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TOTAL

Practical Techniques for Operating Carbon Capture Systems

Lessons Learned from Operating the Amine Plant at TCM

Leila Faramarzi & Noëlie Constant

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Technology Centre Mongstad (TCM)

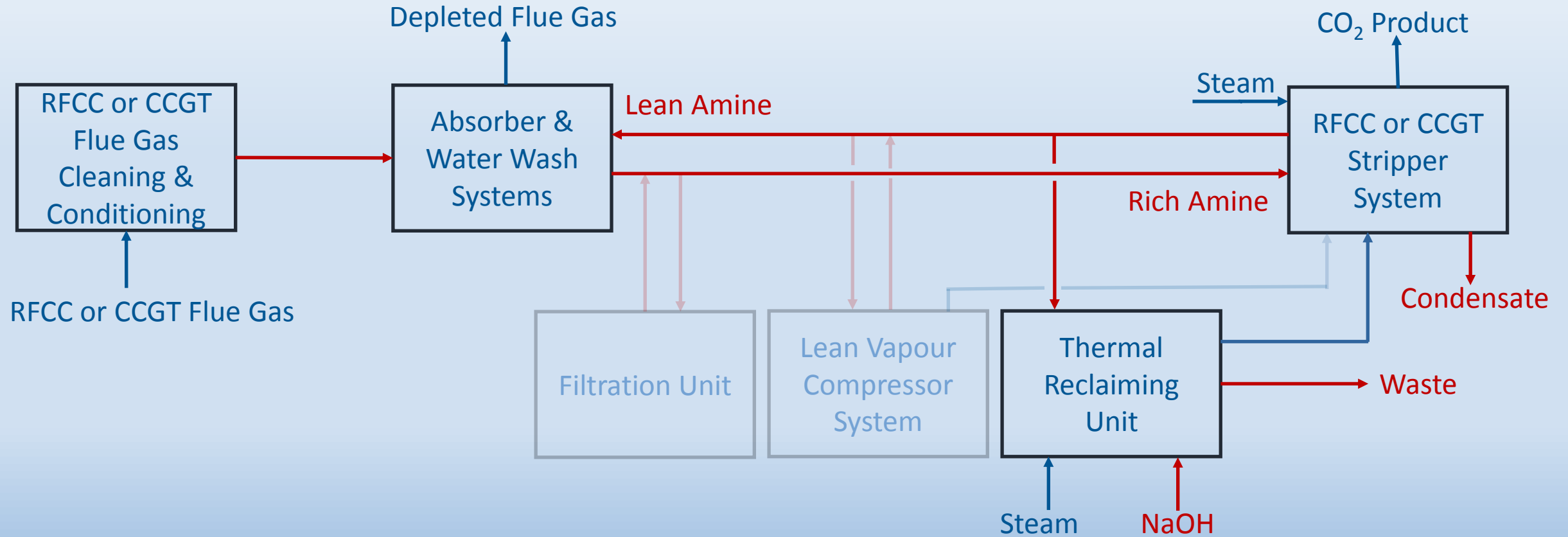


Amine Tower

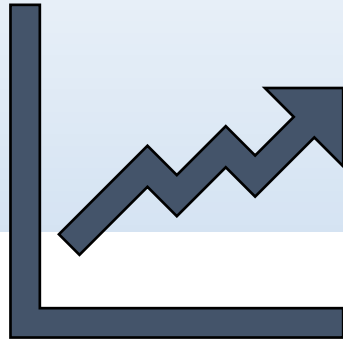
RFCC Flue Gas

CCGT (CHP) Flue Gas

The Amine Unit at TCM

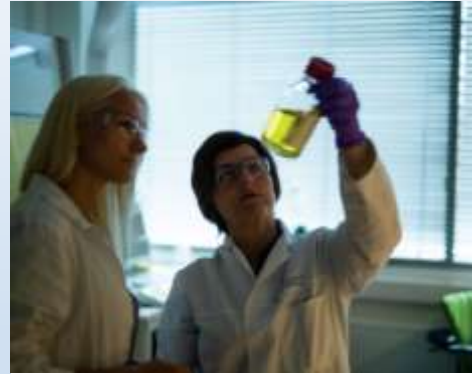


Amine Hygiene Saves You Millions



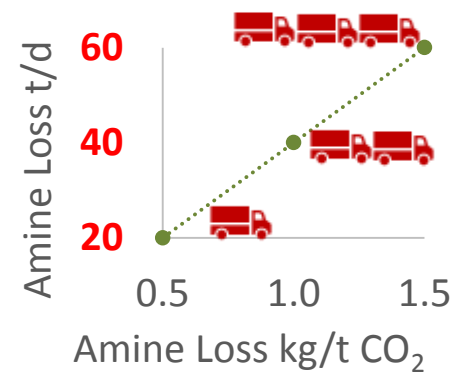
Process Performance

- Smooth operation
- Process reliability
- Plant availability
- Emission control
- Energy efficiency
- Capture capacity



