

Avoiding ammonia slip from ammonia-based post- combustion

- Evaluation of reduction methods

2nd Post-Combustion Capture Conference
Bergen, Norway
19 Sept, 2013

Henrik Jilvero

Carbon Capture and Combustion Group
Department of Energy Technology
Chalmers University of Technology

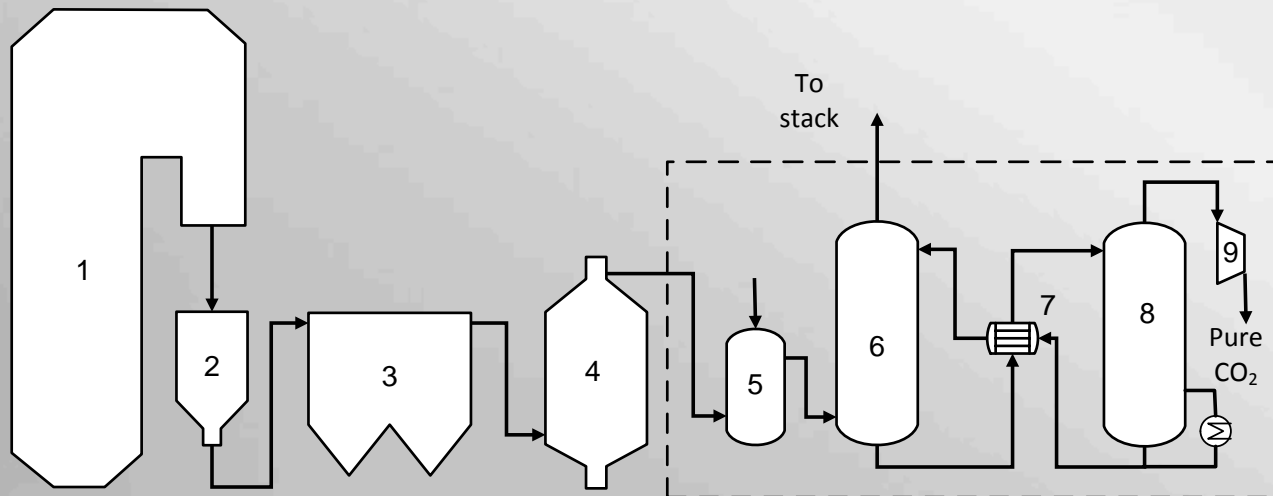
Reduce ammonia slip

HEALTH

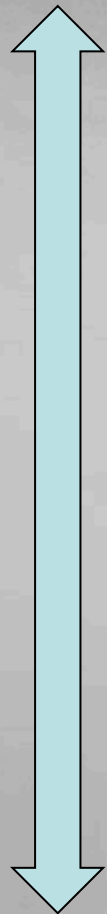
- Respiratory system disease (PM2.5)
- Eye/Skin/Throat irritation

