NEXTCHEM

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STAMICARBON
15TH SYMPOSIUM 2026

NUTRIENT ENHANCED UREA FERTILIZERS

FLUID BED SLURRY GRANULATION DEVELOPMENT

Gerardo Duarte

AGENDA

01 WHY?

02 WHAT?

03 HOW?

04 Q&A

EXECUTIVE SUMMARY

DESIRED OUTCOME:

FLEXIBLE MULTIGRADE FLUID BED INSTALLATION

Facilitating the addition of multiple plant and soil nutrients into urea-based fertilizer to sustainably improve crop yield, address ordinary urea market volatility and increase margins across the value chain.

MORE FLEXIBILITY, MORE VALUE AND ALL UNDER THE SAME RELIABLE TECHNOLOGY

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4R nutrients stewardship

Right Source

Right Time

Right Rate

Right Place

VISION 2030

Agriculture will face many challenges in the future, and a growing world population will require a drastic increase in food supply.

Questions we asked ourselves:

- How can this growing population be fed, while taking care of our environment?
- What differences can Stamicarbon make?

Strategic R&D innovation ambition focusses on two areas:

- Sustainable production of N-based mineral fertilizers
- Production of sustainable N-based mineral fertilizers

ENRICHED NITROGEN FERTILIZER

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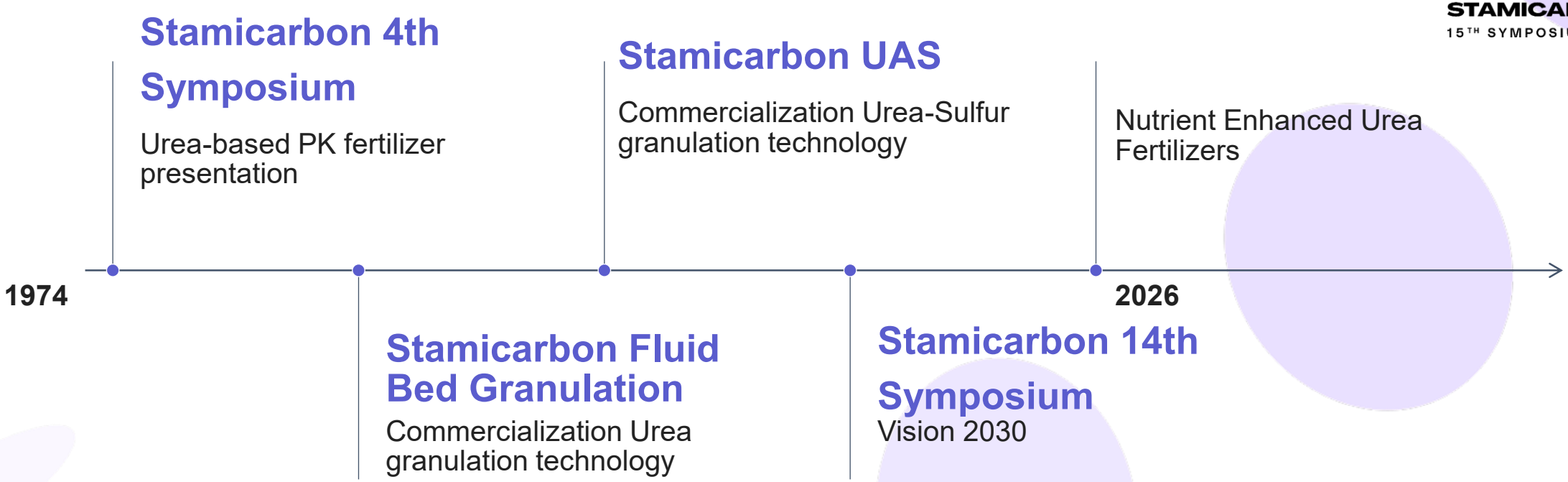

"After prolonged and exclusive use of nitrogen for fertilization, it will become necessary to incorporate P_2O_5 and K_2O. Consequently, there will be a growing interest in NPK fertilizers based on urea, given that urea is the only nitrogen source abundantly available in many regions"