Chemical Consumption

For 40 kt/d CO₂ Capture



Sustainability

- Emission of degradation products
- Liquid waste via reclaiming, bleed & feed etc.
- Use of surface wash chemicals



Asset Integrity

- Longer mechanical life
- Minimized corrosion
- Minimized fouling

Define Strategies to Maintain Solvent Hygiene

Disclaimer: The values are relevant to TCM & MEA. Projects at scale must define their specific thresholds.



OBSERVE

- Solvent colour
- Precipitation
- Local effects
- Pressure-drop in equipment
- Heat transfer efficiency
- Leakages (extreme case)

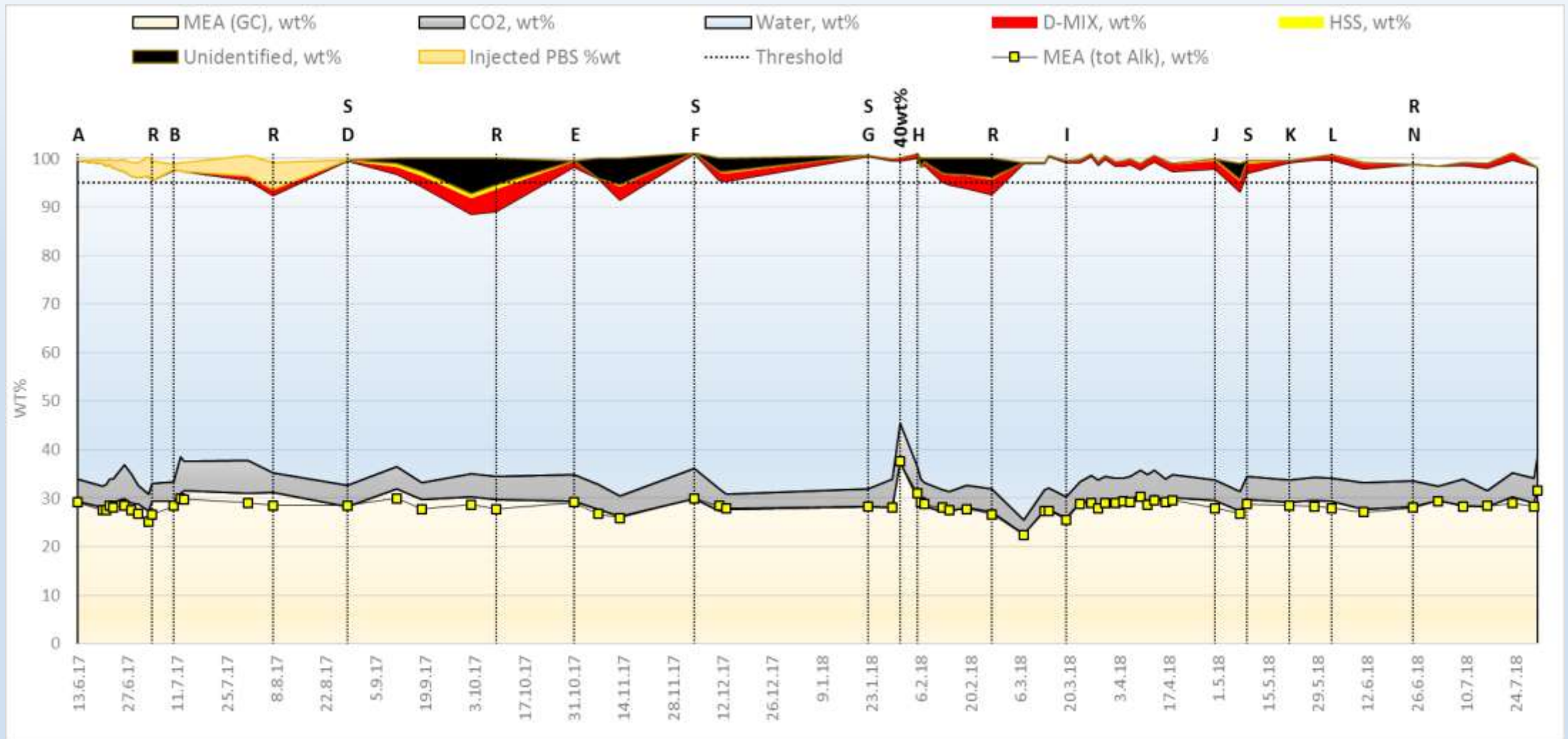
ANALYZE

- Total impurities < 5% wt
- HSS < 1.5% wt
- Metals < 5 ppm wt
- NH₃ emissions < 5 ppm wt
- Particles in solvent < 1 ppm

PREVENT

- Optimized design
- Flue gas conditioning
- Oxygen removal
- Solvent filtration
- Reclaim (Batch, Semi-batch or continuous)
- Bleed and Feed (extreme case)

Watch Your Amine Inventory Closely: Have Control!



Thermal Reclaimers Can Waste Good Amine

Table 2. Thermal Reclaimers Waste Good Amine

<u>Amine</u>	<u>System Free Amine/HSS mol/mol</u>	<u>Reclaimer Bottoms Free Amine/HSS mol/mol</u>
MEA		50
MEA		10
MEA	17	3
MEA		1
MEA	82	2
MEA		26
MEA	3	4
MEA	3	2
MEA	5	6
MEA	4	4
MEA	5	5
MEA	6	3
MEA	3	4
MEA	11	2
MEA	23	1
DGA	62	77
DGA	29	44

Yes! Our Red Cases Had 25-35% MEA Loss.

TCM MEA Campaigns 2015, 2017 & 2018	System Free MEA /HSS mol/mol	Reclaimer Bottoms Free MEA/HSS mol/mol
	24	1 ✓
	12	6
	38	14
	50	14
	69	5 ✓

Cummings et al., Laurance Reid Conf., 2007.

Optimum Thermal Reclaiming: Fine Balance between Chemistry & Operation



Residence Time
Slip-Stream%



Pressure &
Temperature



Neutralizer



Bottoms
Viscosity

The Chemist and the Operator have to work close to find the right parameters for each specific system.

