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15TH SYMPOSIUM 2026

MICROMIST VENTURI AND JET VENTURI SCRUBBERS

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AGENDA

01

INTRODUCTION

INTRODUCTION

INDUSTRY CONTEXT AND DRIVERS

- **Environmental Regulation Pressure**: Industries face increasing pressure to reduce emissions and meet strict environmental standards globally.
- **Emission Challenges in Fertilizer Production**: Fertilizer plants struggle to control fine particulate matter and ammonia as limits fall below 10 mg/Nm^3.
- **Advanced Scrubbing Technologies**: Micromist^{TM} Venturi and Jet Venturi Scrubbers capture submicron particulates and ammonia efficiently.
- **Sustainable Industrial Operations**: These technologies help industries comply now and prepare for future regulatory demands sustainably.

INTRODUCTION

TECHNOLOGY OVERVIEW AND COLLABORATION

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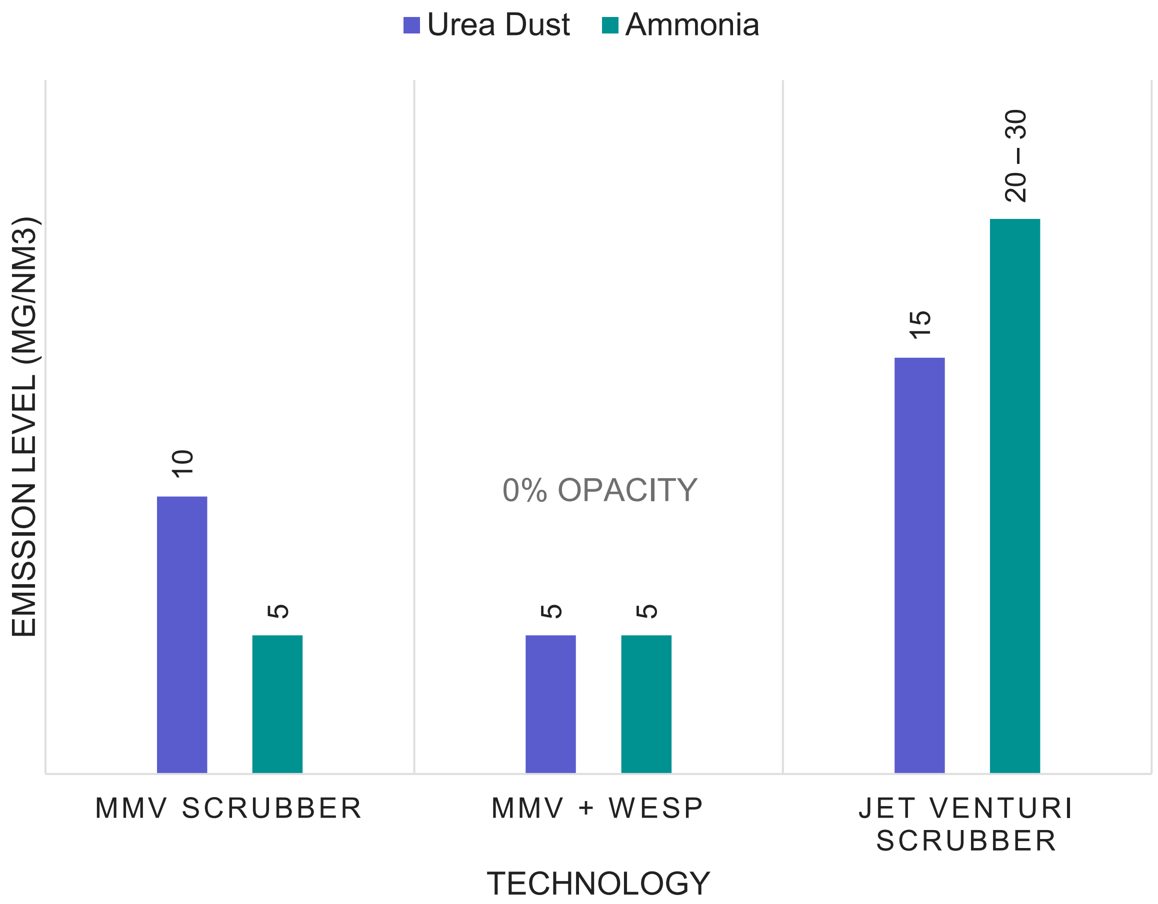
- **Collaborative Technology Development**: MMV for granulation plants and Jet Venturi Scrubbers for prilling towers were developed through a partnership between Stamicarbon and EnviroCare International, with the goal of optimizing emission control for urea granulation and prilling tower operations.
- **Venturi Scrubbing Efficiency**: Both systems use venturi scrubbing to efficiently remove fine particulates.

INTRODUCTION

ACHIEVABLE EMISSIONS



- **MMV Scrubber Performance**: MMV scrubbers reduce urea dust emissions below 10 mg/Nm³ and ammonia emissions below 5 mg/Nm³.
- **WESP Enhancement**: Pairing with WESP lowers urea dust below 5 mg/Nm³ and achieves 0% opacity.
- **Jet Venturi Scrubbers**: Jet Venturi Scrubbers with acidic scrubbing achieve dust below 15 mg/Nm³ and ammonia between 20–30 mg/Nm³.