ENVIRONMENT

- Eutropification
- Soil acidification
- Fertilization
- Smog

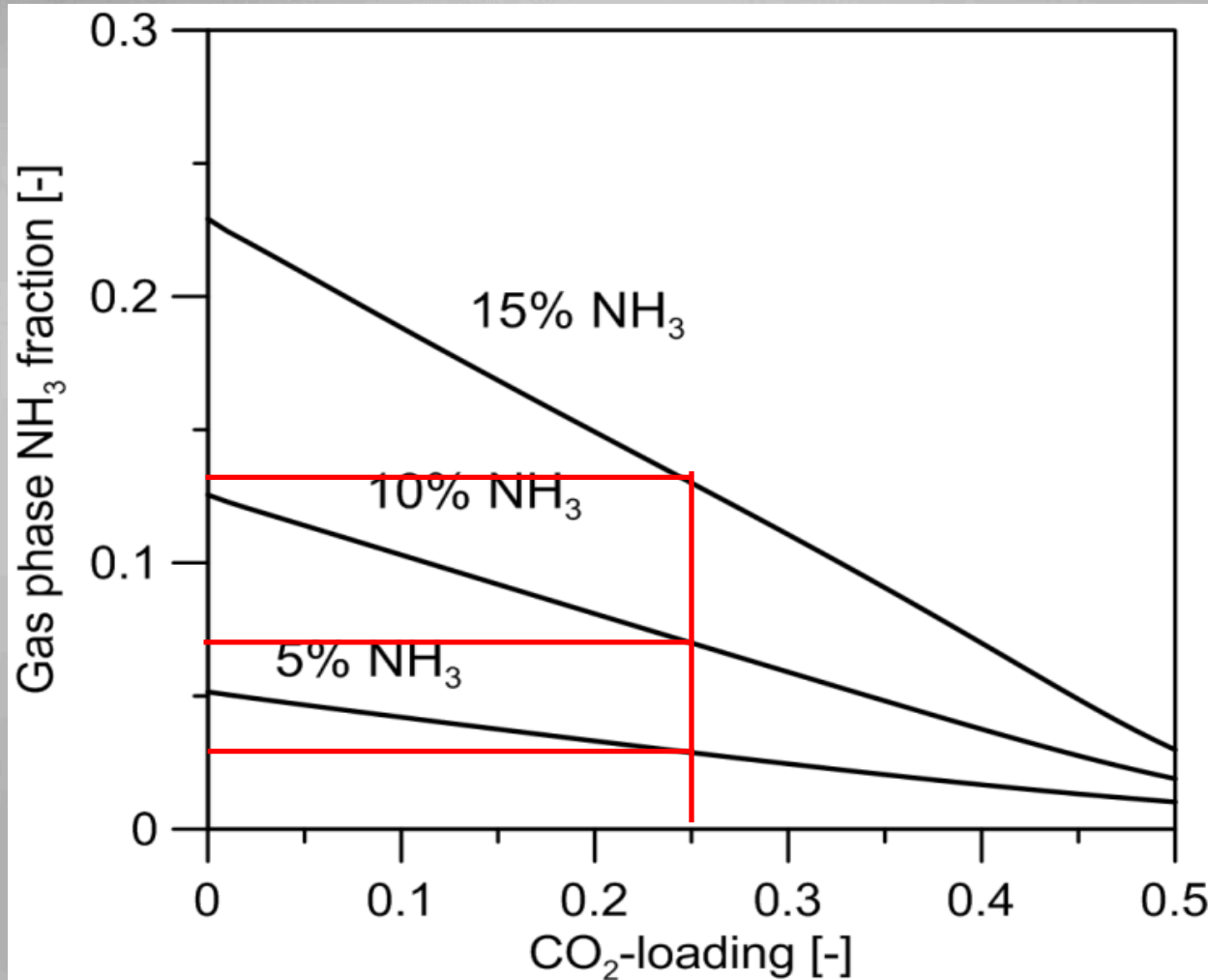


Ammonia concentrations



5000-500 ppm	Prolonged exposure can lead to death
150-50 ppm	Eye/Skin/Throat irritation
50-5 ppm	Odor detection
25 ppm	Recommended 8-hour exposure limit
7 ppm	Recommended long-term exposure limit
300 ppb	Recommended exposure limit urban areas

