Rotoformer units in parallel. The Urea Rotoformer has been successfully in operation in several units for more than four years and the large scale application has been proven for Sulphur (46 units in parallel). By adding one or two units extra in parallel to enable regular maintenance of each unit, one is able to assure an availability of 100%, meaning an on stream time of 365 days a year.

This paper focuses on the process technology aspects while the next paper will focus on the product properties aspects.

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1. Introduction

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2. History of traditional finishing technologies

Until the end of last century all the fertilizer grade solid urea has been produced by either prilling or granulation.

2.1 Prilling

The basic methods for prilling were developed late in the nineteenth century but the application of the prilling technique to the urea fertilizer industry did not take place until about mid nineteen hundred.
The urea melt is typically fed into a conical shaped bucket spinning in the centre of a concrete tall prilling tower. Sometimes static sprayers are applied.
Efforts were made in the past to realize an easy, simple and reliable process.

Optimizing the design of the bucket did result in a more narrow size distribution of the prills which did lead to less dust formation during the prilling process, which is however still significant. Furthermore a considerable ammonia emission is a side effect of the prilling process.
Based on e.g. the ambient conditions, required product temperature, plant load, the free falling height and the internal diameter of the prilling tower can be calculated.
Typically a prilling section (prilling tower, air fans, bucket, product belt) is able to handle loads up to 125-130 % of the design capacity.
The prilling technology has been widely applied. The product resulting from prilling has however a low density and a low crushing strength. Moreover the maximum prill size is limited.

2.2 Granulation

In the sixties of the last century the urea granulation technology was first introduced in North America based on the spherodizer design in a rotating drum.
In the late seventies the urea granulation process based on fluidized bed technology was born. Different licensors use different spraying techniques. For example the Stamicarbon process was developed in the period 1977 to 1983 based on the film spraying technique. This technique results in an end product with better properties. Now today's technology is available to produce 3500 mtpd granules in a single line. Compared to prills, granules typically have a larger size and a higher crushing strength. The dust emission is reduced by means of wet scrubbers, however the ammonia emission remains a concern.

3. Rotoform process instead of traditional finishing technologies

Already for nearly ten years, Stamicarbon and Sandvik Process Systems have been co-operating together to develop the Rotoformer for urea application.
The Sandvik Process Systems' Rotoform process as a very promising and successful alternative or addition to the traditional finishing techniques of prilling and granulation.
The Rotoform process has been successfully employed in the petrochemical, chemical, food and fertilizer industries since the early 1980s and there are currently more than 1500 Rotoform units in operation worldwide.

Sandvik ROTOFORM Process

Picture 1: Different Rotoform products

In the fertilizer industry Sandvik is the market leader in sulphur and sulphur bentonite solidification technology. Other fertilizer products pastillated using the Rotoform process include calcium nitrate, magnesium nitrate and ammonium nitrate. For sulphur solidification in particular, there has been a massive shift away from old techniques such as drum granulation to the Rotoform process. Today, there are more than 450 Rotoform-based sulphur pastillation lines in operation, some sites producing more than 6,000 ton/day of premium quality sulphur pastilles.

3.1 Description of Rotoform-based urea pastillation

Mechanically, a single Rotoform unit for urea pastillation consists of a continuously moving steel belt, typically 1.5 - 2.0 m, wide and between 15 and 20 m in length (for a 125 – 175 metric ton/day unit), with a drop former feeding device at one end of the moving belt and a scraper at the discharge end (see figure 1).

