Effect of Thermophysical Properties of Fluids on Heat and Mass Transfer in Energy Systems

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The main purpose of the present work is a study of the effect of kinematic viscosity, density, conductivity, ion concentration and other properties of electrically conducting fluids (such as solutions of salts and acids, liquid metal coolants etc.) on the vortex motion and swirling of a flow. It was considered an interaction of three factors acting on conductive fluid: constant magnetic field, electric field and swirling of a flow. Presence of two of the three above-mentioned factors leads to appearance of the third. Effects based on interdependency between electrical, magnetic and vortex fields and their influence on velocity flow and heat transfer for liquids with different thermophysical properties were studied. The present research program included development of experimental setup, choice of electrolyte as a modeling liquid, elaboration of techniques for measurement of thermophysical parameters and visualization methods of vortex formation process. Constant magnetic field was created by means of sphere-shape magnet placed in the centre of a tank with electrolyte. Experiments were fulfilled for various solutions of electrolytes. For obtaining of the most precise visualization pictures, the solution of acetic acid was chosen. There were two electrodes under electrical voltage: spherical magnet itself and mobile cylindrical probe having the opportunity to change an angle between probe direction and magnetic axis of sphere. Formation of complicated closed helical vortex structures was visualized in the liquid around the moving probe during the passing of electric current. The physical explanation of the observed processes was proposed on the base of experimental results. The report contains the illustrations demonstrating agreement of proposed physical model of heat and mass transfer with obtained visualization pictures of vortex motion and temperature distributions. Revelation of mechanisms of enhancement of heat and mass transfer in conducting fluids placed in magnetic field is topical for engineering energy systems, such as, for example, nuclear reactors with liquid metal coolants and for prediction of some hazardous geophysical processes such as hurricanes, tornados, tsunami, changing the direction of ocean currents.