

STABILITY ANALYSIS OF STAGNATION-POINT FLOW PAST A SHRINKING SHEET IN A NANOFLUID

(Analisis Kestabilan bagi Aliran Titik-Genangan melalui Helaian Mengecut dalam Nanobendalir)

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ABSTRACT

In this paper, a numerical and theoretical study has been performed for the stagnation-point boundary layer flow and heat transfer towards a shrinking sheet in a nanofluid. The mathematical nanofluid model in which the effect of the nanoparticle volume fraction is taken into account, is considered. The governing nonlinear partial differential equations are transformed into a system of nonlinear ordinary differential equations using a similarity transformation which is then solved numerically using the function *bvp4c* in Matlab. Numerical results are obtained for the skin friction coefficient, the local Nusselt number as well as the velocity and temperature profiles for some values of the governing parameters, namely the nanoparticle volume fraction ϕ , the shrinking parameter λ and the Prandtl number *Pr*. Three different types of nanoparticles are considered, namely Cu, Al₂O₃ and TiO₂. It is found that solutions do not exist for larger shrinking rates and dual (upper and lower branch) solutions exist when $\lambda < -1.0$. A stability analysis has been performed to determine which branch solutions are stable and physically realisable. It is also found that the upper branch solutions are stable while the lower branch solutions are unstable.

Keywords: heat transfer; nanofluid; shrinking sheet; stability analysis; stagnation-point flow

ABSTRAK

Dalam makalah ini, kajian secara teori dan berangka telah dilakukan bagi aliran lapisan sempadan titik-genangan dan pemindahan haba terhadap helaian mengecut dalam nanobendalir. Model nanobendalir bermatematik dengan mengambil kira kesan pecahan isi padu nanozarah telah dipertimbangkan. Persamaan pembezaan separa menakluk tak linear dijelmakan kepada suatu sistem persamaan pembezaan biasa tak linear menggunakan penjelmaan keserupaan yang kemudiannya diselesaikan secara berangka dengan fungsi *bvp4c* dalam Matlab. Keputusan berangka diperolehi bagi pekali geseran kulit, nombor Nusselt setempat, serta profil-profil halaju dan suhu bagi beberapa nilai parameter menakluk seperti pecahan isi padu nanozarah ϕ , parameter mengecut λ dan nombor Prandtl *Pr*. Tiga jenis nanozarah berbeza yang dipertimbangkan adalah Cu, Al₂O₃ dan TiO₂. Didapati bahawa penyelesaian tidak wujud bagi kadar pengecutan yang lebih besar dan penyelesaian dual (cabang atas dan bawah) wujud apabila $\lambda < -1.0$. Analisis kestabilan dilakukan bagi menentukan penyelesaian cabang yang stabil dan bermakna secara fizikal. Didapati juga bahawa penyelesaian cabang atas adalah stabil manakala penyelesaian cabang bawah tidak stabil.

Kata kunci: pemindahan haba; nanobendalir; helaian mengecut; analisis kestabilan; aliran titik-genangan

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