FLUID BED (SLURRY) GRANULATION

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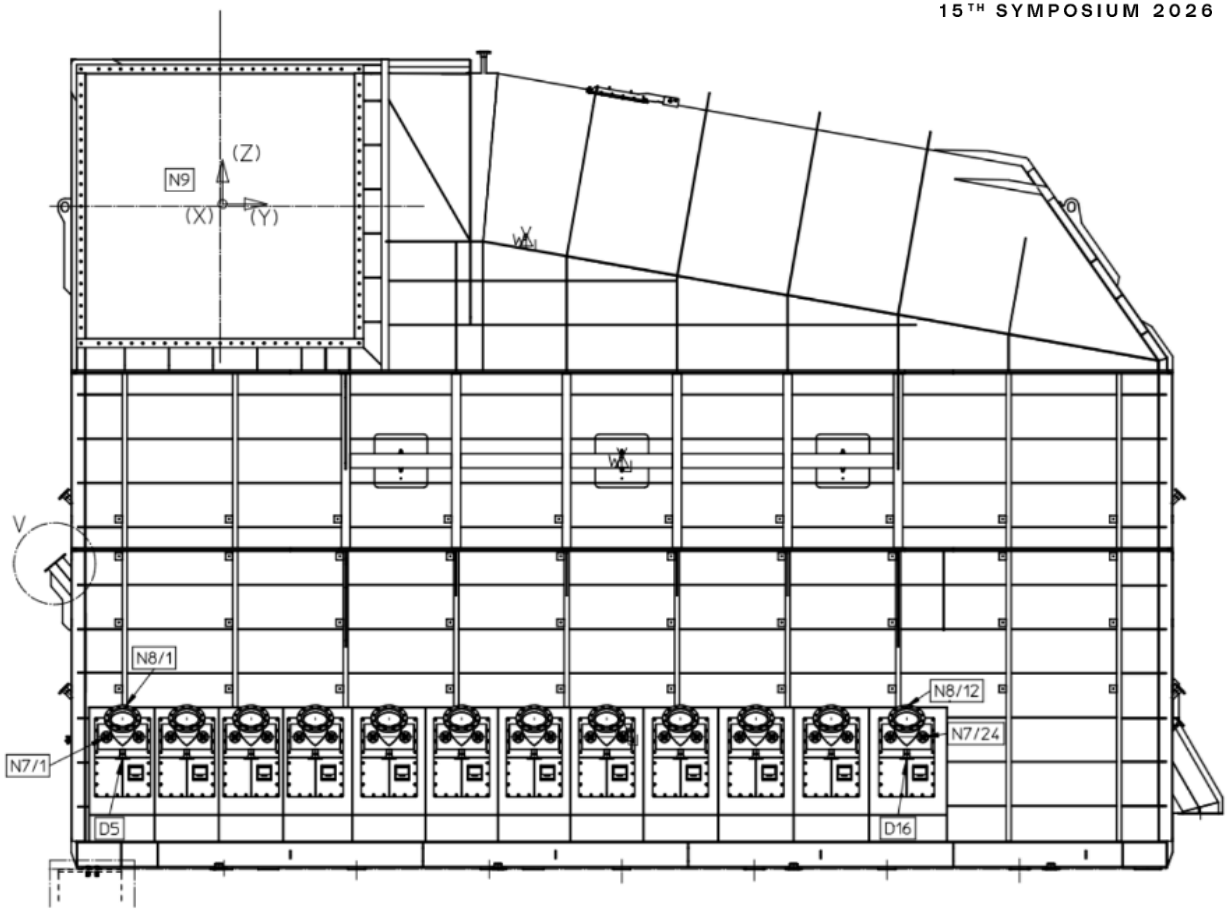
- Significantly lower formaldehyde consumption compared to conventional fluid-bed granulation technologies
- Exceptionally low dust and ammonia emissions from the granulation vent stack
- Reduced equipment footprint = lower CAPEX and simplified maintenance
- Minimized urea dust formation, lower recycle rates and reduced OPEX



