Effect of Membrane Materials and Operational Parameters on Performance and Energy Consumption of Oil/Water Emulsion Filtration

ABSTRACT

Membrane technology is one of reliable options for treatment of oil/water emulsion. It is highly attractive because of its effectiveness in separating fine oil droplets of <2 μm sizes, which is highly challenging for other processes. However, the progress for its widespread implementations is still highly restricted by membrane fouling. Most of the earlier studies have demonstrated the promise of achieving more sustained filtration via membrane material developments. This study addresses issues beyond membrane development by assessing the impact of membrane material (blend of polysulfone, PSF and polyethylene glycol, PEG), operational pressure, and crude oil concentration on the filtration performance of oil/water emulsion. The filtration data were then used to project the pumping energy for a full-scale system. Results show that fouling resistant membrane offered high oil/water emulsion permeability, which translated into a low energy consumption. The oil/water emulsion permeability was improved by three-fold from 45 ± 0 to 139 ± 1 L/ (m^2 h bar) for PSF/PEG-0 membrane in comparison to the most optimum one of PSF/PEG-60. It corresponded to an energy saving of up to ~66%. The pumping energy could further be reduced from 27.0 to 7.6 Wh/m^3 by operation under ultra-low pressure from 0.2 to 0.05 bar. Sustainable permeability could be achieved when treating 1000 ppm oil/water emulsion, but severe membrane fouling was observed when treating emulsion containing crude oils of >3000 ppm to a point of no flux