

Polymer Processing Simulation for Foam Extrusion

By Hirohisa Shiode and Takeharu Isaki, Mitsui Chemicals, Inc., Material Science Laboratory, Chiba, Japan

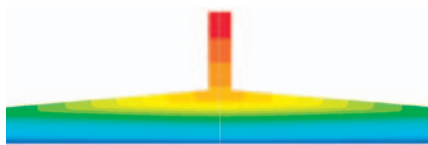
MITSUI CHEMICALS and Mitsui Chemicals Group produce a wide variety of chemical products from catalysts to polymers and fabricated products like films and fibers. The Computational Science Department at the Material Science Laboratory investigates simulation technologies and applications to research and development in the areas of chemistry, engineering, polymeric material design and polymer processing.

Since 1993, POLYFLOW has been used for polymer processing applications involving various rheology models, boundary conditions, and free surface flows, such as extrusions through complex and multi-layered dies and profile extrusions. One area of interest is foam extrusion, which includes gas dissolution into the polymer melt, viscosity reduction, nucleation with pressure drop, and bubble growth. The foam properties are closely related to cell structures, which are determined by the process conditions. A simulation method for gas-dissolved polymer flow has been developed for predicting these cell structures and the optimal die design. It makes use of a viscosity model, which is based on free volume theory [1,2] and which takes into account the temperature, pressure, and gas concentration in the melt. The model is implemented in POLYFLOW by means of user-defined functions (UDFs), and is used for 3D simulations of the flow through the die. To account for the shear-thinning behavior of the material, the Cross-Carreau model is adopted.

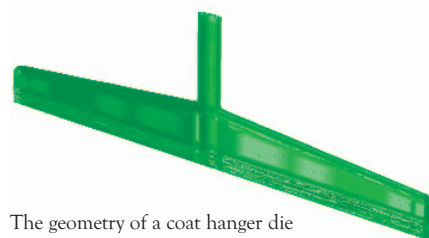
As an example, the customized model has been applied to the flow through a coat hanger style die. The results indicate that the pressure drop through the die decreases with increasing gas concentration as a result of the associated drop in viscosity. This result is consistent with experimental observations. Further work is now being conducted to couple the flow simulations with nucleation and cell growth. ■

References

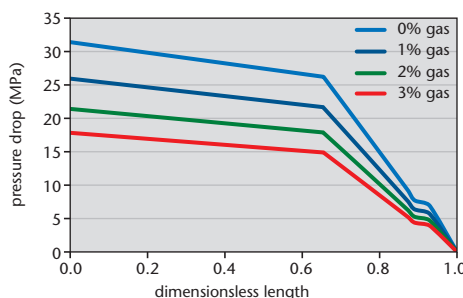
- Shiode, H. and Isaki, T.: Polymer-Supercritical Fluid Systems and Foams. Dec., Tokyo P-22 188, 2003.
- Williams, M.L., Landel, R.F. and Ferry, J.D.: J. Am. Chem. Soc., 77, 3701, 1955.



The pressure distribution in a coat hanger die with a gas concentration of 1%



The geometry of a coat hanger die



The pressure drop through a coat hanger die along the centerline for gas concentrations ranging from 0 to 3%



Please visit Fluent at AICHEMA 2006

Hall 9.2 - Booth J40

Each day, there will be a focus on a dedicated topic, as well as two live demo sessions at 10:30 and 16:00. Visitors to the stand will have the chance to enter a competition to win a free consulting project.