SCOPE

Project number 327341
ACT – Accelerating CCS Technologies

Sustainable and cost-efficient amine emission control

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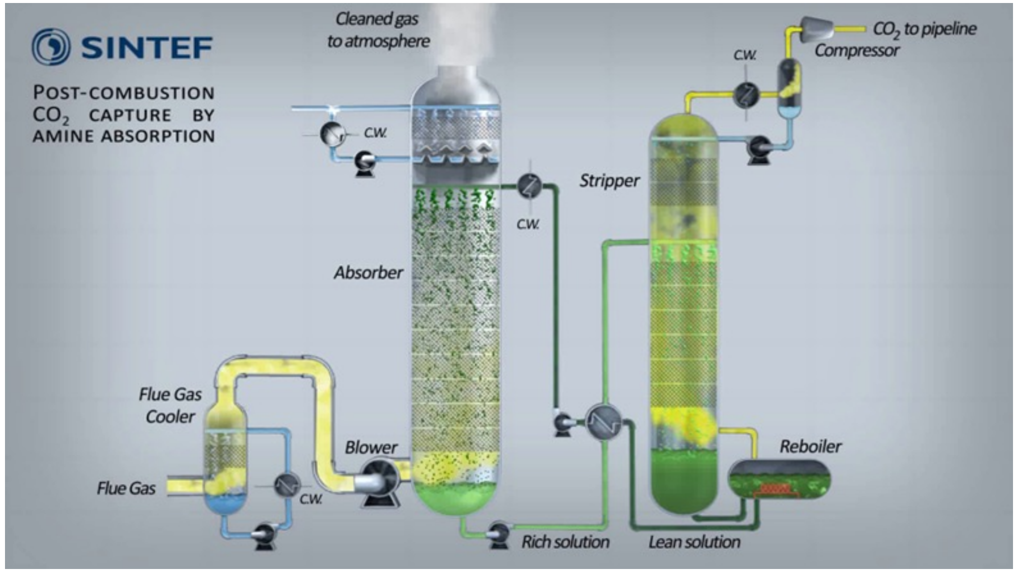
US-Norway bilateral meeting, Washington DC, Oct 31-Nov 1, 2023

Solvent related emissions from a CO_2 capture plant

- Amine-based chemical absorption will play a significant role in decarbonising industry
- It is essential that CO_2 capture plants are environmentally safe and well regulated

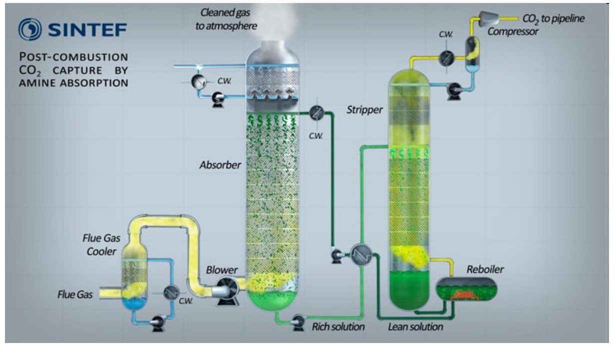


Emission

- Emissions connected to the **volatility** of amine
- Emissions via the formation of **aerosols**
- Potential missions of degradation products
- **Transparent and factual based**
- **Accepted by all stakeholders**

Emissions from a CO_2 capture plant

Plant design
Solvent management and control
Regulation, emission limits



Local or long distance transport in the atmosphere

Reactions and partitioning in the atmosphere

Fate and degradation rates in the environment

No harmful environmental impact, health impact

SCOPE – Sustainable OPEration of post-combustion Capture plants

Follow the continuous path of the treated gas from source to recipient and ensure a sustainable and environmentally safe operation of the capture plant

