Abstract

The present thesis is concerning with non-isothermal spherical Couette flow of Oldroyd-B fluid in the annular region between two concentric spheres. The inner sphere rotates with a constant angular velocity while the outer sphere is kept at rest. The viscoelasticity of the fluid is assumed to dominate the inertia such that the latter can be neglected. A solution of momentum and energy equations up to second order approximation is obtained through expanding the dynamical fields in terms of Name number. Two boundary value problems are considered. The first deals with the motion of the fluid under the action of viscous heating. The second problem is concerned with the combined fluid flow and heat transfer due to viscous heating and temperature gradient from heated boundaries.

The analyses of the first boundary value problem shows that, two additional contributed terms are delivered due to viscous heating; namely, a first order axial-velocity component and a second order stream function. The amplitude of these fields increases as the gap width between the two spheres increases, but the general distribution does not affected. Temperature profile has appeared in first and second order approximation. The first order temperature distribution is identical for all this category of fluids but the second order depends mainly on the gap width between the two spheres. The study reveals that the temperature due to viscous heating mechanism is being of order one degree in agreement with all experimental data in the literatures.

The increase of the temperature of the fluid decreases the rheological properties of the fluid. So, the existence of temperature gradient in second problem provides the same fields but with different properties. First order axial velocity amplitude decreases by that obtained in the first problem. The distribution and amplitude of first and second order secondary flow depend on the fluid parameters and the gap width. On the other hand, the temperature contribution due to heated boundaries appeared in zero order approximation showing that the fluid behaves as solid conductor. The temperature due to viscous heating revealed in first and second approximation. The strong dependence of the fluid parameters on temperature in this problem doesn't enable us to predict the secondary flow and second order heat distribution for this band of fluids.

In general, the axial velocity depends mainly on the gap width between the two spheres and viscous heating process enforced as the temperature of the fluid decreases. Finally, the rate of secondary flow increases with increasing the thermal conductivity and relaxation time and decreases with increasing sensitivity of the fluid and its viscosities.

The force acting on the outer sphere is zero due to the symmetry and there are two torques acting on the outer sphere, one due to primary flow and the other due to first order axial velocity. These torques depend mainly on the gap width between the spheres and decrease exponentially with increasing fluid temperature.