- *Note: Indicated emission values are aligned with recognized EPA measurement methods (EPA Methods 5, 202, and 9) developed by the United States Environmental Protection Agency.*

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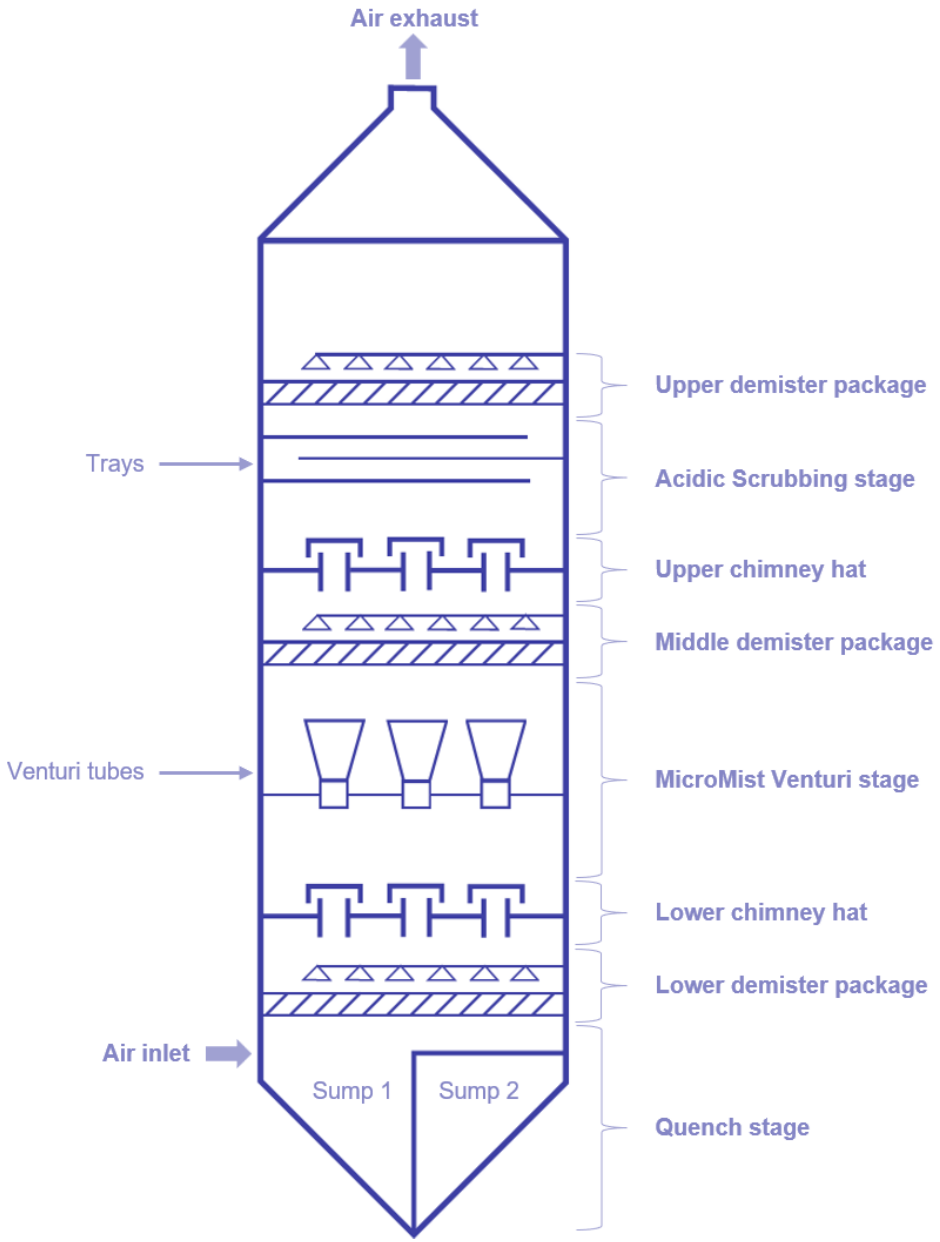
MMV TECHNOLOGY

MMV TECHNOLOGY

PROCESS OVERVIEW

- **Quench Stage**: Cools and saturates exhaust gases while removing large particulates efficiently.
- **MicroMist Venturi Stage**: Fine water droplets collide with submicron dust particles at high velocity for effective filtration.
- **Acidic Scrubbing Stage**: Uses sulfuric or nitric acid to capture ammonia by forming ammonium salts.
- **Demister Packages and Chimney Hats**: Prevent liquid carryover and provide hydraulic separation between scrubbing zones.



