IX Minsk International Seminar "Heat Pipes, Heat Pumps, Refrigerators, Power Sources",
Minsk, Belarus, 07-10 September, 2015

THE DEVELOPMENT OF MATHEMATICAL MODELING FOR NANOFLUID AS A POROUS MEDIA IN HEAT TRANSFER TECHNOLOGY

Amarin Tongkratoke[1], Anchasa Pramuanjaroenkij[1*], Apichart Chaengbamrung[2] and Sadık Kakaç[3]
[1]Department of Mechanical and Manufacturing Engineering,
Kasetsart University, Chalermphrakiat Sakon Nakhon Province Campus,
Sakon Nakhon 47000 Thailand
[*]E-mail: anchasa@gmail.com
[2]Department of Mechanical Engineering,
Kasetsart University,
Bangkok 10900 Thailand
[3]Department of Mechanical Engineering,
TOBB University of Economics and Technology,
Ankara 06560 Turkey

Abstract

Nanofluids are terms representing combinations of nanoparticles and base fluids and used as working mediums in heat transfer technologies. The nanoparticles possess high thermal conductivity property; they can improve overall heat transfer properties of the base fluids (low thermal conductivity) mixed with the particles. In the nanofluid flow, the nanoparticles flowed together with the base fluid and the particles could be assumed to distribute themselves uniformly throughout the base fluid, the nanofluid flow could also be assumed as the fluid flow through the uniform porous media with nanofluid properties. This work presented a mathematical model of the nanofluid flow which has been developed as the steady flow of the base fluid through the porous medium of the Al_2O_3 nanoparticles. The simulated nanofluid flow was to be under fully developed laminar flow condition through a rectangular pipe. The governing equations written in terms of the 3-D dimensionless variables were solved through an in-house program by using the finite volume method with the SIMPLE algorithm. Since the Al_2O_3/water nanofluid flow was simulated as the flow through the porous media, so effects of the porous media characteristics; porosity and thermal conductivity, were studied. The porosity values of 0.98 were considered for the nanofluid volume fraction of 0.02% as relationships between the porosity and the volume fraction. The mixing thermal conductivity model; Yu and Choi model coupled with Maxwell model, was applied for the thermal conductivity model of the porous media. From results, the assumed relationships between the porosity and the volume fraction could be proved to be satisfied; this implied that the particles were distributed uniformly throughout the fluid and the nanofluid flow could be taken as the fluid with the nanofluid properties flowing through the porous media. The developed model using the mixing thermal conductivity model with the porous media assumption could improve the model performance and supported its excellent potential in the nanofluid simulation as the porous media.