S3.5.3 OPTIMIZATION OF CROSS FLOW FILTRATION FOR NASA MISSION SPECIFIC CONSTRAINTS

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In previous work the authors have presented analytical solutions for cross flow filtration models in both cylindrical and rectangular geometries: [N.H. Andreas and C.L. Cox, "New Cross Flow Filter Module Design Parameters: A Theoretical Analysis of Cross Flow Filter Performance Limits", Filtration, 13(4), 247-256, (2013)] and [N.H. Andreas, C.L. Cox, T. Kato, and M. Tamura, "A Model for Transient Cross Flow Filtration in a Narrow Rectangular Domain", Separation and Purification Technology, to appear]. Simultaneous solution of the continuity equations for the carrier and dispersed phases and a modified Darcy equation [Andreas, Advances in Filtration and Separation Technology, 7, 1993, 102-105] result in analytical solutions for permeate flux, carrier fluid flow rate, and pressure, which depend on axial distance and time. Key process governing parameters, including maximum filter length and operating time, arise during the analysis.

Potential applications of the models developed so far fall into one of two categories: Category I problem: Prediction of the performance envelope of a fully characterized filter, and Category II problem: Projected design of a cross flow filter to provide a sufficiently specific performance envelope. Previous efforts have focused on using the models for Category I problems. In order to solve Category II problems, the model of interest must be incorporated within an optimization algorithm so that mission-specific constraints, e.g. filter launch mass, volume footprint, media regeneration process energy requirements are satisfied by the filter design.

The applications of interest, involving particulate filtration, include closed cabin air filtration and dust removal in the processing of the carbon dioxide from the Martian atmosphere to protect the catalyst system of the Sabatier Reactor for the production of water. We will describe an approach for maximizing the permeate flow rate per unit pressure while seeking to minimize the filter mass and volumetric footprint.