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A STUDY ON THE MOTION OF MULTICOMPONENT MEDIA IN PIPES

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بسم الله الرحمن الرحيم

NOTATIONS

A_1 average thickness of the first phase

A_2 average thickness of the second phase

A amplitude of the interfacial wave

B magnitude of variation in the cross area of flow

E complex valued function of y

E^i ith component of the electric field

F complex valued function of y

F_e electromagnetic force

F_g non electric force

f(x) real valued function of x

2H interface curvature

H_o magnetic field intensity

H^i ith component of the magnetic field

i complex variable

J^i ith component of the electric current density

l wave length of the periodic solid wall

m A_1 / A_2

P pressure

P_a ambient pressure

PDES partial differential equations

Q axial flow rate per unit length

q $Q^{(2)} / Q^{(1)}$

R Q/ν , Reynolds number

t time

T stress tensor

T_{ns} normalized stress tensor

T_{nn} normalized stress tensor

u x-direction velocity

v	y-direction velocity
w	z-direction velocity
x	Cartesian coordinate
z	Cartesian coordinate
Z_o	Position of the solid wall
Z_1	Position of the fluid-fluid interface

Greek symbols

α	$\mu^{(2)} / \mu^{(1)}$ ratio of viscosities
β	$\sigma\mu H_o$ magnetic parameter
β_1	$n\beta$ magnetic parameter
γ	Phase shift between fluid-solid and fluid-fluid interfaces
ε	B/A_2
θ	$\rho^{(2)}/ \rho^{(1)}$
Λ	$\mu Q/\sigma_1 A_1$, capillary number
λ	$2 \pi A_2 / l$
μ	viscosity
μ_e	magnetic permeability
ν	Kinematic viscosity
ρ	density
$\rho^{(1)}$	density for first phase
$\rho^{(2)}$	density for second phase
ρ_e	electric charge density
σ_1	surface tension
σ	conductivity of the medium
Ω	force potential of the field in which flow occurs
ψ	stream function
Δ	Laplacian operator

CONTENTS

English Summary

SUMMARY

This study deals with some problems suspended with the motion of multicomponent media in pipes .

The results of this thesis are very important from both a conceptual and an applicative point of view such that , in chemical industries , Nuclear reactors , Petrol industry and in some various industrial devices .

This thesis consists of five chapters :

Chapter one includes an introductry review and a general review of research works related to the proposed point under consideration is presented .

Chapter two contains the problem " Electrical conducting film flow down an inclined periodic plate " , the solution of the problem depends on the analysis of the flow of one fluid through a periodic plate , a regular perturbation analysis is performed to evaluate the velocity field of the one fluid flow and its interfacial shape , we found that the amplitude and the phase shift of the stream function depends on the parameters (β, λ, Λ and D) . The main results obtained in this chapter are summarized as evaluations of the flow of one fluid through a periodic plate show that the magnetic field increases the amplitude (A) of the stream function and decreases the phase shift (γ) of the stream function . There exist some results

depends on the parameters (β, λ, Λ and D) .

Chapter three contains the problem " Slow two-phase flow through a sinusoidal channel with porous wall " , the solution of the flow depends on the parameters ; β : the magnetic field parameter ; α: the ratio of viscosities ; Λ: the capillary number ; λ: the geometrical parameter ; m: the ratio between average thickness ; q: the relation between flow rates and V: the suction parameter . A regular perturbation analysis is performed to evaluate the velocity profile . The main results obtained in this chapter are summarized as follows , the amplitude of the stream function (A) decreases as the parameter of suction (V) is increased , the phase shift of the stream function increases as the parameter of suction (V) is increased . There is also some results on the parameters (λ, α, Λ, q and m) .

Chapter four contains the problem " Two-phase flow in a sinusoidal channel when one of the phases is electrically conducting " . The solution of the problem depends on the analysis of the two-phase flow through a sinusoidal channel , a regular perturbation analysis is performed to evaluate the velocity profile of the two-phase flow and its interfacial shape. we found that the solution of the problem depends on the parameters ($\beta, \alpha, \lambda, \Lambda$, m and q) . The main results obtained in this chapter are summarized as follows the magnetic field increases the amplitude (A) of the stream function and decreases the phase shift of the stream function (γ) . The magnetic field increases the shear stress . The phase shift presents a peak in the solid fluid interface and presents a bottom in the fluid fluid interface . There is also some results on the parameters ($m, q, \alpha, \lambda, \Lambda$ and β) .

Chapter five contains the problem " flow of an electrically conducting two-phase flow through a symmetric sinusoidal channel when one of the two-phase is electrically conducting n-times than the other phase . The solution of the problem depends on the parameters ($\beta, \beta_1, \alpha, \Lambda, \lambda, m$ and q) . A regular perturbation analysis is performed to evaluate the velocity profile of the two phase flow and its interfacial shape . The main results obtained in this chapter are summarized as follows , the amplitude of the stream function (A) do not change when one of the two phases is conducting n-times than the other phase and the phase shift of the stream function (γ) changes slightly . The magneetic field increases the shearing stress of the flow field , since the shearing stress due to the magnetic field is proportional to the magnetic field H which will be zero on the wall . The shear stress increases as the magnetic field is increased .

INTRODUCTION AND AIM OF WORK

CHAPTER I

CHAPTER I
INTRODUCTION

I.1. INTRODUCTION :

Magnetohydrodynamics (MHD) differs from ordinary hydrodynamics in that the fluid is electrically conducting . It is not magnetic , it affects a magnetic field not by its mere presence but only by virtue of electric currents flowing in it .

Multiphase systems consist of a fluid phase or fluid medium and a particulate phase of any number of chemical components . When the fluid medium is a liquid , the particulate phase may consist of solid particles , gas bubbles , or liquid droplets .

The dynamics of multiphase systems include momentum , energy , mass , and charge transfers between the phases whether or not the process is influenced by the presence of a potential field . There are many multiphase systems among engineering equipment and process .

Some of this systems may be obtained as follows :

a. Gas solid particle systems ; such as dust collectors , cosmic dusts , and nuclear fallout problems .

b. Gas-liquid droplet systems ; such as atomizers , air pollution and compustors .

c. Liquid-gas bubble systems ; such as absorbers , air lift pump and aeration .

d. Liquid-liquid droplet systems ; such as extraction .

e. Liquid-solid particle systems ; such as sedimentation .

Studies of dynamics of multiphase systems have followed two methods of approach [3] :

1- Treating the dynamics of single particles and then trying to extend to a multiphase particle system in an analogous manner as in molecular (kinetic) theory .

2- Modifying the continuum mechanics of single-phase fluids in such a way as to account for the presence of particles .

A study of the phenomena occuring in the motion of multiphase media is essential for the solution of many theoretical and engineering problems : the theory of wave propagation in water-saturated ground and dust-saturated air , the theory of fine grinding , the theory of mass entrainment from the surface of a body by a high-parameter flow , the theory of the flow around porous bodies , the theory of the motion of powder gases containing unburned particles , the prefection of water and pneumatic transport , petroleum output and petroleum refining when there is foreign matter in the petroleum , etc. In all three cases the moving material is a mixture of two or more media , i.e. phases .