Erratum

Page 1	paragraph 5	line 4	"were" should be "was"
Page 25	paragraph 5	line 4	"arising" should be "carried"
Page 28	paragraph 1	line 1	"periodical" should be periodic"
Page 29	paragraph 2	lines 1-3	should be "An alternative method of hydraulic cleaning is back-pulsing; short bursts of backpressure, alternative pressurising and depressurising and reversing the feed flow direction with the permeate exit closed (Scott, 1995)."
Page 31	paragraph 2	lines 4-5	should be "Only a few are actually compatible with membranes (Krack, 1995)."
Page 35	paragraph 1	line 5	"avoid" should be "prevent"
Page 85	paragraph 3	line 2	"decreased" should be "increased"
Page 86	paragraph 3	lines 1-8	should be "This work also assisted in highlighting that further work needs to be conducted to evaluate the performance of enzyme cleaners on a commercial scale. These are probably capable of removing foulants not easily removed by other cleaners and have the advantage of being gentle to membranes and of possibly increasing membrane lifespan. They also present fewer chemical disposal problems compared with caustic/acidic based cleaners. However, better performance must be achieved with these in order to realise their benefits."

Evaluation and Development of Chemical Solutions for Membrane Cleaning in the Dairy Industry

A thesis presented in partial fulfilment of the requirements for the degree of Master of Technology in Food Science at Massey University, Albany, New Zealand

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Abstract

Membranes must be cleaned regularly to remove organic material deposited on the surface from the food or biological fluids processed. Cleaning is a compulsory step in maintaining the permeability and selectivity of the membrane and is also necessary to return the plant to its original capacity, to avoid bacteriological contamination, and to produce products with a long shelf-life. Without cleaning, the flux of solution through the membrane would decline to uneconomic levels.

Caustic, acidic and enzymatic based cleaners may be used for membrane cleaning. Such cleaners affect the lifetime and performance of a membrane and should thus be surface-active, soluble, rinsable, non-corrosive, safe, effective and easy to use. The primary objective of work carried out was to evaluate a range of cleaning chemicals and cleaning regimes on a pilot-scale.

Cleaning regimes employing conventional caustic and acidic cleaners, and enzymatic detergents have been evaluated for a Desal ultrafiltration membrane. The membrane was reproducibly fouled during the processing of skim milk and skim milk concentrate on a pilot-scale plant supplied by Tuchenhagen (N.Z.) Limited and compared favourably with an industrial plant. A spiral wound membrane of polyethersulfone with an active area of 7.4 m^2 and a 10,000 molecular weight cut-off was selected. A transmembrane pressure of 2.5 bar, a retentate flow rate of 60%, a temperature of 18.5°C, and a recirculation flow rate of 7 m^3h^{-1} was kept constant during filtration. A combination of flux recovery after cleaning and solute resistance removal was used to assess cleaning performance.

Higher flux recoveries (87.3-93.6%) were achieved with surfactant based formulations compared with enzymatic detergents. This was attributed to the wetting action of surfactants which when used in conjunction with a high strength blended alkali solution, aided the convective cleaning solution flow through the membrane pores.

Enzymatic cleaning was found to be milder to the membrane. While the enzyme-sanitiser regime yielded good flux recoveries (68.4-87.3%), the enzyme-acid and acid-enzyme regimes were not capable of restoring membrane permeability, resulting in low flux recoveries 64.2-78.9%. The acid in these regimes caused the membrane pores to shrink, restricting the ability of the enzymatic detergent or rinse water to penetrate the foulant and remove it. Based on these results, a new formulation (DR292) with more surfactant action was developed and evaluated. Flux recovery using this new formulation increased by 3.5%.

Regimes incorporating non-ionic surfactants and high strength alkali solutions were found to successfully restore membrane permeability because a higher level of surfactant was obtained from the mixture. Further experiments using enzyme-acid and acid-enzyme regimes, and the new formulation need to be trialed on new membranes to determine their long-term effect on membrane permeability and selectivity.

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