NOZZLE DEVELOPMENT

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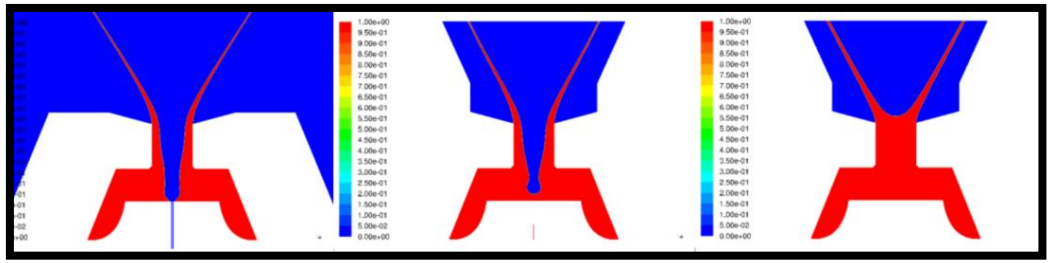
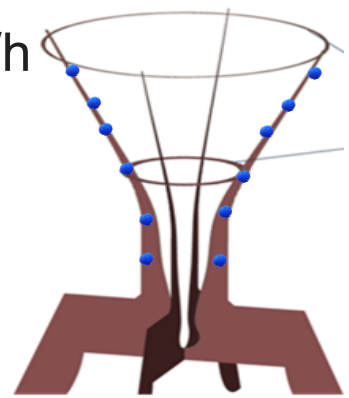
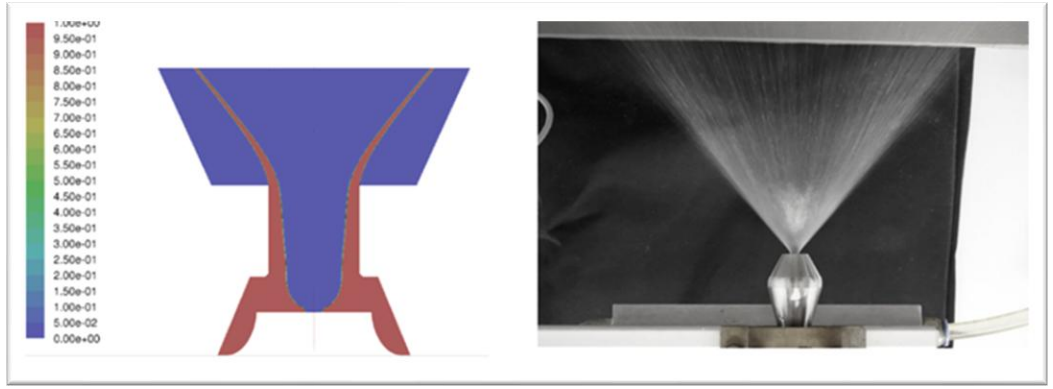
- Stamicarbon thin film nozzle forms a hollow cone
- **Solids addition** tend to alter rheology and spray behavior

Prototype

- Low Solid dosing (Standard. Urea Nozzle)
- Medium Solid dosing (New Slurry)
- Slurry nozzles designed for 450-500 kg/h range, ≈ 2x the standard urea nozzle capacity.







SOLID CHARACTERIZATION

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Essential factors include flowability, wetting, settling, slurry viscosity & density, and particle size distribution (PSD)

PARTICLE SIZE IN SLURRY

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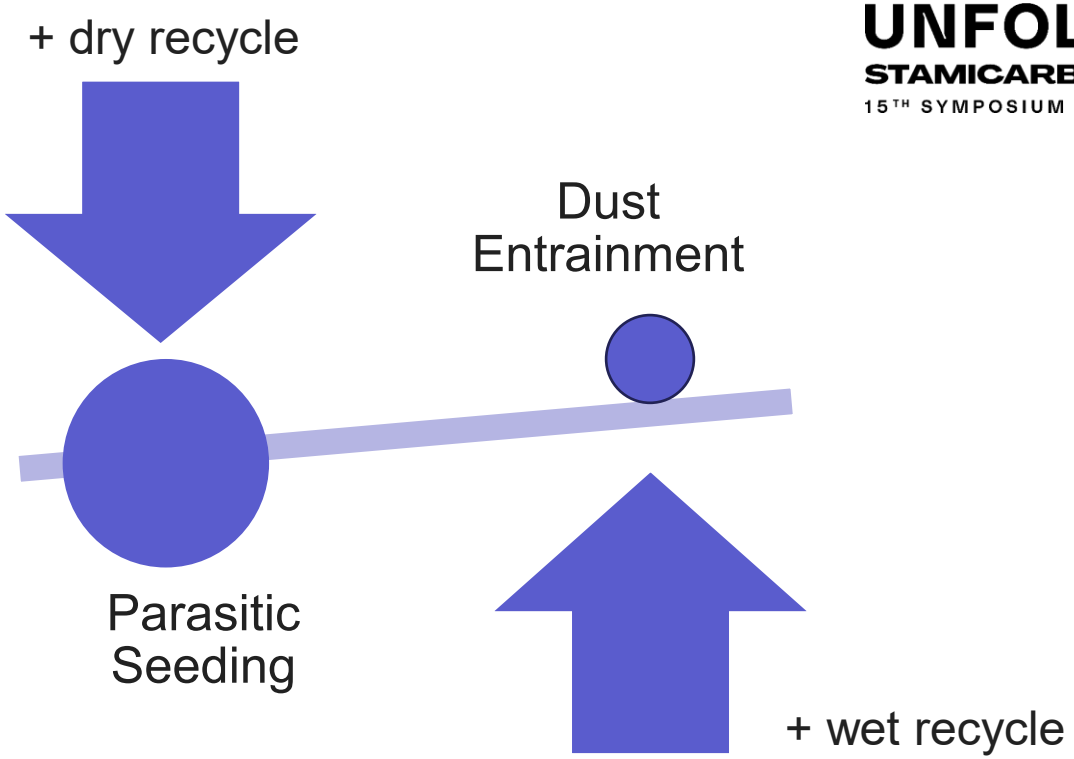

