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## Demonstrating solvent management technologies for an aqueous AMP/PZ solvent

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### Abstract

Uncertainty about the solvent degradation under specific operational conditions is one of the main technical obstacles hindering the implementation of CO<sub>2</sub> capture in various industries, as recognized by Mission Innovation and by countless practical examples. The transatlantic project LAUNCH with partners from Europe and the United States aims at establishing a fast-track, cost-effective de-risking mechanism to predict and control degradation of capture solvents. Within LAUNCH, the solvent management strategies are validated by test campaigns at four capture plants with an adequate plant size and in an industrial environment (3 pilot facilities and a commercial plant with a capture capacity of up to 0,4 ton<sub>CO2</sub>/h).

At the CO<sub>2</sub> capture pilot plant in Niederaussem, which separates CO<sub>2</sub> from the flue gas of the adjacent 1,000 MW lignite-fired unit of the power plant in 24/7 mode, three degradation control technologies with different effect mechanisms will be demonstrated: removal of NO<sub>2</sub> from flue gas, removal of ionic trace elements from the solvent, adsorptive removal of trace elements from the solvent with active carbon.

The test campaigns are carried out with an aqueous solvent named CESARI consisting of 3.0 molar AMP (2-Amino-2-methylpropan-1-ol), and 1.5 molar piperazine. With 2.9 GJ/t<sub>CO2</sub> CESARI has a significant lower specific energy demand for the regeneration of the solvent than 30 wt% MEA (3.5 GJ/t<sub>CO2</sub>). The CO<sub>2</sub> capture pilot plant in Niederaussem will be operated with CESARI for more than 12.000 hours to accumulate a sufficient high and representative concentration of degradation products in the solvent.

The removal of NO<sub>2</sub> from the flue gas will be achieved by addition of thiosulfate to the circulating aqueous fluid flow of a pre-scrubber of the capture pilot plant upstream of the SO<sub>x</sub> pre-scrubber/direct contact cooler. The target concentration of thiosulfate in the pre-scrubber fluid is 120 mmol/kg [1]. To avoid the formation of colloidal sulphur the pH-value in the pre-scrubber is controlled between 7.5 and 9 by addition of aqueous sodium hydroxide solution. By spectroscopic measurements the efficiency of the NO<sub>2</sub> removal is monitored. Regular analysis of the ion concentration in the pre-scrubber fluid as well as of the main oxidative and thermal degradation products of CESARI are carried out to investigate the effects of the NO<sub>2</sub> removal from the feed gas (oxidative degradation products: glycolate, acetate, formate, oxalate; thermal degradation products: ethane-1,2-diamine (EDA), 1-Formylpiperazine (FPZ), 2-oxopiperazine (OPZ)). Additionally, regularly the main dissolved metal ions (iron,

nickel) and components accumulated from the flue gas (sulphur, chloride, nitrate, sulphate) are analysed to evaluate the concentration level of potential catalysts for degradation reactions of CESAR1.

The effect of active carbon on the concentration of trace elements and degradation products in the solvent is investigated. This includes the operation of the plant for 5,000 hours without contact of the solvent with active carbon, before the active carbon filter is activated. The reaction of the degradation rate on the adsorptive removal of trace elements is monitored.

Finally, the removal of ionic trace components in the solvent by reclaiming based on ion-exchange is examined for the CESAR1 solvent in a 10 week-campaign. The ion exchange resin used for the demonstration and the reclaiming procedure (frequency of the exchange cycles, flush and purge rates) will be depend on the level of degradation products in the solvent.

The paper presents the set-up and the results of the testing campaigns.

- [1] Sexton, A., Sachde, D. J., Selinger, J., Fischer, K., Rochelle, G., "Pilot Plant NO<sub>2</sub> Removal with Aqueous Sulfite", Carbon Management Technology Conference 2017 (CMTC 2017)

*Keywords:* solvent management, degradation, AMP, piperazine, NO<sub>2</sub> active carbon, ion-exchange

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