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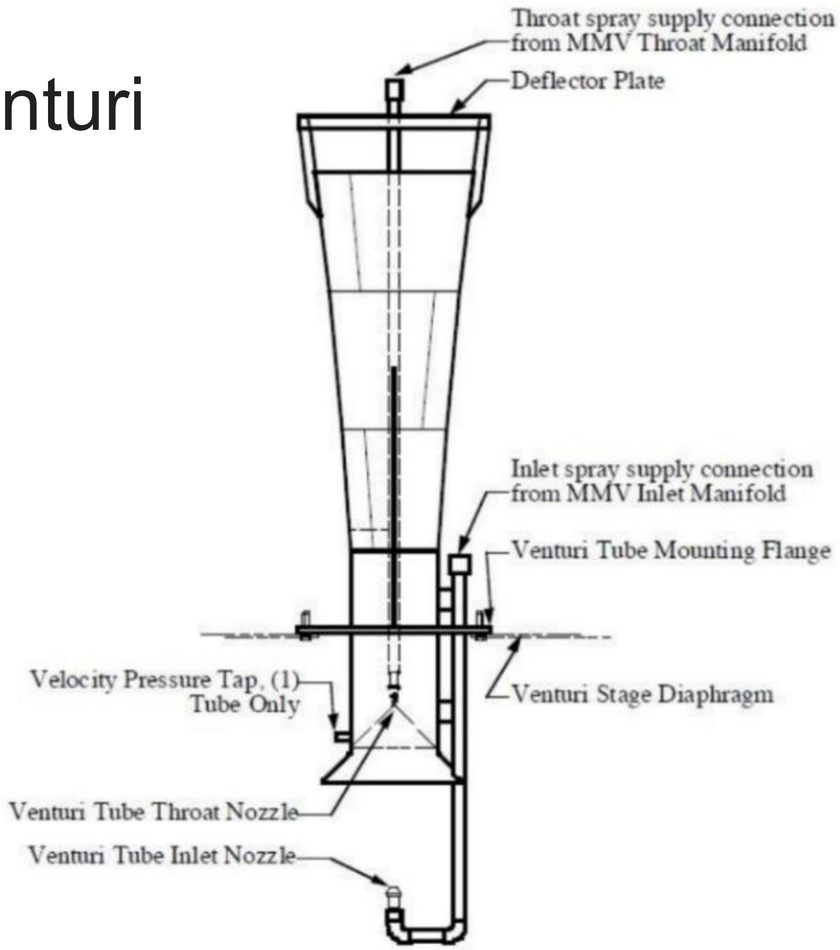
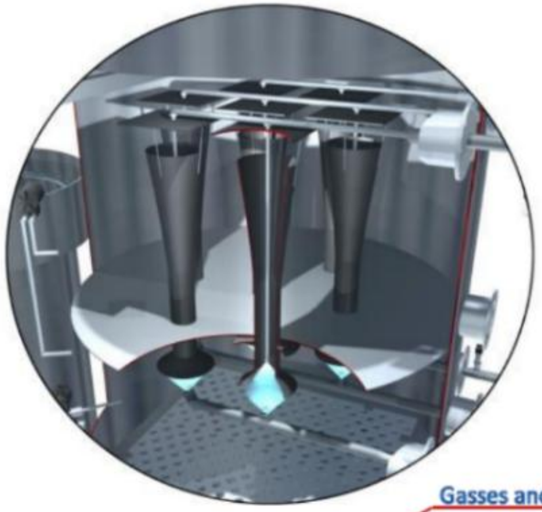
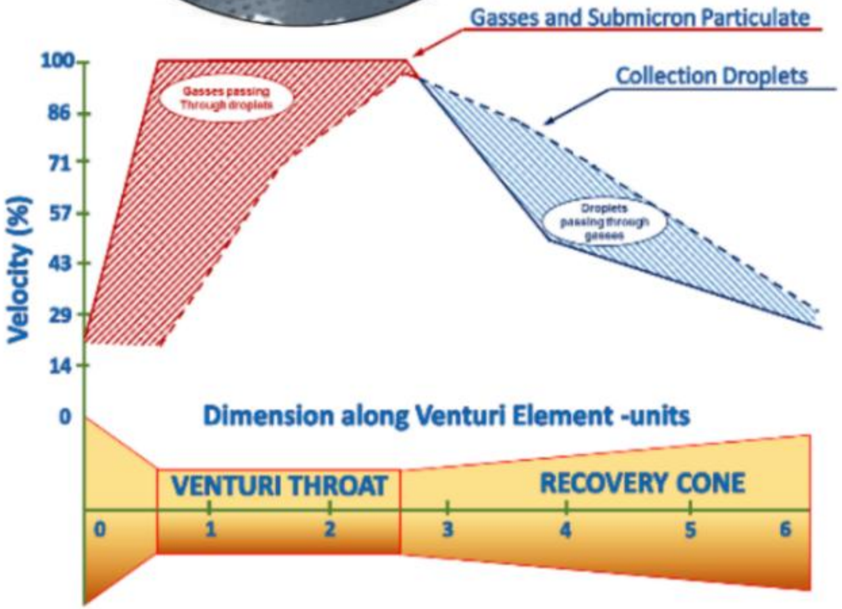
MMV TECHNOLOGY

PROCESS OVERVIEW

MicroMist Venturi







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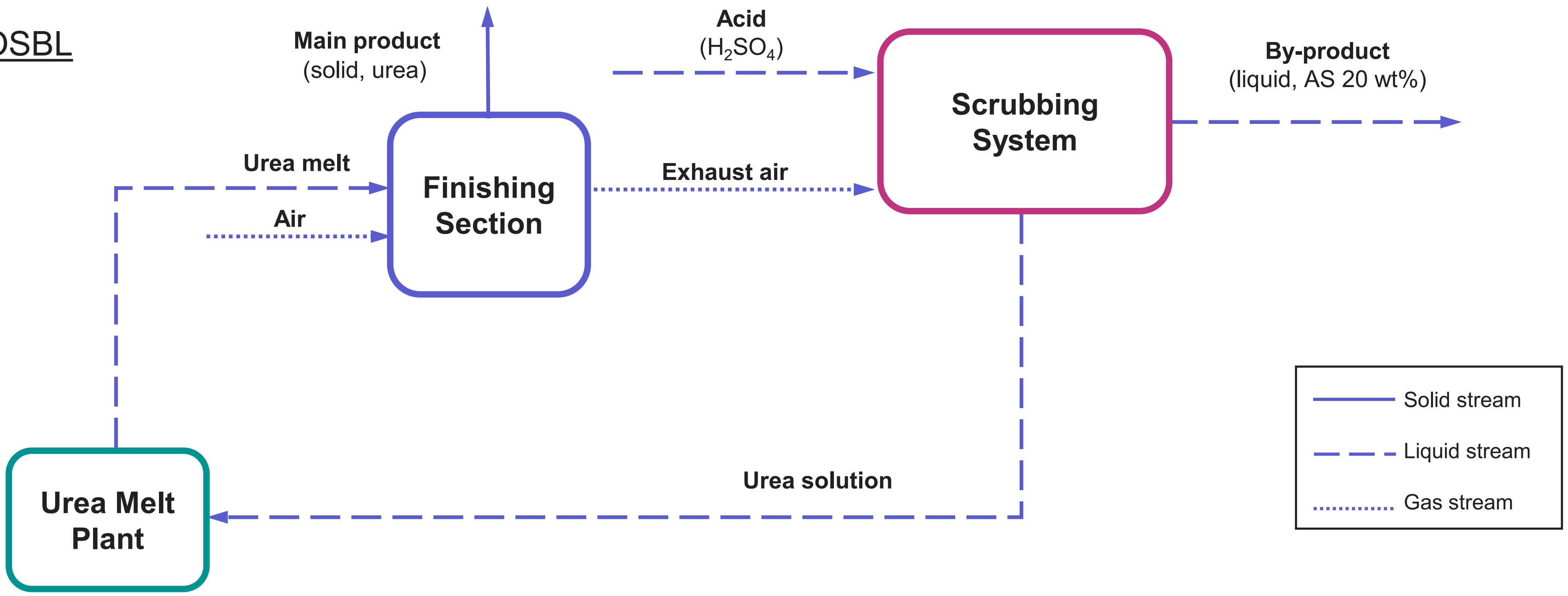
MMV TECHNOLOGY

