362b Determining Protein Fouling Parameters from Microfiltration Test

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Microfiltration has been widely used for clarification of fermentation broth, cell removal and protein recovery, and sterile filtration. The key limitation is fouling of the membrane surface through deposition of protein aggregates on the microporous surfaces by pore blocking and subsequently formation of protein deposit or "cake" on these blocked pores. Ho and Zydney [2000] have presented a useful model in predicting the membrane flux behavior due to pore blockage and simultaneous cake formation on these blocked pores. The model provides a self leveling effect on flow through remaining unblocked pores of the membrane as well as flow through these partially blocked pores in which cake continues to deposit on these blocked pores further reducing flux.

In this work, we provide a novel approach to determine the three parameters of the Ho and Zydney fouling model from transient flux microfiltration test data. These fouling parameters are (1) alpha – the pore blockage parameter, (2) f'R' - f' factor contributes to growth of protein cake layer and R' is the specific protein layer resistance, and (3) Rpo - the initial protein layer resistance. Recognizing that there are two characteristic time scales in the problem: tau_b associated with kinetics of pore blockage which is related to alpha, and tau_c associated with the rate of cake formation which is related to the product f'R', the transient data are plotted in various "logarithmic type curve formats" and compare with test data to back out tau_b (from which alpha can be determined), and tau_c (from which f'R' can be obtained). Also Rpo can be determined after the pore blocking effect is "literally subtracted".

The present method has been applied to the microfiltration test results on bovine serum albumin obtained by Ho and Zydney [2000] to determine the fouling parameters for their tests. The fouling parameters determined compare well with those obtained by Ho and Zydney for a wide range of test protein concentrations. Further, these fouling parameters are used in the model to compare with the membrane flux data from Ho and Zydney with excellent agreement.

Unlike previous approaches with limited applicability in examining a certain range of time scale wherein either pore blocking or cake filtration dominates, the present methodology does not require assumption of dominance of either pore blocking or cake filtration as both are indeed occurring concurrently and these are reflected in the transient flux data in a complicated and intermingled manner. Thus, this allows interpretation of a much wider range of test data which often could have been considered as uninterpretable with conventional approaches. Finally, the present approach can be used to interpret microfiltration testing for a given protein solution from which one can optimize the design and operating conditions of this important process to reduce fouling as well as making process prediction.

Keywords:

Protein, fouling, membrane filtration, microfiltration, transient, flux data, cake formation, pore blocking.

Reference:

C. C. Ho and A. Zydney, "A combined pore blocking and cake filtration model for protein fouling during microfiltration," J. of Colloidal and Interface Sc., 232, 389-399, 2000.