Equilibrium partial pressure



NH_3 - CO_2 - H_2O

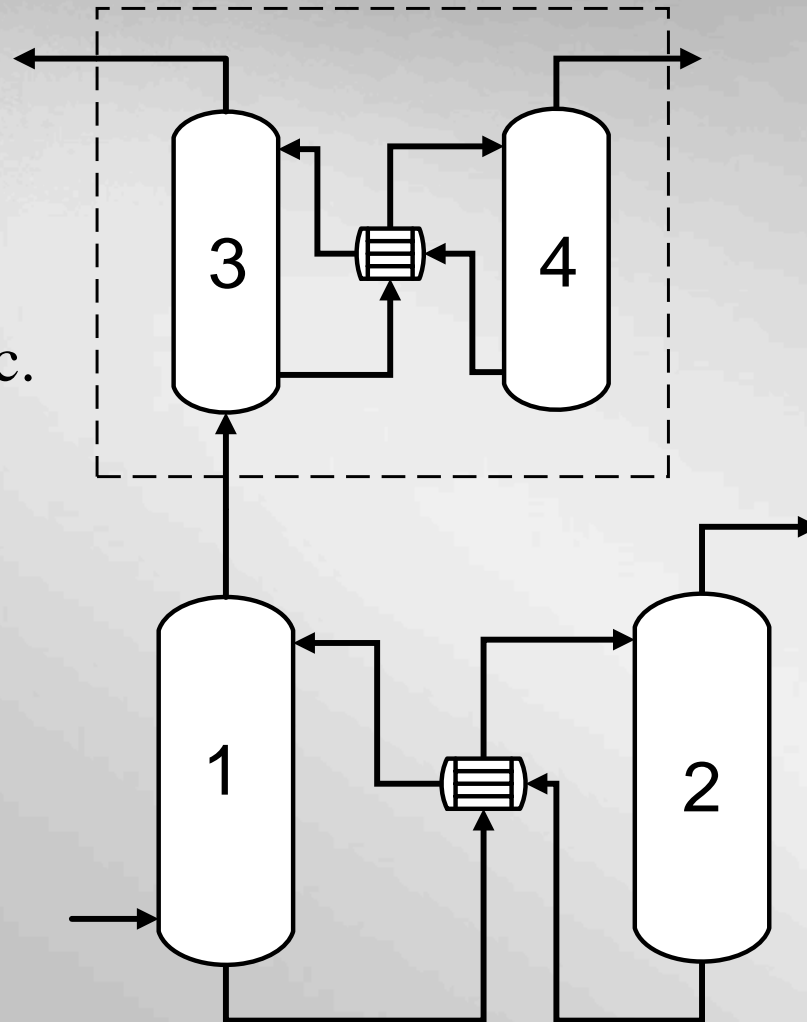
Temp: 20°C

Reduction Methods

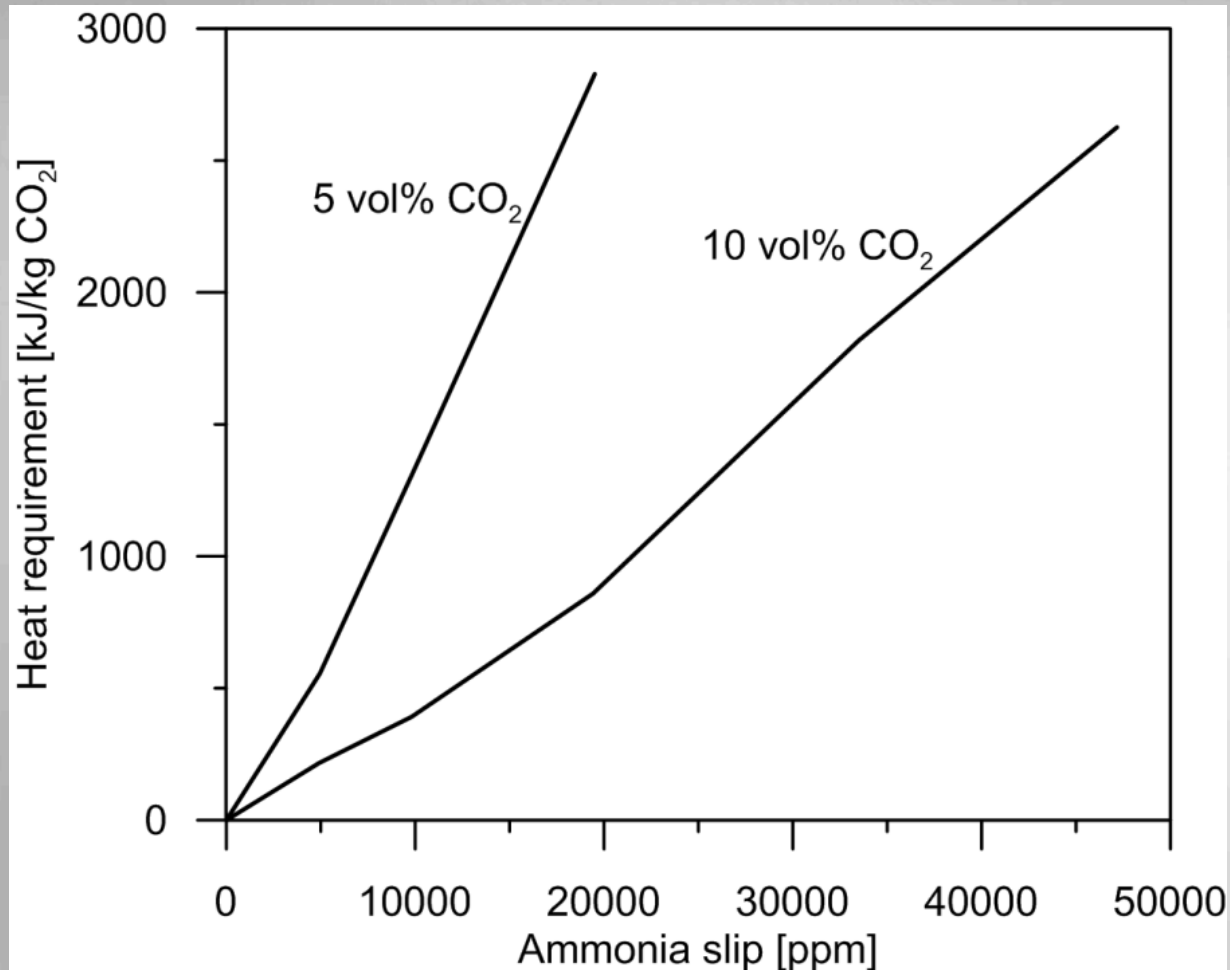
Method	Type
Steam stripping	Secondary/Regenerative
Cooled absorption	Primary
Staged absorption	Primary
Acid wash	Secondary/Destructive

Steam stripping

Beneficial for high CO₂ conc.