SALT REWORKING OPTIONS

Ammonium Sulfate Handling: Ammonium sulfate can be routed to OSBL for external processing or recycled back into the granulation process to reduce waste.

AS TO OSBL



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SALT REWORKING OPTIONS

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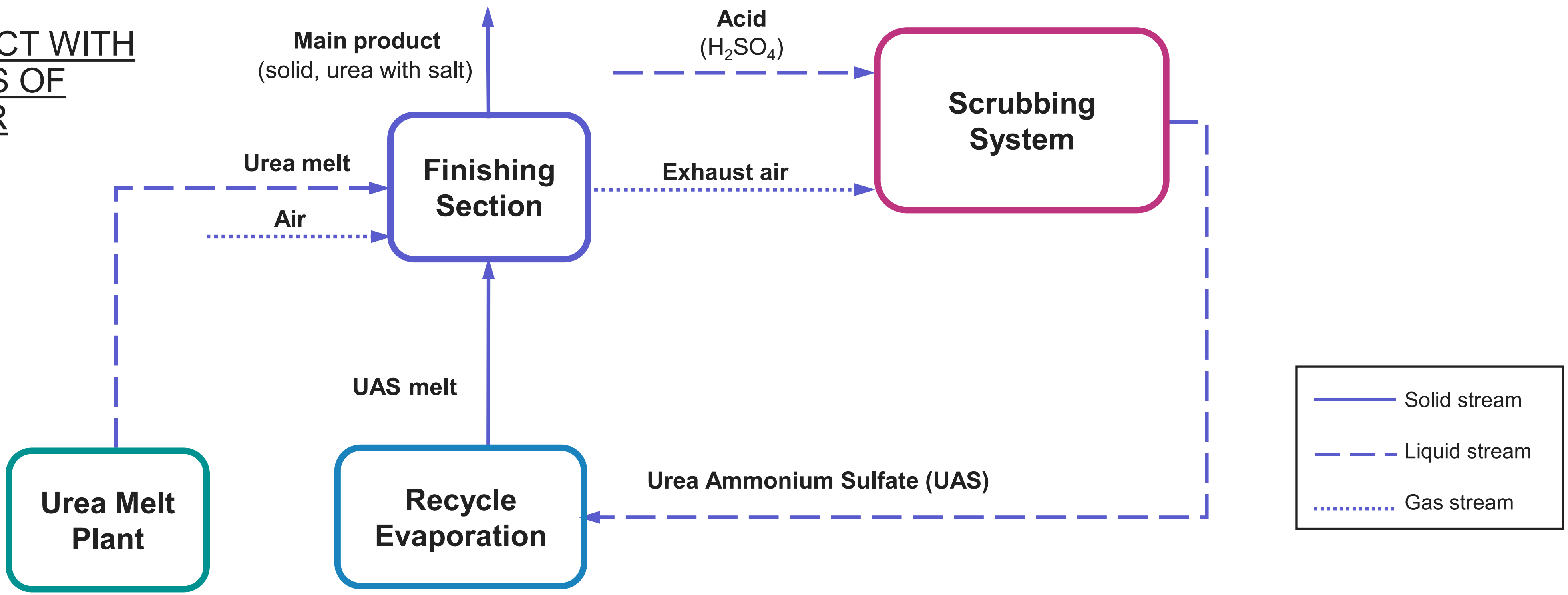
<u>PRODUCT WITH TRACES OF SULFUR</u>



