First results from a novel temperature swing adsorption plant for clean synthesis gas

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Introduction

This work presents the first results of a newly developed gas cleaning unit based on temperature swing adsorption (TSA, Fig. 1).

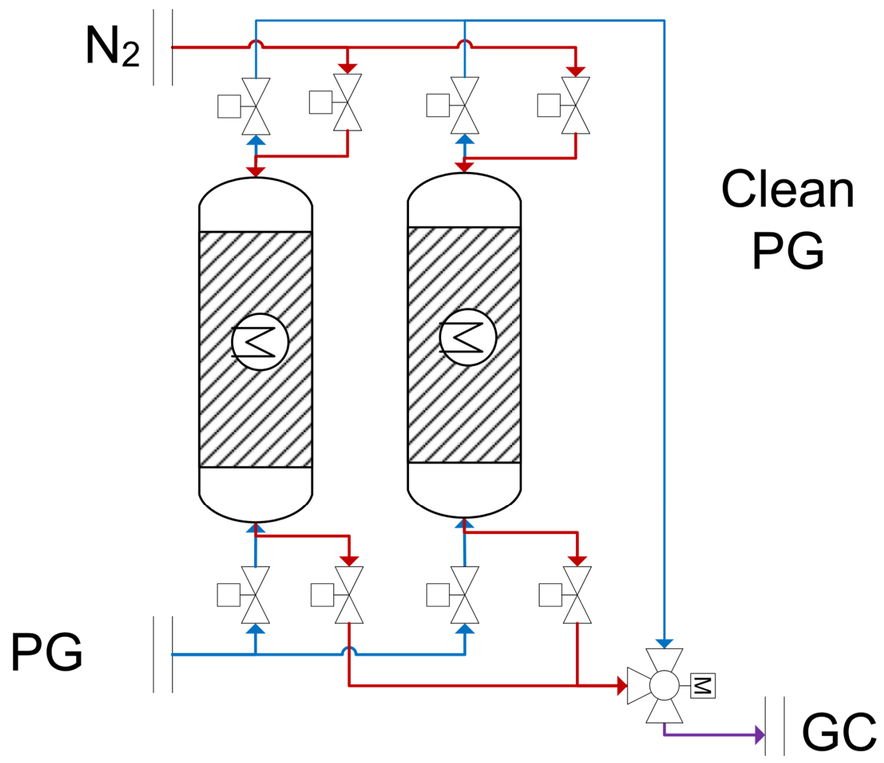

Fig. 1: Temperature swing adsorption unit.

Methods

Product gas (PG) was supplied from a 1 MW DFB steam gasification plant with bark as fuel situated at the Syngas Platform Vienna. The gas was pre-cleaned in the coarse gas cleaning of the plant. The gas cleaning potential of activated carbon was tested in test runs with 5 Nm^3/h product over 12 h at a reactor temperature of around 40 °C in a TSA.

The desorption was performed in three steps: Heat-up of the reactor from 40 °C to 190 °C over 1.5 h with 14 Nm^3/h N_2; desorption at constant temperature with a gas flow of 7 Nm^3/h N_2 over 48 h; cool-down to room temperature for 4 h with 14 Nm^3/h N_2.

During adsorption and desorption Benzene, Toluene, Xylene, o-Xylene, H_2S, COS, Thiophene, C_2H_4 and C_2H_6 were monitored as gas impurities with gas chromatographs (GC).

Results

During adsorption (Fig. 2) it was possible to adsorb many impurities monitored. The adsorption of C_2H_4 was not possible with the chosen operation parameters. COS broke through after only 2 hours of operation but it was possible to adsorb most of H_2S.

The desorption of impurities already started during the heat-up time (time stamps before 0 h). The different start and maximum for each impurity can be linked to a different effect of reactor temperature. H_2S and COS are especially sensitive regarding temperature. After 48 h of desorption all impurities apart from H_2S were fully desorbed, though less than 1 ppm H_2S was measured at that time.

