

Uhde innovate 2024 – June 4-6

Increase of nitrogen use efficiency (NUE)
with innovative granulation additives

June 5th, 2024 | Dr. Matthias Potthoff
thyssenkrupp Fertilizer Technology

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UFT® Fluid Bed Granulation Technology

Granulation Expertise

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Introduction

Greenhouse gas emissions agricultural sector

Contributions to greenhouse gas emission:

- **Agricultural sector:** 10-12%
main contributors are:
 - Methane (CH_4) from livestock, paddy fields
greenhouse gas potential: 28 x CO_2 (100 year basis)
 - Nitrous oxide (N_2O) from nitrogen fertilizer application,
high greenhouse gas potential: 298 x CO_2
- **Fertilizer production alone:** > 2%
mainly CO_2 , plus NO_x , N_2O

Urea is the mostly applied nitrogen fertilizer –
with potential for high nutrient losses to atmosphere
and ground water

What has been achieved so far?

Fertilizer production:

- Energy efficient processes and emission control technologies are available:
 - $\text{NO}_x/\text{N}_2\text{O}$ reduction in nitric acid plants (e.g., EnviNO_x®)
 - CO_2 capture and storage/usage (CCS/CCU) and others

Fertilizer application:

- Optimized nutrient mix
- More specific application schemes (digitalization)
- International fertilizer association (ifa) 4R principles (right source, right time, right rate, right place)

BUT: **This is not enough !!**

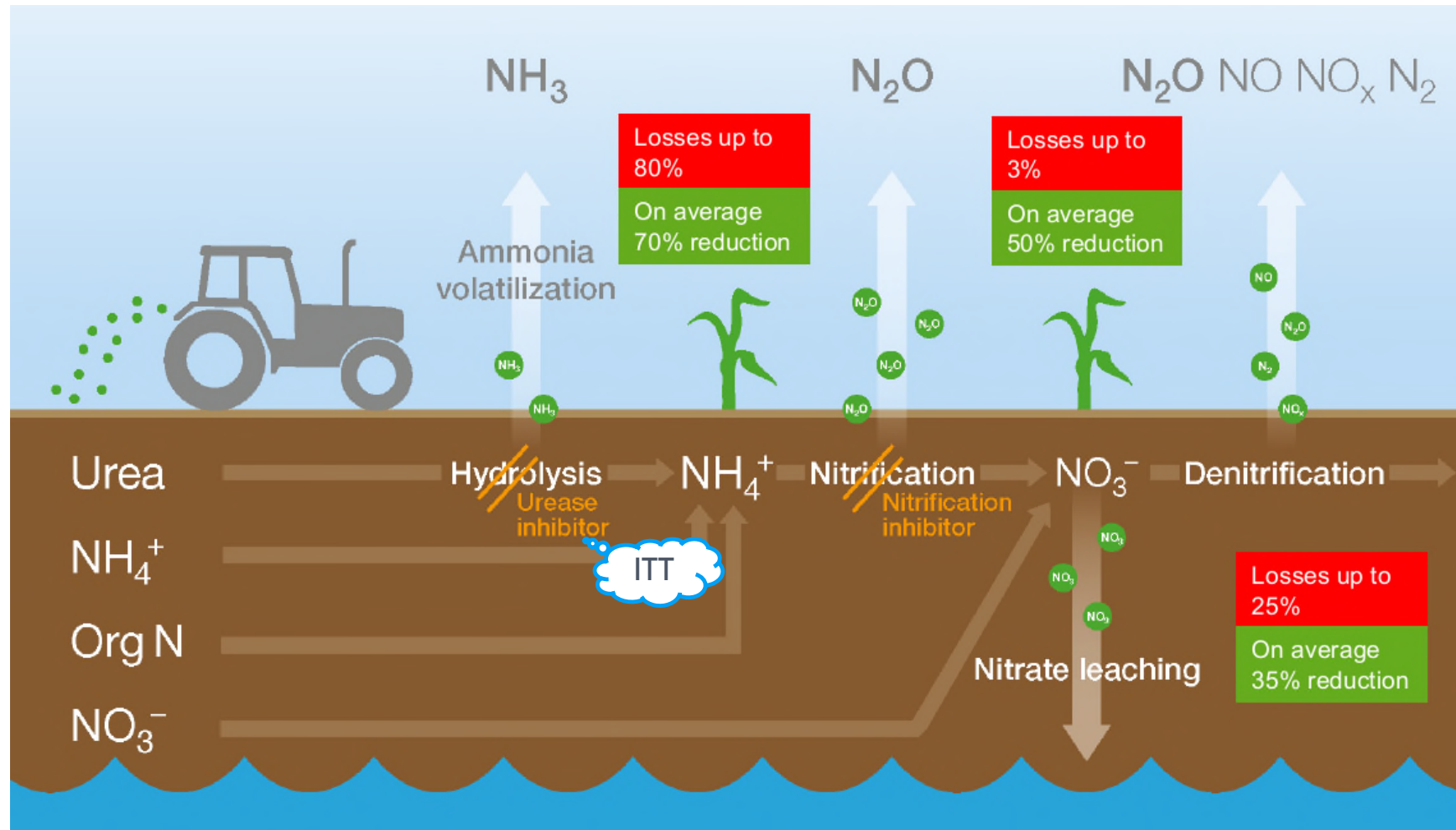
What needs to be done?