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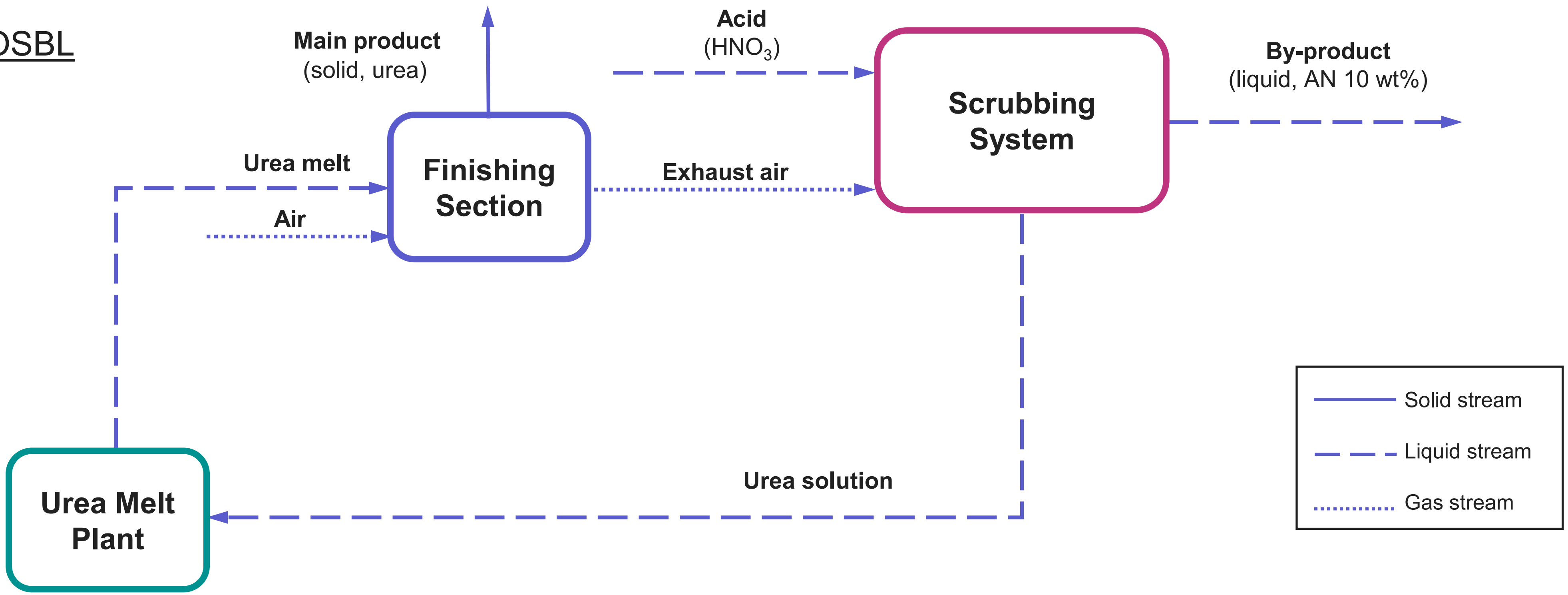
SALT REWORKING OPTIONS

Ammonium Nitrate Handling: Options include sending ammonium nitrate to OSBL or converting it into UAN, a valuable liquid fertilizer for enhanced plant nutrition.

<u>AN TO OSBL</u>



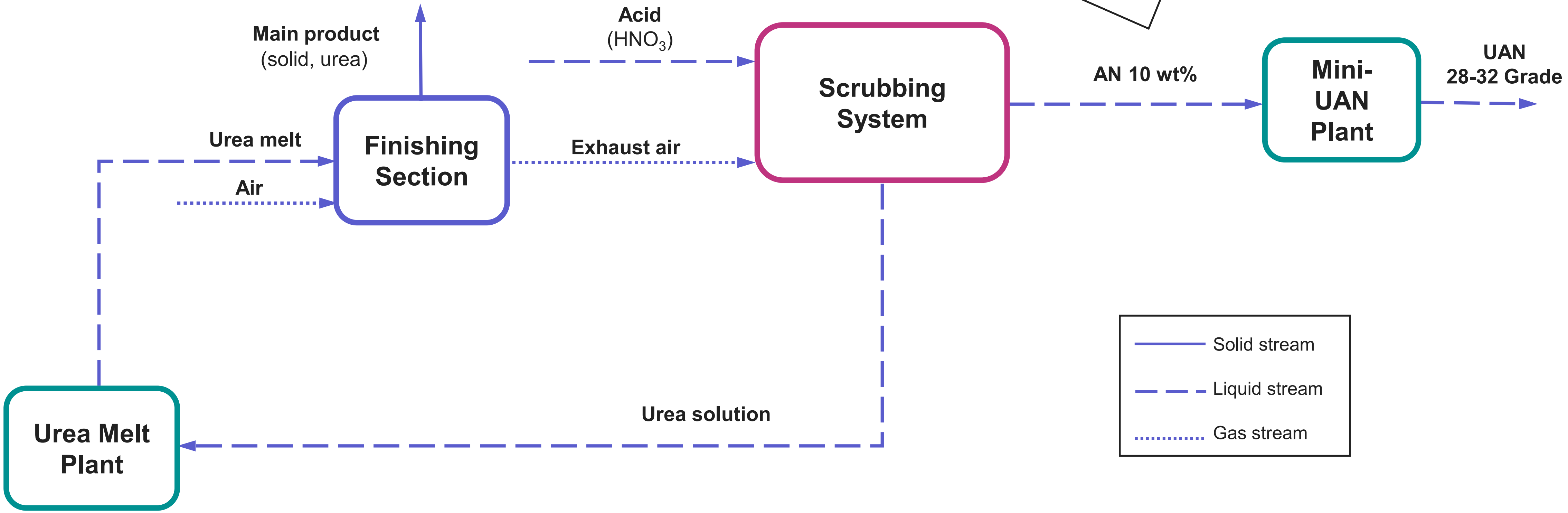
MMV TECHNOLOGY

SALT REWORKING OPTIONS

Ammonium Nitrate Handling: Options include sending ammonium nitrate to OSBL or converting it into UAN, a valuable liquid fertilizer for enhanced plant nutrition.

Process Integration Benefits: Salt reworking strategies minimize waste, improve process integration, and create additional revenue streams through fertilizer production.

UAN



MMV TECHNOLOGY

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REAL-WORLD EXPERIENCE

Successful Global Implementation: MMV scrubbers have been effectively deployed in numerous plants worldwide, proving their operational reliability.

