Simulation of a sorbent enhanced gasification reactor

Development and validation of reactor model

Authors

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Abstract

Sorption enhanced gasification (SEG) is a promising technology for production of a renewable feedstock gas for dimethyl ether (DME) synthesis process. 1D bubbling fluidized bed (BFB) reactor model was developed and validated to gain knowledge from phenomena governing SEG processes.

Introduction

Gasification reactor of SEG dual fluidized process was modeled. SEG process is in-direct steam gasification process utilizing chemically active sorbent as bed material. The sorbent enhances the steam gasification process and producer gas composition can be tailored by adjusting in-bed CO_2 capture of the sorbent.

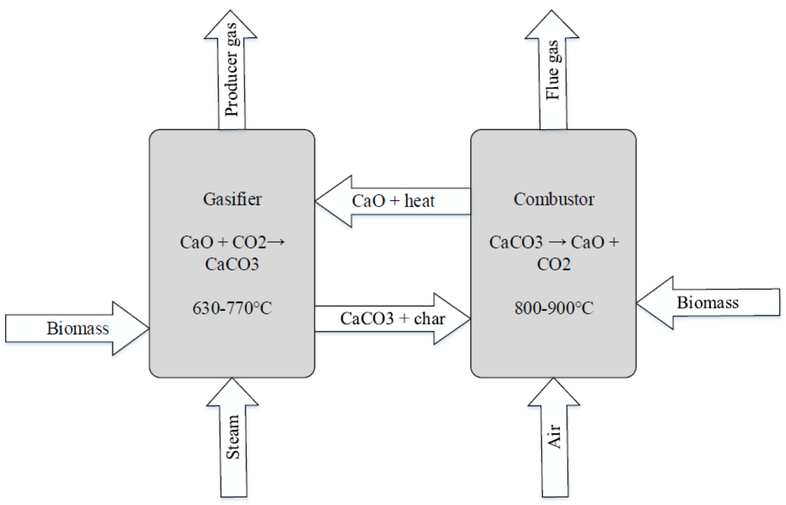

Fig 1. Dual fluidized bed SEG process

Experimental devices

Experimental investigations has been conducted at 200 kW_{th} dual fluidized bed facility at the Institute of Combustion and Power Plant Technology (IFK) at the University of Stuttgart (Hafner et al. 2018). The facility consists of a bubbling (BFB) and a circulating fluidized bed (CFB) reactor.

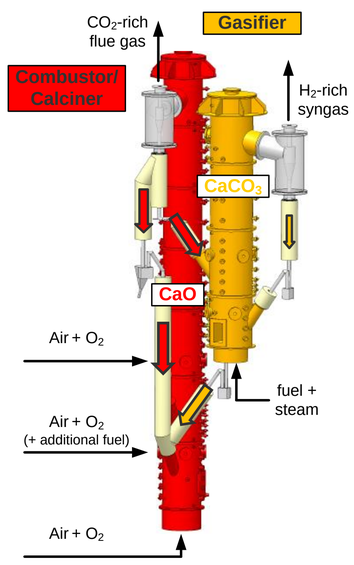

Fig 2. 200 kW_{th} dual fluidized bed facility at IFK, University of Stuttgart.

Methods

The BFB model was derived based on two-phase fluidization theory presented by Kunii and Levenspiel (1991) and Davidson and Harrison (1963). Non-ideal mixing of the dense bed was implemented in the model. With the developed model, an effect of various variables, such as temperature, influencing in behavior of the reactor can be investigated.

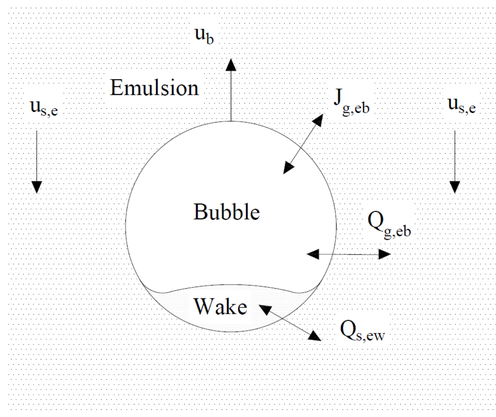

Fig. 3. Two-phase flow scheme of the dense bed. Notations in the figure: *u* is velocity, *J* is diffusion, *Q* is net flow, *e* is emulsion, *b* is bubble, *w* is wake, *s* is solid and *g* is gas.

Results and discussion

Model details and simulation results have been published in Pitkäoja et al. 2019. Model validation improved understanding of chemical and physical phenomena governing SEG processes.

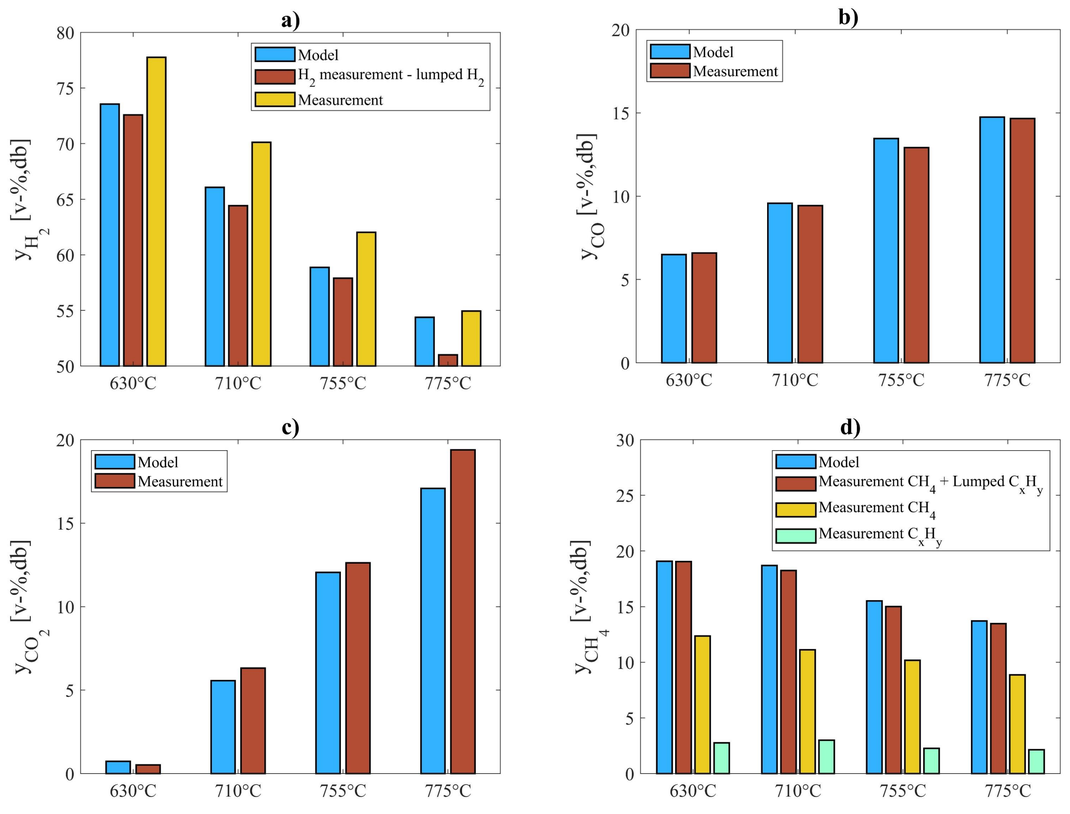

Fig. 4. Simulated and measured volume fractions of producer gas. Experimental bed temperatures are shown in the figure. Good fit to the experimental bed temperatures were attained in each simulation case.

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