ABSTRACT

As a by-product of dairy industry with high pollutant capacity, uncontrolled discharges of cheese whey result in serious pollution problems in the environment. Besides, recovery of water and whey powder in a whey stream has come to the fore as an important one of whey control strategies in environmental pollution. In that sense, the feasibility of water recovery and whey powder production from whey using integrated membrane processes was techno-economically investigated in this study. The study was focused on three case studies including different process scenarios were executed with laboratory-scale experiments in order to determine the technical performances of processes. The process scenarios were selected as following: the ultrafiltration/reverse osmosis (UF/RO), the forward osmosis/reverse osmosis (FO/RO) with NaCl draw solution and forward osmosis/reverse osmosis including thermolysis (FO/T/RO) at 60°C for concentrating NH₄HCO₃ draw solution. The real-scale costs for the processes were estimated separately for each scenario using the process modeling and cost estimation software program. The results revealed that UF/RO system is an effective option in whey treatment. FO/T/RO process supplied relatively low-economic performance with 9 years payback, $353,000 net present value (NPV) and moderate water recovery value with 47.7%. However, FO/RO process seemed to be a featured alternative with the highest water recovery of 77.4%, the whey powder production of 98,874 entity/year, and NPV of $12,347,000 and also an inevitable result of 0.8 years payback lower than that of UF/RO. These results proved that FO/RO system with NaCl draw solution could be successfully employed for both water recovery and whey powder production from whey when compared to UF/RO system known as widely used.

Keywords: Forward osmosis; Integrated membrane systems; Water recovery; Whey powder production

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