465g A Novel Approach for Predicting Permeate Flux Decline in Protein Ultrafiltration

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Ultrafiltration (UF) is widely used for protein bioseparation, mainly for concentration, buffer exchange and desalting. Traditionally, UF is carried out at constant transmembrane pressure. One of the major challenges faced in this mode of operation is the decline in permeate flux with time due to concentration polarization and membrane fouling. Membrane fouling is a complex phenomenon which involves the interplay of a large number of physicochemical factors such as protein concentration, solution pH and salt concentration, and hydrodynamic factors such as wall shear rate and permeate flux. Since the permeate flux decreases which time in constant pressure UF, this hydrodynamic component is almost self-attenuating in nature. It is therefore difficult to model membrane fouling based on first principles. Most models for permeate flux decline in ultrafiltration are based on assumption of exponential decay or minor variants of the same. An alternative way to study membrane fouling is under constant permeate flux conditions. In constant flux ultrafiltration the hydrodynamic factors are kept constant and membrane fouling manifests itself in the form of continuous increase in transmembrane pressure with time. The initial observed increase in transmembrane pressure is non-linear in nature and is due to a combination of rapid initial fouling, concentration polarization and a constant fouling component [1]. Over the remainder of the process a linear increase in transmembrane pressure with time is observed and this is thought to be due to the constant long-term fouling component alone. A simple model for this manner of membrane fouling was proposed by one of the authors [1]. More recently, we have proposed a novel method for modeling the decline in permeate flux in constant pressure UF using a transposed from of the model developed for fouling in constant flux UF [2]. Constant pressure UF was assumed to be made up of a large number of sequential constant flux steps. Scale independent data was extracted from constant flux ultrafiltration experiments and these were fed into the constant pressure UF model to predict the permeate flux decline with time. The current work is essentially an experimental validation of this proposed model. A series of constant flux ultrafiltration experiments was carried out using Human Serum Albumin (HSA) as model foulant. Data extracted from these experiments were used to simulate permeate flux decline in constant pressure HSA ultrafiltration. The simulation data is compared with that obtained experimentally.

References: 1. R. Ghosh, Study of membrane fouling by BSA using pulsed injection technique, Journal of Membrane Science 195 (2002) 117-126. 2. D.M. Kanani, R. Ghosh, Study of membrane fouling by proteins: a model for predicting long-term membrane fouling, 54th Canadian Chemical Engineering Conference 2004, Calgary (October 2004).