COMSOL CONFERENCE 2014 CAMBRIDGE

Modelling an Adsorption Process in a Shell and Tube Heat Exchanger Type Adsorber

Gabriel Salazar Duarte[1], Benedikt Schürer[1], ChristianVoss[1] and Dieter Bathen[2]
1 Linde AG, Engineering Division, RDA, Dr. Carl-von-Linde Str. 6-14, 82049 Pullach
2 University of Duisburg-Essen, Thermal Process Technology, Lotharstraße 1, 47057 Duisburg

Introduction: Mitigation of CO_2 emissions from the combustion of fossil fuels by temperature swing adsorption is known from literature[1]. A novel approach for capturing CO_2 is using indirect heated adsorbers with heat integration and heat recovery strategies.

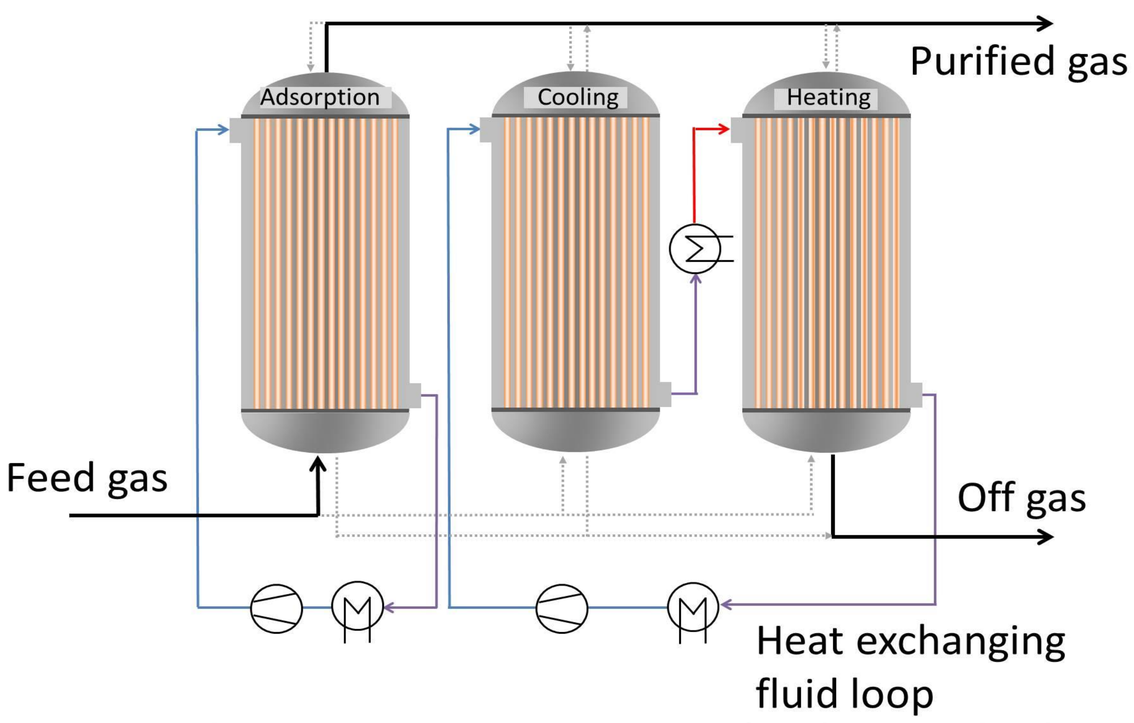

Fig. 1: Schematic representation of a shell and tube heat exchanger type adsorber

Computational Methods: A 2D model (Adsorber tube) and a 1D model (heat exchange fluid) were coupled using COMSOL Multiphysics®. Multiple cycles were simulated using the LiveLink ™ for Matlab® in order to reach cyclic steady state.