Steam stripping

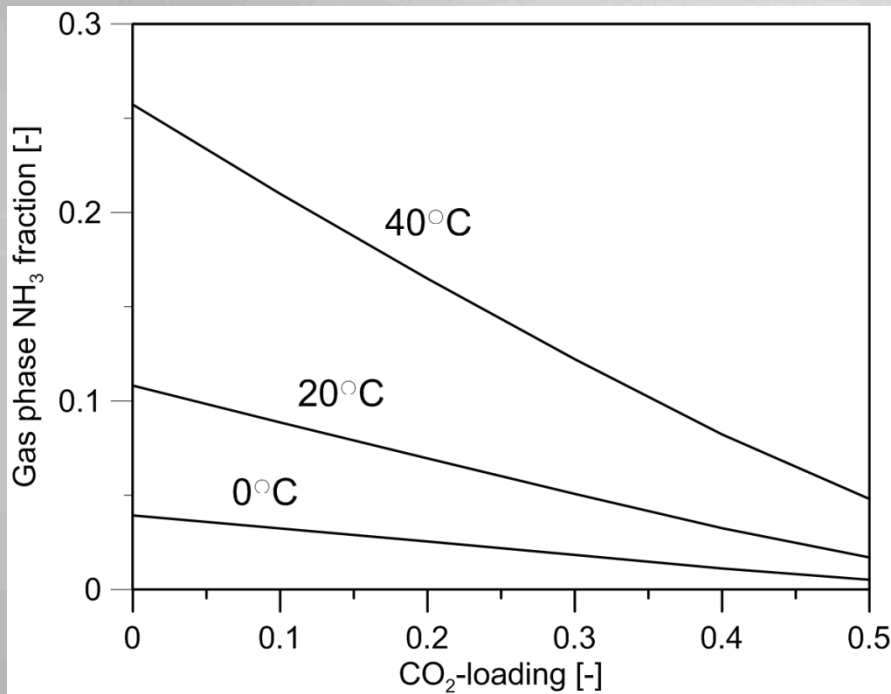


Rate-based simulations

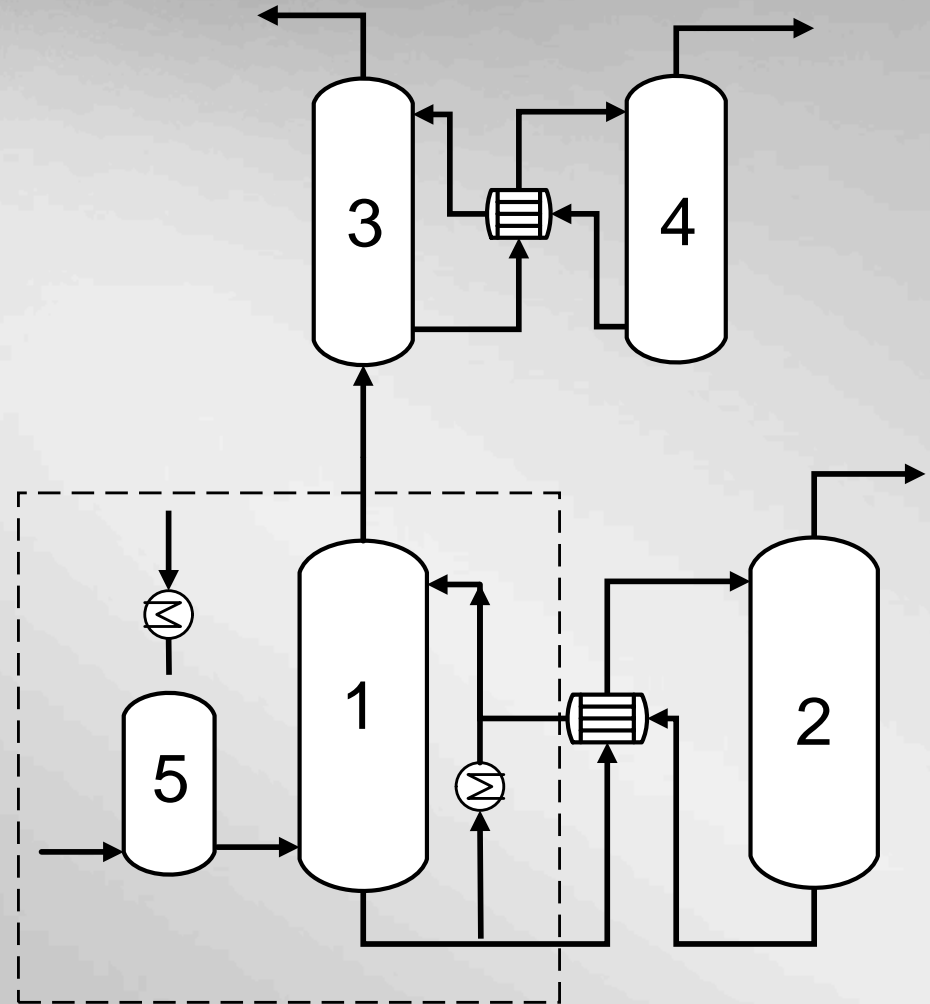
90% CO₂ removal

CO₂ Capture cycle
~2500 kJ/kg CO₂

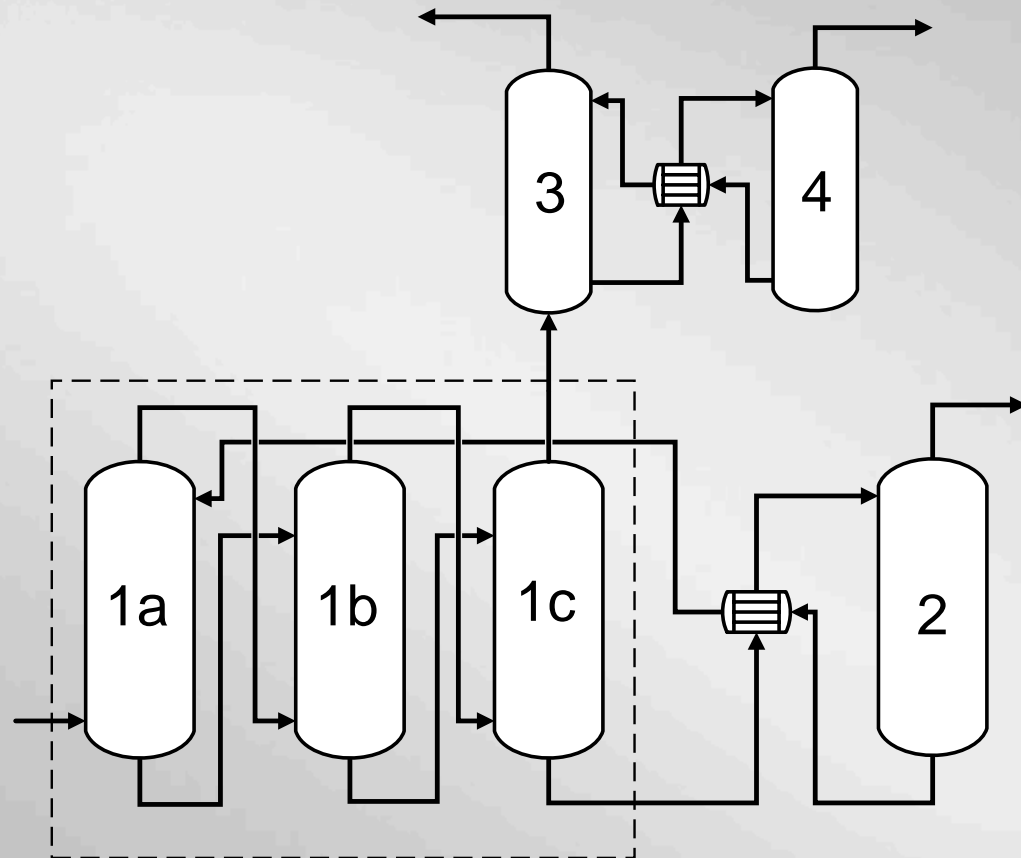
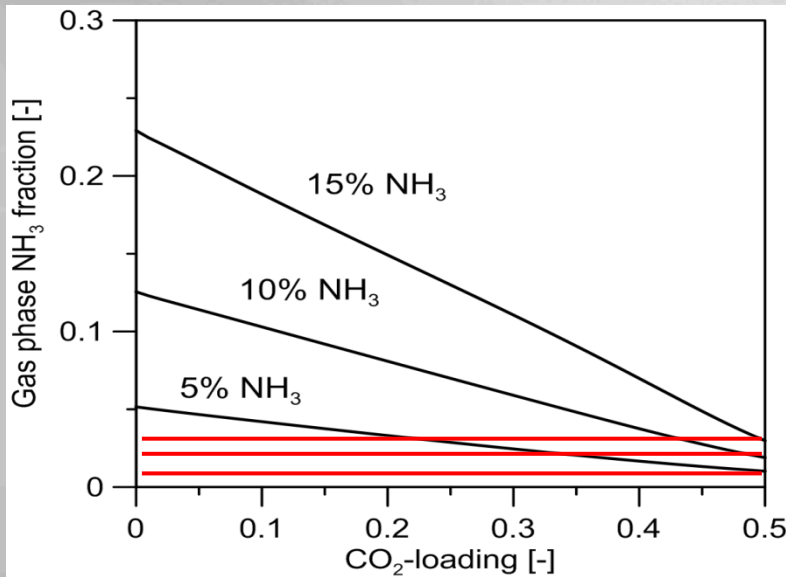
Cooled absorption