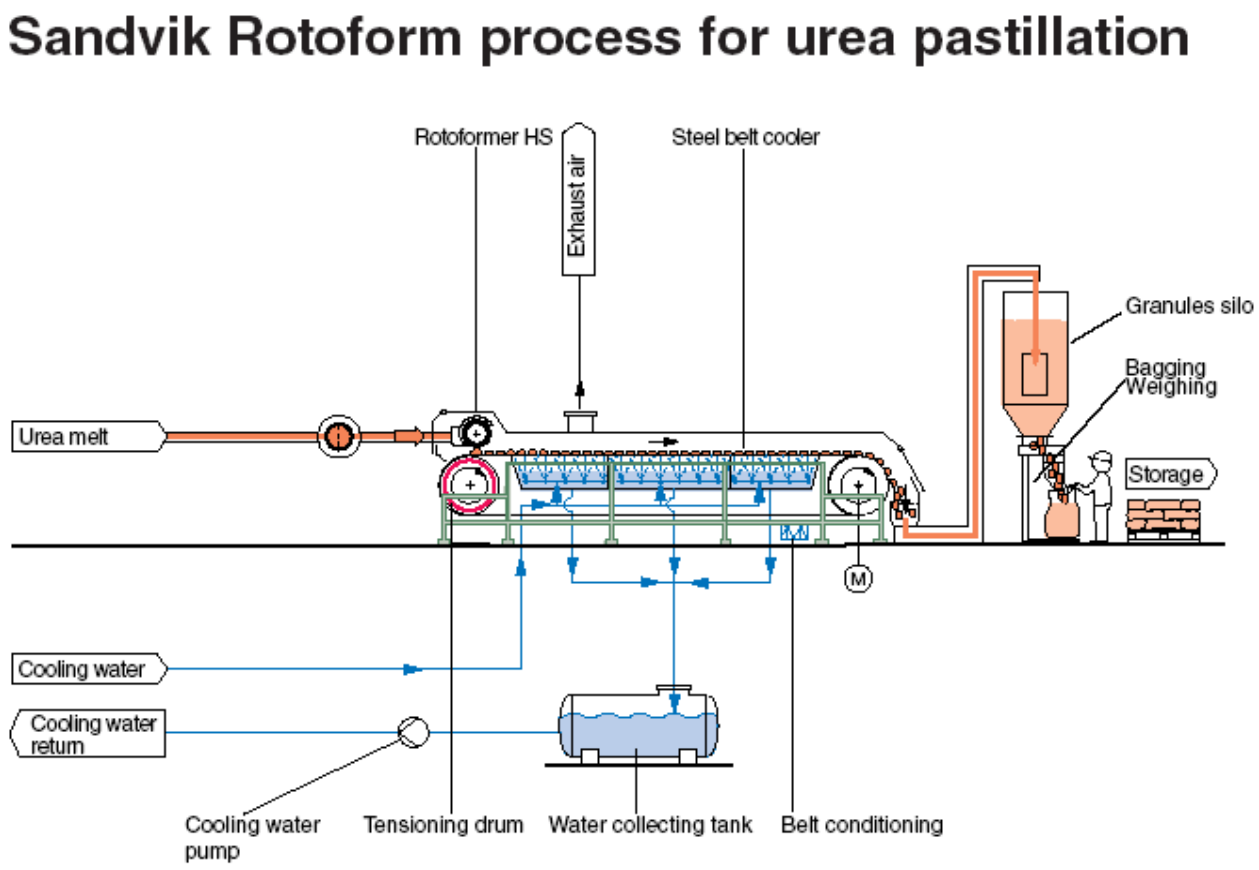


Figure 1: Sandvik Rotoform Pastillation process for urea

The feed to the Rotoform is urea melt with a concentration of 99.6 wt% and in existing urea plants can be branched off from the urea evaporation section downstream of the urea melt pumps.
Urea is introduced under pressure (2-3 barg) in molten form to the drop former. The Rotoform HS (High Speed) drop former, patented by Sandvik, consists of a heated stator and a perforated rotating shell which turns concentrically around the stator to deposit drops of urea across the full width of the belt. The circumferential speed of the Rotoformer is synchronized with the speed of the steel belt cooler ensuring that the drops are deposited on the belt without deformation and, after solidification, result in regular pastilles with an optimum shape.

