TRANSACTIONS ON SCIENCE AND TECHNOLOGY

Viscous Dissipation Effect on the Mixed Convection Boundary Layer Flow towards Solid Sphere

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Received: *20 March 2016*
Revised: *26 April 2016*
Accepted: *29 April 2016*
In press: *2 May 2016*
Online: *30 June 2016*

Keywords:
Mixed convection; Solid sphere; Viscous dissipation

Abstract

In this study, the steady mixed convection boundary layer flow and heat transfer towards solid sphere with viscous dissipation effect is considered. The non linear parabolic partial differential equations are transformed before being solved numerically by Keller-box method. The effects of different Prandtl number values, the parameter of mixed convection and Eckert number are elaborated. The presence of viscous dissipation effect reduced the Nusselt number which physically promoted a conduction heat transfer process along the sphere surface. Further, the Prandtl number gives more significant impact on reduction of thermal boundary layer compared to mixed convection parameter.

Introduction

Convective flow on sphere surface becomes an important topic considered. Due to its contributions in engineering and industrial applications such as the spherical storage tanks, the vaporization and condensation of fuel droplets, packed beds in a chemical reactor or distillation process and in many electronic component that nearly spherical. The efficiency of heat transfer process (convective) depends on various factors including the design, the flow, conductivity, viscosity and the characteristic of the fluid used.

The experimental study on mixed convection boundary layer regarding the sphere surface are first done by Yuge (1960). The analytical and experimental study then has been proposed later by Hieber and Gebhart (1969) with considering the Reynolds and Grashof numbers in tiny scale. Next, Chen and Mucoglu (1977) and Mucoglu and Chen (1978) solved this topic by using approximation technique. The Huge Reynolds and Grashof values are considered with two boundary conditions which is constant wall temperature and constant heat flux. Later, Nazar *et al.* (2002) updated the works of Chen and Mucoglu (1977). The numerical solution from the stagnation point $\left(x=0^\circ\right)$ to $x=120^\circ$ is obtained.

The objectives of the present study is to update the work of Nazar *et al.* (2002), with considering the effects of viscous dissipation on a solid sphere. The viscous dissipation is easily to understand as