- 2 plants in the United States
- 3 plants in Russia

Reference plant – Dakota Gasification Company:

- Second operational MMV scrubber installed
- Smooth operation, reaching 115% short-term and 105% sustained design capacity without emission impact
- Fabricated in eight modular sections for easy transport and installation
- Future expansion, such as the addition of venturi tubes is possible

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FROM MMV TO JET VENTURI SCRUBBERS

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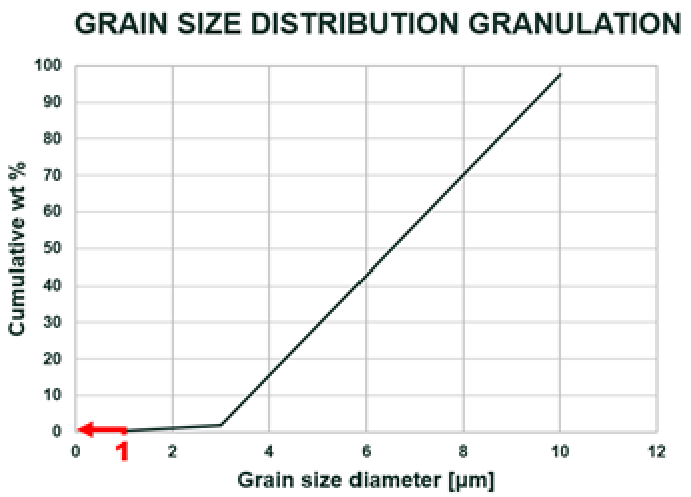
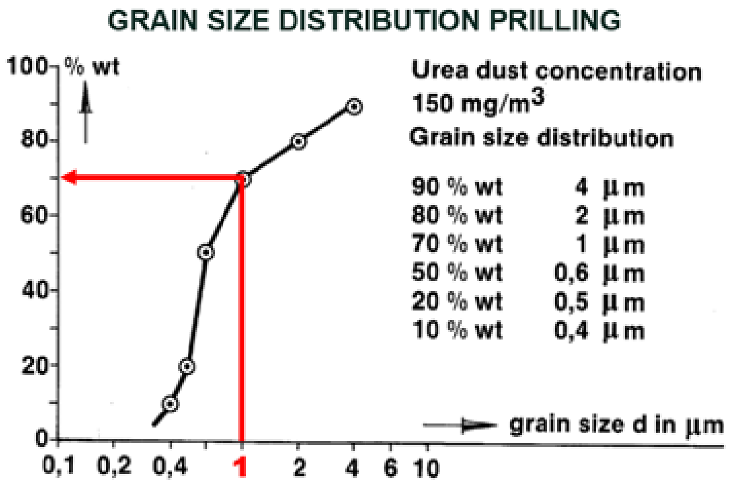
KEY FEATURES

- Proven venturi design for granulation plants adapted for prilling plants accordingly
- High efficiency collection for sub-micron dust
- Applicable for forced and natural draft prilling towers
- Installation at grade level and on top of the prilling tower
- Low pressure drop (in some cases additional fan installation is not required)
- Possibility to include ammonia abatement
- Implementation at grass root and existing prilling towers





FROM MMV TO JET VENTURI SCRUBBERS

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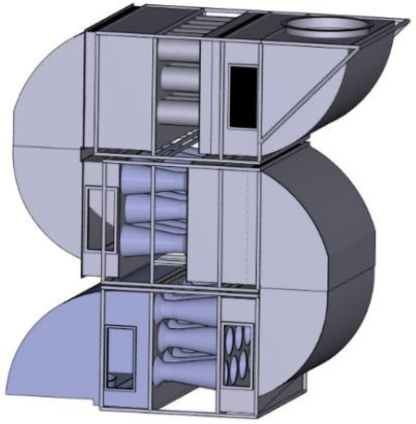
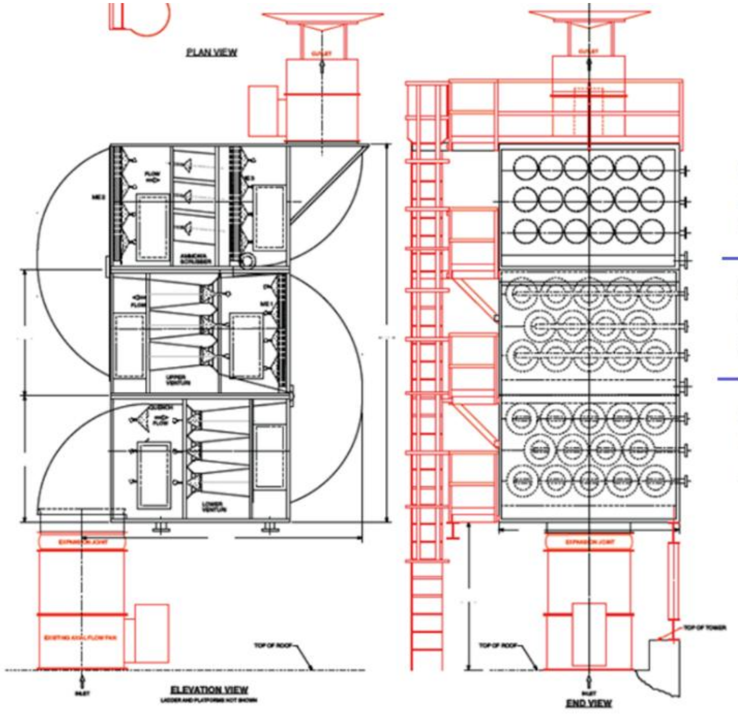
DESIGN AND ADAPTATION

- **Multi-Stage Dust Removal**: The system uses quench and primary Jet Venturi stages to effectively remove coarse dust particles from emissions.
- **Fine Particulate Capture**: Secondary Jet Venturi stages capture fine particulate matter ensuring cleaner emissions from prilling towers.
- **Ammonia Removal and Stability**: Acidic scrubbing stages remove ammonia, while mist eliminators ensure droplet removal and stable operation.
- **Flexible and Efficient Design**: Design supports both natural and forced draft prilling towers, offering installation flexibility and energy efficiency.