Flue gas impurities and pre-treatment, impact of load and fuel variations

Emissions control and mitigation, minimizing aerosol emissons

Emissions monitoring and measurements of component and whole effluent

Atmospheric chemistry and dispersion modeling

Biodegradation, Ecotoxicity, Environmental effect concentrations

SCOPE – accelerating the decarbonisation of industry

Accelerating CCS Technologies

- **Objective:** ensure that emission reductions in amine-based CCUS are technically feasible, cost-efficient, and robust enough to mitigate environmental risks and gain public acceptance
- **Collaboration**: Interdisciplinary group of experts from academia, research, technology providers and end-users

Preparation for demonstration: TNO, SINTEF, NTNU, Heriot Watt University, hovyu, CCSI², Technology Centre Mongstad, Total, Microfilt, Guru Gobind Singh Indraprastha University, OGT, Linde, hvc energie en hergebruik, Herøya Industripark, Twence, RWE, Aker Carbon Capture

Technology Demonstration: Twence, RWE, hvc energie en hergebruik, Linde, SINTEF, Microfilt, Guru Gobind Singh Indraprastha University, Heriot Watt University, TNO

Environmental impact assessment: Imperial College London, SINTEF, NILU, Guru Gobind Singh Indraprastha University, CERC, Technology Centre Mongstad, Total, Herøya Industripark, Environment Agency, Aker Carbon Capture

Deployment of amine based CCUS projects

Societal impact, risks, barriers, techno-economics and SPRINT Forum: University of Sussex, TNO, SINTEF, Microfilt, Twence, hvc energie en hergebruik, Aker Carbon Capture, Imperial College London, hovyu, Technology Centre Mongstad, Guru Gobind Singh Indraprastha University, RWE, Linde, Total, Herøya Industripark

Societal readiness and Plan for Exploitation

Project management, administration and external communication: SINTEF, TNO, RWE, Imperial College London, University of Sussex, Guru Gobind Singh Indraprastha University, CCSI²

Timeline: 01.10.2021-30.09.2024

Budget: € 6 M
Funding from ACT € 3.7 M

Partners:
24 (19 from Norway, The Netherlands, UK, and Germany, 2 from USA and 3 from India)

7 AFFORDABLE AND CLEAN ENERGY

13 CLIMATE ACTION

SCOPE test facilities: small pilots to larger demonstration plants

Tiller CO_2 Lab (SINTEF IND), NO

Biomass or propane incineration: 30-40 kg CO_2/h
Solvent: CESAR1 (blend of AMP and PZ)
Flue gas: CO_2 11 vol.-%, O_2 4 vol.-%
Focus in SCOPE: Emission monitoring

Alkmaar (HVC), NL

Waste-to-energy plant 540 kg CO_2/h
Solvent: MDEA/Piperazine blend
Flue gas: CO_2 11.3 vol.-% (dry), O_2 4.1 vol.-% (dry),
Focus in SCOPE: Emission mitigation, effect of particles in the flue gas on emission

Niederaussem (RWE), DE

Lignite-fired power plant: 300 kg CO_2/h
Solvent: CESAR1 (blend of AMP and PZ)
Flue gas: CO_2 15.2 vol.-%, O_2 5.0 vol.-%
Focus in SCOPE: Long-term test campaigns and various emission mitigation tools

Tuticorin site, India

Alkali Chemicals and Fertilizers: 7.5 t CO_2/h
Solvent: CDRmax (Proprietary solvent of Carbon Clean Ltd)
Flue gas: CO_2 ~ 12 vol.-%, O_2 8 vol.-%
Focus in SCOPE: Emission measurement

Hengelo (Twence), NL

Waste-to-energy plant 500 kg CO_2/h
Solvent: 30% MEA,
Flue gas: CO_2 9.5 vol.-%, O_2 8.3 vol.-%,
Focus in SCOPE: Emission mitigation, effect of particles in the flue gas on emission