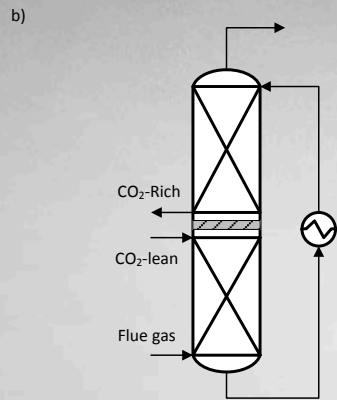
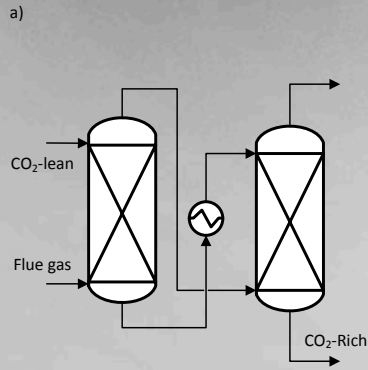
10% NH_3



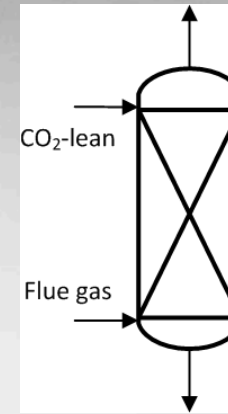
Staged absorption



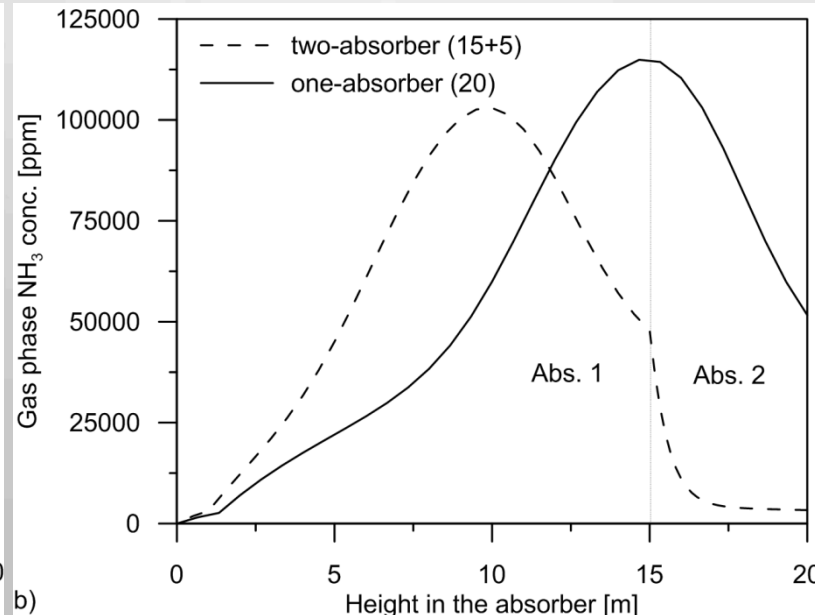
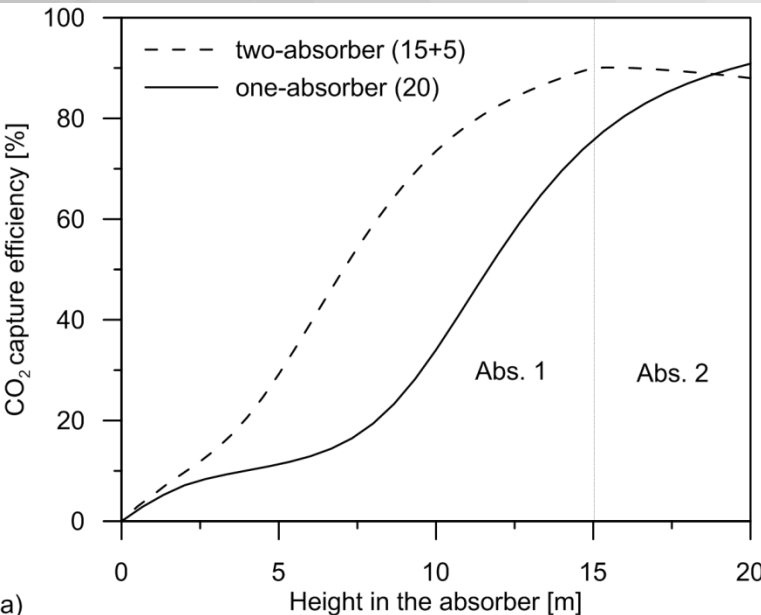
Staged absorption



