Modeling of Debris Deposition on an Extrusion Filter Medium

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At the Center for Advanced Engineering Fibers and Films (CAEFF), we are interested in simulating a fiber spinning process from the polymer melt to the finished product. One of the components of the process is the extrusion filter, which separates debris particles from the polymer. The strength properties of the fiber are severely weakened if these particles remain in the polymer during spinning.

The filter is often composed of a sintered metal, compressed with sufficient force to produce a cake material, or layers of wired mesh, with mesh spacings small enough to trap particles a few microns in diameter. Previous work in CAEFF has provided retention data for filter media and size distributions for debris particles [1.].

The mass flow rate through the filter at any time t must be constant; a decrease in this rate leads to a weakened fiber. However, as the filter is contaminated, the pressure at the filter inflow region must be increased to maintain the mass flow rate at the filter exit. The primary goal in filter management is to predict when the pressure drop across the filter becomes so large that it could damage the pumping mechanism.

In this talk, we will discuss models for the mechanisms that govern debris deposition in a porous filter medium. We consider the complete coupled, differential system that includes the flow equation for the suspension, the particle transport equation, and the equation that models particle deposition. The mass balance and particle transport equations are adjusted to account for non-Newtonian fluids. We will also discuss preliminary work on establishing probability models for the debris particles and give initial numerical results.

References

1. B. Seyfzadeh, D.A. Zumbrunnen and R.A. Ross. Non-Newtonian flow and debris deposition in an extrusion filter medium. SPE Proceedings, 2001.