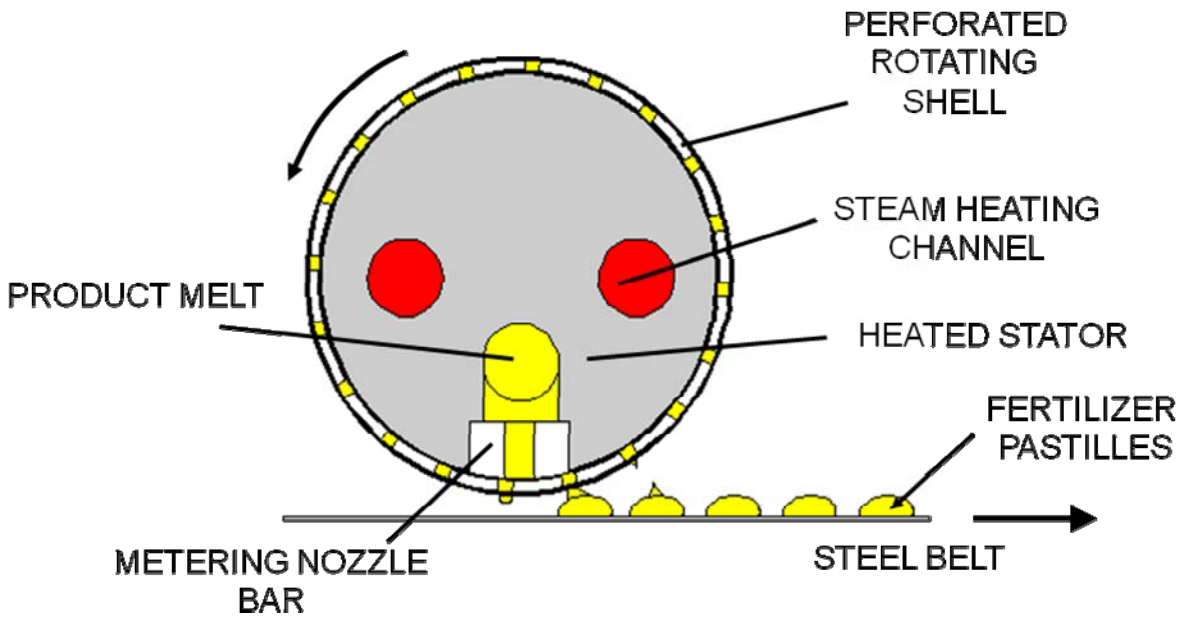


Figure 2: Rotating shell delivers droplets with the required size

The rotating shell contains rows of small holes which are sized to deliver the required product size. The heat released during crystallization and cooling is transferred by the stainless steel belt to the cooling water. The cooling water is sprayed against the belt underside, absorbs the heat and is collected in pans, cooled in a cooling system (cooling tower) and returned to the Rotoform units.

Under no circumstances can the cooling water come into contact with the urea product.

The use of formaldehyde is not necessary in this technology to realize pastilles with a high crushing strength. The pastilles are very uniform and additional screening is not needed.

After solidification the pastilles are smoothly released from the steel belt via an oscillating scraper. The product then falls directly onto a conveyor belt for transfer to storage. The section above the moving steel belt is enclosed with a hood and vented to an existing vent system.

There are no large air flows involved in this technology and there is no visible urea dust emission. Only some ammonia vapors which can be easily caught in a simple atmospheric absorber leading to a negligible emission of ammonia and urea, which is a unique feature of this technology.

Picture 2: Rotoform skid mounted equipment showing the hood by which the ammonia emissions can easily been caught.

Several Rotoform units can be installed in parallel in order to achieve higher capacities, no upscale risks are applicable. A spare unit assures an availability of 365 days a year (100%), which is another unique feature of this technology.
Rotoformer units can be installed at different elevations leading to much flexibility and the freedom to choose the most optimum foot print.

Figure 3 shows a typical process flow diagram of a pastillation plant using four Rotoform units to achieve a capacity of 700 t/day.

