Joint Stock Company Research and Design Institute of Urea and Organic Synthesis Products. JSC

IMPROVED UREA PRILLING TECHNOLOGY FROM R&D INSTITUTE OF UREA: concept and case study facts

INTRODUCTION Research and Design Institute of Urea, Russia is the leading company in development of basic and detailed projects for prilling towers of different design. Our company has a vast experience in retrofitting of the existing towers and construction of new ones.

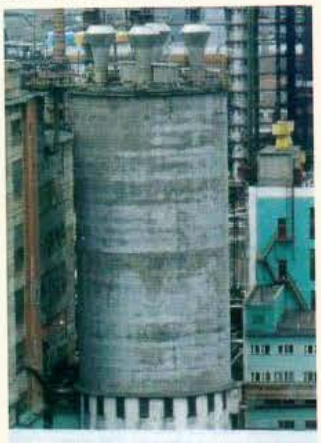
The basis for all the developed by our company projects is an improved proprietary technology comprising the following:

- spraying of urea melt by means of improved dispergator;
- intermediate cooling of falling particles and their crystal lization in the air counter flow in the tower barrel;
- final cooling of granules down to 50 0 in the integrated "fluidized bed" ;
- purification of exhaust air before venting out in high performance dust scrubber of injection type.

There is a great number of prilling towers operating by the "so-called" old technology in the countries of the Middle East, Africa and Asia and here dwell upon their modernization all aimed at capacity increasing, improvement of final product quality, reduction of harmful emissions (ammonia and urea dust).The described objectives can be reached by implementing JSC NIIK's technology which proved its efficiency in a number of cases.

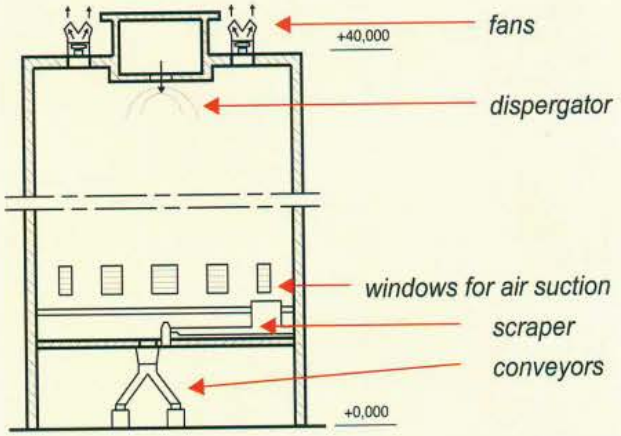
One of the most successful modernizations of prilling tower described in details below, was provided at the urea plan of Nevinnomysky Azot company located in Stavropol region, on the South of Russia.

The mentioned company has been operating two prilling towers of old design (see picture 1). Both towers are 16m in diameter and 40m height with capacity of 450 - 500 mtd of urea. The towers are equipped with shower type melt dispergators, scraping system for unloading of prills and fans for suction and venting out of the exhaust air.



Picture 1
Prilling tower of old design

New market and environmental requirements as well as company's strategy aimed at production increasing up to 1200 mtd found prilling section to be the bottleneck. To overcome this challenge with minimum profit losses our company suggested implementation of its improved technology



at one of the towers, keeping, thus the second one still in operation. The load was distributed between the existing tower and production of UAN. This measure enabled minimum profit loss planned from product sales.

