Nanocomposited and nanomaterials

Towards design of nanoporous materials with optimal properties

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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 [1]. Micro and nanoporous materials can also provide efficient transportation, adsorption, and mixing of fluids. The simplest model of the porous material is based on the bunch of parallel tubes (Kozeni model). In this paper the model is generalized for the micro/nanotubes and micro/nano fluid flows. The difference with the Kozeni model is the 1-st/2-nd order velocity slip and temperature jump boundary conditions that influence the flow rate through each single tube and, therefore, through the porous media [2], allowing the system design optimization for given flow conditions.

Different packing of the tubes in the volume has been considered: quadratic, rhombic, triangular and hexagonal. The tubes of the same cross section and different distances between them have been studied. The following expression for the permittivity of the composed porous medium has been obtained

$$K = \frac{m^3(1-2aKn\lambda + bKn^2\lambda^2)}{\varphi \mathrm{k}(1-m)^2 S_T^2} \tag{1}$$

where m is porosity, S_T is the ratio of the porous surface to the solid volume, a, b are the 1-st and 2-nd order slip coefficients, Kn is the Knudcen number, $\lambda = (1-m)S_T / m$, φ is the tortuosity, $k = const$ dependent on the cross section of the tube. When $a, b = 0$, (1) gives the well-known Karman- Kozeni formula.

The steady and wave flow of the micro/nano fluids in the porous medium are studied based on (1). The numerical results are compared to the experimental data.

1. *Gad-el-Hak M.* The MEMS Handbook. Second ed. CRC Press, New York. – 2006.
2. *Cherevko V., Kizilova N.* Complex flows of immiscible microfluids and nanofluids with velocity slip bounary conditions // Nanoplasmonics, Nano-Optics, Nanocomposites, and Surface Studies, Springer Proceedings in Physics, **183**, O. Fesenko, L. Yatsenko (eds.). – 2018.