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Report 288

Produced Water Management: Membrane Engineering for Water Reclamation

By Ronald Smith and Sumod Kalakkunnath

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Abstract

Rising global energy demand coupled with the unbalanced allocation of energy and water resources make the issue of water treatment and reuse pivotal to several of the fuel and chemical production processes. In addition, future regulations and public sentiment are reversing the priority list of produced water management strategies, with wastewater treatment, reuse, and reduced discharge gaining importance. Efficient conservation and reuse of water can be a major contributor to the production cost and in turn affect key project considerations such as site selection and economic viability.

In a first-of-a-kind report, we provide an independent assessment of process economics for plants treating wastewater emerging from two water-intensive fuel production processes: 1) coal indirect liquefaction, and 2) hydraulic fracturing for shale gas. The coal liquefaction wastewater plant accepts water from a world-class, indirect coal-to-liquids (CTL) facility that produces 53,000 bpd of clean fuels via coal gasification followed by Fischer-Tropsch (FT) synthesis. The shale gas produced water treatment plant is a state-of-the art, centralized facility that accepts wastewater from multiple wells in the Marcellus Shale play. The treatment trains designed herein utilize the SuperPro® simulation package and employ advanced membrane-based separation strategies customized based on the feedwater chemistry. Separate treatment trains have been developed in the CTL wastewater plant for the gasification wastewater with high solids content and the Fischer-Tropsch wastewater with high oxygenates content. In a unique design, the centralized, shale gas produced water treatment facility utilizes treatment trains to handle produced water at two different levels of total dissolved solids (TDS). A thorough capital and production cost analysis is provided for the above wastewater plants as estimated using our in-house cost algorithms (designed specifically to develop economics for environmental processes) and corroborated by industry thought leaders. In addition, a detailed basis developed according to EPA guidelines is provided for the incremental costs incurred via waste hauling and disposal.

This report lays a framework for sustainable production of fuel from coal and shale gas, by devising a water management strategy and estimating associated costs that ultimately influence the respective fuel pricing. Our analyses indicate that water treatment and waste disposal add nearly 6% to the middle distillate fuel price (produced via indirect coal liquefaction). Centralized wastewater treatment and waste management for Marcellus Shale flowback fluid reduce the freshwater intake by 30%. The additional incremental cost for doing so under Level III (TDS <20,000 ppm) regulation requirements for fracturing water reuse is $6.13/bbl of flowback fluid. This report will be of interest to policy analysts, strategic planners, project managers, process engineers, environmental engineers, and shale gas operators.

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