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Final Design and Initial Operation of a SMART Test Unit

Mike Ownsworth[a,*], Lucas Joel[a], Mathieu Lucquiaud[a], Jon Gibbins[a]

[a]*University of Sheffield, Sheffield S7 3RD, UK*

Abstract

Long term testing of amine solvents is included in the guidance by the UK Environmental Agency for permitting of new post combustion CO_2 capture facilities. The guidance states "You must work out the performance of your solvent, including reclaiming requirements and modelling emissions to atmosphere. Determine this through realistic pilot (or full scale) tests using fully representative (or actual) flue gases and power plant operating patterns over a period of at least 12 months".

Long term pilot trials including solvent management on MEA have been carried out at pilots plants at Test Centre Mongstad (Morken2017) and Niederaussem (Moser, 2020). Both trials reported an initial linear degradation of the MEA amine. The longer trial at Niederausem then showed an accelerating degradation effects appearing after almost 250 days of operation.

Costs for installing and operating large pilot plants may reach many millions of pounds. Plans for a small pilot test rig intended to facilitate long term testing of a slip stream of real flue gases have previously been presented, (Elliott, Benz et al. 2022, Joel, Pokora et al. 2024) A reduced size and complexity of test unit, which reduces cost , allows construction of multiple, modular, test units in the future. A diagram of the SMART unit is shown in Figure 1 and a photograph of the unit in place in the University of Sheffield laboratory is shown in Figure 2.

The SMART (Solvent Management at Reduced Throughput) test unit is intended to capture approximately 100 kg/day of CO_2 from a slipstream of an industrial flue gas. The test unit will in particular provide data about the effectiveness of solvent reclaiming. While not expected to provide information about absorption performance, industrially realistic operating temperatures and pressures are used in the stripper, reboiler and reclaimer. This is essential to match solvent degradation effects, with the objective then being that the reclaimer can be shown to be able to remove these realistic impurities effectively.

Many industrial locations are expected to have limited space and height availability. The unit is intentionally restricted in height. A short, wide absorber with high-area gauze packing is used to achieve realistic solvent loadings.

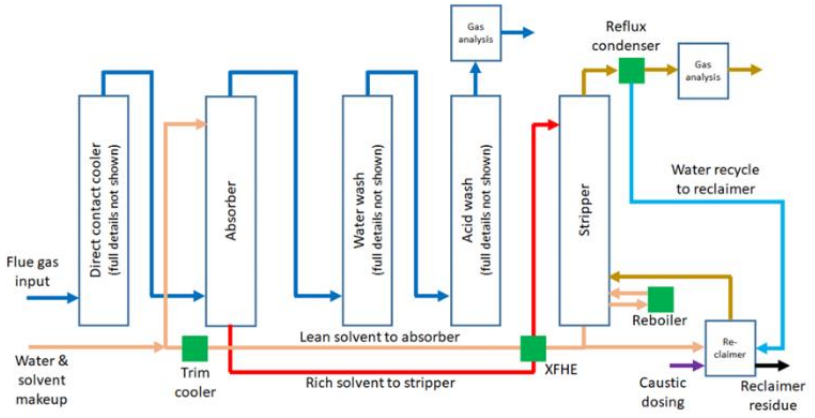

Figure 1 Simplified SMART test diagram, some details omitted

A Hazard Study has been carried out on the stand-alone reclaimer for laboratory operation. A similar study will be performed for the integrated test unit before it is deployed to an industrial location.

Following the Hazard Study, an operation and control strategy will be prepared intending for long term continuous operation. Alterations to the design are anticipated as an outcome of the Hazard Study. The alterations will be presented in this paper.

Figure 2 SMART unit in place in UoS laboratory

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