- Further improvements in production technologies (e.g., green ammonia)
- Increase of nutrient use efficiency, specifically **nitrogen use efficiency**



Introduction

Mitigation of nitrogen losses



Other options:

- Controlled release fertilizer (CRF)
- Slow release fertilizer (SRF)
- Optimized application schedule
- Combination of nutrients
- Application at the right time
- Following 4R guideline



Motivation for Inhibitor Treatment Technology (ITT)

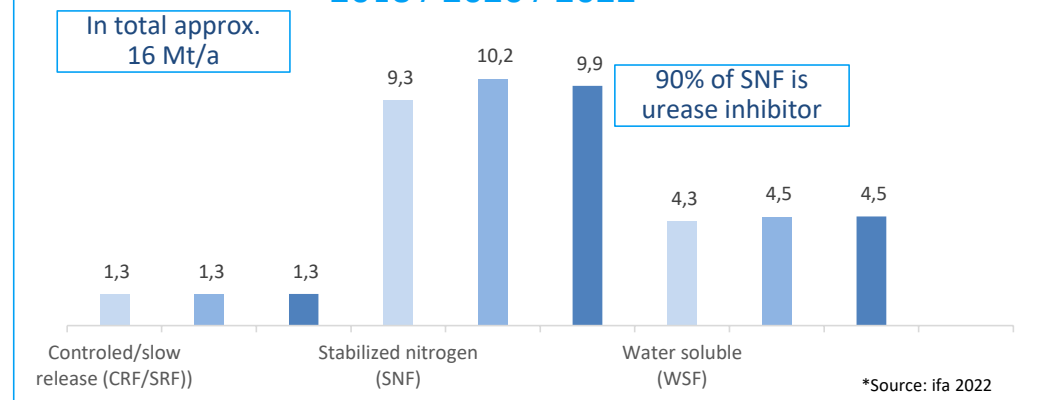
Market for so called specialty fertilizers

Production Nitrogen products worldwide, 2022, in [Mt/a]

	Product	Nitrogen	
Urea	184	85	77%
AN/CAN	59	19	17%
UAN	22	7	6%
Total	265	111	

Source: ifa 2022

Specialty fertilizers demand product* [Mt/a], 2018 / 2020 / 2022



- ⇒ Only approx. 6% of nitrogen is treated (10% incl. neem-coated urea in India)
- ⇒ The major part of treated nitrogen fertilizers is stabilized urea (urease inhibitor, nitrification inhibitor)
- ⇒ Market is price sensitive

Effect of nitrogen use efficiency increase:

- reduced nitrogen losses/green house gas emissions
- yield increase to feed more people from less arable land or reduction in application rate

Basic acceptance criteria:

