Journal of Membrane Science, 48 (1990) 343–347
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

Short Communication

EFFECT OF TURBULENCE ON FILM PERMEABILITY IN CROSS-FLOW MEMBRANE FILTRATION

RUBEN D. COHEN

Department of Mechanical Engineering & Materials Science, Rice University, Houston, TX 77251 (U.S.A.)

(Received March 27, 1989; accepted in revised form July 11, 1989)

Summary

A previously developed model for the laminar cross-flow membrane filtration of coagulating particulate suspensions is extended to account for turbulence. This is made possible by utilizing certain existing semi-empirical expressions for turbulence induced coagulation rates in pipe flow and applying them to the present model. One of the important results obtained here is that in certain situations turbulence induced coagulation has a significant impact on the filter cake structure, and thereby on the flux decline rate. In such cases, therefore, in addition to the influence of turbulence induced diffusivity at the cake–solution interface on cake growth rate (and consequently on the flux decline rate), the effects of coagulation caused by turbulence must also be considered.

Introduction

A simple model accounting for the effects of dispersion destabilization on flux decline rates in membrane filtration was previously proposed [1]. Qualitatively, the model appears to be in satisfactory agreement with the repeated observation that coagulation of the suspension during filtration leads to significant enhancements in product flux, caused by an increase in filter cake permeability. Moreover, it was established that the permeability controlling parameter is a dimensionless quantity, β, expressible by

$$\beta = \omega t_R \qquad (1)$$

where ω represents the coagulation frequency, and t_R is the residence time. It should be noted that ω, in general, is dependent on solution chemistry, stability and flow properties, while t_R is mainly governed by the flow and geometry.

Furthermore, it was demonstrated that the magnitude of β strongly influences the permeability characteristics of the filter cake by affecting the effective sizes of particles depositing on the membrane surface. For example, if the system design implies that

0376-7388/90/$03.50