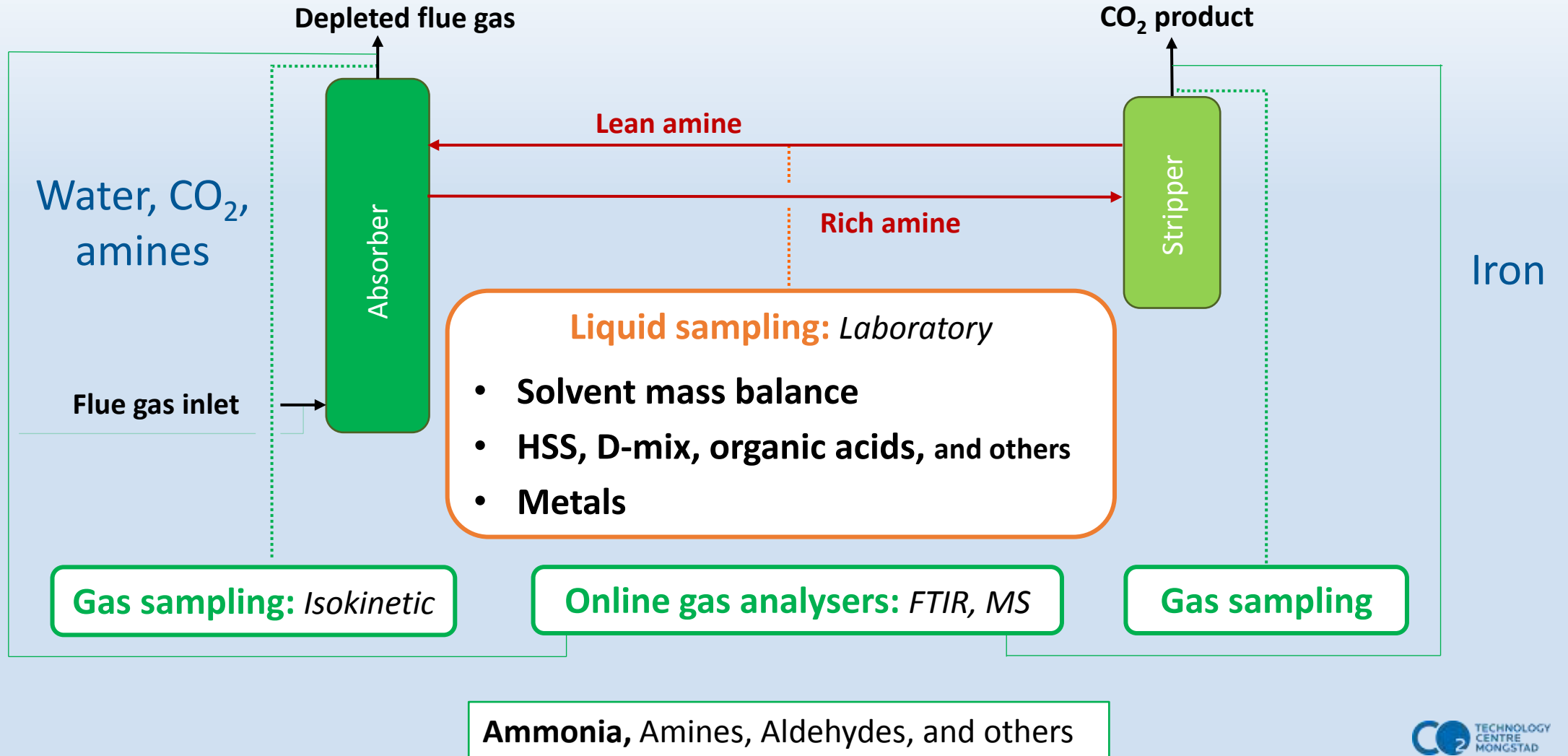
Long residence time	Short residence time
Risk of thermal degradation	Insufficient reclaiming

Insufficient or no salt neutralizer agent
<ul style="list-style-type: none"> Risk of vaporization of acids (e.g formic) to stripper Insufficient reclaiming

Too viscous bottoms	Adding water to lower viscosity
Challenge in waste disposal	Risk of dumping large amounts of good amine

Do Regular Analysis

Main components for solvent monitoring



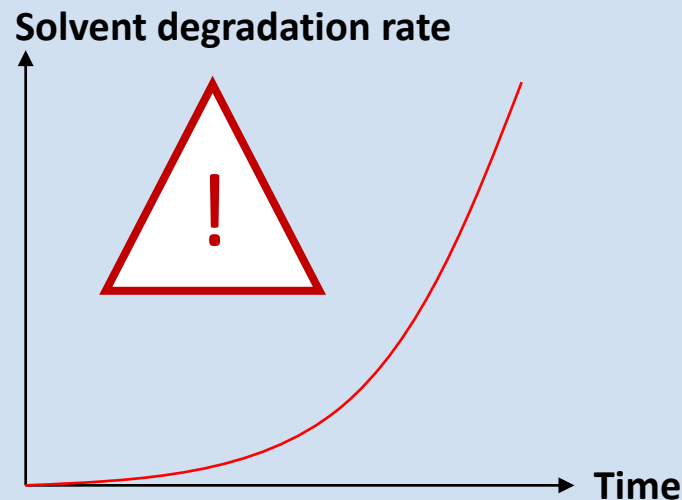
Do You See Symptoms of Solvent Contamination?

Change Your Analysis Routine

From a well established Laboratory schedule



Without actions:



To an increase in the analysis frequency

Do Rectifying Actions:

Last Resort to Maintain Performance and Integrity of the Plant

Actions depending on diagnosis

Reclaiming of full solvent inventory

CHP stripper packing deposits
316 stainless steel material

Solvent swap

Cleaning of the plant

- Water wash
- Chemical wash

Citric acid (10-20%)



Conclusion

**Keep Your Amine System As Clean
As Possible.**

**«THERE'S NO EXCUSE TO
OPERATE A DIRTY AMINE
SYSTEM.»***

*Cummings et al., Laurance Reid Conf., 2007.

Thanks to **Gassnova, Equinor, Shell and Total**, the owners of **TCM DA**, for their work, financial support and contributions.