The characteristics of inlet solids significantly influence the nozzle spray performance and granulation stability

PARTICLE SIZE IN SLURRY

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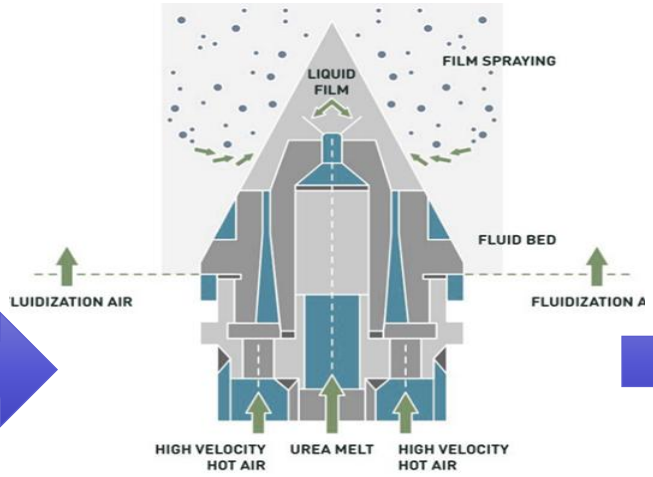
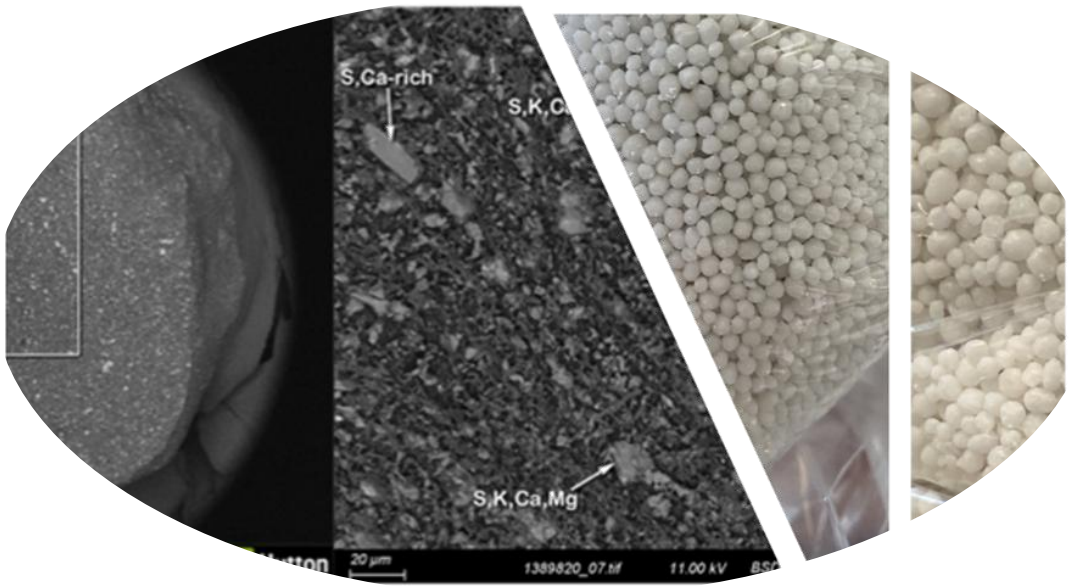
Urea dispersed slurry

Wet Milling

Fluid Bed Granulation



Nutrient Enhanced Urea



PILOT PLANT LEARNINGS

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Fluid Bed operational window for

I. Low dosing solid range (5-10% wt)

II. Medium dosing (20-30% wt)

- Fluid Bed process performance comparable to standard urea
- Product Quality comparable to standard urea
  - Note Urea-CRH is affected by added nutrient(s); when needed, (anti-caking) coating may be applied.

