

# Long-Term Prevention of Second-Stage Evaporator Fouling

Operational Case Study – Urea Plant,  
Vacuum Section

**Presenter:** Syed Munawar Zaman

**Designation:** Operation Manager Urea





## Syed Munawar Zaman

Operation Manager, Urea Plant

 **19 Years Experience**

 **Joined in 2007**

## Key Achievements



Presented research paper at Nitrogen Conference



SME in Process Safety Management



Authored catastrophic incident analysis



Multiple plant operational experience

**Education:** Chemical Engineer

**Expertise:** Urea Plant Operations, Process Safety Management

## Career Timeline

**2007**

Joined Fatima Group as Operations Engineer

**2010**

Commissioned Stamicarbon Pool Reactor Urea Plant

**2015**

Promoted to Senior Operations Engineer

**2020**

Appointed as Operation Manager, Urea Plant

## Key Expertise Areas



Urea Plant Engineering



Stamicarbon Technology



Commissioning



HAZOP Studies



Process Safety



Technical Research & Documentation



## Fatima Fertilizer Company Limited

Leading fertilizer manufacturer in Pakistan

A fully integrated Greenfield fertilizer complex producing both intermediate and final products,

**Urea Plant:** Stamicarbon Pool Reactor technology with a capacity of 1,500 MTPD



2010

Commissioned



1,500

MTPD Urea



500+

Employees



## Technology

Stamicarbon 2000+



Pool Reactor Technology



Engineering by Kawasaki

Japan



Capacity

1,500 MTPD



Status

Operational



## Products Portfolio



**Ammonia/Nitric Acid**  
Intermediate



**Urea**  
Final Product







**CAN**  
Final Product



**NP**  
Final Product





- 1 How and What Happened?**   
Operational case study from a STAMI-design Urea plant focusing on Second-stage evaporator fouling
- 2 What was the Root Cause?**   
Analysis of the underlying causes leading to the vacuum section fouling incident
- 3 Corrective & Preventive Actions**   
Implementation of operational changes and preventive measures
- 4 How Changes Were Validated?**   
Results and validation of implemented changes





# UREA PLANT PROCESS OVERVIEW

Fatima Group



## Process Flow: 32% to 99.1% Urea Concentration

Complete production process from pool reactor to prilling tower



### Concentration Process

32% urea solution produced in Pool Reactor

Initial concentration in reactor

### HP/LP Concentration

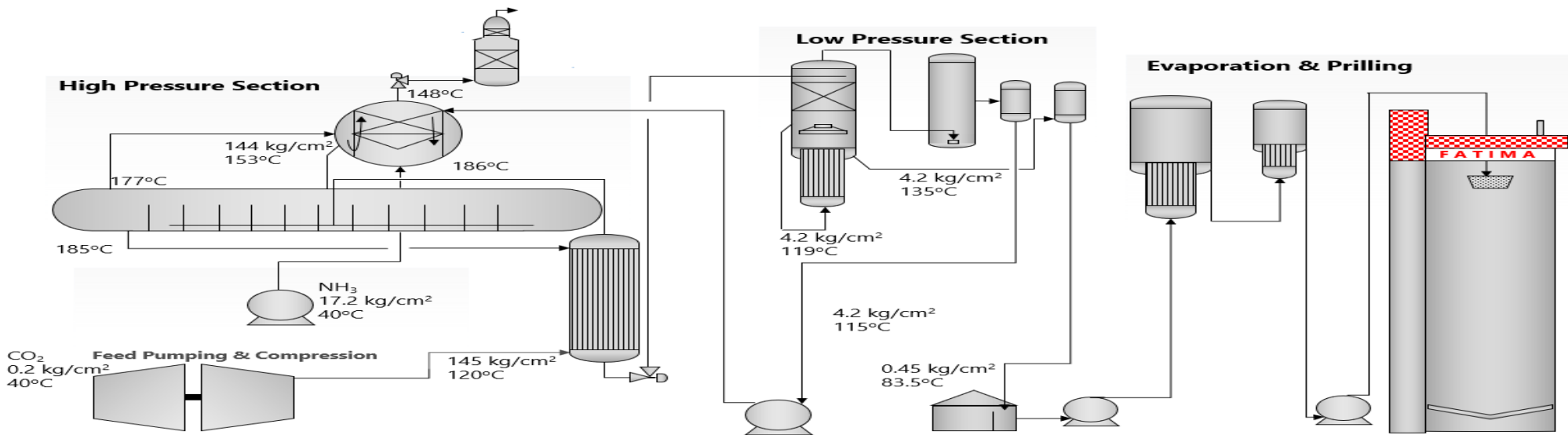
Concentrated to 72% in HP and LP sections

