MITIGATION SOLUTIONS TO HIGH AMINE EMISSIONS DUE TO AEROSOLS AND PARTICULATES CONTAINED IN OIL REFINERY FLUE GASES

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Introduction

- Particle/aerosol-rich flue gas as RFCC flue gas
- CO_2 capture amine plant
- Acceptable amine emissions and solvent losses
- Mitigation measures
- Pre-treatment technology

Content

1. 2015 test results on diluted RFCC flue gas
2. Maximum acceptable particle / aerosol concentration for operation with MEA
3. New Brownian Diffusion filter installed on RFCC flue gas (description and performance test results)
4. On-going aerosol test campaign on RFCC flue gas with MEA

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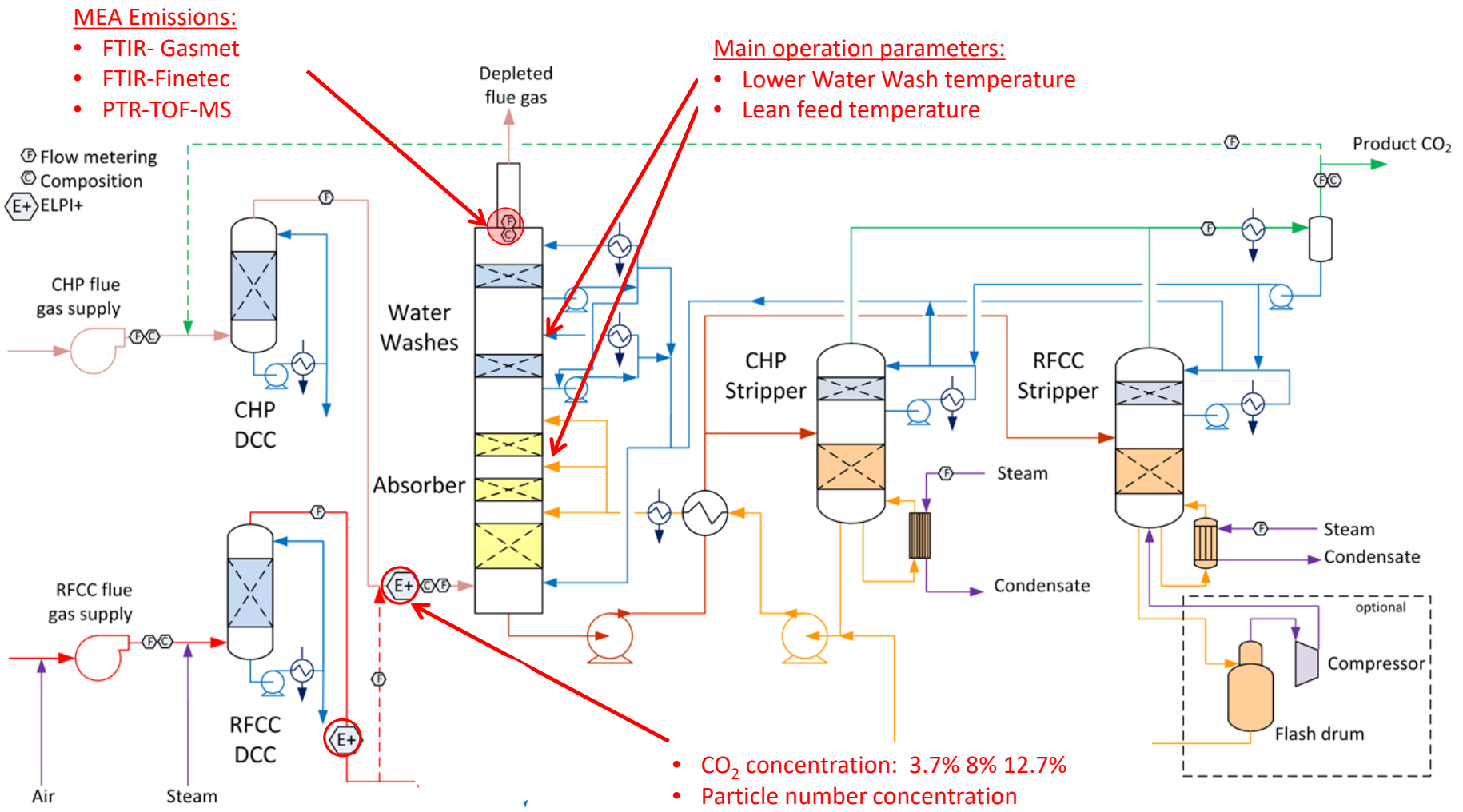
Findings from the aerosols tests carried out in 2015 on diluted RFCC flue gas with MEA