- Make sustainable fertilizers affordable for farmers all over the world

Regulatory requirements:

EU fertilizer directive, other regions will follow

Nowadays specialties need to become the commodities of tomorrow



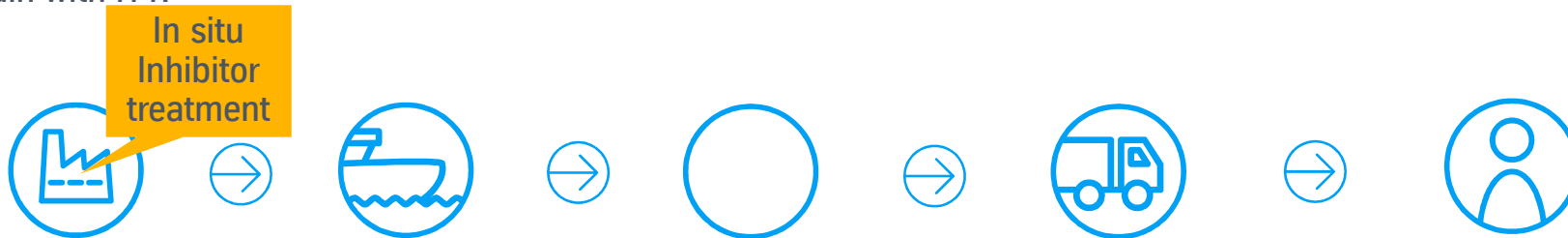
Motivation for ITT

Value chain

Today's value chain:



Value chain with ITT:



Fertilizer producer

Port, distributor

Farmer

Advantage:

- Treatment of large quantities easily possible
- Homogenous distribution of inhibitor in granules
- Saving process step of treatment in coating drum => reduced cost to farmer

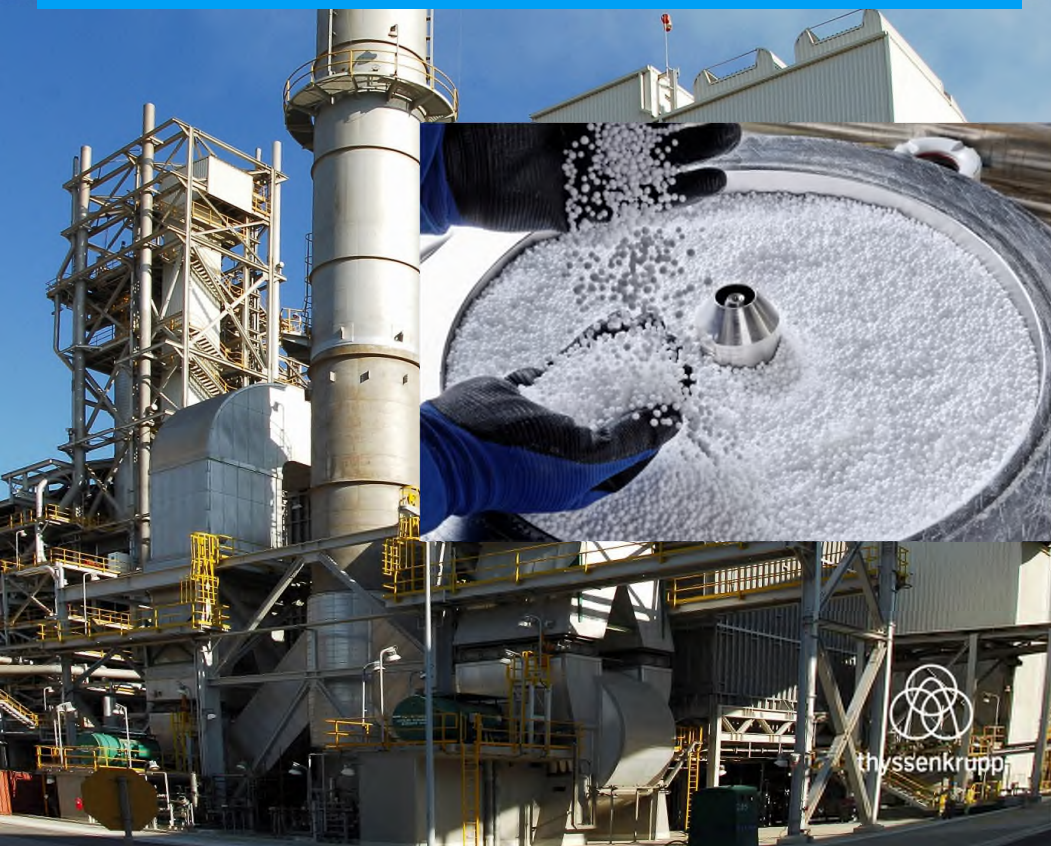
Challenge:

