Activated Carbon for Selective Exhaust Gas Recirculation Recycling in Combined Cycle Gas Turbine Power Plants with Carbon Capture

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Abstract

The purpose of selectively recirculating CO2 in power plants is to push the limits of process intensification for Post-Combustion Carbon Capture (PCC) by using Selective Exhaust Gas Recirculation (SEGR) to increase the CO2 concentration in flue gases (> 6.5 vol%) at the inlet of the PCC system, while maintaining oxygen levels in the gas turbine combustor above limiting values, since other components in the flue gas, e.g. nitrogen and water, are ideally not recirculated.

This work presents the results of a conceptual design study for a large-scale rotary system transferring CO2 from combustion exhaust gases into the ambient combustion air of a large-scale Combined Cycle Gas Turbine power plant (CCGT), continuing on the work of Herraiz et al, by focusing on a promising alternative to membrane systems, previously proposed for CO2 transfer (Merkel et al (2013)), which main advantage is the limitation of pressure drop to avoid derating the gas turbine power output.

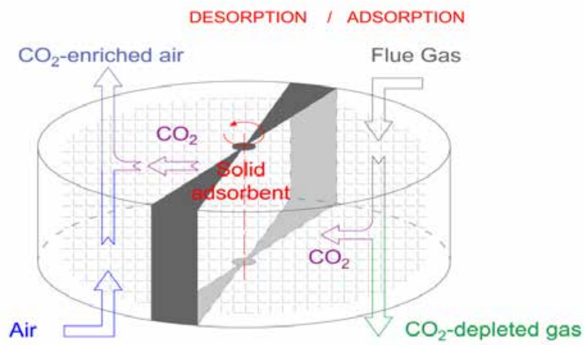

Figure 1 - Schematic diagram of the rotary adsorber for selective CO2 transfer.

The analysis, consisting of several rigorous steps, provides insights for adsorption material selection and pilot scale development.

Using the previous results of a parametric analysis of the conceptual design assessment with the assumption of equilibrium for CO2 absorption, and the experimentally obtained equilibrium and kinetic parameters of a novel activated carbon, the process simulations of a large scale selective CO2 transfer rotary adsorption system for a 800 MWe CCGT with PCC is extended by kinetics and heat transfer to move away from the assumption of equilibrium. A more accurate assessment of the mass of adsorbent and the resulting size of the wheel system is therefore possible. Furthermore the incorporation of the kinetics allows now the optimisation of rotational speed, residence time and flue gas velocity and identifying operational limits to propose a better conceptual design of a large-scale rotary wheel system for SEGR.

The results from this study demonstrate the potential of large-scale rotary wheel system for SEGR application and provide guidelines for the development of improved material targets for typical operating conditions with SEGR, by providing parameter space for performing material and identify class of suitable material.

References:
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