BURNERS, COMBUSTION AND HEAT TRANSFER

(668) - (*) - ADAPTION OF A 300 KWTH PILOT PLANT FOR TESTING THE INDIRECTLY HEATED CARBONATE LOOPING PROCESS FOR CO2 CAPTURE FROM LIME AND CEMENT INDUSTRY

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Production of lime and cement is one of the major sources of CO_2 emissions in the energy and carbon-intense industry sectors. These emissions are classified in two categories according to their source: unavoidable process CO_2 emissions, caused by calcination of the raw educts, e.g. natural limestone or marl-type cement raw meal, and CO_2 emissions resulting from the combustion of fuels to generate the necessary heat for the calcination. While renewable fuels can be utilized to reduce CO_2 emissions from combustion, the process CO_2 emission can only be avoided by CO_2 capture. A very efficient technology for CO_2 capture from lime and cement production plants, which can be implemented as integrated or retrofitted solution, is the indirectly heated carbonate looping (IHCaL) process. It offers low energy penalty and high integration potential of mass and energy streams into such plants.

In the carbonate looping (CaL) process, CO_2 contained in the flue gas stream is absorbed by CaO in the carbonator. The formed $CaCO_3$ is transferred to the calciner, where the CO_2 is released by addition of heat at around 900°C. The needed heat for the calcination can be added directly by supplementary firing with fuel and oxygen. In the IHCaL process, this heat is supplied indirectly, e.g. via heat pipes, thus avoiding the need of an air separation unit (ASU). Indirectly heating allows for a higher purity of the separated CO_2 stream. Furthermore, potential synergies between the IHCaL and the lime and cement production exist, since same solid materials are used in both processes. While combining the utilization of fuels with a high biogenic fraction with CO_2 capture, this concept offers a high potential for net negative CO_2 emissions.

This concept is tested in a 300 kWth pilot plant at Technische Universität Darmstadt, which has already operated for 300 h at stable CO_2 capture under power plant conditions. The pilot plant consists of three fluidized bed reactors. The calciner operates as a bubbling fluidized bed, while the carbonator is designed as circulating fluidized bed. Both reactors are coupled by several devices. A fueled bubbling bed combustor is thermally connected with the calciner via 72 heat pipes. The pilot plant is modified in order to demonstrate feasibility under industrially relevant conditions, i.e. using the same fuels, sorbents, and operating parameters as expected in large-scale commercial IHCaL plants for lime and cement applications. The combustor is complemented with a feeding system in order to be fueled with solid feedstock. Furthermore, as a means to supply the carbonator with real flue gas, combustor and carbonator are being connected by a flue gas circulating system.

The presentation will include the design optimizations of the 300 kWth IHCaL pilot plant and first experimental results from pilot tests using limestone as sorbent.

Palavras-chave : Carbonate Looping, Carbon Capture, Pilot Plant, Heat Pipes, Cement & Lime Production