- Industrial application
- Stability of inhibitor



tkFT

- Market leader in urea fluid bed granulation
- > 40 years experience in granulation technology
- Large customer base: more than 70 plants
- Pilot plant available



BASF

- Strong in inhibitor chemistry and formulation
- Vast agronomic expertise
- Well positioned in inhibitor market
- Limus® as product well known in the market



ITT Inhibitor Treatment Technology

- Limus®, a highly effective formulation
- Direct application in the fluid bed granulation process
- Professional support from two strong partners

BASF
We create chemistry

Initial approach

Initial testing in tkFT's pilot plant



tkFT Batch operated Pilot Plant (BoPP) in Leuna, Germany

- BASF:
 - Limus[®] contains a synergetic combination of two active ingredients (NBPT and NPPT)
 - A lot of experience in coating of urea granules
- BASF developed formulation Limus[®]Direct, suitable for application in granulation process
- Tests in tkFT's pilot plant:
 - Melting of formaldehyde free prills, adding urea formaldehyde pre-condensate (UF) and Limus[®]Direct, followed by fluid bed granulation

Impact of Limus [®] Direct on product quality		
	Market standards	Pilot plant
Chemical composition • Nitrogen content • Moisture content	Min. 46.0 wt% Max. 0.3 wt%	> 46.0 wt% < 0.2 wt%
Size distribution	Min. 90% between 2-4mm	Good granulation behavior
Crushing strength	Min. 3 kgf	> 3.0 kgf
Stability of inhibitor Limus [®] Direct during storage of treated urea	Coating on commercial product: Good	Granulation with inhibitor: not satisfying

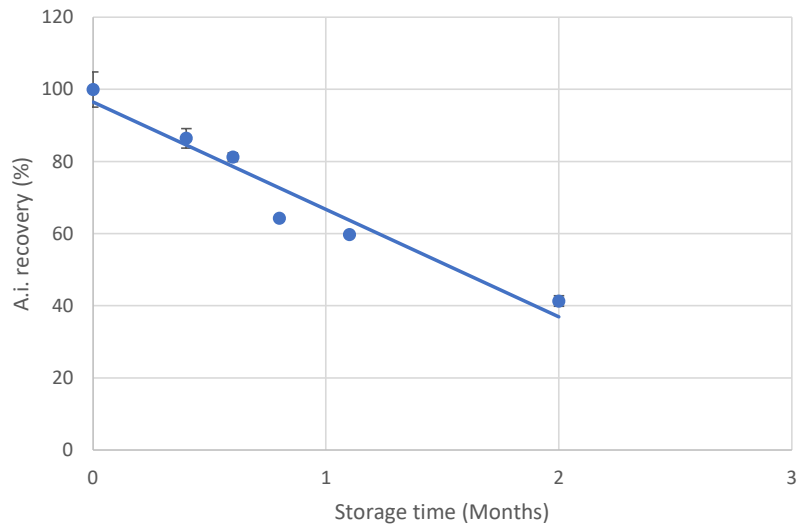
Urea granule quality good, however unexpected fast degradation of urease inhibitor during storage of treated urea



Development steps

Root cause analysis

Stability of thio phosphoric triamide inhibitor in urea
produced in pilot scale fluid bed granulator
(storage temp 20°C)



Several routes have been followed to identify the reason for the unexpected urease inhibitor degradation during storage of the treated urea

