COMPUTATIONAL FLUID DYNAMIC (CFD) FOR MICROCHANNEL MICROFLUIDIC DEVICES

by

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APPROVAL AND DECLARATION SHEET

This project report titled Computational Fluids Dynamic For Microchannel Microfluidics Devices was prepared and submitted by Mohd Fairuz Bin Harun (Matrix Number: 031010242) and has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the Bachelor of Engineering (Microelectronic Engineering) in Universiti Malaysia Perlis (UniMAP)

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PERKOMPUTERAN BENDALIR DINAMIK (CFD) UNTUK SALURANMICRO PERANTI BENDALIRMICRO

ABSTRAK

Peranti bendalir-mikro mengalami pembangunan yang amat pesat sejak konsep bendalir litar bersepadu, teknologi makmal berasaskan chip, dan sistem analisis penuh-mikro (uTAS) diperkenalkan. Kelebihan teknologi ini bukan sahaja mengecilkan saiz peranti malah penghasilan bahan untuk tujuan fabrikasi juga murah. Walaupun menggunakan bahan cecair yang agak mahal, tetapi hasilnya ia dapat mengawal suhu dan ciri-ciri system lain. Pengecilan sistem juga dapat meningkatkan kadar kualiti pengeluaran di dalam industri kimia, kejuruteraan, biologi dan aplikasi perubatan serta dapat mengurangkan masa pemprosesan. Lebih penting lagi, peranti bersaiz mikro mempunyai potensi di dalam merevolusikan sesuatu kawasan dan industri berkaitan. Rekabentuk, fabrikasi, dan aplikasi terhadap bendalir-mikro telah menarik minat penyelidik yang datang dari pelbagai aspek pekerjaan termasuk industri kimia, biologi, fizik, kejuruteraan dan aplikasi matematik. Lantaran itu, laporan ini akan membincangkan dan memberi tumpuan serta difinasi tentang bendalir-mikro yang mengalir secara teratur. Cecair akan mengalir melalui saluran yang berdiamensi mikro di mana pecutan aliran berpandukan di bawah aras number Reynold, Re dan jenis aliran adalah teratur. Permukaan pemecutan aliran adalah licin jika menggunakan dimensi biasa tetapi akan berlaku perubahan aras secara rawak mengikut masa. Semakin kecil saluran (bersaiz mikro) aliran akan menjadi satu hala; semua bendalir bergerak selari dengan orientasi dinding saluran. Pergerakan seperti ini akan menyebabkan momentum, hadirnya sifat-sifat bendalir, dan haba bergerak normal sealiran dengan mekanisme molekul, sifat menghalang rintangan bendalir bermolekul, kemeresapan bermolekul, dan pengaliran haba.

ABSTRACT

Microfluidic devices have been developing rapidly since the concept of fluid-integrated-circuits, lab-on-a-chip or micro-total-analysis systems (uTAS) was introduced. Among the great benefits of miniaturized devices are that they require less fabrication material and can also be manufactured as cheap disposable test kits. They consume smaller amounts of expensive reagents in comparison to conventional macro-scale devices and can control temperature and other system properties precisely. Miniaturized systems can increase yields significantly in chemical, engineering, biological and clinical applications and can also reduce process time. More importantly, micro-devices can have additional functionalities beyond those of conventional devices, with the potential to revolutionize many scientific areas and associated industries. The design, fabrication and application in microfluidics has attracted researchers from a variety of disciplines including chemistry, biology, physics, engineering and applied mathematics. This report focused on laminar flow which is the definitive characteristic of microfluidics. Fluids flowing in channels with dimensions on the order of certain micron size and at readily achievable flow speeds are characterized by low Reynolds number, *Re* as described in introduction, flows in this regime are laminar, not turbulent: The surfaces of constant flow speed are smooth over the typical dimension of the system, and random fluctuations of the flow in time are absent. In the long, narrow geometries of microchannels, flows are also predominantly uniaxial: The entire fluid moves parallel to the local orientation of the walls. The significance of uniaxial laminar flow is that all transport of momentum, mass, and heat in the direction normal to the flow is left to molecular mechanisms: molecular viscosity, molecular diffusivity, and thermal conductivity.

TABLE OF CONTENTS

CHAPTER 3 METHODOLOGY

CHAPTER 4 RESULTS AND DISCUSSION

LIST OF TABLES

LIST OF FIGURES