PILOT PLANT VALIDATION OF A DYNAMIC ABSORBER MODEL IN CO2SIM

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Introduction

Even though post-combustion concepts are regarded as the most flexible among proposed applications for CO_2 capture, there are several factors that contribute to the importance of using dynamic simulation to improve the overall design and process optimization. Firstly, the upstream power plant might operate with a varying load. In the case of bio-fueled or coal-based power plants, the quality of the fuel may change implying varying flue gas composition. Usually, the power plant responds very quickly to changes in operating conditions, but what about the response in the downstream capture plant? Will non-standard conditions (such as flooding and a higher pressure drop than can be overcome by the blower) occur during transient conditions, and if so, how should the plant be operated in an optimal manner? Secondly, there is no/inadequate experience concerning large scale integration with power-plants. The capture plant may reduce the flexibility of the power plant and thus, dynamic simulation can be used to reveal any operational bottlenecks under transient conditions in the planned integrated plant. Thirdly, the emergence of alternative process configurations different from the traditional absorber/stripper design, may inherently incur more complex operation.

In order to study these aspects, a dynamic process model is under development within the framework of the CO2SIM simulator implemented at NTNU and SINTEF. So far, a dynamic column model for CO_2 absorption and desorption has been implemented based on previous work (Kvamsdal et al., 2009). An important challenge related to this type of modelling is the validation of the model. One thing is the lack of appropriate data in literature, especially obtained from dynamic tests. The other thing is lack of application on large/full scale-facilities. In such cases, the usual approach is to compare the model with pilot-plant data and adjust the model parameters to make a proper fit. However, the model may not be valid for other plants operating at different conditions. This is illustrated in an extensive analysis done to identify the effect of applying different correlations for many of the model parameters found in the literature (Kvamsdal et al. (2010a). Though the results are based on steady state simulations only, the effect was much more pronounced for the test case applied in the analysis from the VOCC rig at NTNU and SINTEF than the test case from the pilot rig at The University of Texas.

While the model and its implementation is described in Tobiesen et al. (2011), the focus here is related to dynamic model validation and model adjustment.

Simulation model verification and validation

One of the important features of the CO2SIM column model is that, the column mass-balance at steady state is automatically verified. This is presented by Tobiesen et al. (2011). Even more important, CO2SIM has an inbuilt automatic procedure for the validation against pilot plant data, thus, making the process of any model adjustment and choice of correlations for many of the model parameters very efficient.

Dynamic tests at the VOCC pilot rig at NTNU and SINTEF were specifically done to validate the previous model described in Kvamsdal et al. (2009). The results of this validation were presented in Kvamsdal et al. (2010b). A similar validation is presently being done for the CO2SIM dynamic column model. It has been seen that further adjustment of the model is needed and as a first attempt, the most sensitive parameters identified in the steady state analysis by Kvamsdal et al. (2010a) will be tested in the same manner, but compared to the dynamic test results.

Preliminary results

As an example, the rich loading obtained from simulations with the CO2SIM dynamic column model is compared to the results obtained during the dynamic test case A in the VOCC rig in Figure 1. Only a fraction of the input data from the test case is simulated and compared, but the same tendency as obtained in Kvamsdal et al. (2010b) is observed. In the presentation a more comprehensive analysis will be given.

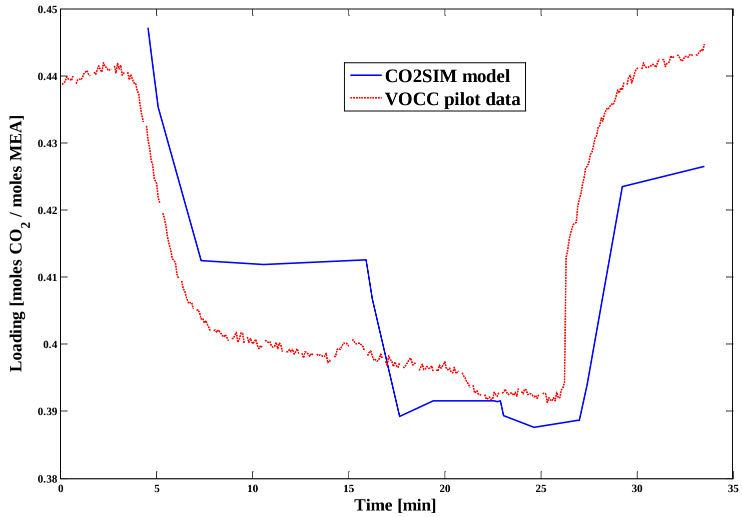

Figure 1: Simulated rich loading compared to VOCC rig data for Case A, variation in gas and liquid flow, respectively

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