DESIGN OF A CARBON LOOPING COMBUSTION PROCESS

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CarboLoop is an alternative method for chemical looping combustion of solid carbons, proposed by Salatino and Senneca [1,2]. It pursues the simple idea that the carbon-based fuel can act itself as oxygen carrier as it is cycled between an Oxidizer and a Desorber. Looping of the carbon fuel between the two reactors enables stepwise conversion of carbon and yields a nearly pure stream of CO2 at the exhaust of the Desorber. Further development of the CarboLoop process relies on energy integration between the Oxidizer and the Desorber.

In the present work a model of the CarboLoop process is presented which solves material and energy balances. The model is used to calculate the main process variables, like solids recirculation rate, carbon loss in the solids purge, solids inventory and thermal throughput at the Oxidizer and at the Desorber. Emphasis has been posed on partitioning of the thermal throughput between the two reactors. Maximizing the thermal throughput at the Desorber, which operates at high temperature, while keeping the Oxidizer, which operates at relatively mild temperature, thermally self-sustained is the key to maximizing the efficiency of power generation.

Results show that thermal throughput at the Desorber is maximum in the absence of ash. The presence of ash or other inert material increases the solids inventory and the solid circulation rate and negatively affects the thermal throughput at the Desorber. Purge of ash must be accomplished in this case and must be adjusted so as maximize thermal throughput at the Desorber while limiting carbon losses in the purge stream. Moreover, it appears that selective purge of ash, e.g. by “carbon stripping”, is necessary to avoid unacceptable losses of carbon in the purge.

A sensitivity analysis has confirmed the criticality of the oxygen chemisorption capacity of the fuel and of the thermochemistry of the chemisorption-desorption steps to the performance of the CarbLoop process. Oxygen uptakes and thermochemical properties measured for medium rank coals are compatible with application of the CarboLoop concept.

1. Salatino P., Senneca O. (2009), Ind. Eng. Chem. Res. 48(1), 102.
2. Salatino P., Senneca O. (2010) Int. Patent application WO2010/026259A2.

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