Development of Novel Water-Lean Solvent for CO_2 Capture Applications

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Abstract

The most effective approach to reduce global carbon emissions is capturing CO_2 from large, point-source emitter such as power plants. Approximately one-third of the annual CO_2 emission is generated from the power industry. Research and development efforts have been made to scaleup CO_2 capture technologies which can be used at scale and reasonable cost. In near-term, solvents are the most promising technology for large-scale CO_2 capture in terms of technology maturity. The first-generation of solvent technologies, developed more than 40 years ago, such as aqueous monoethanolamine (MEA) are not commercially suitable due to their high energy consumption and high equipment cost. The high energy consumption stems from the vaporization of water to be used as the CO_2-stripping agent during the regeneration process. The high equipment cost is attributed to the low CO_2 absorption capacity combined with corrosive nature of these solvents requiring higher grade steel as materials of construction for the process equipment.

Recently, water-lean solvents (WLS) have emerged as an advanced solvent technology with reduced energy requirements. The low energy consumption is realized by replacement of the water by an organic diluent. RTI's WLS eCO_2Sol^{TM} has demonstrated low energy requirement, achieving as low as 2.1 GJ/ton-CO_2, a 42% reduction compared to that of MEA. eCO_2Sol^{TM} has shown to perform more than 90% CO_2 removal from gas streams containing 1-20 vol% CO_2. In addition, eCO_2Sol^{TM} displays significant performance improvements over MEA such as 4X CO_2 working capacity, 7X faster absorption kinetics, and 100X lower corrosivity. These performance results have been consistently observed from lab- to pilot-scale demonstration at various third-party testing sites around the globe. The improved solvent properties of eCO_2Sol^{TM} results in smaller process equipment with lower-cost materials of construction than that of MEA thereby lowering the equipment cost. A technoeconomic assessment of the eCO_2Sol^{TM} has shown ~25% improvement in cost of capture compared to MEA.

The eCO_2Sol^{TM} CO_2 capture process design differs only slightly from a conventional gas absorption process thus likely to be quickly adopted by industries. The process can be retrofitted to existing power plants or green-field installation. The combination of eCO_2Sol^{TM} formulation and process improvements has resulted in the low-cost CO_2 capture solvent technology that could be implemented at scale across various industries.