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# Transient / Dispatchable operation & Process control

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TECHNOLOGY CENTRE MONGSTAD (TCM)

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At TCM we are committed to promote the competitive deployment of carbon capture technologies to help combat climate change. We do that by supporting technology vendors to derisk at the largest scale before commercialization and by providing invaluable knowledge to project owners throughout their project cycle.

## The owners' intentions

«We see an increasing interest for testing at TCM, and we are very pleased that we can continue our important work with testing and research necessary for the deployment of large-scale carbon capture.»

GASSNOVA

«TCM has contributed to maturing the carbon capture supplier market and will remain relevant with the increasing number of technology suppliers lining up for testing.»

equinor

«TCM plays a key role in further developing and reducing the cost of CCS – a crucial technology to help society and economies thrive through the energy transition.»

«In our climate ambition, carbon capture is key. TCM is the best platform to learn, test technologies and accelerate the technology scale up for implementation on our assets.»

TotalEnergies

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# Demonstration of non-linear model predictive control of post-combustion $CO_2$ capture processes

(2018)

This article is behind a paywall.

Computers and Chemical Engineering 123 (2019) 184–195

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# Demonstration of non-linear model predictive control of post-combustion $CO_2$ capture processes

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ABSTRACT

Nonlinear model predictive control applications have been deployed on two large pilot plants for post combustion $CO_2$ capture. The control objective is formulated in such a way that the $CO_2$ capture ratio is controlled at a desired value, while the reboiler duty is formulated as an unreachable maximum constraint. With a correct tuning, it is demonstrated that the controllers automatically compensate for disturbances in flue gas rates and compositions to obtain the desired capture ratio while the reboiler duty is minimized. The applications are able to minimize the transient periods between two different capture rates with the use of minimum reboiler duty.



For futher information: https://www.sciencedirect.com/science/article/abs/pii/S1750583619303652?via%3Dihub

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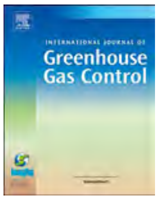


# Demonstrating flexible operation of the Technology Centre Mongstad (TCM) $CO_2$ capture plant

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A B S T R A C T

This study demonstrates the feasibility of flexible operation of $CO_2$ capture plants with dynamic modelling and experimental testing at the Technology Centre Mongstad (TCM) $CO_2$ capture facility in Norway. This paper presents three flexible operation scenarios: (i) effect of steam flow rate, (ii) time-varying solvent regeneration, and (iii) variable ramp rate. The dynamic model of the TCM $CO_2$ capture plant developed in gCCS provides further insights into the process dynamics. As the steam flow rate decreases, lean $CO_2$ loading increases, thereby reducing $CO_2$ capture rate and decreasing absorber temperature. The time-varying solvent regeneration scenario is demonstrated successfully. During “off-peak” mode (periods of low electricity price), solvent is regenerated, reducing lean $CO_2$ loading to 0.16 $mol_{CO_2}/mol_{MEA}$ and increasing $CO_2$ capture rate to 89–97%. The “peak” mode (period of high electricity price) stores $CO_2$ within the solvent by reducing the reboiler heat supply and increasing solvent flow rate. During peak mode, lean $CO_2$ loading increases to 0.48 $mol_{CO_2}/mol_{MEA}$, reducing $CO_2$ capture rate to 14.5%, which in turn decreases the absorber temperature profile. The variable ramp rate scenario demonstrates that different ramp rates can be applied successively to a $CO_2$ capture plant. By maintaining constant liquid-to-gas (L/G) ratio during the changes, the $CO_2$ capture performance will remain the same, i.e., constant lean $CO_2$ loading (0.14–0.16 $mol_{CO_2}/mol_{MEA}$) and $CO_2$ capture rate (87–89%). We show that flexible operation in a demonstration scale absorption $CO_2$ capture process is technically feasible. The deviation between the gCCS model and dynamic experimental data demonstrates further research is needed to improve existing dynamic modelling software. Continual development in our understanding of process dynamics during flexible operation of $CO_2$ capture plants will be essential. This paper provides additional value by presenting a comprehensive dynamic experimental dataset, which will enable others to build upon this work.

