Abstract

Carbon dioxide Capture and Storage (CCS) is expected to be one of the major measures contributing to carbon reduction and net near-zero emission in the near future. Fossil fuel power plants equipped with CCS can be considered to be near-zero carbon power generation if nearly full CO$_2$ recovery is feasible.

Kansai Electric Power Co., Inc. (Kansai EPCO) and Mitsubishi Heavy Industries, Ltd. (MHI) developed the high-efficiency post-combustion CO$_2$ capture technology known as KM CDR Process™ (Kansai Mitsubishi Carbon Dioxide Recovery Process). Thirteen (13) commercial plants with CO$_2$ capacities ranging from 200 ton per day to 4,776 ton per day have been delivered around the world, and two (2) plants are under construction, as of April 2019.

Even though the MHI commercial plants with KM CDR Process™ were designed at 90% CO$_2$ capture ratio as standard, KM CDR Process™ is able to increase the CO$_2$ capture ratio up to 99% or higher depending on flue gas source in consideration of the equilibrium CO$_2$ concentration in flue gas at the absorber outlet and lean solvent condition.

The objective of this presentation is to investigate the process performance and plant economics at max. 99.5% CO$_2$ capture ratio that has not been studied before using MHI’s CO$_2$ capture technology. It is expected that this work using experiences and empirical data that MHI has accumulated is more indicative of current commercial CCS technology and economics than past works.

One of the reference plants is a coal-fired power plant in U.S. with 650 MW gross output. This study assumed that flue gas is pre-treated by typical air purification technologies equipped with modern coal-fired power plant (e.g., SCR, FGD, and ESP) to meet US regulation before being emitted from stack. Around 3.5 million tonnes of CO$_2$ are emitted from flue gas annually without CO$_2$ capture. The scope of this study is a CO$_2$ capture section and CO$_2$ compression section with dehydration unit. The CO$_2$ product at 130 bar will be delivered as product for geological storage or utilization.

The near-zero emission design proposed in this work using 50% additional absorption packing achieves 99.5% capture ratio with similar normalized OPEX ($/tonne CO$_2$) and 6% higher normalized CAPEX compared to base case at 90% capture ratio. Near-zero emission coal-fired power plant is technically feasible using MHI’s latest process, Advanced KM CDR Process™ with KS-1™ solvent, and will increase cost of CO$_2$ captured by 3% compared to default design at 90% capture ratio.

Keywords: MHI; amine scrubbing; CO$_2$ capture; Petra Nova

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