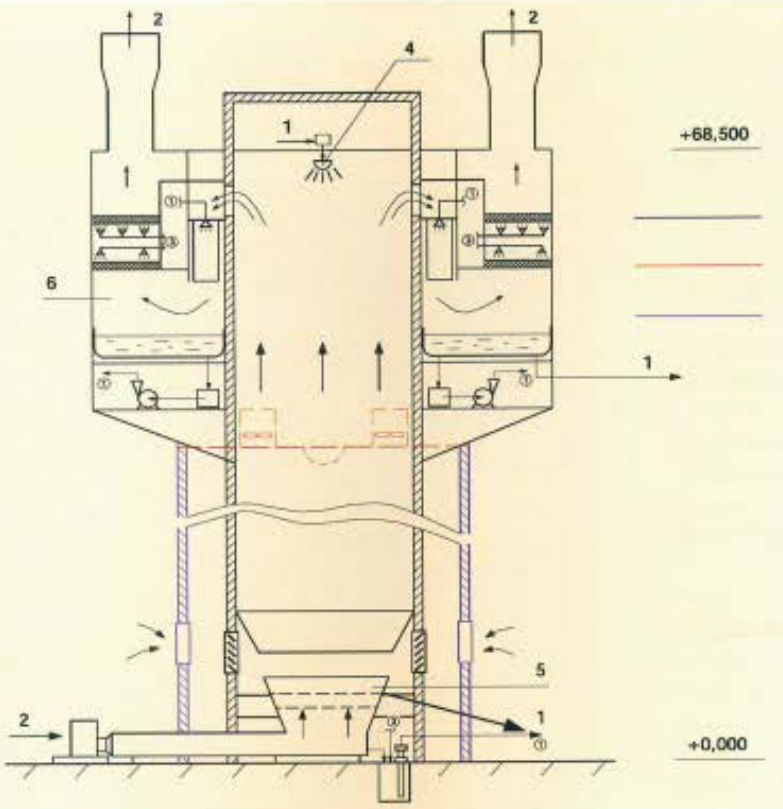
CONCEPT OF MODERNIZATION

To achieve the mentioned goals of the tower capacity increasing, product quality improvement and reduction of emissions the following was provided (picture 2):

- Unloading scraper was removed from the bottom part of the tower. From the top part of the tower the original urea melt dispergator was removed along with all supporting structures;
- A new metal barrel of a less diameter was erected inside of the existing tower;
- "Fluidized bed" unit for cooling of prills was integrated into the bottom part of the tower and unloading conveyor was retrofitted;
- Dispergator of a new design was installed in the top part of the new metal barrel along with fixing and supporting structures;
- A new purification unit of injection type was installed from the outside of the tower.

It is necessary to note prilling towers operating in the countries of the Middle East and Southern East Asia do not require barrel of a less diameter because high single line capacity. This fact is very beneficial for duration of modernization and volume of capital investment.

With regard to the mentioned, we believe that detailed consideration of urea melt dispergator ,"fluidized bed" and injection purification unit are much more worth.



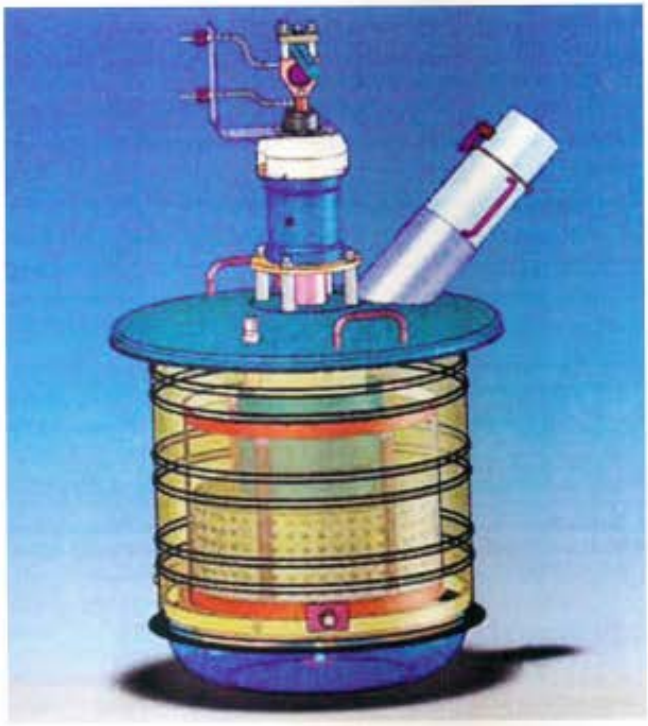
Legend:

Newly installed equipment and structures
Dismantled equipment

«Old»barrel of the tower

1 – urea
2 – air
3 – water
4 –vibro dispergator
5 – "fluidized bed' unit
6 – purification unit of injection type

Picture 2 - Sketch of retrofitted prilling tower



Picture 3 - Urea melt dispergator of vibration type

UREA MELT DISPERGATION UNIT

Dispergation unit is one the main element in the prilling flow-chart, since its efficiency is extremely critical for such parameters as granulometric composition of final product and distribution of spraying melt across tower's section.

The retrofitted by our concept prilling tower was equipped with high performance dispergator (picture3) of vibration type. Its design considers overlapping of regular perturbances on melt streams enabling very monodispersed product.

The main advantages of vibrating dispergators are the following:

- Monodispersed final product - similarity of prills' size is in average 93-96%, and in some cases - 99%;
- Reliable and simple in operation;
- Achievable capacity up to 100 t/h as per final product ;
- Environmental friendliness: minimum dust formation and caking;
- Low consumption of electric energy - up to 2 kW/h.

