Achievement of stable PRO performance of Toyobo hollow fiber membrane under ultra-high salinity by controlling ICP effect

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In Pressure Retarded Osmosis (PRO) process, membrane active layer faces high salinity side, while support layer faces fresh water or low salinity side, in order to reduce internal concentration polarization (ICP) effect to ensure high net driving force across membrane for high water migration [1]. Here, ICP is in normally considered caused by either asymmetric structure of membrane wall or the non-perfection of active layer, which means the salt (NaCl) rejection does not reach 100 % so that salt may reversely diffuse through active layer to support region, as a result, salt continuously accumulates in porous substrate to build up ICP. In lab scale researches, ICP effect has been experimentally simulated by adding NaCl in feed side, and indicated by decrease of water flux and increase of reverse salt flux [2]. But ICP concentration has never been measured directly. Besides, such finite element analysis is limited by simplification of boundary condition, where only single salt is considered and at relative low pressure. In reality, water contains versatile ions, and their diffusion tendency across active layer increases under high applied pressure. Most of them are further stuck in porous layer due to porous tortuosity, together with those rejected by active layer from feed side. Accumulation of multi-electrolytes in porous support may become unneglectable impact on ICP in long term running. In a pilot scale PRO study, SaltPower achieves a stable performance of 10 inch commercialized membrane module under 250 g/L for 150 h, by controlling ICP effect. In this long term experiment, multi-electrolytes besides NaCl are considered. In addition, a simple method is built up to detect ICP effect directly utilizing the reversible properties of ion absorption. By this way, accumulation of more ions than NaCl in porous substrate is verified and evaluated.

References

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Acknowledgements

The project is funded by European commission under Horizon 2020, 954945-SaltPower-H2020-EIC-SMEInst-2018-2020. Membrane used in this pilot test is customer developed by Toyobo CO., LTD. according to SaltPower's request. Special acknowledgement to Shinsuke Hirata and Takahito Nakao for communication.