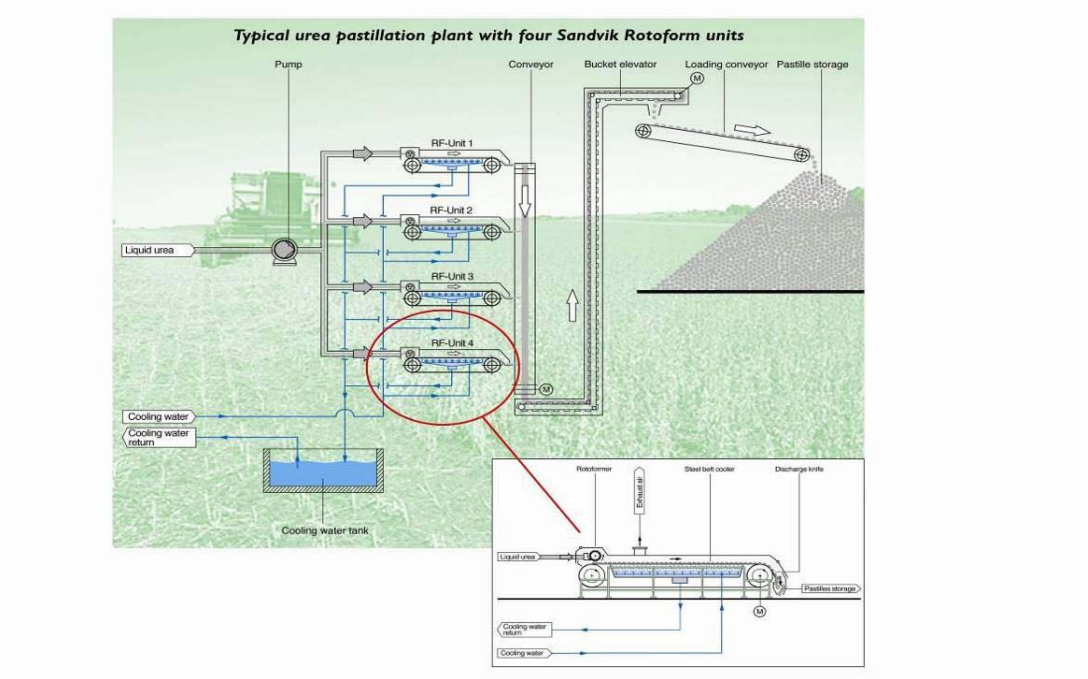
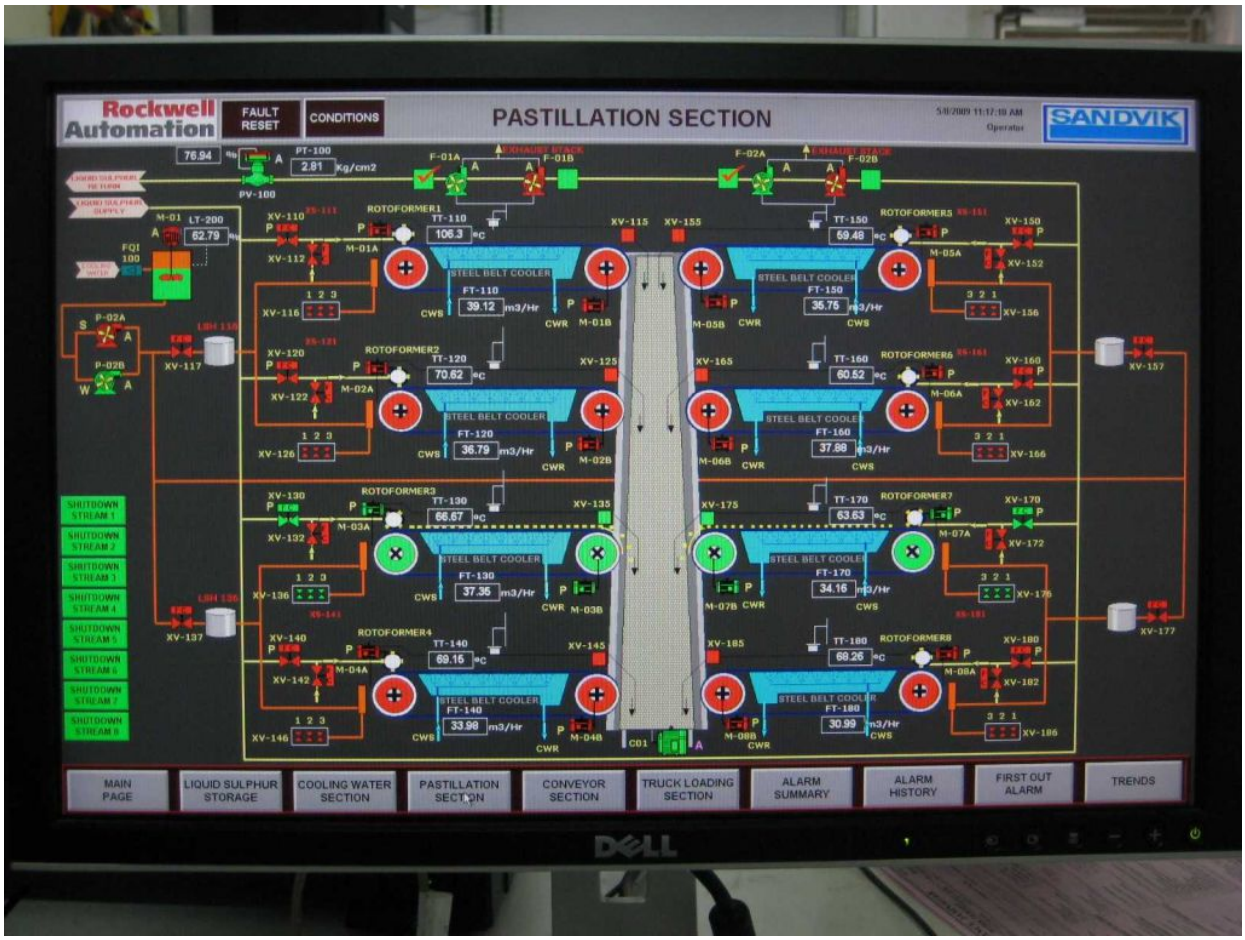