Table 1 - Indications of granulometric composition

	Granulometric composition Mass fraction %				Granules strength kgs/granule
	Less than 1 mm	1,0 -2,0 mm	2,0 – 3,0 mm	More than 3mm	
Before retrofitting	2,5 – 3,5	75,0 – 84,0	6,3 – 12,5	The rest	0,40-0,45
After retrofitting	1,0	4,0 – 6,0	88 - 93	The rest	0,95 – 1,15

The scope of delivery includes::

- Rotation dispergator of vibration type - 1 pc.;
- Dispergator buckets with profiled bottom - 1 or 2 pcs. as per Client's request;
- Dispergator driving mechanism - 1 pc.;
- Hood of V-belt drive - 1 pc.;
- Transformer of electric current frequency - 1 pc.;
- Spare parts and tools - 1set;
- Urea melt filter (in case of necessity);
- Lifting and rotating mechanism for dispergator (upon Client's request).

Urea melt dispergator is protected by patent as proprietary know-how of our company and is already introduced in a number of urea plants in Russia, Ukraine, Belarus, Lithuania, Estonia, Bulgaria, and Serbia.

PRILLS COOLING UNIT WITH "FLUIDIZED BED"

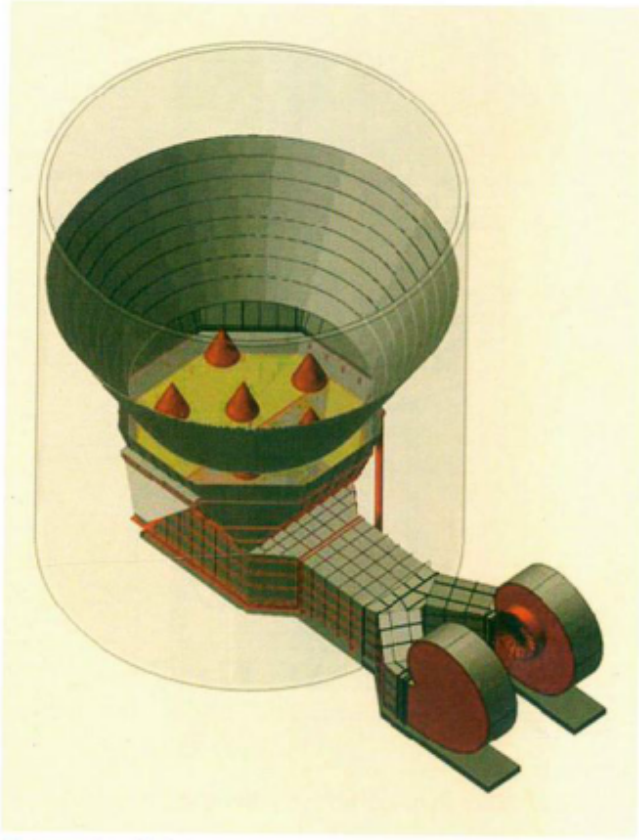
A new "fluidized bed" for prills cooling was integrated into the bottom part of the tower (Picture 4) replacing unloading scraper mechanism.
Operating principle of such unit is based on heat and mass exchange processes in between air and solid particles of urea. Efficient heat removal from urea particles is ensured by air turbulence and intensive mixing in the constantly moving fluidized bed all resulting in maximum decrease of final product temperature.

Table 2 - Operation parameters of urea prilling tower as per final product

	Production capacity, mtd	*Product temperature at the outlet of tower, °*
Before retrofitting	*500*	*80 - 93*
After retrofitting	*1200*	*45 ±5*

The recognized advantages of fluidized bed cooling units are the following:

- Developed contact surface of solid product and fluidizing agent contributing to the intensity of heat exchange ;
- Highly efficient heat exchange enabling low product temperature - not more than 50 0□;
- Continuous availability of solid phase entrainment and extraction allows uninterrupted operation of the unit ;
- Intelligent design ensures easy integration into tower structure;
- Possibility of particle size increasing;
- Improved product quality resulted from exclusion of defected particles (flatted, semi crystallized and not crystallized) formed when falling upon rigid floor or damaged by unloading scraper mechanism.



