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MASS TRANSFER OF FREE CONVECTION FLOW BETWEEN TWO PARALLEL OSCILLATING PLATES.

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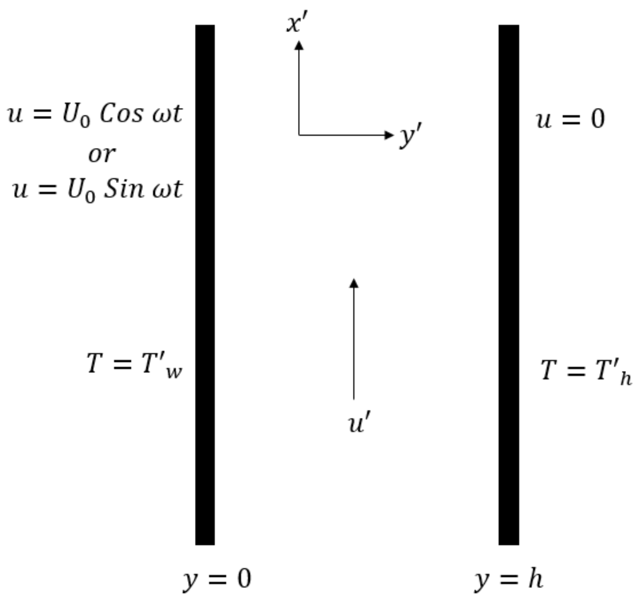
RESEARCH HIGHLIGHTS

This paper investigated unsteady free convection flow between two parallel plates with mass diffusion. One of the plate are considered oscillating. Appropriate non-dimensional variables are used to reduce the dimensional governing equations along with imposed initial and boundary conditions. The exact solution for velocity, temperature and concentration profiles are obtained using the Laplace Transform technique. The graphical results of the solutions are presented to illustrate the behavior of the fluid flow with the influenced of Schmidt number, Prandtl number, oscillating parameter, Grashof and mass Grashof number. The corresponding expressions for skin friction, Nusselt number and Sherwood number are also calculated. It is observed that increasing Prandtl and Schmidt number will increased the Nusselt number but decreased the skin friction.

Keywords: *Free Convection, Parallel Plates, Mass Diffusion, Oscillating*

GRAPHICAL ABSTRACT



RESEARCH OBJECTIVES

The aim of this research is to investigate oscillating free convection between two parallel plates with mass diffusion. It is because fluid flows between parallel plates have received much attention due to the various applications involving heat transfer. It has various application such as in petroleum industry, purification of crude oil, pumps accelerators and power generators (1). Researchers have took a great interest investigated problem regarding free convection flow between two parallel plates (2,3). Oscillatory flow between parallel plates have received some attention between the researchers. There are many researchers considered oscillation in their research such as (4-6) but not many considered oscillations in between two parallel plates. The importance of oscillation problem is it has various applications in science and engineering such as in heat exchanger. That is why we are interested to investigate oscillation problem between two parallel plates with mass diffusion.

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Materials and Methods

This research would investigate oscillating free convection flow between two parallel plates with mass diffusion. The governing equation was introduced under Bousssinesq' approximation and was reduced by using non dimensional variables. The dimensionless equation would be solved by using exact method which are Laplace Transform. The results would be plotted by using Mathematica software and the behavior of the fluid would be discussed. Equation below shows dimensionless governing equations,

$$\frac{\partial u}{\partial t'} = \frac{\partial^2 u}{\partial y^2} + Gr\theta + GmC$$

$$Pr\frac{\partial \theta}{\partial t} = \frac{\partial^2 \theta}{\partial y^2}$$

$$\frac{\partial C}{\partial t} = \frac{\partial^2 C}{\partial y^2}$$

$$t \leq 0 \ : \ u = 0 \quad \theta = 0 \quad C = 0 \quad 0 \leq y \leq 1$$
$$t > 0 : \ u = cos\, \omega t \ and \ sin\, \omega t \ \theta = 1 \ \ C = 1 \ \ y = 0$$
$$u = 0 \quad \theta = 0 \quad C = 0 \quad y = 1$$

Where,

$$Gr = \frac{g\beta h^2}{\nu U_0}(T_w' - T_h') \qquad Gm = \frac{g\beta^* h^2}{\nu U_0}(C_w' - C_h') \qquad Sc = \frac{\nu}{D} \quad Pr = \frac{\mu C_p}{k}$$

Gr is the thermal Grashof number, *Gm* is the mass Grashof number, *Pr* is the Prandtl number, *Sc* the Schmidt number and ωt is the oscillating parameter. The equation will be solved using Laplace transform.

Results

The solutions was verify by checking LHS is equal with RHS. From the solutions it is determined that LHS is equal to RHS. This is to check the correctness of the solutions. From the solutions, it shows that increasing Sc number will decreased the concentration but increasing Pr number will decreased the temperature of the fluid flow. Then we would like to see the effects of different parameters on the velocity profile. For oscillation parameter, the graph shows that increasing the oscillation parameter will cause the velocity to decrease. Then we woluld like to see velocity field with different Grashof number (Gr) and mass Grashof number (Gm). It is observed that velocity increasing with increasing the value of Gr. Similar to mass Grashof number, when Gm is increased, the velocity was found increased. For Nusselt number, it shows that increasing the Pr number will increases the Nusselt number. While for skin friction, increasing Pr number causes the skin friction decreases. For Sherwood number shows that increasing the Sc number will increase the Sherwood number. The solution satisfy the boundary condition of the problem.

Findings

From this study, it was found that increasing Schmidt number will decreased the concentration of the fluid but increased the Sherwood number. While for Prandtl number, increasing Prandtl

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number will decreased the temperature and skin friction but will increased the Nusselt number. For oscillation parameter, it was found that increasing the oscillation parameter will decreased the velocity. While increasing Grashof and mass Grashof number will increased the velocity of the fluid flow.

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