Figure 3: Urea pastillation plant for 700 ton/d with four Rotoform units in parallel

Picture 4: Front view of installation of urea plant with 4 Rotoform Units.



Picture 5: DCS screen of several Rotoform Units.

Urea Rotoformer specifications

Capacity of one unit	125-175 mtpd
Urea pastille size	free to choose between 1 and 4 mm
Crushing strength	40-75 N on d50 of 3.0 mm
Biuret increase in Rotoformer	Negligible (< 0.05 wt%)
Product feeding temperature	138 ^{o}C
Product feeding pressure	2 barg
Product feeding concentration	99.6 wt%
Pastilles formaldehyde content	zero
Pastilles discharge temperature	40-50 ^{o}C
Cooling water temperature	15-35 ^{o}C (from cooling tower)
Main dimensions	
Length	23-28 m
Width	1.8-2.3 m
Height	2.0 m
Belt width	1500-2000 mm
Cooling length	20-25 m
Weight per unit	12-15 tons
Materials of construction	stainless steel
PLC controlled system with automatic operation	
Air consumption	Not required
Steam consumption	0,004 t/t
Electrical consumption	4 kWh/t
Equipment washing	3hr/month
Operation/Maintenance Personnel	1 per shift

3.2 Benefits of the Rotoform process in comparison with other finishing technologies

- ✓ Rotoform is a very easy process with a minimum of equipment.
- ✓ Rotoform process needs no screening, no recycling, no crushing, no bulk cooling systems, no scrubbing, etc.
- ✓ Rotoform produces very little dust, since dust creating sources like screening, recycling or crushing do not exist.
- ✓ Rotoform product has a crushing strength significantly higher than prills, as there is multi-crystal growth of the urea pastille. No additives, formaldehyde or otherwise, are needed during the manufacture of these pastilles.
- ✓ Rotoform process produces hardly any emissions. The high strength of the pastille translates into low fines generation so no dust scrubbing is required; furthermore, hardly any air flow is needed with this technology. Gaseous ammonia emissions can be reduced further by means of a small atmospheric absorber column, a significant advantage compared with prilling or granulation technologies.
- ✓ Rotoform product is very regular in comparison with the other finishing technologies. Please refer to pictures 6 and 7).

Picture 6: Pastille distribution on the running steel belt.