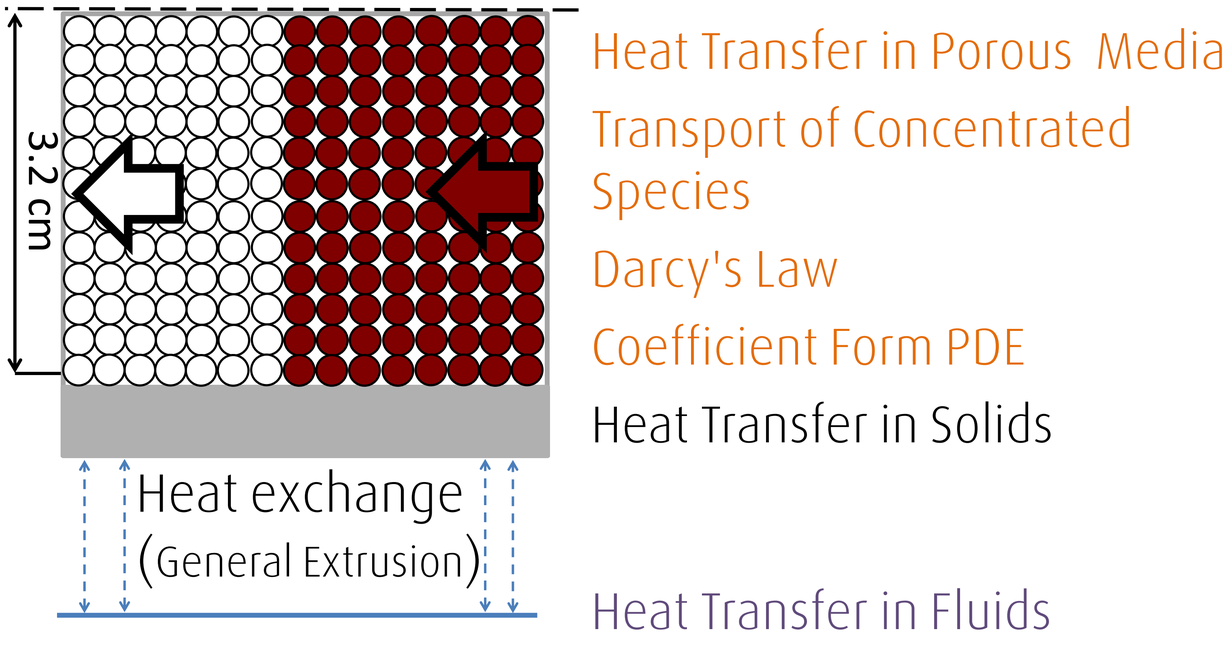

Fig. 2: Model and physics used in COMSOL Multiphysics®

Results: The simulated flue gas consists of 15 vol% CO_2 and 85 vol% N_2. Using heat integration and heat recovery strategies a specific energy consumption of ~ 3.6 MJ/kg_{CO2} with a CO_2 recovery of ~ 90 % is obtained using the given geometry.