Two stage series wet milling set-up for

II. Medium dosing (20-30% wt)

- ΔT across mills as proxy for milling intensity
- Wear identified in milling tools
  - Hardened SS and superalloys showed partial improvement

Solids Corrosion Assessment

Impact of sulfates or chlorines in added solids

- Std. (304/316) compatible in granulation plant
  - Yet, wet recycle evaporator remains best practice to isolate synthesis section

PILOT PLANT LEARNINGS

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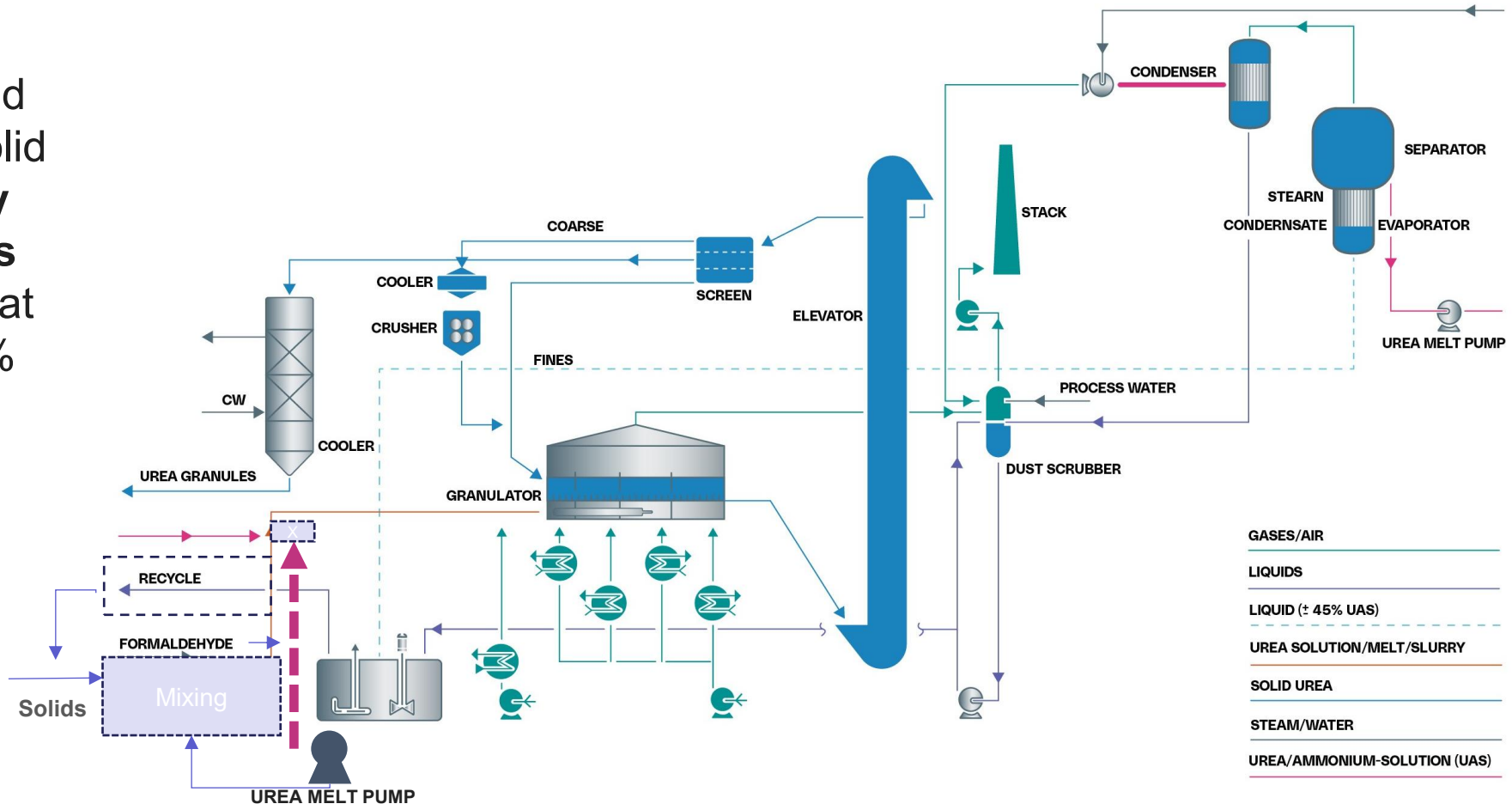
Process Concept

Low Solid Dosing, oriented on urea enrichment with solid **micronutrients, efficiency enhancers, bio stimulants or granulation additives**, at solid dosing typically 5-10% by weight.