Stage 3: Acidic scrubbing for ammonia capture

Stage 2: Secondary Jet Venturi dust scrubbing

Stage 1: Quench and Primary Jet Venturi dust scrubbing

FROM MMV TO JET VENTURI SCRUBBERS

IN-FIELD PILOT TESTING

- **Effective Dust Emission Control**: The two-stage Jet Venturi Scrubber consistently reduced dust emissions below 15 mg/Nm³, meeting EU standards.
- **Ammonia Reduction Performance**: With an addition of acid, it is expected to achieve 20 – 30 mg/Nm3 ammonia emissions.
- **Demister**: Chevron-type demisters provided optimal performance.
- **PSD Analysis**: Particle size distribution analysis ~20 wt% <1 μm, but design must accommodate up to 70 wt% fines in worst-case scenarios.

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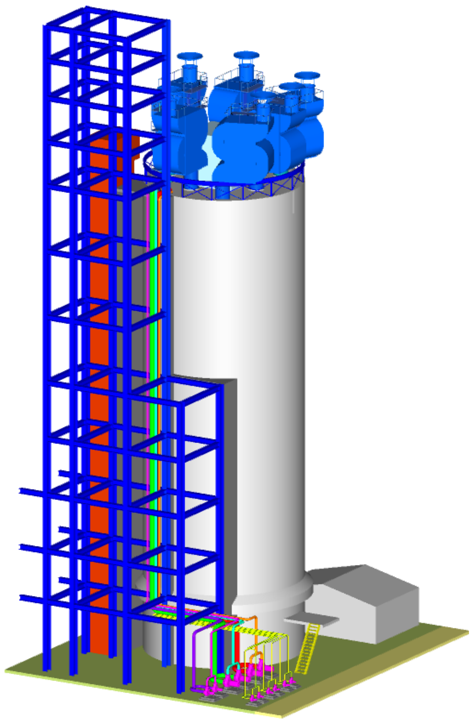
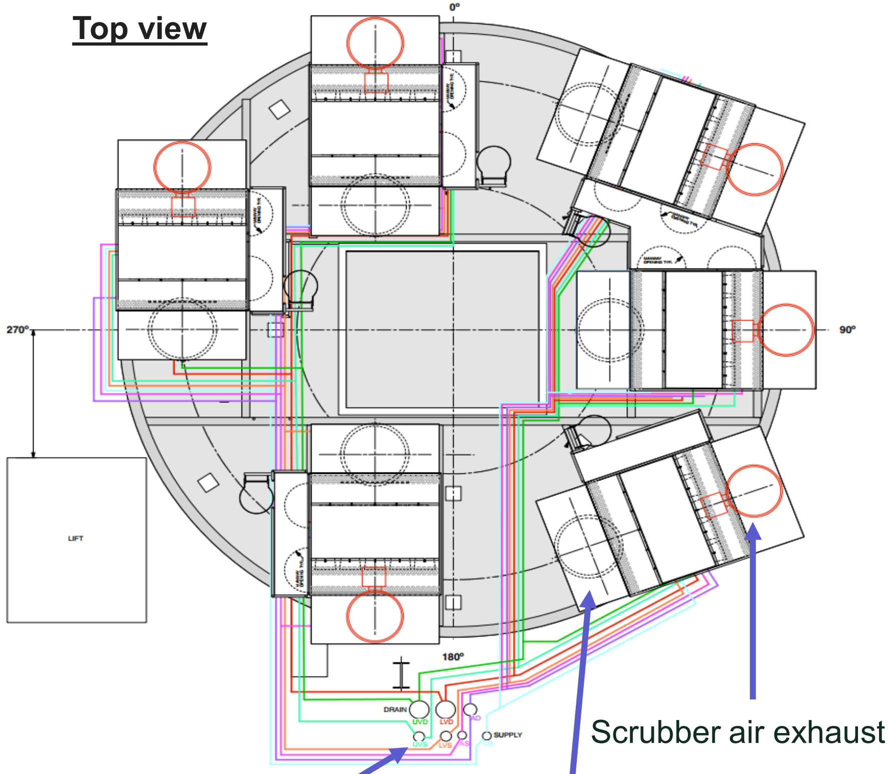
FLEXIBLE INSTALLATION CONFIGURATIONS

JET VENTURI SCRUBBER ON TOP OF THE PRILLING TOWER



Top view



Design optimizations:

