Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Nanofluid Flow and Heat Transfer in Channel Entrance Region

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The present work uses the continuum description of nanofluid flow to study the flow, heat and mass transfer in the entrance and developing region of channels or tubes, where the viscous and heat conduction layers are thin and the heat transfer is much more intense than fully developed flow. Instead of supplementing the formulation with thermodynamic properties based on mixture calculations, use is made of recent molecular dynamical computations of such properties, specifically, the density and heat capacity of gold-water nanofluids. The more general formulation results, within the Rayleigh-Stokes (plug flow) approximation and perturbation for small volume fraction, show that the nanofluid density-heat capacity has an enormous effect in the inertia mechanism in causing the nanofluid temperature profile to steepen. The nanofluid thermal conductivity though has an explicit enhancement of the surface heat transfer rate has the almost hidden effect of stretching the nanofluid temperature profile thus giving the opposite effect of enhancement. Quantitative results for Gold-Water nanofluid is presented.

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Date submitted: 01 Aug 2014 Electronic form version 1.4