Membrane filtration and aeration approaches to treat hydraulic fracturing flowback and produced water

Isabel Plata Enriquez

Extraction of oil and gas reserves from unconventional deposits through multistage hydraulic fracturing combined with horizontal drilling is expanding rapidly around the world. These operations require the use of large amounts of water, which is usually derived from freshwater sources. Subsequently, the water is mixed with chemicals and injected into wells to create a network of fractures, allowing for the flow of oil and gas toward the wellbore and ultimately to the surface. Much of the injected water returns to the surface as flowback and produced water (FPW). FPW usually contains potentially toxic compounds as a result of subsurface interactions between the injected fluid and constituents of the target geologic formation. Therefore, exploration of treatment options such as membrane filtration technologies and aeration are critical to improve the quality of FPW for reuse and recycling in hydraulic fracturing operations.

In this study, we tested three commercial microfiltration (MF) and one ultrafiltration (UF) polymeric membranes (PVDF and PES) with different pore sizes, comparing flux efficiencies and fouling mechanisms. An FPW sample collected from the Duvernay Shale play in Alberta, Canada, was used in the experiments. Additionally, we added an FPW aeration pre-treatment step, to investigate its impact on filtration rates and also to evaluate geochemical changes in the suspended load. The solids collected from the filtration tests were subjected to sequential extraction procedures, scanning electron microscopy equipped with energy dispersive spectroscopy (SEM-EDS), and X-ray powder diffraction (XRD) analysis to identify and characterize differences in the physicochemical constituents before and after the aeration treatment. We found that through the aeration treatment the flux efficiency on the MF and UF membranes improved considerably decreasing filtration times. This study has implications on the advantages and disadvantages of using MF and UF membrane technologies, combined with cost-effective aeration techniques, in the treatment and management of FPW.