Picture 7: Urea Pastille distribution on the running steel belt (close up)

- ✓ Rotoform process requires much lower power consumption than granulation technologies.
- ✓ Rotoform uses an indirect water cooling system which is more efficient than the air cooling system applied by other finishing technologies.
- ✓ Rotoform cooling water requires no treatment as there is no direct contact with the product.
- ✓ Rotoform specialty urea products such as S-coated urea, AS/urea, urea with micronutrients, technical urea can easily be produced in limited quantities, with simple switching between different products (high flexibility, easy market introduction).
- ✓ The Rotoformer modular system design enables capacity to be increased/reduced quickly and easily.
- ✓ Pastille size can be changed simply by replacing the perforated rotating shell with one of a different hole size.
- ✓ Rotoform can be installed in a single-storey structure.
- ✓ Rotoform allows a greater range of product variety than existing technologies.
- ✓ Rotoform process suffers minimal production stops and/or loss of production as a result of maintenance or cleaning as one can do maintenance unit-wise and realize an on stream time of 100% or 365 days a year.
- ✓ Up scaling to large scale application can be done without any risks due to the modular design.
- ✓ Turn down ratios are very small.
- ✓ The modular design also provides one the freedom to choose the most optimum footprint.

4. References of the Rotoform urea process

Since 1983 already more than 1500 Rotoformer units are in operation.

More than 450 units are in operation for Sulphur and more than 30 units for urea, magnesium nitrate, calcium nitrate, sulphur bentonite etc.

The development of the Rotoform for the urea process started nearly ten years ago. First small scale experiments at the test facilities of Sandvik Process Systems in Fellbach, Germany provided encouraging results. Small pilot commercial runs were later carried out at SKW Piesteritz in Germany.

PCS in the USA have been successfully operating five Rotoform units for urea for more than four years, mostly for technical urea applications.

In December 2007, trials involving the addition of elementary sulphur (8%) to the urea melt were successfully carried out on a commercial Rotoform line at Yara Brunsbüttel in Germany and the quality of the S-Urea pastilles was very good.
The Rotoform plant at Yara has been also used for production of fertilizer urea and technical urea, which quality has been very much appreciated by the German farmers en even worth a premium price as the hardness and size was better than prills and the pastilles did not show any caking problems. The urea pastilles show a good field distribution, working width 24-27 m (by Amazone).

Picture 8: German farmers are willing to pay premium prices for urea pastilles.

Acron in Russia is installing two Urea Rotoformer lines as part of their debottlenecking project, which will start operation in Q2 2010.

Petrobras in Brasil bought one Urea Rotoformer line including a mixing/grinding unit last month and expects to start operation in March 2011. Petrobras intends to produce urea based mixed fertilizers and also to develop new kind of fertilizers with this plant.

More than 450 Sulphur Rotformer lines are in operation, also in large scale applications. For example Shell Canada has 46 lines in operation in parallel since1993 producing 6000 mt/day during 365 days a year !

Picture 9: Shell Canada has 46 Rotoformer lines in operation producing 6000 mtpd during 365 days a year

Rotoform-based sulphur bentonite plants are in operation at a number of different fertilizer companies including: Esseco/Italy, NEAIS Saud Arabia, Coromandel Fertilizer/India, Martin Resources /USA, Montana/USA, Coogee/AUS. New plants at Kanghiran /Iran and Ilam /Iran (both 600 ton/day) are under construction.

Successful tests for mixing urea with other components such as P_2O_5, K_2O and micronutrients (ZnO etc) have been performed in 2009 and commercial scale operation will start at Petrobras next year.

Several urea producers are currently evaluating the Rotoform process and soon we can expect more Sandvik Rotoform urea pastilles to enter the market, due to its distinctive features and benefits compared to other finishing technologies.

5. Conclusions

The Rotoform process offers high flexibility in urea production and opportunities to add value to your existing urea products, with low investment and operational costs, low energy consumption, negligible emission figures and premium product quality. One or more Rotoform units can be added in parallel to the existing finishing system at any time. The Rotoform process is a good technical and economical method of debottlenecking or revamping existing urea finishing units.

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