Picture 4 - "Fluidized bed" unit

Scope of delivery includes:

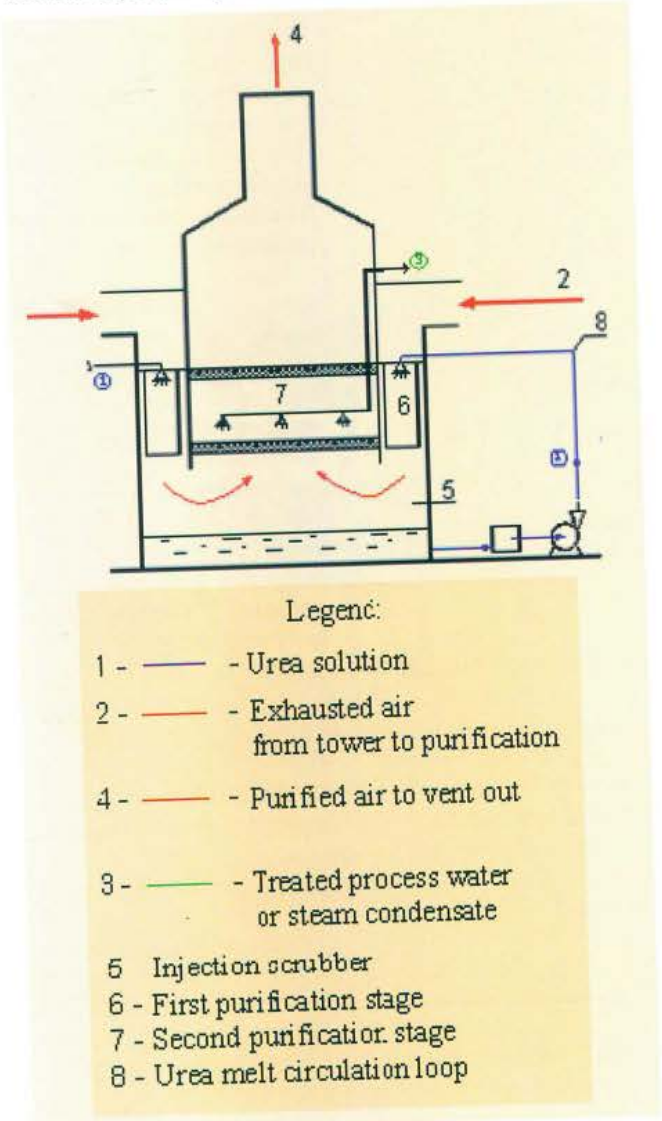
- Blower fans with electric motors - 2 pcs.;
- Air duct - 1 pc;
- Dampers, hinged flap, soft insertion - 1 set;
- "Fluidized bed" unit - 1pc, including case, two perforated grids, product unloading nozzle, separating and guiding cones;
- Louvers for air suction windows with adjustable impinging angle (if necessary) ;
- Drainage collector - 1pc.;
- Pump - 1 pc.

Prills cooling unit with "fluidized bed" is protected by patent as a proprietary know-how of our company and is already introduced at a number of urea plants in Russia, Ukraine, Uzbekistan, Belorussia, Lithuania.

AIR PURIFICATION UNIT

Revamping and modernization of urea production facilities require very careful attitude to environmental issues. Prevention of ammonia and urea losses along with hygiene requirements are very critical to economics since the share of urea and ammonia cost in the net price of final product takes ~70%.
Urea dust trapping, due to its high hygroscopicity and water solubility, can be efficiently provided only by wet method in gas washing units. Such unit should be compact and ensure high purification rate with minimum hydraulic resistance with moderate energy consumption.

The unit also should have high performance gas washers and spray traps. The mentioned requirements are considered in injection units developed by our company. These units are already successfully operating at a number of large scale urea production plants. Picture 5 below represents injection unit used as scrubber. This type of injection system ensures not only urea but also partially ammonia trapping. This is achieved by very intensive heat and mass exchange at the filtration stage of exhaust air through fine level of dispergating washing liquid.



Picture 5 - Injection type scrubber

The main advantages of such unit are the following:

- High purification rate of exhaust air: ammonia rate at the outlet not more than 40 mg/nm3, urea - not more than 25 mg/nm3;
- Reliable and simple in operation, minimum requirements to maintenance;
- Convenient design - accessibility to all structural components;
- Compact - small overall size considering large air volume;
- Low metal consumption;
- Energy saving - return of the trapped substances into the process.

The scope of delivery includes:

- Purification unit including case, nozzles with injecting elements, spray traps, exhaust pipes;
- Pumps - 6 pcs.