Mongstad (TCM), NO

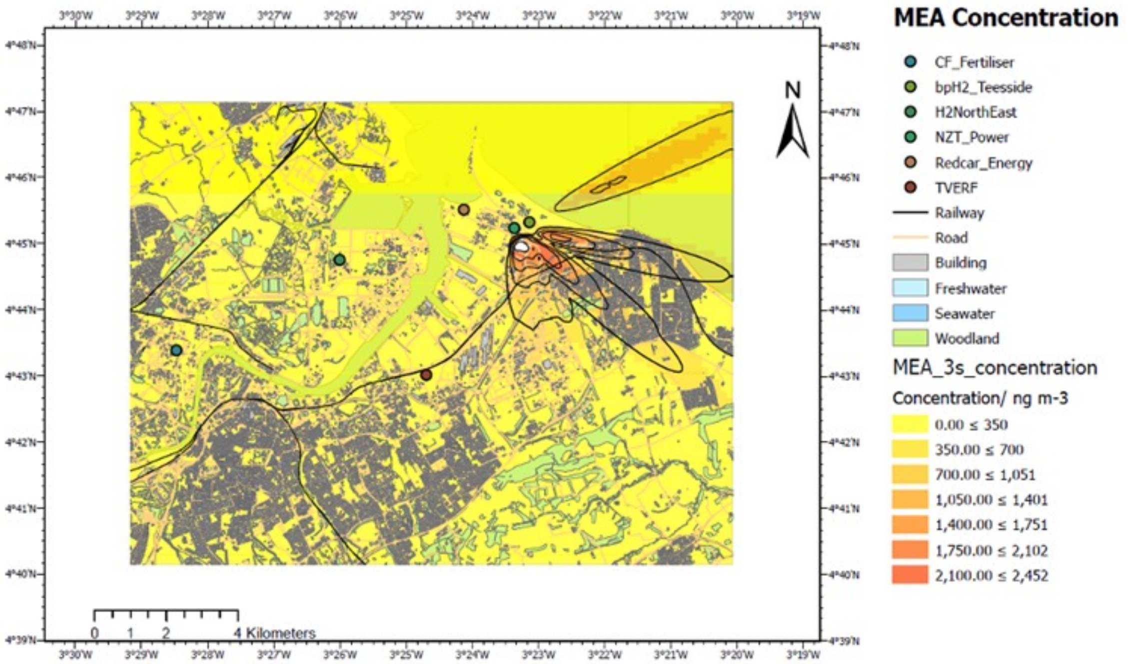
Flue gas from CHP and cracker: 10 t CO_2/h
Solvent: CESAR1 (blend of AMP and PZ)
Focus in SCOPE: Results from previous campaigns for comparison and emission limits

Activities in SCOPE so far

1. Conducting **test campaigns** with focus on emission and emission control in different pilots
2. Models for design of **mitigation options**
3. Improving **dispersion models** to better predict the atmospheric chemistry
4. Reviewing status related to **fate of emission** and explore how seasonal variations impact the fate of emission
5. Reviewing knowledge related to determining realistic levels not influencing the **human health**

Project deliverables, published at: https://www.scope-act.org/project-deliverables

ADMS dispersion model by CERC/Imperial College Atmospheric ground-level concentrations varying as a function of distance from emitting PCC facilities UK case study (single facility and multiple facility studies)



SPRINT – Stakeholder forum

1. **CO_2 capture regulations** (Bergen, Norway, May 2022)
2. Developing **best practices for emissions control** (Niederaussem, Germany, November 2022)
3. Mitigating **Environmental Impacts** of Post Combustion Carbon Capture Plants (New Dehli, India, April 2023)
4. How to address, interact and act on the main **knowledge gaps** related to emissions (Trondheim, Norway, June 2023)

- Planned:

5. Emission **mitigation technologies** for post-combustion capture plants (Netherlands April/May 2024)
6. SCOPE: **Project results and recommendations** for future research and policy initiatives (London, September 2024)

Acknowledgements

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How shall we determine what is acceptable capture plant emission?

Approach in SCOPE:

1. Determine acceptable levels of emitted compounds in the environment (most important: nitrosamines, nitramines, amines, ammonia and aldehydes)
2. Based on 1., determine acceptable plant emissions

Requires insight into a number of topics:

1. Detailed insight into stack emissions
2. Atmospheric dispersion and atmospheric chemistry
3. Fate of chemicals in the environment
4. Determination of acceptable concentrations in the environment