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Construction and Operation of a non-Metallic pilot CO_2 Capture Rig

Jasper Ros[a,*], Arjen Huizinga[a], Niels Warning[a], Jon Hermansen[b], Olav Larsen[b], Trond Engebretsen[c], Per-Axel Wiig[c], Jarl Robert Pedersen Heer[c], Peter van Os[a], Juliana Garcia Moretz-Sohn Monteiro[a]

[a]*TNO Leeghwaterstraat 44, 2628 CA Delft, The Netherlands*
[b]*BioBe, Kampenveien 5, 1618 Fredrikstad, Norway*
[c]*Goodtech AS, Innspurten 15, NO-0607 Oslo, Norway*

Abstract

Solvent degradation poses considerable challenges to post combustion capture processes [1]. In longer test campaigns running with MEA, a sudden increase of degradation products and dissolved metals in the solvent are reported [2]. In full-scale operation, this could lead to high operational costs and solvent management strategies are needed to control the degradation of the solvent. The exact mechanism for this degradation is currently still not fully understood and it is therefore hard to predict and control solvent degradation. Therefore, in the past years, a lot of research in post-combustion capture is devoted to these solvent degradation mechanisms, both from a fundamental and practical perspective. In the LAUNCH project, universities, knowledge institutes and industry work together to gain a better fundamental understanding of solvent degradation and further develop solvent management strategies.

One of the activities to gain a better fundamental understanding of solvent degradation is the operation of a pilot CO_2 capture rig, that is fully made out of non-metallic equipment (at least for the parts that are in contact with the solvent). Cyclic operation in this regard is important, since bench-scale tests do not seem to describe the same degradation behaviour observed in (pilot) capture plants. This non-metallic plant can give a better understanding of solvent degradation under cyclic operation when the metal content in the solvent cannot increase by taking up metals from the construction elements of the plant. This paper describes the construction of the rig and the first operational results.

The non-metallic capture rig is designed by TNO, BioBe and Goodtech AS. Suitable materials for the plant are chosen based on previous results from the Climit supported FANGST project. Biobe, who is manufacturer of products in polymer materials, focused on finding solutions in both composite and thermoplastic materials. The goal was to exclude steel and metal materials completely. For the columns, this was achieved mainly due to material qualifications performed in the FANGST project. For the other equipment (e.g. pumps, sensors, heat exchangers) suitable materials are chosen so that again no metallic parts can reach the solvent. A picture of the non-metallic plant can be found in Figure 1. The non-metallic rig has an absorber and desorber packing height of 1.2 meters, and is equipped with a coated thermosiphon reboiler.

* Corresponding author. Tel.: +31 29158397, *E-mail address:* jasper.ros@tno.nl

The rig is currently being commissioned, and the first experimental campaign of the non-metallic plant will be performed in Q1 of 2022, using synthetic flue gas. For the first few months, the plant will be tested with the first generation MEA solvent. A clean MEA solvent is used to create a benchmark run, after which iron is stepwise added to the solvent. The solvent will be analysed by taking daily samples, and degradation products and metal content of the solvent will be reported. An Fourier transform infrared spectroscopy (FTIR) device will be installed to measure ammonia (and solvent) emissions from the absorption column, which can give further information on the degradation behaviour of the solvent.

After the MEA campaign, other (2nd generation) solvents can be tested in the non-metallic plant, to further increase the understanding of solvent degradation mechanisms.

Figure 1, Picture of the non-metallic rig.

References

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