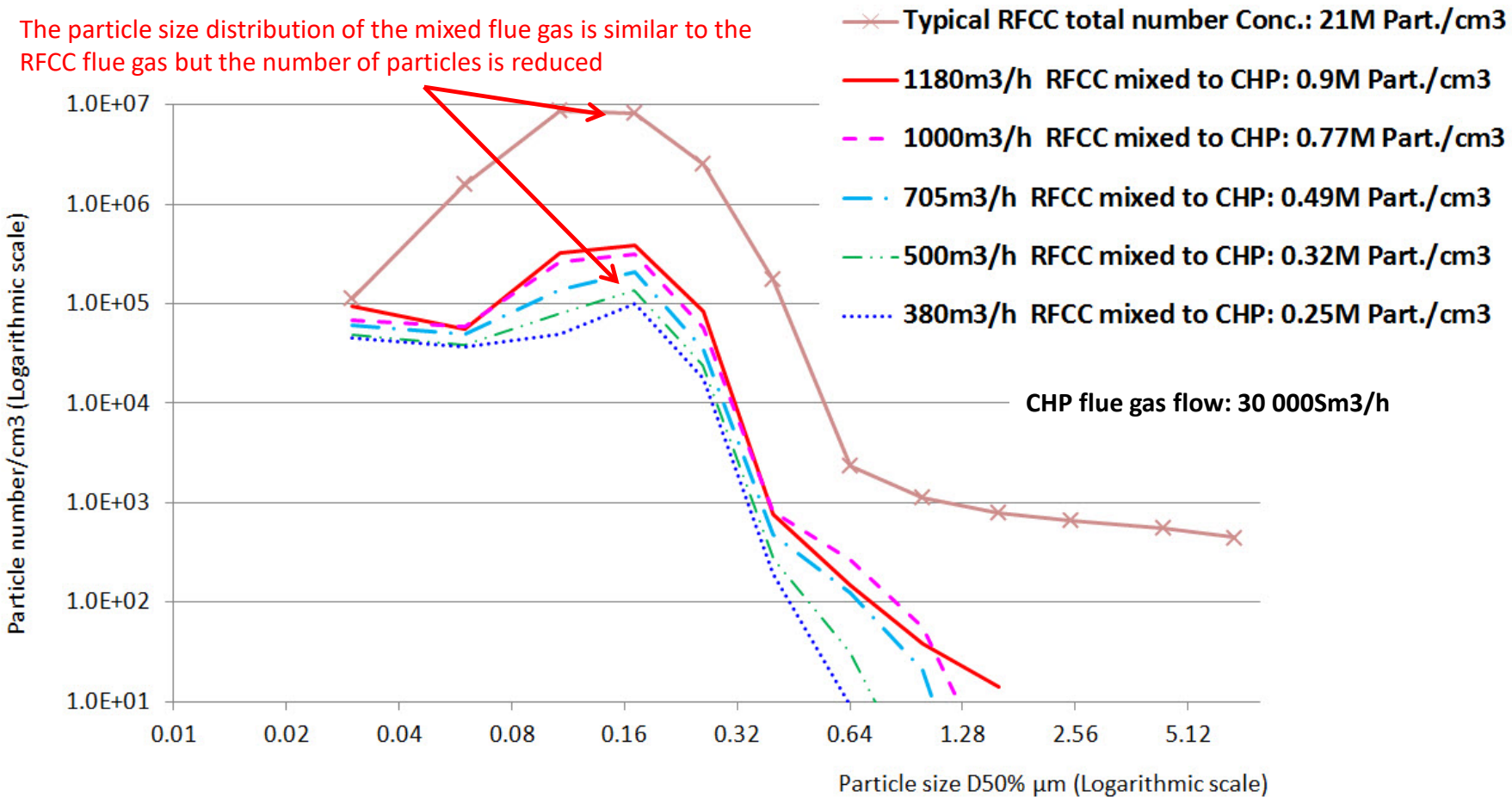
Amine plant overview and test flow diagram



Electrical Low pressure Impactor

Inlet particle size distribution to the absorber measured by ELPI+

The particle size distribution of the mixed flue gas is similar to the RFCC flue gas but the number of particles is reduced



