سامية محمد مصطفى

شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

سامية محمد مصطفى

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

سامية محمد مصطفى

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

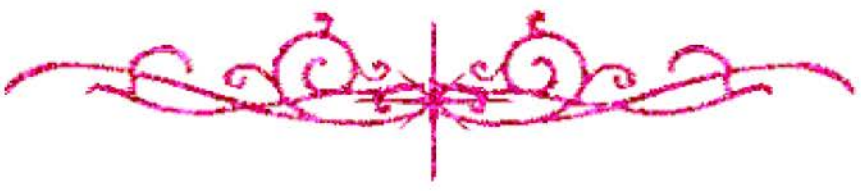
يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

سامية محمد مصطفى

شبكة المعلومات الجامعية

بعض الوثائق الأصلية تالفة



سامية محمد مصطفى

شبكة المعلومات الجامعية

بالرسالة صفحات لم ترد بالأصل

Mansoura University
Faculty of Engineering
Mechanical Power Engineering Dept.

Transient Slip Flow in Microchannels

Thesis
Submitted in Partial Fulfillment of Requirements
For the Master Degree in Mechanical Power Engineering

By

Eng. *Mohamed Hassan Mansour Hassan*
B.Sc. of Mechanical Power Engineering
Mansoura University

Supervisors

Prof. Dr.
Mohamed Nabil Sabry
Faculty of Engineering
Mansoura University

Assoc. Prof. Dr.
Abdel-Rahim A. Abdel-Rahim
Faculty of Engineering
Mansoura University

2004

Mansoura University
Faculty of Engineering
Mechanical Power Engineering Dept.

Transient Slip Flow in Microchannels

Thesis
Submitted in Partial Fulfillment of Requirements
For the Master Degree in Mechanical Power Engineering

By

Eng. *Mohamed Hassan Mansour Hassan*
B.Sc. of Mechanical Power Engineering
Mansoura University

Supervisors

Prof. Dr.
Mohamed Nabil Sabry
Faculty of Engineering
Mansoura University

Assoc. Prof. Dr.
Abdel-Rahim A. Abdel-Rahim
Faculty of Engineering
Mansoura University

2004

Supervision Committee

Thesis Title:

Transient Slip Flow in Microchannels

Researcher Name:

Mohamed Hassan Mansour

Supervision Committee:

No.	Name	Position	Signature
1	Prof. Dr. Mohamed Nabil Sabry	Mechanical Power Dept. - Faculty of Engineering - Mansoura University	
2	Assoc. Prof. Dr. Abdel-Rahim A. Abdel-Rahim	Mechanical Power Dept. - Faculty of Engineering - Mansoura University	

Head of department Vice dean Dean

Examination Committee

Thesis Title:

Transient Slip Flow in Microchannels

Researcher Name:

Mohamed Hassan Mansour

Supervision Committee:

No.	Name	Position	Signature
1	Prof. Dr. Mohamed Nabil Sabry	Mechanical Power Dept. - Faculty of Engineering - Mansoura University	
2	Assoc. Prof. Dr. Abdel-Rahim A. Abdel-Rahim	Mechanical Power Dept. - Faculty of Engineering- Mansoura University	

Examination Committee:

No.	Name	Position	Signature
1	Prof. Dr. Nabil I. Hewedy	Mechanical Power Dept. - Faculty of Engineering - Menoufia University	
2	Prof. Dr. Lotfy Hassan Rabea	Mechanical Power Dept. - Faculty of Engineering- Mansoura University	
3	Prof. Dr. Mohamed Nabil Sabry	Mechanical Power Dept. - Faculty of Engineering - Mansoura University	
4	Assoc. Prof. Dr. Abdel-Rahim A. Abdel-Rahim	Mechanical Power Dept. - Faculty of Engineering - Mansoura University	

Head of department Vice dean Dean

Acknowledgement

Thanks to God the merciful, who guided me along the years until this work was accomplished.

The author wishes to express his sincere gratitude for Prof. Dr. Mohamed Nabil Sabry and Assoc. Prof. Dr. Abdel-Rahim A. Abdel-Rahim for their supervision and valuable advice during the work.

May all who helped me in preparing the manuscript also receive my deep gratitude.

ABSTRACT

The assumption usually made of spatially fully developed flow during transient establishment is revised here. A computational model for transient two-dimensional Navier-Stokes equations has been used to study both time and space development of flow due to a sudden pressure rise. Two kinds of boundary conditions are used, the no-slip condition as well as the slip condition encountered in microchannels. Compressibility effects are however neglected in order to concentrate on slip effect.

Microchannel of height 100 μm and 750 μm length was investigated at different pressure drop values (400, 575, 750, 900 Pa) for both slip and no slip conditions. Also the case of pressure difference 750 Pa was studied at different slip length values ranging from 1 to 4 μm. The flow rate, velocity profile, pressure distribution along the channel, and the developing length were obtained as a function of time. Also, the velocity profile was obtained at different locations during the developing region. The results show that flow rate, velocity profile, pressure distribution, and developing length depends to a great extent on the pressure difference across the microchannel for both slip and no slip conditions, in such away that increasing the pressure difference increases the discharge and the developing length. For all investigated values of pressure drop, the developing length for slip conditions is higher than that for no slip conditions in the fully developed region. The results also show that the developing length reaches about 1.1 of the hydraulic diameter, which

corresponds to 25% of the channel length under study, therefore it must be taken into consideration when designing and constructing the short microchannels. The pressure gradient in the fully developed region takes linear shape, which agrees with the concept of constant shear in fully developed flow, while the pressure gradient in the developing region differs greatly from linear shape in the fully developed region. This result must be taken into consideration when calculating the pressure drop in the microchannels.

The obtained results concerned with the developing length in case of no slip agree enough with that obtained in the literature, in addition a new correlation were obtained for the developing length as a function of Reynolds number for slip condition.

Contents

Chapter 1- Introduction

Chapter 2- Literature Review

Chapter 3- Mathematical Model