Intermediate storage capacity: 930m<sup>3</sup>

### Final Concentration

Achieved 99.1% concentration

Ready for prilling

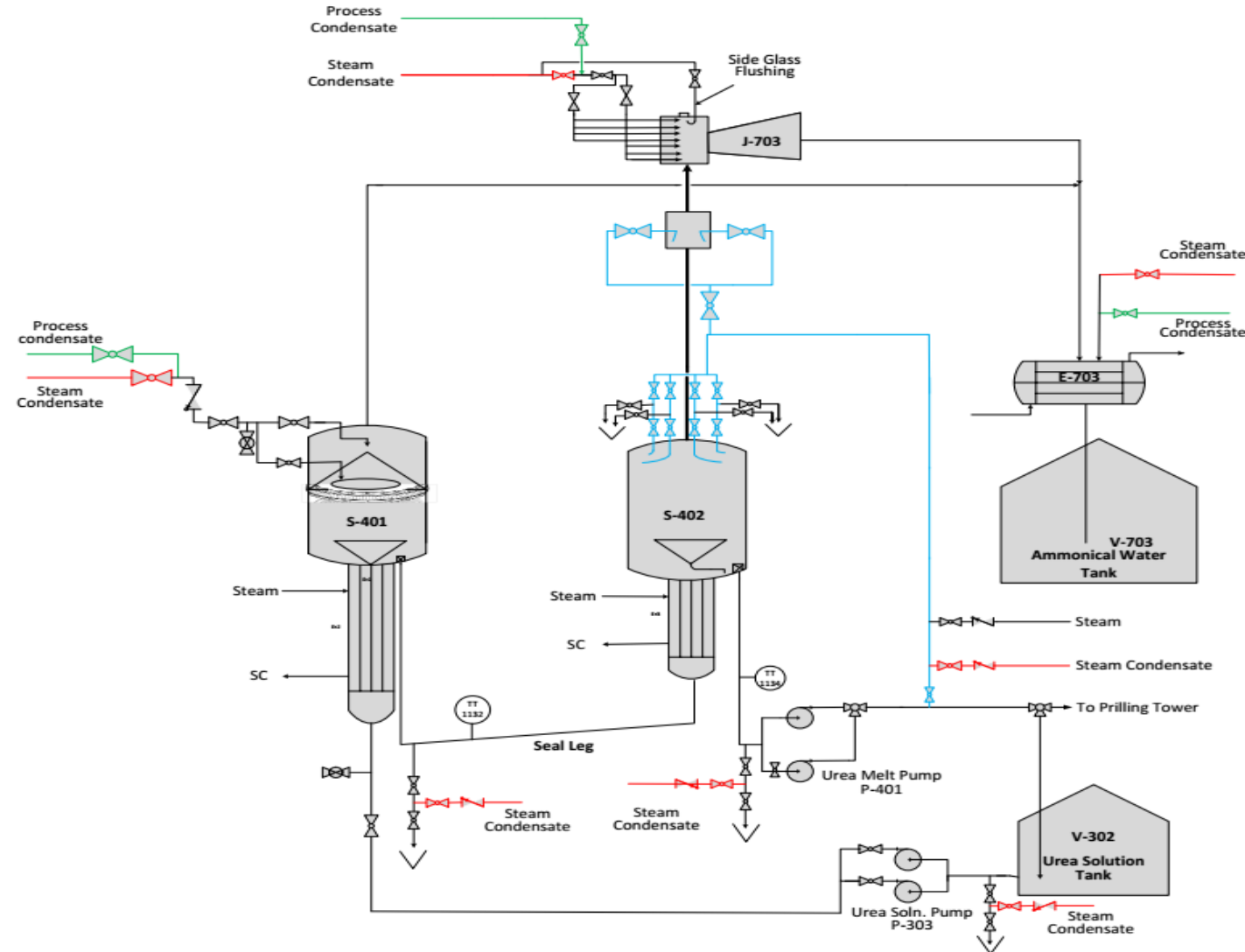


# VACUUM SECTION OVERVIEW AND OPERATIONAL MANAGEMENT

Every 8 hour SC flushing on Red highlighted points for 3-5 mints.

Process condensate flushing remain open on Green highlighted points every time.

As Blue highlighted Urea Melt flushing of second stage separator and vapor line is done for 1.5 hours every Monday.





