Evaporation from Porous Media

Industrial Presenter

W. L. Gore, Inc.

Thirty-Sixth Annual Workshop on Mathematical Problems in Industry
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Introduction

The 36th Annual Workshop on Mathematical Problems in Industry (MPI), was held virtually for the first time from June 14–18, 2020. Participants from multiple time zones across the globe coordinated their efforts to work on the industrial problem presented. Special thanks go to the lead organizer, Taras Lakoba of the University of Vermont, who handled all the hosting and technical duties. Other members of the organizing committee were David A. Edwards and Louis Rossi (University of Delaware), Linda Cummings (New Jersey Institute of Technology), and Richard Moore (Society for Industrial and Applied Mathematics).

At the workshop, several industrial representatives from Gore (Uwe Beuscher, Vasudevan Venkateshwaran, and Zhenyu He) presented the following problem in evaporation in porous media.

In certain liquid filtration problems, a fluid flows through a porous media designed to trap solute molecules. (In the case under consideration, the porous media is polytetrafluoroethylene, better known as PTFE.) As the solvent evaporates, these surfactant molecules are left behind on the internal pore walls. Questions then arise about the mass distribution of the solute molecules left as the solvent evaporates, whether the pores will clog as the evaporation process occurs, etc.

This manuscript is really a collection of reports from teams in the group working on several aspects of the problem. Here is a brief summary of each:

1. Breward *et al.* consider a pore-level analysis. Solute transport and pore clogging are considered for two cases. In the first, the pores are treated as fluid-filled cylinders bounded by the porous media matrix. In the second, the porous media is treated as solid cylinders immersed in the solvent. Analytical and numerical results are obtained, indicating how the pores could clog with solute as the solvent evaporates.
2. Tilley and Broadbridge take a more macroscale approach, considering porous media flow in the filter as a whole. After specifying a suitable dimensionless PDE model, they perform numerical simulations to track the evaporation front and concentration of dissolved surfactant molecules.
3. Gu *et al.* examine the case of two surfactants in water using a ternary diagram and a system of ODEs to track their evolution.

In addition to the authors of these reports, the following people participated in the group discussions:

- Eduardo Corona and Pejman Sanaei, New York Institute of Technology
- Donald Schewendeman, Rensselær Polytechnic Institute
- Naren Vohra, Oregon State University