Use of Membranes in Gas Conditioning

Executive Summary

Natural gas processing is one of the largest industrial gas separation applications worldwide and is on the verge of innovative technology which may prove more economically sound. One such technology is membrane networks which compete directly with amine units to separate carbon dioxide from natural gas. Currently, membrane networks consisting of multiple membranes, compressors, mixers and splitters are being investigated to determine whether these systems can handle larger flow rates than membrane units at a reduced cost.

A model was designed in GAMS to assess the feasibility of an amine unit versus a membrane network where the annual processing cost was minimized. Several membrane networks processing natural gas at 19% CO_2 were designed to determine the optimal network. The two membrane network resulted in an annual processing cost of $163K with a total of 11% methane lost. A four membrane network was run in GAMS resulting in the three membrane network which was the optimal solution. The three membrane network had the smallest annual processing cost of $130K with 7.77% methane lost. Furthermore, the three membrane network was scaled up at varying flow rates with 19% and 9% CO_2 to compare the operating cost and total annualized cost to the amine unit's. At flow rates less than 270 MMscfd (19% CO_2) the membrane network had lower operating costs ranging from $175K to $39MM and a total annualized cost ranging from $202K to $45MM. At the same flow rates, the amine unit had operating costs ranging from $490K to $37MM and a total annualized cost ranging from $532K to $38MM. For the 9% CO_2 case, the membrane network had a lower operating cost of $16MM and a total annualized cost of $17MM at a flow rate below 150MMscfd. At the same flow rate and CO_2 concentration, the amine unit's operating cost and total annualized cost were $16.5MM and $17.5MM. It is recommended that membrane networks be used in applications with high CO_2 concentrations at flow rates less than 270 MMscfd.