Two-absorber



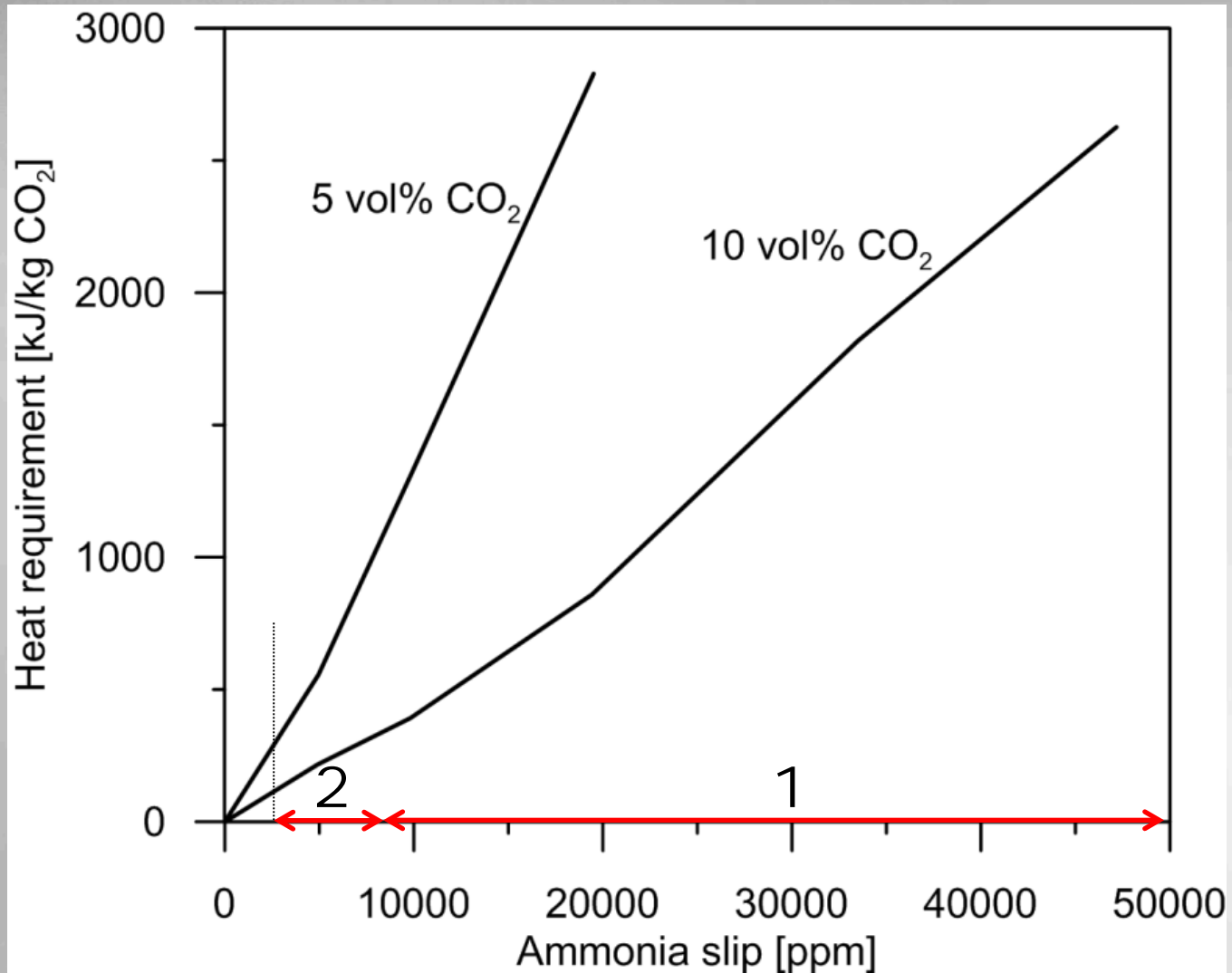
One-absorber



Summary

Reduction method	Ammonia reduction potential	Advantage	Disadvantage
Steam stripping	~ 100%	Full recovery	Heat req. Low CO ₂ conc.
Cooled absorption	~ 60-70%	Low cost	Chilling req.
Staged absorption	~ 80%	High impact	Absorber height
Acid wash	~ 100%	Byproduct	Ammonia destruction

