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# DEVELOPMENT OF CHEMICAL LOOPING COMBUSTION TECHNOLOGY FOR BIO-CCS APPLICATION

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Carbon capture and storage (CCS) is acknowledged as an important technology in cost-efficiently achieving the required greenhouse gas emission reductions this century. Combining biomass combustion with CCS (Bio-CCS; BECCS) offers the possibility of "negative" $CO_2$ emissions. In the latest IPCC assessment, bio-CCS was found to have an important role to play in climate change mitigation. Many scenario models were not able to achieve the necessary reduction in greenhouse gas concentration in the atmosphere to 450 ppm $CO_2$eq by 2100 if key technologies, such as bioenergy, CCS, and their combination were limitedly available (IPCC, 2014).

Chemical looping combustion (CLC) is a new technology being developed that could be promising both for biomass combustion and as a bio-CCS application. In chemical looping combustion, the fuel is oxidized in two separate reactors with solid metal oxide particles, called "oxygen carriers", transporting the oxygen between the two reactors. In the air reactor, the metal oxide particles react with the oxygen in air, after which the particles are transported to the fuel reactor, where they react with the fuel. It is expected that high-temperature corrosion problems can be significantly reduced in a bio-CLC reactor as compared to a conventional biomass furnace. This is because heat will be extracted mainly in the exothermic air reactor, in which there will be no alkali compounds present and very little fly ash. This should in turn allow the use of higher steam parameters in comparison to conventional biomass combustion, which would improve the power generation efficiency.

In order to test and verify the benefits of bio-CLC, a new dual fluidized bed (DFB) test rig applicable for biomass was converted into a 10-50 kWth scale bio-CLC test rig. The test rig is located at VTT's new piloting centre Bioruukki in Finland and consists of a circulating fluidized bed (CFB) air reactor interconnected with a bubbling fluidized bed (BFB) fuel reactor. A set of tests is currently being carried out using ilmenite as oxygen carrier and wood pellets as fuel. The main objectives are to study and optimize operation and process parameters for CLC using biomass-based fuels with both high and low volatile contents. In addition, deposit formation and corrosion will be evaluated in order to evaluate the possibility for improving power generation efficiency by using enhanced steam parameters.

The research is carried out in the framework of two research projects: the Carbon Capture and Storage R&D Program (CCSP) with financial support from Tekes - the Finnish Funding Agency for Innovation, and Nordic Energy Research's flagship project "Negative $CO_2$ Emissions with Chemical Looping Combustion of Biomass".

IPCC, 2014: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment. Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K.. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.