Microfiltration Membrane Fouling by Dairy Proteins

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by

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For Sylvia

Abstract

Microfiltration membrane fouling occurs through the deposition of proteins both on the membrane surface and within the membrane pores. Fouling is complex with both the nature and location of fouling dependent upon the properties of the feed material, the properties of the membrane material and the operating conditions used.

Two aspects of fouling have been investigated, one in which the feed contained proteins considerably larger than the membrane pores (casein micelles) and the other, in which the protein (ß-lactoglobulin) was much smaller than the pores. In this way, it was possible to separately investigate surface layer formation and fouling within the membrane pores.

It has been demonstrated that a casein "gel layer" forms on the membrane surface causing severe fouling during the microfiltration of skim milk on a 0.1 μm polysulphone membrane if the combination of cross-flow velocity and permeate flux leads to a concentration of casein at the membrane wall equal to or higher than that required for "gel layer" formation. Once formed, the gel layer restricts the passage of protein through the membrane and reduces plant throughput.

During the microfiltration of ß-lactoglobulin on a 0.1 μm zirconium oxide membrane, in the presence of calcium and with high fluxes, protein-protein interactions at or near the pore entrance lead to pore narrowing and the eventual retention of protein by the membrane. High localised shear rates at the pore entrance lead to partial unfolding of the protein and calcium appears to form an ion-bridge between exposed negatively charged protein groups leading to aggregation and multi-layer deposition on the membrane pore walls. The removal of calcium or a reduction in the permeate flux prevents severe fouling and greater than 90% transmission of protein can be achieved.

The importance of understanding the properties of the feed material in interpreting and explaining membrane fouling is stressed.

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Now all has been heard;
here is the conclusion of the
matter:
Fear God and keep his
commandments,
for this is the whole duty of man.

Ecclesiastes 12 v13.

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