Natural Gas Sweetening by Membrane Separation

PEP Report 216B

July 2020

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Abstract

The traditional approach, for sour gas processing, is to utilize solvent systems for natural gas cleanup and Claus technology for conversion of H_2S to elemental sulfur. However, this technology is difficult to operate and could be uneconomical when used on lower amount of highly sour acid gases in remote locations. Moreover, the production of sulfur is a nuisance as currently there are insufficient market resources to absorb large volumes of elemental sulfur, which is brought into the market from natural gas treating applications. Hence with the existing sour gas production areas producing large amounts of sulfur, a new technology that can envisage a more sustainable future is needed.

In the past, membranes could only be used for coremoval of H_2S and CO_2 when the acid gas sulfur level is low. But some wellhead sources of natural gas may contain acid gas sulfur level as high as 80%. Upon combination with water, these gas streams are highly corrosive and can rapidly destroy pipelines and equipments unless they are partially removed. Hence, exotic and expensive materials are required for the construction of pipeline and downstream facilities. Before entering the distribution pipelines, natural gas needs to be purified from acid gasses, CO_2 and H_2S, to prevent pipeline corrosion. Apart from being corrosive, H_2S is also highly toxic, hence only small traces of H_2S are allowed to be present (<4ppm). For CO_2, the pipeline specification is often set at 2% or 3%, with an additional reduction required (<50 ppm) if the gas is turned into liquefied natural gas (LNG).

Some companies have developed polymeric membranes,which can be used for bulk H_2S removal from natural gas carrying very high concentration of H_2S, at high operating pressures. This approach allows more sustainable development of new sour gas fields or retrofitting of existing applications. The membrane system can be used to either treat the gas to meet pipeline specifications or make a bulk cut of acid gases, and then final pipeline specifications can be met using the traditional amine processes or other traditional follow-on operations. Ideally, the permeate gas from the membrane system is reinjected rather than being converted to elemental sulfur. The advantages of membrane systems over conventional processes are site specific, but may include lower capital and energy costs, reduced space requirements, faster delivery time, and lower installation costs owing to smaller, lighter modular design; lower operating costs and limited manpower requirements owing to simplified operation and maintenance; increased adaptability to changing feed flow and composition; elimination of dehydration equipment; potential elimination of costly sulfur recovery units; faster, easier start-up and shutdown. In general, significant reductions in capital and operating costs can be achieved over traditional acid gas removal processes and this report compares the process designs and economics using membrane technology for a wide range of acid gas removal operations

This report addresses treatment of natural gas in a remote location using membrane technology and utilizing PEBAX® material as membrane, and a process scheme which limits methane loss. Analysis is carried out for two flow rates 2 MMscf/d and 35 MMscf, containing varying amounts of CO_2 (2% to 7%) and H_2S (1% to 6%), using PEBAX® 4011 material for membranes and treating gas to pipeline specification. A material balance table, a sized equipment list, and process flow diagrams are also

included in the report. Simulation was carried out using PROMAX® version 4. An Excel based tool, iPEP Navigator®, is also provided for easy economic analysis in different regions of the world.

The technological and economical assessment of the process is PEP's independent interpretation of a potential commercial process based on the information presented in open literature, such as patents or technical articles and it may not reflect in whole or in part the actual plant configuration. IHS Markit believes that they are sufficiently representative of the process and process economics within the range of accuracy necessary for economical evaluation of the conceptual process design.

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