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On-Site Demonstration of Post-Combustion CO_2 Capture from Industrial Blast-Furnace Gas with Heterogeneous Hollow-Fiber Contactor Membrane Absorption Modules

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Abstract

In the IEA Sustainable Development Scenario, CCUS accounts for 15% of the cumulative reduction of emissions by 2070. ENGIE has recently set a goal of Zero Net Carbon Emissions by 2045, following a decarbonization trajectory compatible with a warming limit well-below 2˚C, certified by the SBTi. This includes a target reduction in carbon intensity below 110 g.CO_2/kWh for all energy production activities by 2030.

ENGIE Lab CRIGEN, along with 10 other partners, is a member of the C2FUEL Consortium tasked with demonstrating nascent technologies for 1) CCU from industrial blast-furnace gas (BFG), 2) H_2 produced with a solid oxide electrolyser, and 3) in-line production via CO_2 hydrogenation of e-fuels and e-chemicals. Given that the first of the three pillars is directly connected with an industrial actor – the DK6 combined cycle power plant downstream the ArcelorMittal steelmaking plant in Dunkerque, France – the Lab adopted the strategy of designing a first generation “minipilot” system to validate the following KPIs: 1) the pretreatment design ensures acceptable performance of the downstream absorption module, 2) the absorptive performance of the heterogeneous hollow-fiber contactor membrane (HFCM) module used conforms to laboratory results and modelling, 3) the regenerated CO_2 quality is characterized and the successful removal of sulfur species is established, and 4) long-duration testing in an industrial environment is exercised to define protocol for future generations of the system. In collaboration with CNRS-LRGP, the pilot system was constructed and containerized on the DK6 site, where rigorous tests were conducted on a

standard solvent system – 30wt% MEA – to establish performance relative to the literature. This culminated in a 1000h campaign to outline performance – and potential degradation – with time.

Results of the campaign were positive, with the process design, HFCM chemical compatibility, and regenerated CO_2 quality definitively established. HFCM absorption and thermal regeneration were both conducted below 300 mbarg, resulting in a measured cyclic capacity of roughly 47 g.CO_2/L.solvent. H_2S and COS were also successfully detected and removed at the outlet of the regenerator by means of an impregnated activated carbon adsorption module, achieving a project milestone target of <50ppb of H_2S at the outlet of the system.

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