- Weight reduction (pumps, hold-up volumes)
- Common pumps
- Power consumption

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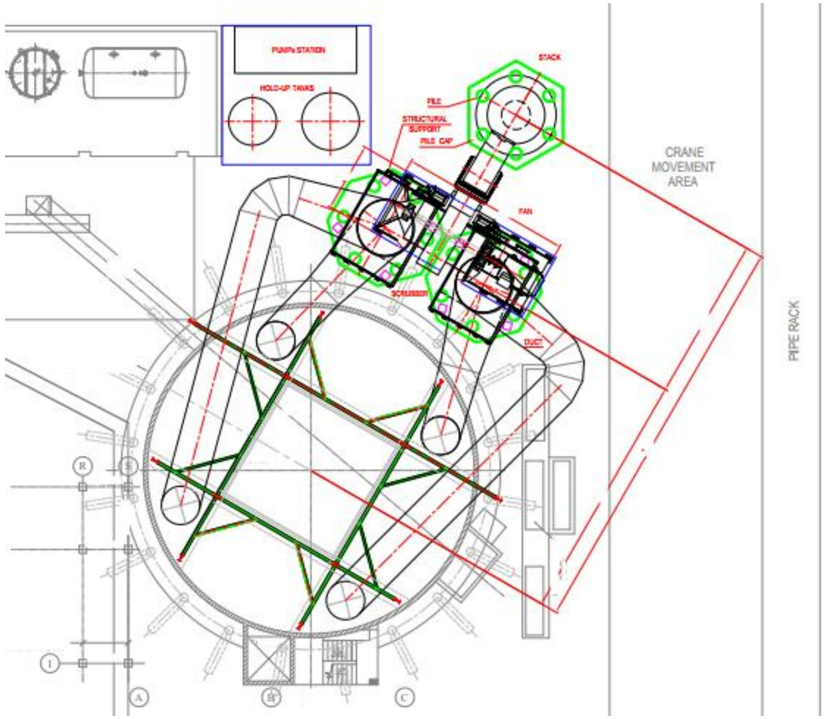
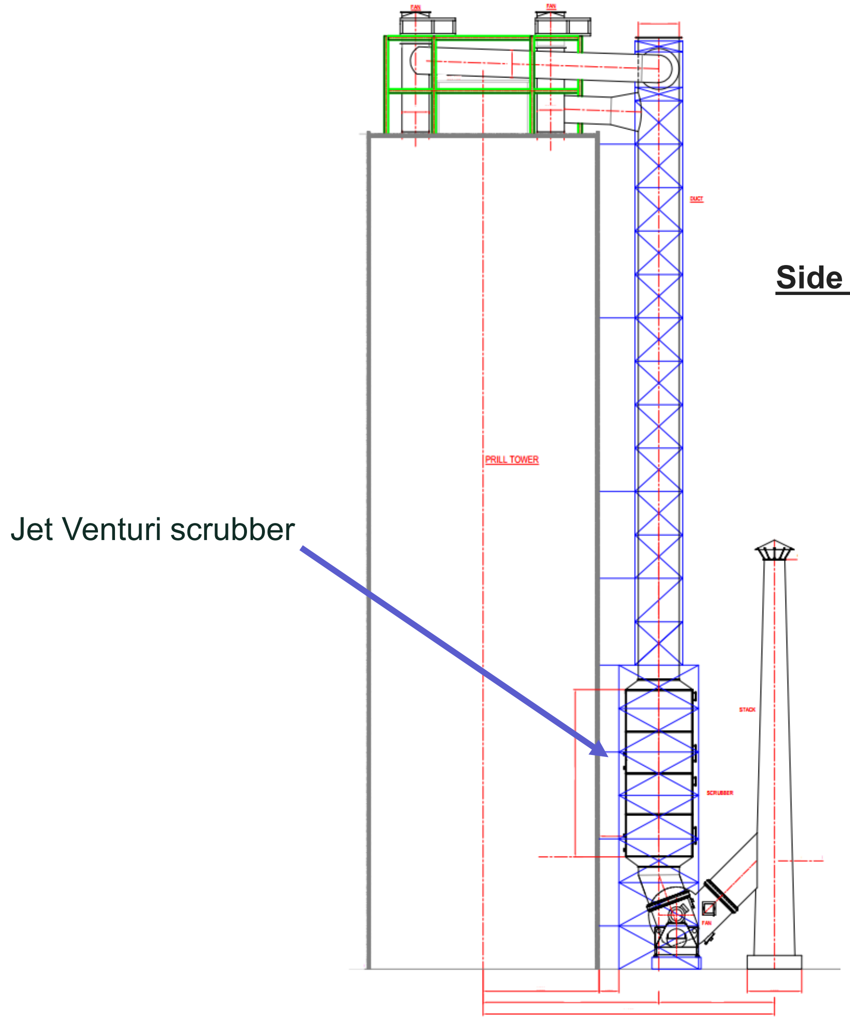
FLEXIBLE INSTALLATION CONFIGURATIONS

JET VENTURI SCRUBBER AT GRADE LEVEL OF THE PRILLING TOWER

Top view



Side view



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EMISSION MEASUREMENT STANDARDS

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METHODS AND PRACTICAL CHALLENGES

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REGULATORY MEASUREMENT METHODS
(What regulators measure?)

- **EPA Method 5**: filterable particulate matter measured at stack conditions.
- **EPA Method 202**: condensable particulate matter measured after gas cooling.
- **EPA Method 9**: visual determination of emission opacity.

PRACTICAL CHALLENGES
(What plants see day-to-day?)

- Optical dust monitors operate at high stack temperature.
- Condensable particulates remain in vapor phase and are not detected.
- Total particulate emissions may therefore be underreported.

Emission compliance is increasingly driven by measurement methodology, not only by scrubber performance

EMISSION MEASUREMENT STANDARDS:

MMV + WESP: COMPREHENSIVE SOLUTION

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- **EFFECTIVE PARTICULATE REMOVAL**: The combined MMV and WESP system efficiently removes submicron particulates and condensables from emissions.
- **REGULATORY COMPLIANCE**: The integrated solution ensures compliance with the very strict environmental standards and regulatory requirements.
- **ZERO EMISSION OPACITY**: Achieves 0% opacity in emissions, enhancing confidence in emission reporting and operational reliability.

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CONCLUSION

CONCLUSION & KEY TAKEAWAYS

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- **High Efficiency and Modularity**: MMV and Jet Venturi Scrubbers provide high efficiency and modular designs suitable for new and retrofit installations.
- **WESP for Stringent Standards**: WESP functions as an accessory to help meet the most stringent environmental and operational standards effectively.
- **Compliance and Reliability**: These technologies ensure regulatory compliance, reliable operation, and adaptability to future environmental regulations.
- **Modular Design Benefits:** Modular design facilitates easy transportation, assembly, and system upgrades, enhancing operational flexibility and efficiency.
- **Venturi Tube Flexibility:** Venturi tubes can be added or removed to adjust air flow without reducing overall system performance.
- **Minimal Maintenance Needs:** The system requires minimal routine maintenance, reducing downtime and operational costs.

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THANK YOU

QUESTIONS?