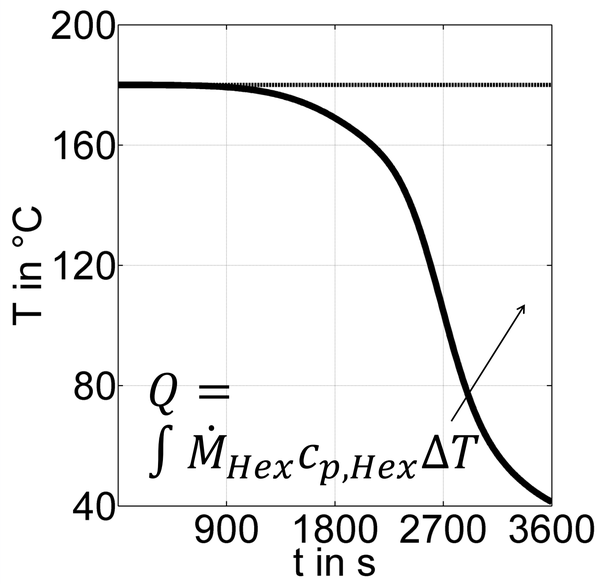

Fig. 3: Temperature profile of heat exchange fluid

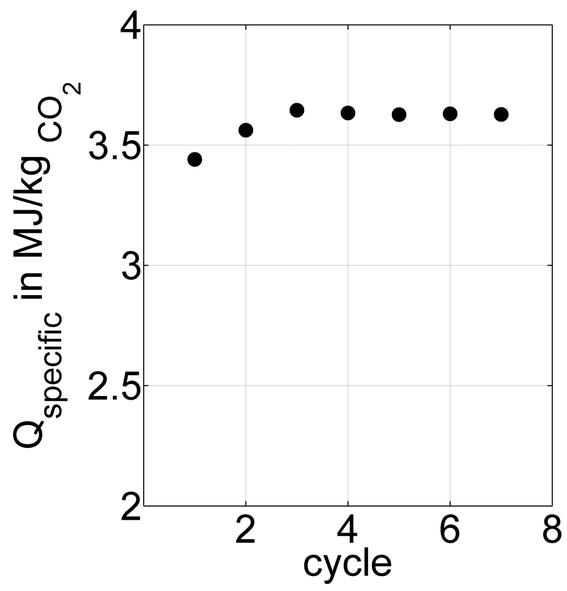

Fig. 4: Specific energy requirement

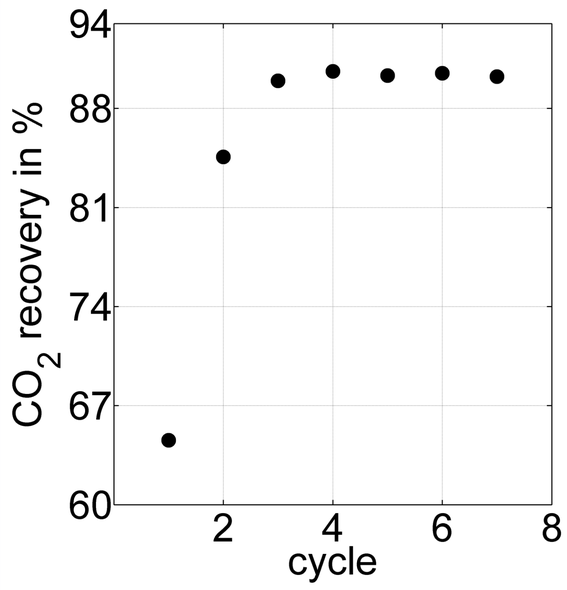

Fig. 5: CO_2 recovery

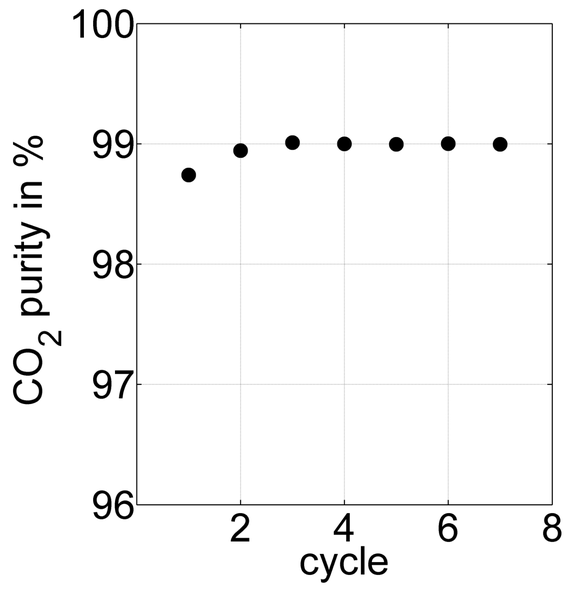

Fig. 6: CO_2 purity

Conclusion: An indirect heated adsorber is modelled and simulated. The first results regarding the energetic requirements are still higher than the reference process (amine wash) but a reduction of the energetic requirement by optimization is expected. The results have to be validated with experimental data.

References

[1] K.B. Lee and S. Sircar: 'Removal and Recovery of Compressed CO2 from Flue Gas by a Novel Thermal Swing Chemisorption Process'; AIChE Journal 54 (2008), P. 2293