KM CDR Process Project Update and the New Novel Solvent Development

Osamu Miyamoto¹, Cole Maas¹, Tatsuya Tsujiuchi², Masayuki Inui², Takuya Hirata², Hiroshi Tanaka², Takahito Yonekawa², and Takashi Kamijo²

¹ Mitsubishi Heavy Industries America, Inc., 20 Greenway Plaza, Suite 600, Houston, TX 77046
² Mitsubishi Heavy Industries, Ltd., 3-3-1, Minatomirai, Yokohama 220-8401 Japan

Abstract

Mitsubishi Heavy Industries, Ltd. (MHI) has developed a high efficiency chemical solvent process, the KM CDR Process® (Kansai Mitsubishi Carbon Dioxide Recovery Process), in collaboration with the Kansai Electric Power Co., Inc. The process has been applied to eleven (11) commercial CO₂ capture plants with a maximum CO₂ capture capacity of 500 metric tons per day (tpd). These commercial plants are primarily providing captured CO₂ from natural gas-fired flue gas to enhance urea production for the chemical and fertilizer industries. The eleventh plant started operation in Qatar, and the captured CO₂ is used for enhancing methanol production.

MHI further developed the KM CDR Process® to be applicable for coal fired flue gas. MHI completed several test programs capturing CO₂ by utilizing the 10 tpd slip stream test facility from the flue gas of a commercial 500MW coal fired power plant in Matsushima, Japan, in 2006. Long term operation of this plant allowed MHI to verify the impact of coal fired flue gas impurities on the KM CDR Process® and to develop countermeasure technologies. In the demonstration test program of a 500 metric ton per day fully integrated Carbon Capture and Storage (CCS) plant with Southern Company Services, Inc., approximately 200,000 tons of CO₂ were captured with stable operation and high availability from a coal-fired unit at Alabama Power Company’s James M. Barry Electric Generating Plant. More than 100,000 tons of captured CO₂ were successfully injected into a geologic structure, the Citronelle Dome, as part of the Department of Energy (DOE) funded Southeast Regional Carbon Sequestration Partnership (SECARB) Phase-III “Anthropogenic Test”. This combination of experiences resulted in development of the world’s largest CO₂ capture and compression plant for a coal-fired boiler at 4,776 metric tons per day in Texas. This project was developed by Petra Nova, a 50/50 joint venture between NRG Energy and JX Nippon Oil & Gas Exploration. The plant captures CO₂ from a slipstream of an existing boiler’s coal-fired flue gas. The captured CO₂ is compressed and transported for injection into the West Ranch oil field to boost oil production. Through EOR, it is expected that oil production will be increased to approximately 15,000 barrels per day.

The consortium of Mitsubishi Heavy Industries America, Inc. (MHIA) and TIC (The Industrial Company) is constructing the plant that is expected to be operational in the fourth quarter of 2016. It is generally recognized that one of the main challenges of CO₂ capture technologies is cost reduction. MHI continues to improve the process to reduce both the capital cost and the operational cost. Through numerous investigations and screening, a new novel solvent was developed. MHI and Kansai Electric Power Co., Inc. conducted a pilot scale test and evaluated its performance using the 2 tpd Nanko pilot plant in Japan. The test was conducted with natural gas fired flue gas and mimic...
gas for coal-fired flue gas conditions. Compared with KS-1, the new novel solvent achieved 5~10% lower steam consumption. The new novel solvent can reduce the operation costs and the energy penalty of the power plant due to the reduced steam extraction.

Amine emission reduction is also one of the key factors in deployment of the commercial scale CO$_2$ capture plant. The solvent’s emissions were evaluated in the pilot test. The new solvent emissions were less than half that of KS-1 emissions. Therefore, the new solvent will significantly reduce not only the operational cost, but also the amine emissions for a commercial plant. A new DOE-funded solvent demonstration program was applied for with Southern Company Services, Inc. The Phase 1 study was awarded from DOE in October, 2015, and the basic design is being conducted.

Two main topics will be introduced in the presentation. One is the latest progress and key process technologies of the world’s largest CO$_2$ capture plant in Texas. The plant will be ready for gas-in or will be started up before GHGT-13. GHGT-13 will be the first conference to announce the starting up of the plant. The other topic is the newly developed novel solvent. The presentation shows the pilot test results of the new novel solvent and advantages of the solvent.