Purification unit of injection type is protected by patent as proprietary know-how of our company and is already introduced at a number of urea plants in Russia, Ukraine, Uzbekistan, Belorussia, Lithuania, Estonia.

CONCLUSION

The mentioned article we have described our capabilities in urea prilling technology on the example of retrofitting provided at Nevinnomyssky Azot Urea Prduction plant. Our company has successfully retrofitted a number of prilling towers of different design in Russia an CIS (see attachment 1). Research and Design Institute of Urea is ready to offer our services (see attachment 2) grass root construction and modernization of urea prilling towers with guaranteed capacity increasing, final product quality improvement and reduced atmospheric emissions.

Picture 6 - Old and retrofitted prilling towers

Table 3 - Operating parameters of prilling tower as per emissions

	Atmospheric emissions, mg/nm^3	
	Ammonia	Urea dust
Before retrofitting – without purification unit	80 - 125	200 - 250
After retrofitting – with purification unit	35 - 40	12 - 25

Attachment 1 – References of prilling towers projects

Location	Year of start	Product	Capacity, thsd.t/y
Dzerzhinsk (Russia)	1971	urea	248
Salavat ((Russia)	1976	urea	270
Chirchik (Uzbekistan)	1986	urea	270
Toglitti (Russia)	1986	urea	270
Severodonetsk (Ukraine)	1986	urea	270
Novgorod ((Russia)	1986	urea	360
Grodno (Belorussia)	1986	urea	270
Jonava (Lithuania)	1986	urea	270
Severodonetsk (Ukraine)	1986	urea	330
Odessa (Ukraine)	1985, 1986	urea	330, 330
Dneprodzerzhinsk (Ukraine)	1986	urea	330
Fergana (Uzbekistan)	1986	urea	330
Grodno (Belorussia	1987	urea	330
Gorlovka (Ukraine)	1993	urea	330
Nevinnomyssk (Russia) (retrofitting)	1997	urea	400
Gorlovka (Russia) (retrofitting)	1997	urea	510
Cherepovets (Russia)	1998	urea	330
Novomoskovsk (Russia) (retrofitting)	2005	urea	400
Togliatti (Russia) (retrofitting design is completed)	2006	urea	450
Salavat (Russia) (retrofitting)	2007	urea	330
Arzew (Algeria) (final stage of construction)	2008-2009	urea	400
Nevinnomyssk (Russia) (retrofitting is planned)	2008-2009	urea	400
Salavat (Russia) (design is completed)	2008-2010	urea	400
Cherepovets (Russia) (design under development , construction is planned)	2008-2010	urea	450

Attachment 2 – Scope of services provided by Research and Design Institute of Urea for prilling towers construction and modernization

1. Process monitoring with issuing of recommendation to adjusting process parameters to formally required, product quality improvement methods, reduction of energy consumption and atmospheric emissions, development of retrofitting methodology.
2. Investment estimation and feasibility study for both grass root construction and retrofitting of the existing ones.
3. Development of design documentation for both grass root construction and retrofitting of the existing towers in any geodesic and climate conditions.
4. Manufacturing and delivery of materials: regulating and stop valves, equipment and instrumentation, turnkey commissioning.
5. Contract and field supervision.
6. Pre-commissioning, commissioning and performance guarantees test.

Prior to any retrofitting our company provides detailed process monitoring aimed at acquiring data of basic operating parameters of the tower and definition of critical points of the prilling process. Our specialists provide such monitoring according to the program that includes the following works:
Inspection of all units of the tower aimed at definition of existing deviations and developing of amendments to the original flow-chart as well as collection of information necessary for working out of technical solutions to be implemented in retrofitting ;
Data collection for development of equipment and civil solutions to be introduced at design stage;
Reading of basic operating parameters of the tower.

Process monitoring is followed by development of basic and detailed design in all parts, including equipment manufacturing and realization of retrofitting concept.
Equipment manufacturing quality is ensured by inspections provided by our engineers. Client accepts delivered equipment according to technical documentation.

Next step after packaged equipment delivery are assembly and erection works where Research and Design Institute of Urea provides contract and field supervision to ensure consistency of the executed works to the developed and approved design documentation.
Retrofitting project is normally finished with commissioning and performance test. Within commissioning period the retrofitted tower is brought into stable operation mode with designed capacity. This followed by performance guarantees test that is a 72 hours continuous run of the prilling tower. The guaranteed performance is considered to be reached when parameters were found better or equal to those indicated in Contract.