A novel implementation of water recovery from whey: “forward–reverse osmosis” integrated membrane system

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ABSTRACT

As a result of its emerging contribution to water recovery and clean water production, forward osmosis (FO) in integrated membrane system has recently especially been preferred by research communities on membrane science and desalination technology. In this study, the effectiveness of FO reverse osmosis (RO) integrated membrane system in whey dewatering was investigated in laboratory scale experiments in which FO and RO were utilized for whey concentration and water recovery, respectively. FO experiments were carried out at different conditions of cross-flow rate, temperature, membrane kind, membrane orientation mode, and microfiltration (MF) pretreatment. A single-step RO system was applied for water recovery from the FO draw solution. In the FO process, about 1.6 L water of 3 L whey was withdrawn into 3 M NaCl draw solution during 6 h operating time, and a sufficiently high performance in whey concentration was obtained, with the solid content being increased from 6.8 to 14.3%. However, the process resulted in a high salt permeation into the whey, in addition to some soluble organics being permeated into the draw. RO process are operated with relatively low performances due to excessive salt concentration of the FO draw solutions, which indicates that there is a need for RO implementation in two or three sequential levels for achieving an absolute success in the water recovery from whey. Despite the fact that MF pretreatment to some extent decreased the FO performance, it could be used for directly productive activities intended to recover fats from whey. Results have proved that prior to whey powder production, the integrated system could be effectively employed for whey concentrations up to a solid content of 25–35%. Accordingly, FO–RO system can be utilized as a novel alternative in concentrating whey compared to ultrafiltration-RO combined system widely used worldwide. However, before practical implementation of the system, an optimization between alleviating the salt concentration in FO draw and multi-step RO implementation should have to be considered concurrently with the economics of the investment.

Keywords: Forward osmosis; Reverse osmosis; Integrated membrane system; Whey; Water recovery

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