Findings:

- Higher aerosol / particle concentration results in higher MEA emissions (from 1 to 25 ppmv)
- Higher CO_2 concentration in flue gas results in lower MEA emissions (e.g. from 25 to 5 ppmv)
- Higher lean amine temperature results in lower MEA emissions (between 30 and 50%)
- Higher water wash temperature results in lower MEA emissions (half)

2 Maximum acceptable particle / aerosol concentration for operation with MEA

Findings:

- MEA emissions acceptable with max. 500 000 particles/cm^3
- And adequate control of the lean amine temperature and the water wash temperature.
- MEA emissions due to flue gas aerosols are predictable

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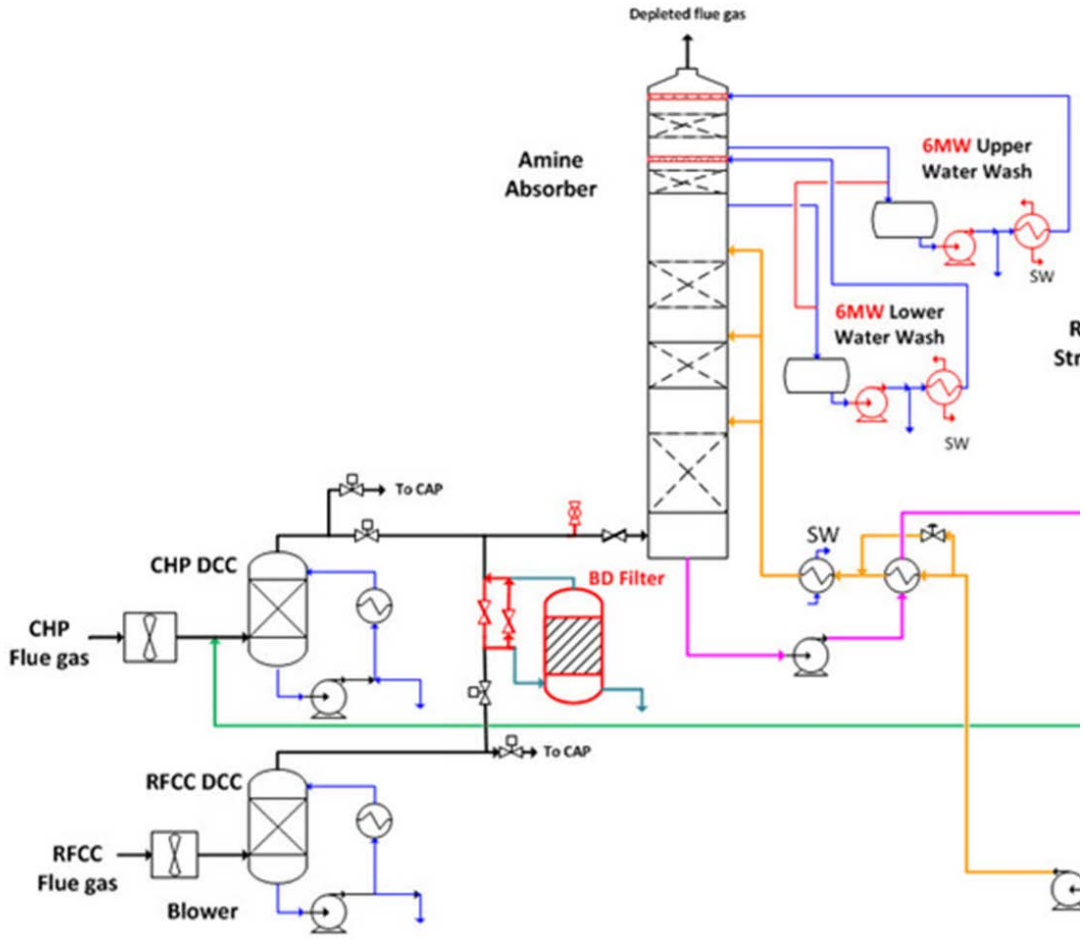
New Brownian Diffusion filter installed on RFCC flue gas (description and performance test results)

