

Long term membrane performance comparison of full scale Toyobo CTA HFMs in PRO at high applied hydraulic pressure

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Abstract

Water permeability coefficient (A), salt permeability coefficient (B), and structural parameter (S) are defined as the key inherent properties of a membrane for pressure retarded osmosis (PRO). An ideal PRO membrane is expected to have high A, low B and low S to enable the utmost power harvest. For this concern, existing commercial thin film composite (TFC) polyamide membranes are not good enough for PRO application, because they have a 80 ~ 120 µm thick fabric substrate which provides mechanical support but leads to high S. Moreover, concentration polarization happens in fabric layer which continuously adverse membrane performance. In contrast, the hollow fiber membrane (HFM) is superior to flat sheet membrane (FSM). In detail, osmotic CTA HFM has thinner membrane thickness but can withstand higher hydraulic pressure due to its hollow structure.

Today, Toyobo is the unique supplier who is able to provide high pressure resistant PRO HFM and module. SaltPower is in effort of commercializing PRO systems for power generation combing with e.g. solution mining. Since 2018, SaltPower has expertized in launching long term (above 1000 h) PRO test using 10 inch Toyobo CTA HFM module in hyper salinity up to 300 g/L at 70 bar applied hydraulic pressure with ambitus temperature in range of 5 ~ 35°C.

It was confirmed that standard Toyobo osmotic membrane can withstand the above harsh PRO conditions for at least 1000 h. To further reduce energy consumption and optimize power generation in this PRO process, Toyobo developed new HFM as SaltPower specified. Both standard and new developed membranes have the same polymer composition but differ from A, B and S (hollow dimension). Long term performance from different membranes in PRO are compared. The stability of these membranes affected by high applied hydraulic pressure and salt concentration are analyzed.