- Interaction UF-85 with NBPT/NPPT reason for degradation
- Replacement for UF needed that does not influence inhibitor stability

Conclusion: A new granulation additive had to be developed



Development steps

Pathway to Limus[®]Direct compatible additive

Success criteria for new granulation additive:

- a) Product quality parameters for granulated urea at least as good as with UF
- b) Stability of inhibitor over time in granulated urea (in months)
- c) Easy application of granulation additive in industrial environment

Laboratory scale



pilot plant scale



industrial application



Considerable resources have been mobilized for this product development



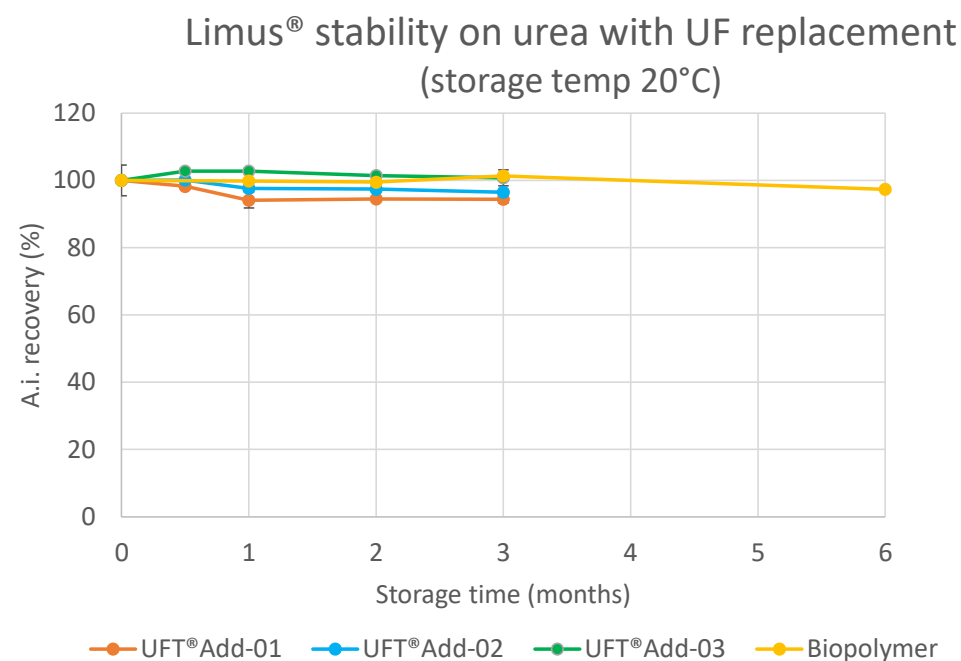
Results

- New granulation additives result give same or better properties compared to commercial urea produced with UF

Key product quality parameters

	Crushing strength [kgf@3.15 mm]	Moisture content [wt.%]
UFT®Add-01	3.3	0.1
UFT®Add-02	3.1	0.11
UFT®Add-03	3.1	0.12
Biopolymer	3.4	0.2

