Non-coaxial rotating flow of viscous fluid with heat and mass transfer

Ahmad Qushairi Mohamad[1] · Ilyas Khan[2] · Sharidan Shafie[1] · Zaiton Mat Isa[1] · Zulkhibri Ismail[3]

1 Department of Mathematical Sciences, Faculty of Science, Universiti Teknologi Malaysia, 81310 Johor Bahru, Malaysia
2 Basic Engineering Sciences Department, College of Engineering Majmaah University, Majmaah 11952, Saudi Arabia
3 Faculty of Industrial Science and Technology, Universiti Malaysia Pahang, 26300 Kuantan, Pahang, Malaysia

Abstract

Heat and mass transfer in unsteady non-coaxial rotating flow of viscous fluid over an infinite vertical disk is investigated. The motion in the fluid is induced due to two sources. Firstly, due to the buoyancy force which is caused because of temperature and concentration gradients. Sec-ondly, because of non-coaxial rotation of a disk such that the disk executes cosine or since oscillation in its plane and the fluid is at infinity. The problem is modeled in terms of coupled partial differential equations with some physical boundary and initial conditions. The dimensionless form of the problem is solved via Laplace transform method for exact solutions. Expressions for velocity field, temperature and concentration distributions are obtained, satisfying all the initial and boundary conditions. Skin friction, Nusselt number and Sherwood number are also evaluated. The physical significance of the mathematical results is shown in various plots and is discussed for several embedded parameters. It is found that magnitude of primary velocity is less than secondary velocity. In limiting sense, the pre-sent solutions are found identical with published results.

Keywords Buoyancy convection · Non-coaxial rotation · Heat and mass transfer · Exact solution