Summary

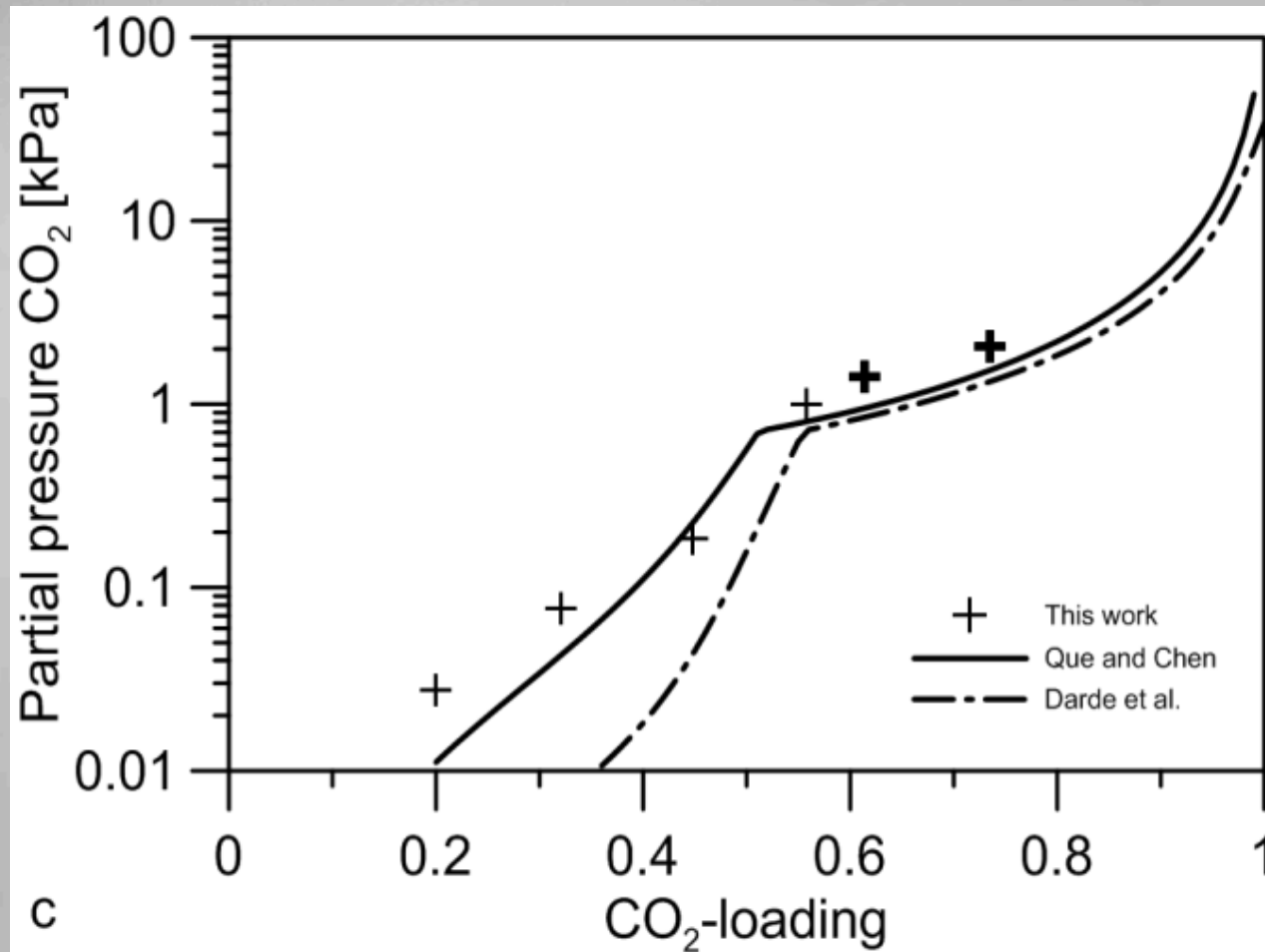


Conclusion

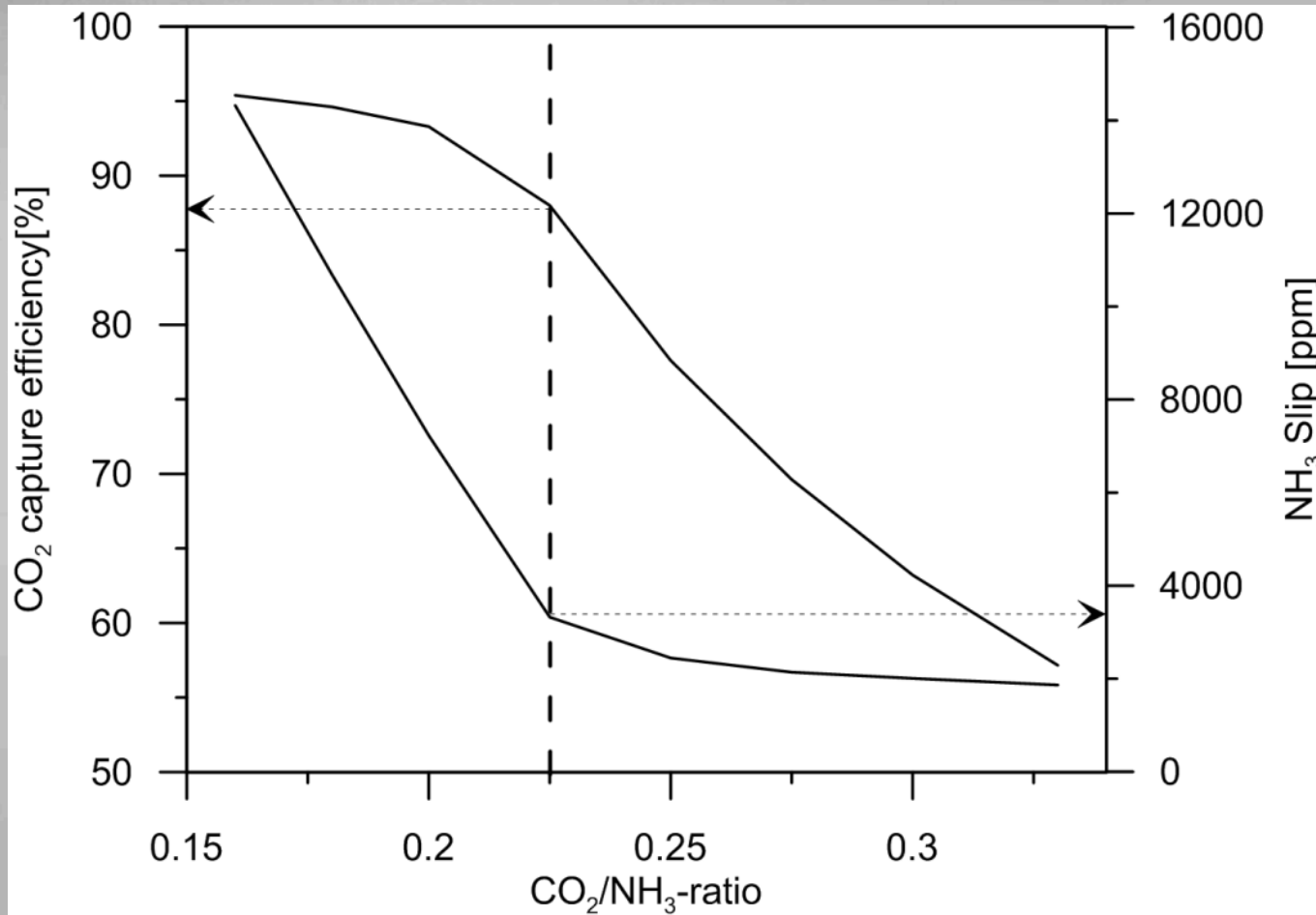
- Slip is an important design aspect of the absorber
- Trade-off between capture efficiency, ammonia slip and absorber height
- Cost of destructive/regenerative methods?

