Nanofluidic flows in the tubes and minimum entropy generation principle

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Flows of the suspensions of nanoparticles ($d \sim 1 - 500nm$ nanofluids) and microparticles ($d \sim 1 - 500mcm$ microfluids) through nano/microtubes, channels and other types of ducts are governed my the Navier-Stokes equations with velocity slip and temperature jump boundary conditions at the walls [1]. During the past decades numerous units and systems for mixing, purification, separation, heating and cooling of micro and nanofluids have been proposed for technical, electrical and biomedical applications [2]. In this paper the nanofluid flows through a circular microtube driven by the pressure drop at the ends of the tube, with heat exchange through the wall is studied. At some types of boundary conditions the analytical solution for the velocity v, pressure p and temperature T distributions can be obtained. The entropy production in the system can be then computed as [3]

$$\dot{S} = \frac{1}{V} \int_V \left(\frac{\nabla^2 T}{T^2} + ReEuEc \frac{v \cdot \nabla p}{T} \right) dV, \tag{1}$$

where Re, Eu and Ec are the Reynolds, Euler and Eckert numbers, V is the volume of the duct.

Numerical computations on (1) needs a large set of the material parameters. That allows finding out the optimal control and flow optimization as a relationships between the dimensionless combinations of the parameters. Some reasonable ways to minimize the dissipation in the micro heating or cooling system based on the nanosuspensions with certain properties are discussed.

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