# PLANT SHUTDOWN

Fatima Group

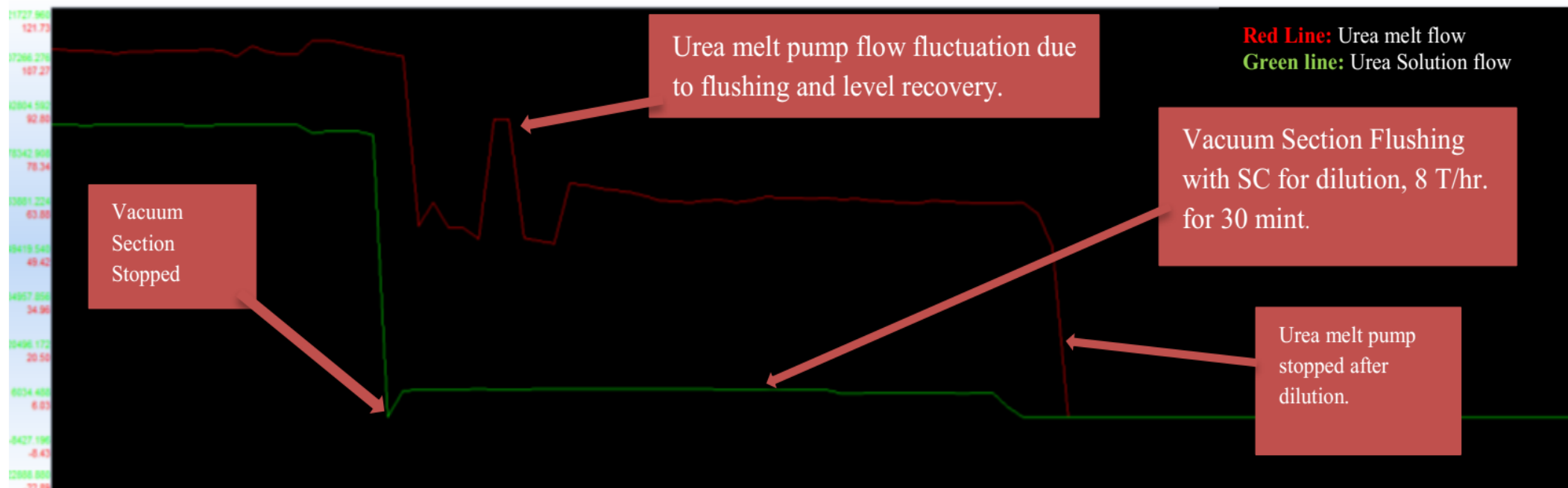
- On 03 April 2024, the urea plant was shut down due to an unplanned outage of the ammonia plant.



- As per the shutdown procedure, extensive flushing with steam condensate was carried out in the vacuum section.



- Following flushing and dilution, the urea melt pump was stopped, and the system was fully drained.





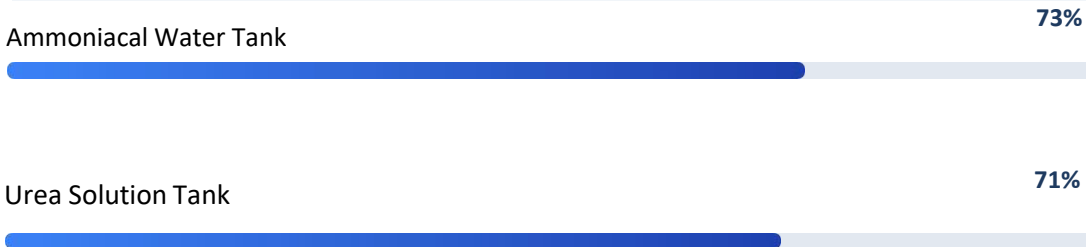
## Timeline of Events

- **15:30 hrs.**  
On 4th April, 2024 Urea Plant startup was initiated.
- **19:20 hrs**  
At 1920 hrs. when vacuum section started then no flow was observed towards second stage of Vacuum section.
- **20:10-02:30 hrs.**  
Temperature of first stage discharge kept on decreasing indicating no flow between first and second stage.  
Several Attempts were made, Still now flow.
- **02:30 hrs. 5<sup>th</sup> April, 2024**  
Eventually Plant was stopped as levels in Urea Solution tank (V302) and Ammoniacal water tanks (V-703) increased above 70%.