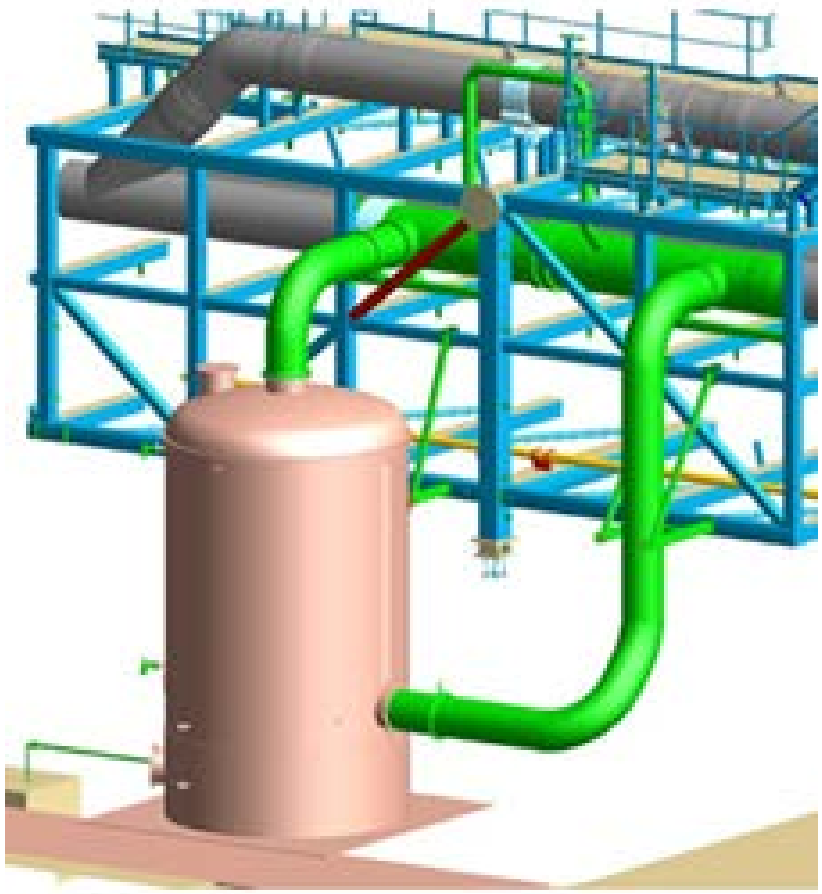
- To prevent too high solvent losses, emissions of amines and degradation products
- Removal of particles / aerosols from RFCC flue gas.
- Evaluation of various technologies and test of a pilot Brownian Diffusion (BD) filter done at TCM in 2015 validated this technology for test purpose(removal efficiency and dP).
- A 35000Sm3/h Brownian Diffusion filter installed end of 2016 upstream amine plant absorber
- A by-pass line around the BD filter enables testing at a wide range of particle concentrations
- Modification of absorber water wash sections for capacity increase

Process Flow Diagram



Description

- Brownian diffusion type glass fibre candle filters for removal of aerosols.
- Candles lifespan 4 years.
- 8 cm/s apparent velocity.
- Specific demister below (upstream) for removal of flue ash.



Performance test results:

- 7 weeks test at design flow rate
- Higher particles / aerosols removal efficiency than design: > 98% for a broad range of particle size (0.01 – 10 µm)
  - Inlet: 15 – 30 10^6 particles / Ncm^3
  - Outlet: < 0.25 10^6 particles / Ncm^3
- Pressure drop below 20 mbar at design flow rate and particles / aerosols composition

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On-going aerosol test campaign on RFCC flue gas with MEA – part of AeroSolve project funded by the Norwegian CLIMIT program

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Objectives of AeroSolve project

- Obtain a deeper understanding of phenomena that lead to amine emissions by mist
- Establish criteria for effective control of flue gas mist composition via combinations of WESP, BDU and Sulphur pre-scrubbing prior to amine absorption
- Develop methodologies for mist quantification, monitoring and characterization
- Test effects of operating conditions, pre-treatment options and mist reducing technologies under full-scale plant operation conditions
- Establish knowledge to allow the techno-economic optimisation of aerosol control at industrial scale.

Concluding Remarks

- Better understanding of amine emissions by aerosols.
- Tested effects of operating conditions on aerosols growth and resulting amine emissions.
- Tested efficiency and capacity of Brownian Diffusion filtration technology as a pre-treatment solution for the RFCC flue gas.
- Testing proprietary amines on RFCC flue gas at TCM is possible.
- On-going test with research and industrial partners to establish deeper knowledge on how to control amine emissions in a cost effective way.

Thank you for your attention!!!

Acknowledgments to TCM DA owners