Thank you!

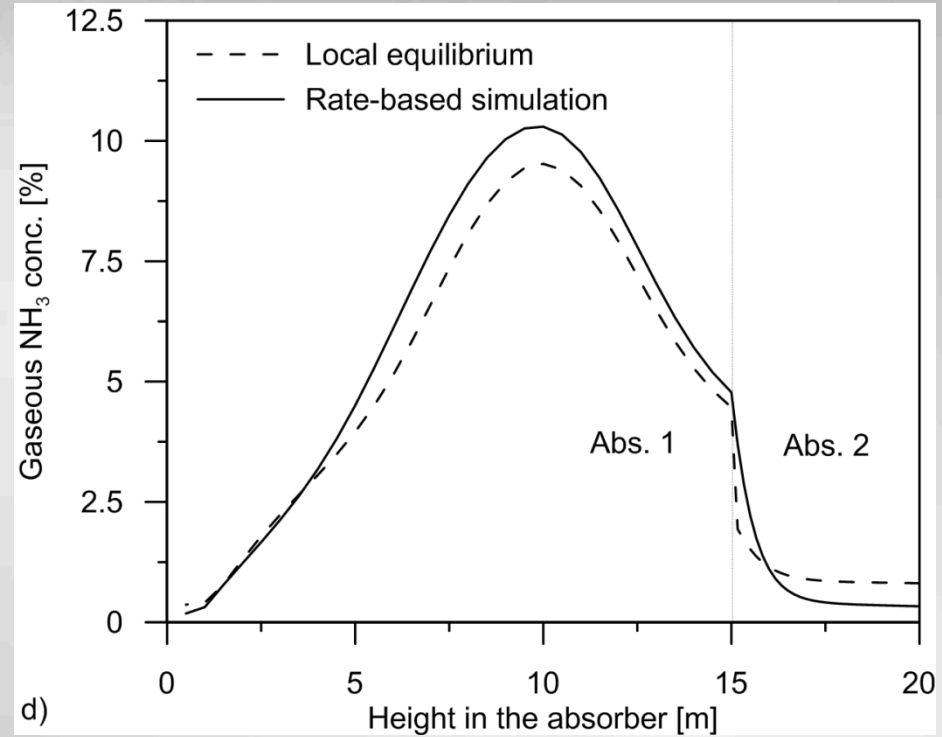
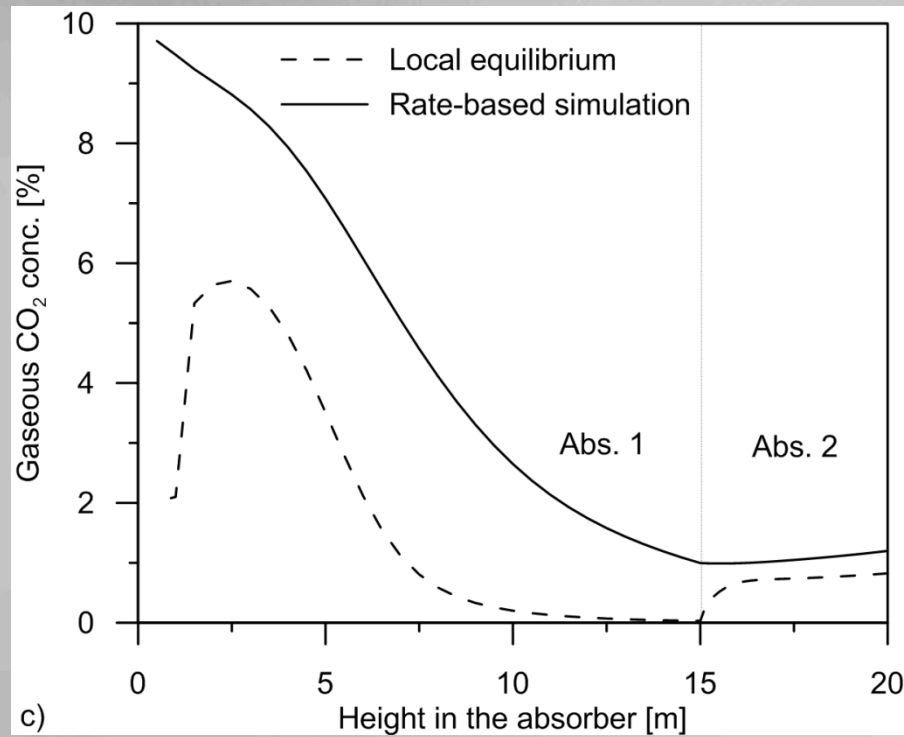
Extra slide 1



Extra slide 2



Extra slide 3



Extra slide 4