- Urease inhibitor stable on urea produced with new additives



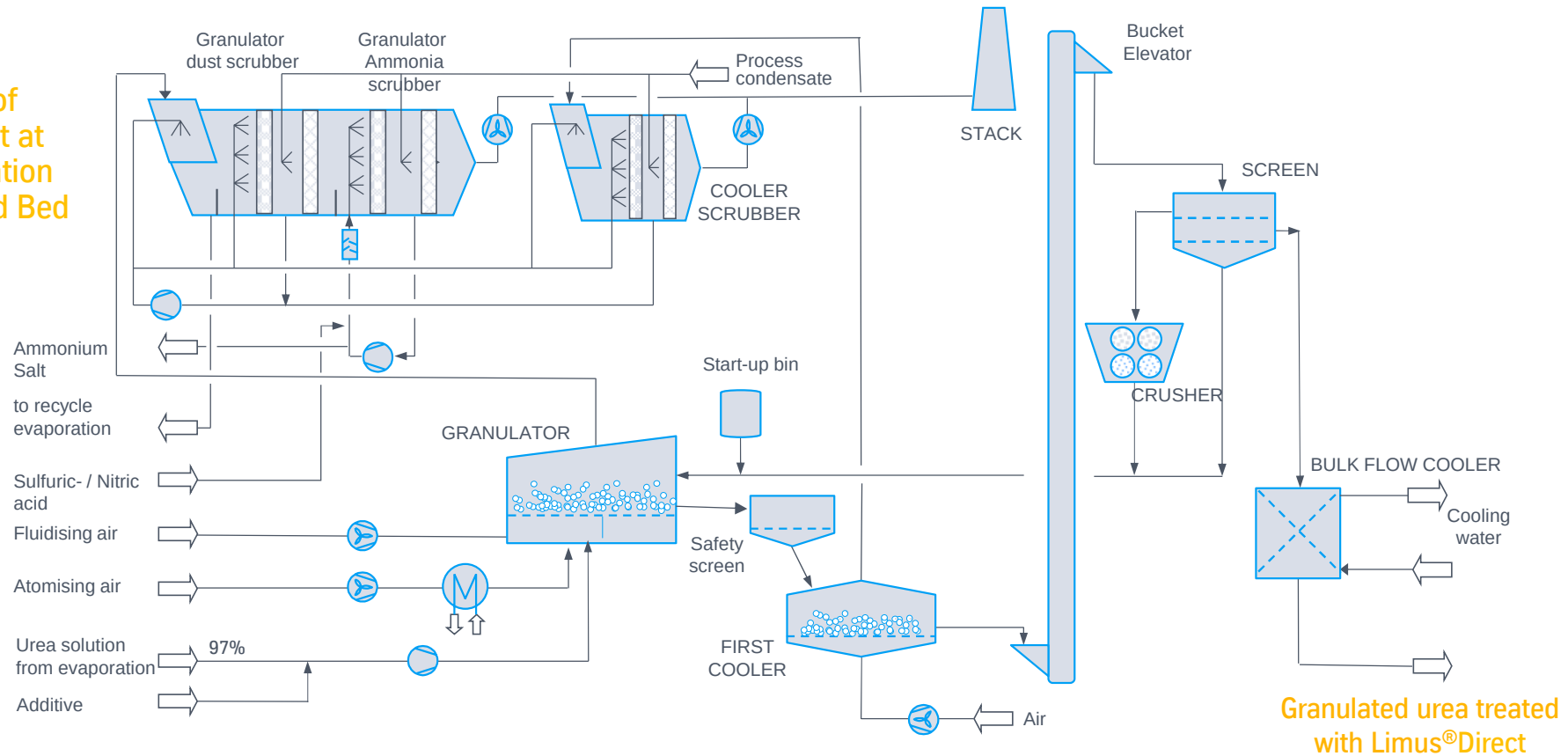
No significant inhibitor degradation with new UFT®Add formulations → to be confirmed in industrial scale trial



Outlook

Industrial application in UFT® Fluid Bed Granulation plant

Application of
Limus®Direct at
suitable location
in UFT® Fluid Bed
Granulation



Confirm results of pilot plant tests in industrial scale UFT® Fluid Bed Granulation plant



Outlook

Commercialization of Inhibitor Treatment Technology (ITT) after successful industrial application

Target:

- High reduction of green house gas emissions at farm level
- High stability of inhibitor in ITT-urea granules
- Eliminating handling of carcinogenic urea formaldehyde pre-condensate solution
- Large scale production of urease inhibitor treated urea granules, ready for direct delivery to farmers
- Simplification of distribution chain
- Investment at production site: storage and dosing facilities only, no coating drum

Market perspective:

- Annual growth rate for inhibitor treated urea expected with 4-6% p.a. ($\approx 0.65 - 1.0 \text{ Mt/a}$), will increase with tighter regulatory framework
- Several inquiries of urea producers received

ITT: Making a specialty fertilizer of today affordable for farmers all over the world by tomorrow





Thank you for your attention



Managing Director



matthias.potthoff@thyssenkrupp.com



+49 231 547 2641