Plant Stop



## System Status





# INCIDENT MANAGEMENT- PART 1 (DIAGNOSIS)



## Initial Diagnosis & Troubleshooting

Systematic approach to identify the root cause of vacuum section flow blockage

### 1 Seal Leg Dismantling

First step was to dismantle the seal leg between first and second stage to check for blockages.

❗ Found badly choked

### 2 De-choking Attempt

Line was de-choked and reinstalled. Restart attempted but still no flow observed.

✅ Line cleared

### 3 Manway Inspection

Decided to open manways of both stages for direct visual inspection. Results showed:

First Stage Status

✓ Clear - Normal flow confirmed

Second Stage Status

✗ Heavily choked

Entrance Blockage

⚠ Large lump observed

Flow Status

⊘ No flow detected



Figure 1 As found condition of S-401 (Clean)



Figure 2: As found S-402 (heavily choked)



# INCIDENT MANAGEMENT - PART 2 (RECOVERY)

Fatima Group

## 1 Blockage Identification

Identified observed blocking entrance from 2nd-stage evaporator to separator after clearing manway.

× **Critical Blockage**

## Flushing Attempts

Opened flushing from every possible location to break the lump but of no use.

30% effective



## 2 Pressure Application & Passage Formation

### Formation

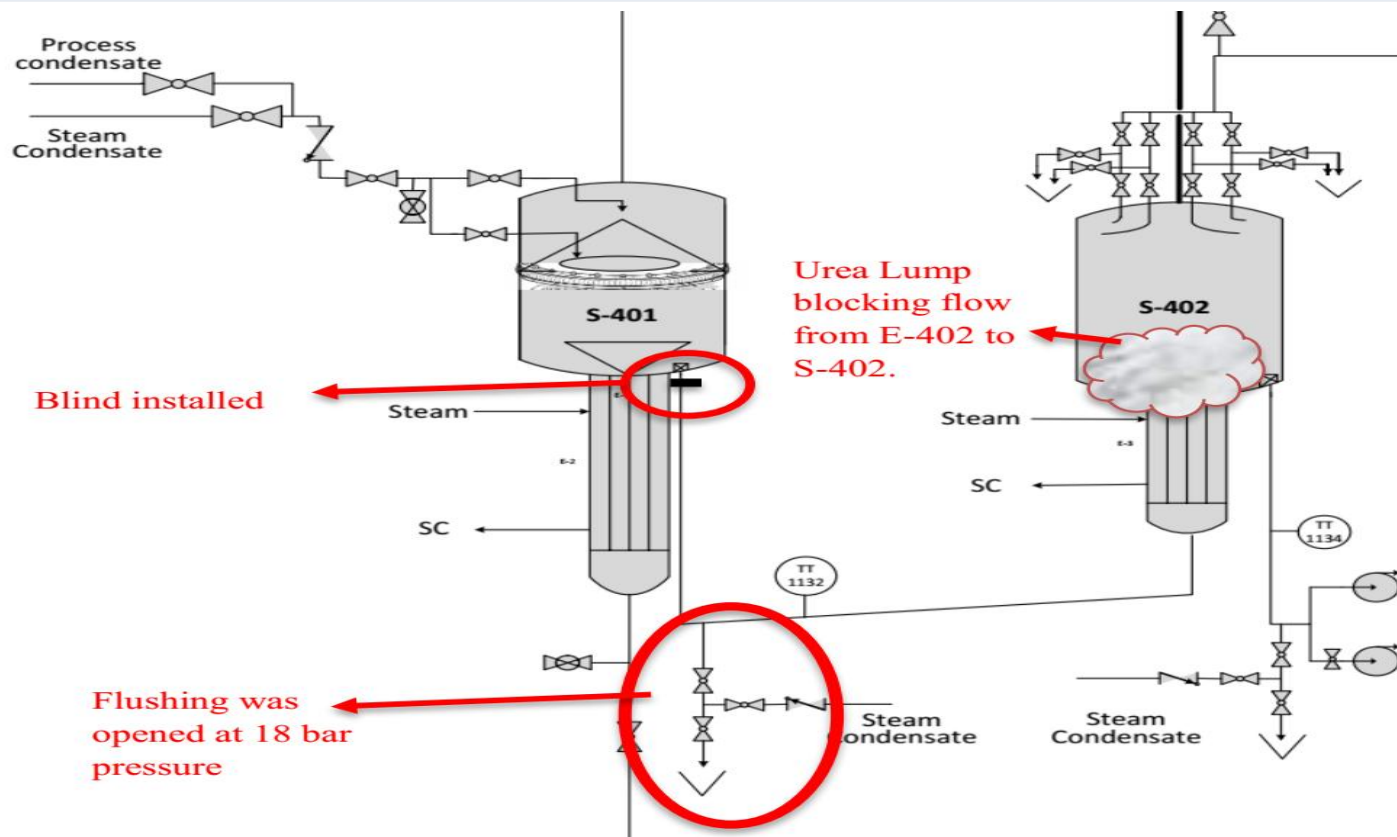
Applied 18 bar SC flushing via seal leg between first and second stage to build pressure:

Pressure Applied  
**18 bar SC**

Flushing Type  
**Steam Condensate**

Duration  
**Multiple attempts**

✓ After multiple attempts, passage developed through lump and positive flow ensured



# ROOT CAUSE ANALYSIS - 5 KEY FINDINGS



## Investigation Summary

Systematic analysis of vacuum section choking incident reveals 5 critical findings

**Critical Issues Found**



01

### STAMI Design Philosophy

Stamicarbon design relies on periodic urea melt flushing in 2nd stage to dissolve biuret and polyurea deposits.

✓ **Design Valid**



02

### Melt Flushing Discontinuation

Melt flushing was gradually discontinued after switch to vibro-priller due to carryover lumps.

✗ **Critical Issue**



03

### SC Flushing Reduction

Routine steam condensate flushing duration reduced due to temperature reduction concerns.

! **Warning**



04

### Deposit Accumulation

Progressive accumulation of heavy deposits within S-402 due to insufficient flushing.

✗ **Critical**



05

### Missed Inspections

Vacuum section internal inspections were missed post-2021, delaying deposit detection.

⏸ **Delayed Detection**

## Root Cause Chain



Melt Flushing Stopped



Deposit Buildup



Choking Incident

## Corrective Actions



Reinstate Flushing






Regular Inspections






Prevention

## REVISED PROCEDURES AND OPERATIONAL CONTROLS TO PREVENT RECURRENCE OF VACUUM SECTION FOULING




### Operating Procedures Revised

-  **Reinstated flushing requirements** during normal operation, shutdown, and start-up sequences
-  **Incorporated flushing activities** into operator and Boardman checklists for consistent execution
-  **Added accountability measures** to ensure compliance with flushing schedules



### Vibro-Priller Switchover

-  **Switch to conventional bucket** during melt flushing to avoid mesh choking
-  **Prevent overflow issues** and maintain product quality
-  **Resume vibro-priller** after flushing completion

### Operational Controls

-  **Conduct melt flushing** only under stable operating conditions
-  **Expect short-term fluctuations** in urea melt pump load during flushing
-  **Monitor product quality** during and after flushing operations

### Outcome Focus

-  **Preserve long-term cleanliness** without compromising operability
-  **Achieve sustained operation** with minimal life cycle maintenance



- Following implementation of the revised flushing regime, the urea plant operated continuously for approximately 1.5 years without recurrence of vacuum section choking or abnormal pressure drop trends. No unplanned outages related to vacuum section fouling were recorded during this period.
- During a planned outage in November 2025, S-402 was opened for internal inspection.
- Figure 4 shows as found condition of S-402 after 1.5 years operation, with flushing practices
- Contrary to typical findings of heavy lumps in second stage separators in Urea Plants, the separator was found completely clean and free from urea or poly-urea deposits. No mechanical cleaning was required, providing direct physical validation of melt flushing and routine flushing effectiveness as intended in Stamicarbon design



**Figure 4 As found condition of S-402 after 1.5 years operation, with flushing practices**



## Lessons Learned for Sustained Reliability

Three critical insights from the April 2024 vacuum section choking incident

 **Validated**

### Procedural Deviation

The April 2024 choking event stemmed from **long-term procedural deviation** rather than inherent equipment design limitations

**Root Cause**  
Gradual discontinuation of melt flushing after vibro-priller installation

- ✗ Not equipment failure
- 📄 Process deviation

### Disciplined Flushing

By **reinstating and properly managing** urea melt flushing and steam condensate flushing, chronic fouling was eliminated.

**Implementation**  
Controlled melt flushing during stable operation

- ✓ 1.5 years no fouling
- 💧 Regular SC flushing

### Governance Essential

**Governance** (procedures, checklists, periodic inspection) is essential to maintain vacuum-section integrity.

**Key Action**  
Incorporate flushing into operator checklists

- 📄 Regular inspections
- 👤 Accountability



# Thank You for Your Attention

Presentation on Long-Term Prevention of Second-Stage Evaporator Fouling



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