Minimum Modifications



PILOT PLANT LEARNINGS

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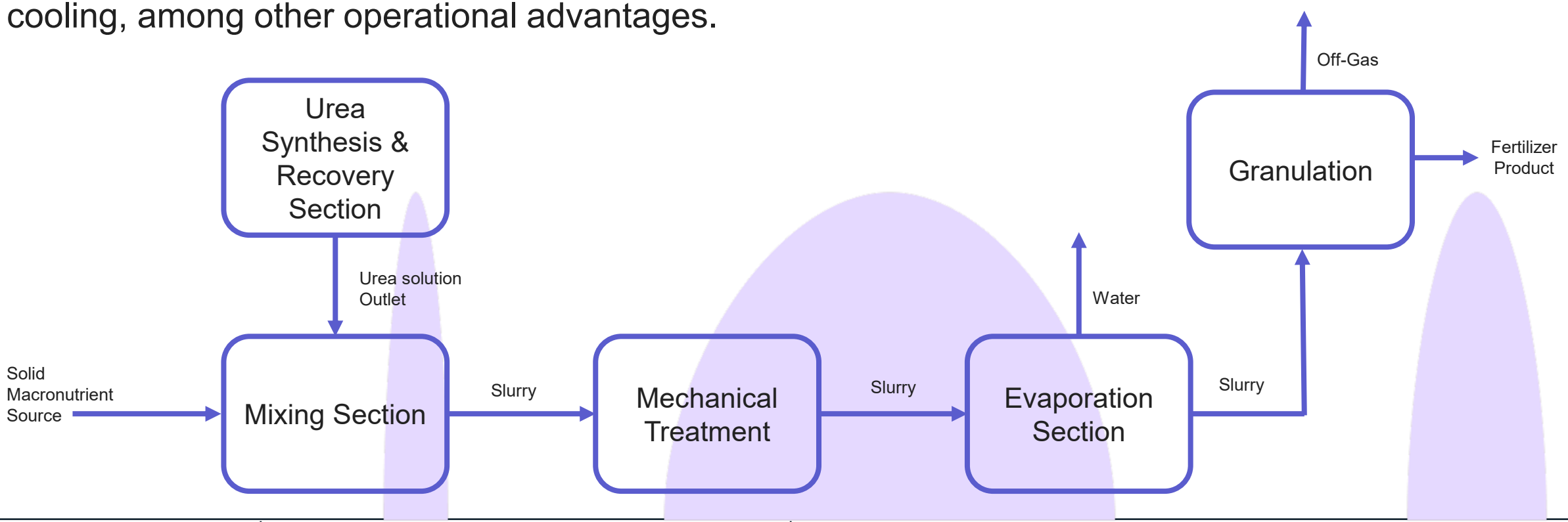
Process Concept

Medium Solid Dosing is a concept oriented for producing (Macro)nutrient-enriched urea granules by utilizing an aqueous urea solution during slurry production. It operates below 100℃, minimizing heat-related issues and removing the need for cooling, among other operational advantages.



PILOT PLANT LEARNINGS

STEPS AHEAD

Full Scale Validation

Coatings test

Increase wear resistance material

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Key Features

Feature	Low Solid Dosing	Medium Solid Dosing
Target Products	Specialty urea (micronutrients, inhibitors, bio-stimulants, FFA…)	Multi-nutrient urea (NPK, NKS, N-K-S-Ca-Mg...)
Typical Solid Content	Typically, **< 10 wt%**	Typically, **< 20-30 wt%**

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TECHNOLOGY ADDED VALUE

Cost-effective approach for urea de-commoditization

- Granulation net capacity could increase by 20-25%
- Product with higher market value per mt
- Slurry granulations nozzles with higher throughput

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THANK YOU

QUESTIONS?

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