PREDICTION OF FORMATION PROPERTIES AND UNCERTAINTY WITH PORE NETWORK MODELING

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As part of our on-going efforts to develop HiMuST (Hierarchical Multiscale Simulator Technology), an integrated simulator for hydrocarbon flow through porous formations using a hierarchy of simulations, we are faced with the problem of the characterization of the properties of the porous medium based on numerical methods. Determination of these properties when only scarce information is available plays a vital role in predicting the behavior of systems such as hydrocarbon reservoirs and aquifers.

Pore network (PN) models can be used to provide computational predictions of the medium permeability, k, and the non-Darcy flow coefficient, β [1, 2]. We have developed both 2D and 3D implementations that are very flexible in the variety of networks that they can generate. For each pore, the length, the diameter, the orientation, and the coordination number (the number of pores incident on a vertex) are randomly distributed according to user-specified probability density functions. A flow simulation module solves the equations that describe single phase flow through the PN (i.e., flow though a pipe, mass balance and mechanical energy balance around junctions). Our approach to the problem, based on Monte Carlo (MC) methods, is to solve for the flow in a large number of PN realizations. Statistical analysis of the results reconstructs the macroscopic behavior of the system and provides a measure of the uncertainty for the porous medium properties. In the case of non-Darcy flow, a correlation between permeability and non-Darcy flow coefficient is estimated from the MC results.

It is found that these properties are strongly affected by the porous medium structure. A model based on ordinary least square estimation will be presented that predicts the permeability as a function of parameters such as the pore size distribution, the porosity of the medium, the orientation of the pores and the tortuosity. The effects of compaction on permeability and on β will also be discussed.

Literature Cited

1. Wang, X., Thauvin, F., and K.K. Mohanty, (1999) *Chem. Eng. Sci.,* **54**, 1859-1869.

2. Lao, H-W, Neeman, H.J., and D.V. Papavassiliou, "A pore network model for the calculation of non-Darcy flow coefficients in fluid flow through porous media," in press, *Chemical Engineering Communications,* 2003.