Chapter 10
Double Diffusive Convection in a Layer of Maxwellian Visco–Elastic Nanofluid

INTRODUCTION

Double-diffusive convection or thermosolutal instability in a nanofluid occurs when the base fluid of the nanofluid is itself a binary fluid. Binary nanofluids such as when titanium dioxide nanoparticles (1% by mass) are dispersed in the mixture of water and eutectic of chloride salts (KCl-CaCl$_2$-LiCl). Double-diffusive convection is an important phenomenon that has various applications in the fields of chemical science, food processing, engineering and nuclear industries, geophysics, bioengineering and cancer therapy, movement of biological fluid, oceanography and also used as solar thermal applications. The onset of double-diffusive nanofluid convection in a layer of a saturated porous medium (the Horton-Rogers-Lapwood problem) was studied by Kuznetsov and Nield (2010a, 2010b, 2010c, 2011) and found that the stability boundaries for both non-oscillatory and oscillatory cases. The Cheng-Minkowycz problem for the double-diffusive natural convective...
boundary layer flow in a porous medium saturated by a nanofluid was studied by Nield and Kuznetsov (2009b). Yadav et al. (2012b) examined the effects of boundary and internal heat source on the onset of Darcy-Brinkman convection in a porous layer saturated by nanofluid and they have obtained the critical Rayleigh number as well as critical wave number by using Galerkin-type weighted residuals method.

Hence due to the importance of binary nanofluid, the main objective in this chapter is to examine theoretically the double-diffusive convection of Maxwellian visco-elastic nanofluid for more realistic boundary conditions.

MATHEMATICAL FORMULATIONS OF THE PROBLEM

The Physical Problem

In this chapter we shall investigate the double diffusive convection in a horizontal layer Maxwellian visco-elastic nanofluid. The physical configuration of the problem to be considered as:

An infinite horizontal layer of Maxwellian visco-elastic nanofluid of thickness ‘d’ bounded by horizontal boundaries z = 0 and z = d. A Cartesian coordinate system (x, y, z) is chosen with the origin at the bottom of the fluid layer and the z-axis normal to the fluid layer. Fluid layer is acted upon by gravity force \( \mathbf{g}(0, 0,-g) \) and heated from below in such a way that horizontal boundaries \( z = 0 \) and \( z = d \) respectively maintained at a uniform temperature \( T_0 \) and \( T_1 \) (\( T_0 > T_1 \)). The normal component of the nanoparticles flux has to vanish at an impermeable boundary and the temperature \( T \) is taken to be \( T_0 \) at \( z = 0 \) and \( T_1 \) at \( z = d \), (\( T_0 > T_1 \)) as shown in Figure 1. The reference scale for temperature and nanoparticles fraction is taken to be \( T_1 \) and \( \phi_0 \) respectively.

Assumptions

The mathematical equations describing the physical model are based upon the following assumptions:

1. Thermophysical properties of fluid except for density in the buoyancy force (Boussinesq Hypothesis) are constant,
2. The fluid phase and nanoparticles are in thermal equilibrium state and thus, the heat flow has been described using one equation model,
3. Dilute mixture,
4. Nanoparticles are spherical,
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Hidehiro Kamiya (2014). *Surface Engineering Techniques and Applications: Research Advancements* (pp. 281-305).

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