Closure to "Discussion of 'Friction Numbers and Viscous Dissipation Heating for Laminar Flows of Water in Microtubes'" (2008, ASME J. Heat Transfer, 130, p. 082405)

Mohamed S. El-Genk
e-mail: mgenk@unm.edu

In-Hwan Yang

Institute for Space and Nuclear Power Studies,
Department of Chemical and Nuclear Engineering,
University of New Mexico,
Albuquerque, NM 87131

The derivation in our paper is for liquid (water) flow in a microtube, with a slip at the wall. For this problem, in the paper by El-Genk and Yang, a stationary microlayer, δ, whose thickness depends of the jump distance, β, separates the fluid flow from the wall of the microtube. In fact, the boundary of the flow field near the wall ($r = R - \delta$) moves with the slip velocity relative to the stationary adiabatic wall. Under this condition, the viscous dissipation and, hence, the temperature gradient at the wall would be negligible, justifying omitting of the volumetric conduction term in Eq. (3) in the commentary offered by Asako. With no-slip at the wall, viscous dissipation could be important in some cases, e.g., for high viscosity fluids and gasses, but not when the effect on the fluid temperature is small. This is certainly truer as Reynolds number increases.

The commentary by Asako on the above referenced paper, questions the reasoning for omitting the volumetric heat conduction term $[k(1/r)(\partial/\partial r)(k(\partial T/\partial r))]$ in the energy equation (Eq. (3)). While the formulation by Asako in the above discussion is mathematically correct, in practice, making realistic assumptions help coming up with a closed form solution that is useful, without compromising the accuracy of the results. This is particularly true when comparing with the experimental measurements, in order to make the case for the plausibility, or the absence, of a slip at the wall of a microtube. For flow through microtubes or microchannels, the fluid is under stress due to the applied high pressure. Such pressure could exceed 100 MPa. In short, the viscous dissipation term for liquid flow in a microtube or a microchannel with a slip boundary is negligible.

We regret the statement "*However, there is a significant error in the above paper….*" Our paper explicitly states the assumptions and the practical reasoning from them, making it clear why omitting the volumetric conduction term in the energy equation was justified. When the flow velocity and the liquid thermal conductivity are low, even with no slip at the wall (i.e., $\delta = 0$), viscous heat generation could be negligible, and hence, the temperature gradient ($\partial T/\partial r$). In this case, omitting the volumetric heat conduction term in the energy equation $[k(1/r)(\partial/\partial r)(k(\partial T/\partial r))]$ would be justified.

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