For futher information: https://www.sciencedirect.com/science/article/abs/pii/S0098135418303818?via%3Dihub

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# Experimental results of transient testing at the amine plant at Technology Centre Mongstad: Open-loop responses and performance of decentralized control structures for load changes

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# Experimental results of transient testing at the amine plant at Technology Centre Mongstad: Open-loop responses and performance of decentralized control structures for load changes

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ABSTRACT

Flexible operation of combined cycle thermal power plants with chemical absorption post combustion $CO_2$ capture is a key aspect for the development of the technology. Several studies have assessed the performance of decentralized control structures applied to the post combustion $CO_2$ capture process via dynamic process simulation, however there is a lack of published data from demonstration or pilot plants. In this work, experiments on transient testing were conducted at the amine plant at Technology Centre Mongstad, for flue gas from a combined cycle combined heat and power plant (3.7–4.1 $CO_2$ vol%). The experiments include six tests on open-loop responses and eight tests on transient performance of decentralized control structures for fast power plant load change scenarios.

The transient response of key process variables to changes in flue gas volumetric flow rate, solvent flow rate and reboiler duty were analyzed. In general the process stabilizes within 1 h for 20% step changes in process inputs, being the absorber column absorption rates the slowest process variable to stabilize to changes in reboiler duty and solvent flow rate. Tests on fast load changes (10%/min) in flue gas flow rate representing realistic load changes in an upstream power plant showed that decentralized control structures could be employed in order to bring the process to desired off-design steady-state operating conditions within (< 60 min). However, oscillations and instabilities in absorption and desorption rates driven by interactions of the capture rate and stripper temperature feedback control loops can occur when the rich solvent flow rate is changed significantly and fast as a control action to reject the flue gas volumetric flow rate disturbance and keeping liquid to gas ratio or capture rate constant.

For futher information: https://linkinghub.elsevier.com/retrieve/pii/S1750583618300306

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# Scale-up and Transient Operation of $CO_2$ Capture Plants at $CO_2$ Technology Centre Mongstad

(2014)

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## SPE 171873

# Scale-up and Transient Operation of CO2 Capture Plants at CO2 Technology Centre Mongstad

G.M. de Koeijer, Statoil ASA, K.I. Aasen, Statoil ASA, E.S. Hamborg, TCM DA



This paper was prepared for presentation at the Abu Dhabi International Petroleum Exhibition and Conference held in Abu Dhabi, UAE, 10–13 November 2014.



**Abstract**

The $CO_2$ Technology Centre Mongstad (TCM) is the world's largest facility for testing and improving technologies for CO2 capture. The knowledge gained will prepare the ground for full scale $CO_2$ capture initiatives to combat climate change. TCM is a joint venture between the Gassnova, Statoil, Shell and Sasol. It is located at the West coast of Norway, north of the city Bergen. This paper will discuss the scale-up and transient operation of amine based post-combustion $CO_2$ capture plants in general, and presents some typical results. Scale-up and transient operation are typically among the last topics to be assessed in the technology development process because it requires bigger plants. Results from the monoethanolamine (MEA) campaign that was executed in fall/winter 2013/2014 were used. Normalized transient data were presented for 7 important variables during a plant stop and restart and a sudden stop case. Stable $CO_2$ product flow could be obtained after 3-4 hours, while stable emissions and $CO_2$ product temperature took 1-2 hours more. $NH_3$ emissions showed a peak after restart due to accumulation in the solvent during the stop. It was concluded that amine based $CO_2$ capture plants should be able to follow their power plants without significant additional $CO_2$ emissions. Furthermore, the discussion on scale-up showed that the process of upscaling is ongoing and that emissions, material choice, construction method, vapour/liquid distribution and reclaiming are important technical aspects of this process. The main non-technical learning for efficient upscaling is to systematically learn from previous projects on how to build and operate cheaper.

For futher information: https://onepetro.org/SPEADIP/proceedings-abstract/14ADIP/3-14ADIP/D031S045R003/210190

Technology Centre Mongstad (TCM) is the largest and most flexible test centre for verification of $CO_2$ capture technologies and a world leading competence centre for CCS.

**Here is an overview of the main topics where TCM has gathered together its professional contributions:**

| | |
|---|---|
| 01 | TCM Design & Construction |
| 02 | Operational Experience & Results |
| 03 | TCM Verified Baseline Results |
| 04 | Emissions – Limits, Measurements and Mitigation |
| 05 | Aerosols & Mist |
| 06 | Solvent Degradation, Management and Reclaiming |
| 07 | Process modelling, Scale-up and Cost reduction |
| 08 | Transient / Dispatchable operation & Process control |
| 09 | Corrosion & Materials |
| 10 | CESAR 1 Solvent |
| 11 | MEA Solvent |

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