A stability analysis of solutions on boundary layer flow past a moving thin needle in a nanofluid with slip effect

ABSTRACT

The purpose of this work is to study the effects of partial slip on the boundary layer flow over a moving horizontal thin needle in nanofluid. Three types of nanoparticles, namely, alumina, copper and titania are considered. The self-similar ordinary differential equations are obtained by adopting the similarity transformations and these equations are then solved numerically using bvp4c function in MATLAB software. Special emphasis has been given to the parameters of interest which include the nanoparticle volume fraction, slip, needle size and velocity ratio. The effect of these parameters on the velocity and temperature profiles, skin friction coefficient and heat transfer rate are further discussed through graphs. It is revealed from the study that the dual solutions exist when the needle oppose the direction of the fluid motion $\varepsilon < 0$, and the range of the possible solutions obtained is strongly depending on the needle size and slip parameters. The stability of the solutions is determined using a stability analysis. This analysis indicated that the upper branch solution is linearly stable and there is an initial decay of disturbance in the system. Meanwhile, the result is invertible for the lower branch solution.

Keyword: Dual solutions; Nanofluid; Slip; Stability analysis; Thin needle