UNIVERSITI PUTRA MALAYSIA

MARANGONI CONVECTION BOUNDARY LAYER WITH SUCTION AND INJECTION

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MARANGONI CONVECTION BOUNDARY LAYER WITH SUCTION AND INJECTION

By

ROHANA BINTI ABDUL HAMID

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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To My Beloved Family, Lecturers and Friends

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

MARANGONI CONVECTION BOUNDARY LAYER WITH SUCTION AND INJECTION

By

ROHANA BINTI ABDUL HAMID

May 2011

Chair: Associate Professor Norihan Md. Arifin, PhD

Faculty: Institute for Mathematical Research

Marangoni convection boundary layer has become of noticeable importance in recent years. Its influential role in numerous engineering applications such as crystal growth and circuit manufacture tends to attract the researchers. In this study, we have numerically discovered the effects of suction and injection on the Marangoni forced convection boundary layer in the presence of many other parameters such as thermal radiation, Joule heating, viscous dissipation and magnetic field. The continuity equation, the momentum equation and the energy equation with the governing parameter of interest are transformed into the ordinary differential equations using similarity transformation. The transformed equations are then solved using the shooting method and Runge-Kutta-Fehlberg method in the Maple programming. Numerical results obtained in this study are the interface velocity, the heat transfer rate at the wall, the velocity profiles as well as the temperature profiles. From the results, it is noticed that the parameters can be used to control the

Marangoni convection boundary layer flow. The Joule heating, viscous dissipation, magnetic field, thermal radiation and suction parameters have the effects to increase the thermal boundary layer thickness, thus reduce the heat transfer at the interface.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

ALIRAN LAPISAN SEMPADAN OLAKAN MARANGONI DENGAN SEDUTAN DAN SEMBURAN

Oleh

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Mei 2011

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Aliran lapisan sempadan olakan *Marangoni* telah menjadi terkenal sejak kebelakangan ini. Kepentingan aliran ini dalam pelbagai aplikasi kejuruteraan seperti pembentukan kristal dan pembinaan litar menarik minat para pengkaji. Dalam kajian ini, kesan sedutan dan semburan ke atas aliran lapisan sempadan olakan paksaan *Marangoni* dengan kehadiran pelbagai parameter lain seperti radiasi terma, pemanasan *Joule*, disipasi likat serta medan magnet telah diketahui secara berangka. Persamaan keselanjaran, persamaan momentum dan persamaan tenaga telah dijelma kepada persamaan perbezaan biasa menggunakan kaedah penjelmaan serupa. Persamaan yang telah dijelmakan kemudiaannya diselesaikan dengan menggunakan kaedah *shooting* dan kaedah *Runge-Kutta-Fehlberg* di dalam pengaturcaraan *Maple*. Keputusan berangka yang diperolehi dalam kajian ini adalah halaju permukaan, kadar pemindahan haba pada dinding, profil halaju dan juga profil suhu. Hasil kajian menunjukkan bahawa parameter-parameter tersebut boleh digunakan untuk

mengawal aliran lapisan sempadan olakan *Marangoni*. Penggunaan parameter seperti pemanasan *Joule*, disipasi likat, medan magnet, radiasi terma dan sedutan dapat meningkatkan ketebalan lapisan sempadan seterusnya mengurangkan kadar permindahan haba pada permukaan.

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I certify that a Thesis Examination Committee has met on 20 May 2011 to conduct the final examination of Rohana Binti Abdul Hamid on her thesis entitled "Marangoni Convection Boundary Layer with Suction and Injection" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the degree of Master of Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

_____

ROHANA BINTI ABDUL HAMID

Date:

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