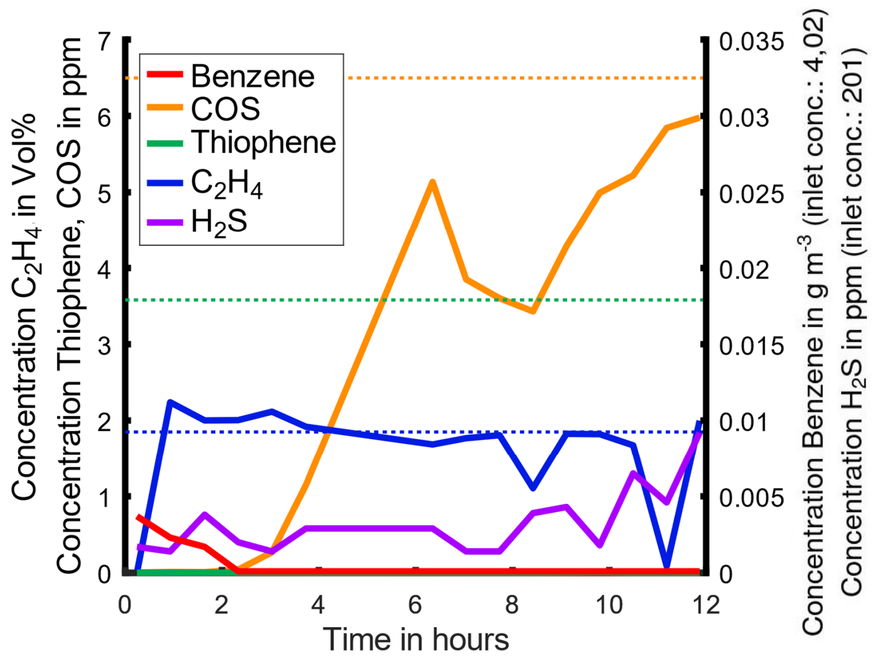

Fig. 2: Adsorption of various gas impurities over 12 h.

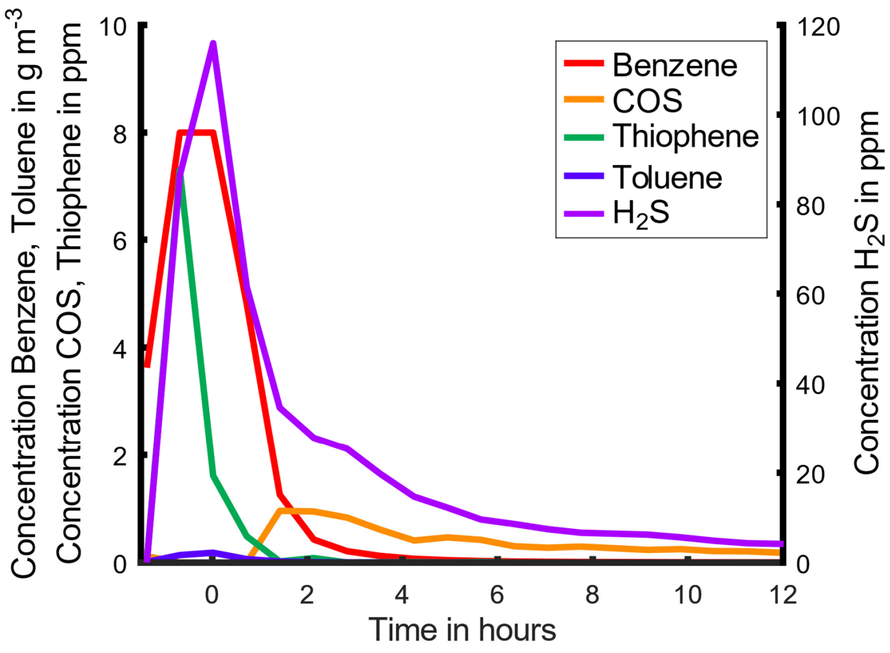

Fig. 3: Desorption of various gas impurities over 48 h. Shown are the heat-up time and the first 12 h of constant temperature operation.

Discussion and Outlook

The presented data shows promising results for the further development of adsorption as a possible step for fine gas cleaning of product gas for synthesis applications.

Further investigations are necessary regarding cycle stability as well as influences of process parameters like gas velocity and reactor temperature.

Acknowledgments
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