

RESEARCH ARTICLE

Dual Solutions for Nonlinear Flow Using Lie Group Analysis

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Abstract

The aim of this analysis is to investigate the existence of the dual solutions for magnetohydrodynamic (MHD) flow of an upper-convected Maxwell (UCM) fluid over a porous shrinking wall. We have employed the Lie group analysis for the simplification of the nonlinear differential system and computed the absolute invariants explicitly. An efficient numerical technique namely the shooting method has been employed for the constructions of solutions. Dual solutions are computed for velocity profile of an upper-convected Maxwell (UCM) fluid flow. Plots reflecting the impact of dual solutions for the variations of Deborah number, Hartman number, wall mass transfer are presented and analyzed. Streamlines are also plotted for the wall mass transfer effects when suction and blowing situations are considered.



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Introduction

The non-Newtonian fluids at present are acknowledged more appropriate for scientific and technological applications than the materials obeying the Newtonian law of viscosity. However, there exists no single constitutive equation by which all the non-Newtonian materials can be described. Researchers and applied mathematicians have proposed a variety of constitutive equations in view of their rheological properties describing the non-Newtonian behavior. Such constitutive equations give rise to several complexities in the momentum equations which arises various challenges for researchers to model the problems in mathematical forms and to evaluate/analyze the computed solutions mathematically and physically. The classifications of non-Newtonian fluids in general are classified into three types known as the differential, rate and integral. Available information on the topic indicates that much attention of the researchers has been accorded to the flows of second, third and fourth order fluids i.e. the subclasses of differential type materials. Undoubtedly these subclasses predicts the normal stress, shear thickening and thinning features but cannot describe relaxation time effect which many polymers show at low molecular weight. The relaxation time effect can be examined using Maxwell model (the simplest subclass of rate type fluid). The literature for flows of Maxwell fluid is quite sizeable. Few recent studies and several references on rheology of Maxwell fluid can be seen in the investigations [1–15].

Nonlinear Flow Using Dual Reciprocityhc2001 Vol 38

W. F. Florez



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Nonlinear Flow Using Dual Reciprocity W. F. Florez,2001 The purpose of this book is to introduce a boundary integral method based on domain partition for the solution of nonlinear fluid mechanics problems including non Newtonian applications In the present work the Dual Reciprocity Method has been improved by paritioning the domain into smaller sub domains and in each sub domain the Dual Reciprocity Method was applied to obtain an expression for the velocity field only in terms of boundary integrals Several numerical examples are presented including Newtonian flow at high Reynolds numbers and non Newtonian flow of polymers inside complex geometry Multi-domain Dual Reciprocity Method for the Solution of Nonlinear Flow Problems Whady Felipe Florez,2000

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