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Parameter Test Results of Large Scale BECCS ready CO2 Capture Demonstration Plant (MOEJ's Sustainable CCS Project)

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Abstract

Toshiba Energy Systems & Solutions Corporation (Toshiba ESS) has constructed a CO2 Capture Demonstration Plant (Figure 1) in 2020 and has been operating this plant from 2020 until now. This is carried out as part of the "Sustainable CCS Project" commissioned by Ministry of the Environment, Government of Japan (MOEJ). This Demonstration Plant treats the flue gas from the Mikawa Power Plant (capacity: 50MW) operated by Toshiba ESS's subsidiary, SIGMA POWER Ariake Corporation, in Omuta, Fukuoka prefecture, Japan, fueled with 100% biomass, palm kernel shells (PKS). So, this plant can be a part of total BECCS system. This Demonstration Plant captures more than 600 tons-CO2/day which corresponds to more than 50% of emitted CO2 from the Mikawa Power Plant and both plants are fully integrated in the aspect of not only flue gas system but also steam cycle system for desorbing CO2 at the stripper.

Fig. 1. CO2 Capture Demonstration Plant

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The layout of the Mikawa Power Plant and CO2 Capture Demonstration Plant are shown in Figure 2. These two plants are fully integrated in the aspect of both steam cycle system and flue gas system. Steam for the reboiler is extracted from the steam turbine generator and condensate is returned to the deaerator. About 60% of the flue gas emitted from the Mikawa Power Plant is introduced into the absorber after cooled down by the GGH (Gas-Gas-Heater; rotating heat exchanger) and FGD. Treated flue gas is heated before returning to the flue gas duct of the Power Plant. Average CO2 concentration in the flue gas is 15 vol.% in dry base.

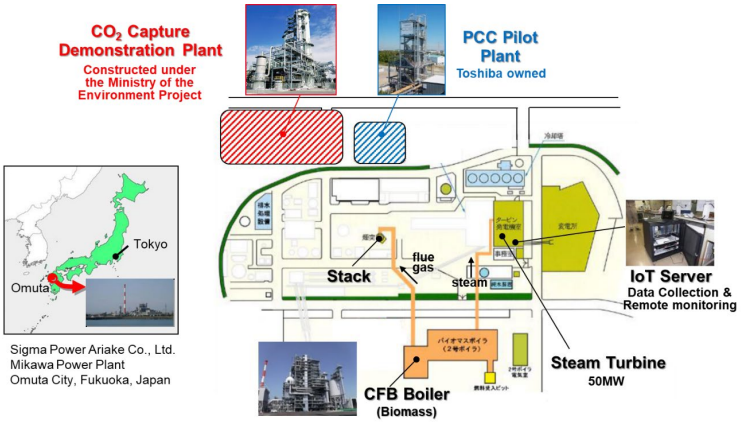

Fig. 2. Layout of the Mikawa Power Plant and CO2 capture plants

Hereby, Figure 3 shows the outline diagram of absorber of this plant. In the absorber, there are three stages of packing, and the supply stages of the lean solvent can be changed for each packing stages (upper, middle, lower), allowing the CO2 capture rate relative to the volume of the packing material to be evaluated. In addition to changing the parameters (Solvent flow rate, Steam flow rate), the supply stage was also modified, and performance evaluation for CO2 capture amount, CO2 capture rate and CO2 capture energy of was conducted.

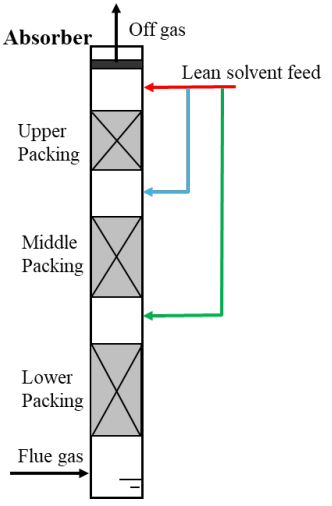

Fig. 3. Outline diagram of Absorber

Some operation results are shown in Figure 4. This shows CO2 capture amount in response to changes in Steam flow rate and Solvent flow rate. In the rated load, the CO2 capture amount is 645 tons-CO2/day. In the maximum flow test (Solvent flow rate 110%, Steam flow rate 130%), the capture amount is 696 tons-CO2/day. However, no significant difference was observed between the 130% steam flow test and the 120% steam flow test at 110% of solvent flow rate. It is needed to consider determining optimal conditions for the plant including other parameters.
Other results including changing packing stages test will be described in the presentation.

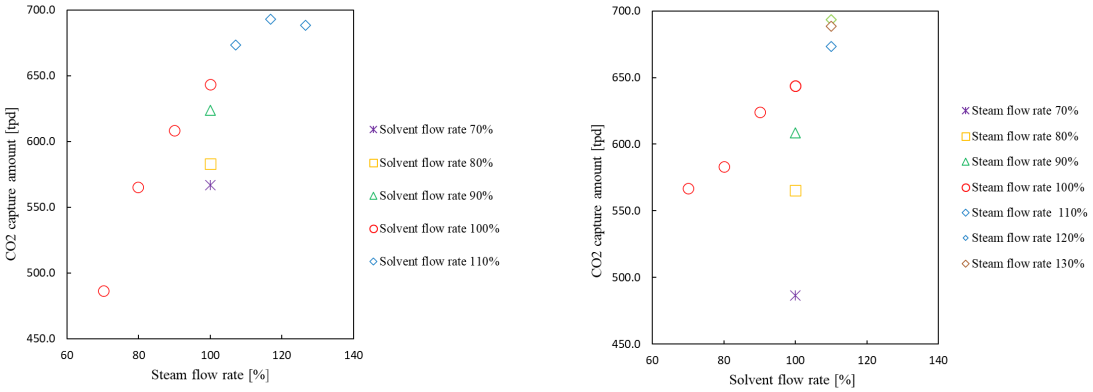

Fig. 4. CO2 capture amount in response to changes in Steam flow rate and Solvent flow rate

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Keywords: post combustion CO2 capture; Large Scale Demonstration Plant; biomass power plant; BECCS; integration