



UNIVERSITI PUTRA MALAYSIA

***NUMERICAL ASSESSMENT OF COANDA EFFECT FOR WIND TURBINE
APPLICATION***

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**NUMERICAL ASSESSMENT OF COANDA EFFECT FOR WIND TURBINE
APPLICATION**

By

MOHD FAISAL BIN ABDUL HAMID

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Abstract of thesis presented to the Senate of Universiti Putra Malaysia
In fulfillment of the requirement for the degree of Master of Science

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June 2012

Chair : Professor Harijono Djojodihardjo, Sc.D

Faculty : Engineering

Various methods of flow control for enhanced aerodynamic performance have been developed and applied, such as continuous, synthetic and pulsed jets, compliant surface, vortex-cell and the like, to dramatically alter the behavior of aerodynamic components such as airfoils, wings, and bodies. In an effort to optimize aerodynamic performance of wind turbine, the use of the Coandă effect, by blowing high velocity jet tangential over a highly curved surface (such as a rounded TE) to increase the circulation and lift has gained renewed interest, in particular with the progress of CFD. The present work review the influences, effectiveness and configurations of Coandă-jet fitted aerodynamic surface, in particular S809 airfoil, to improve its lift augmentation and lift over drag ratio, with a view on its incorporation in the design of wind turbine. For this purpose, a simple two-dimensional CFD modeling using k – omega and k – epsilon turbulence models is utilized to reveal the key elements that could exhibit the desired performance criteria for a comprehensive series of configurations. A parametric study indicates that Coandă configured airfoil can only be effective in a certain range of the TE radius, the jet thickness and the momentum

jet size; the location of the jet was found to be effective when it is placed close to the TE. The results are compared with existing experimental data for benchmarking. Three-dimensional configurations are synthesized using certain acceptable assumptions. A trade-off study on the S809 Coandă configured airfoil is needed to judge the optimum configuration of Coandă-jet fitted wind turbine design.



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

**PENILAIAN ANALISA BERANGKA KESAN COANDA UNTUK APLIKASI
TURBIN ANGIN**

Oleh

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Pelbagai kaedah kawalan aliran untuk meningkatkan prestasi aerodinamik telah dimaju dan diaplikasikan, seperti jet berterusan, sintetik dan denyutan, permukaan patuh, sel vorteks dan sebagainya, untuk mengubah sifat komponen aerodinamik seperti kerajang udara, sayap, dan badan secara mendadak. Dalam usaha untuk mengoptimumkan prestasi aerodinamik turbin angin, penggunaan kesan Coandă, dengan meniupkan jet berhalaju tinggi ke atas satu permukaan melengkung (seperti di pinggir lelar yang bulat) untuk meningkatkan edaran dan daya angkat telah menarik minat baru, khususnya dengan kemajuan CFD. Hasil penyelidikan menunjukkan pengaruh, keberkesanan dan konfigurasi jet Coandă dapat disesuaikan kepada permukaan aerodinamik, khususnya kerajang udara S809, untuk meningkatkan penambahan daya angkat and nisbah daya angkat kepada daya seret, dengan memberi perhatian dalam kesesuaian reka bentuk turbin angin. Untuk tujuan ini, satu analisa CFD dua dimensi mudah menggunakan model kegeloraan $k - \omega$ dan $k - \epsilon$ diaplikasikan untuk mendedahkan elemen utama yang boleh menunjukkan kriteria prestasi tinggi untuk satu siri konfigurasi komprehensif yang diingini. Kajian berparameter menunjukkan kerajang udara berkonfigurasi Coandă

hanya boleh memberi kesan yang efektif dalam lingkungan jejari pinggir lelar, ketebalan jet dan saiz momentum jet yang tertentu; lokasi jet didapati dapat memberi kesan yang efektif hanya apabila ia diletakkan hampir kepada pinggir lelar. Keputusan juga telah dibandingkan dengan data eksperimen bagi tujuan penanda aras. Konfigurasi tiga dimensi disintesisikan dengan berdasarkan andaian tertentu yang boleh diterima. Kajian keseimbangan bagi konfigurasi kerajang udara Coandă S809 diperlukan untuk menentukan konfigurasi jet Coandă yang optimum bagi aplikasi reka bentuk turbin angin.



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I certify that an Examination Committee has met on **21 June 2012** to conduct the final examination of **Mohd Faisal Bin Abdul Hamid** on his **Master of Science** thesis entitled "**Numerical Assessment of Coandă Effect for Wind Turbine Application**" in accordance with the Universities and University College 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 Master of Science.

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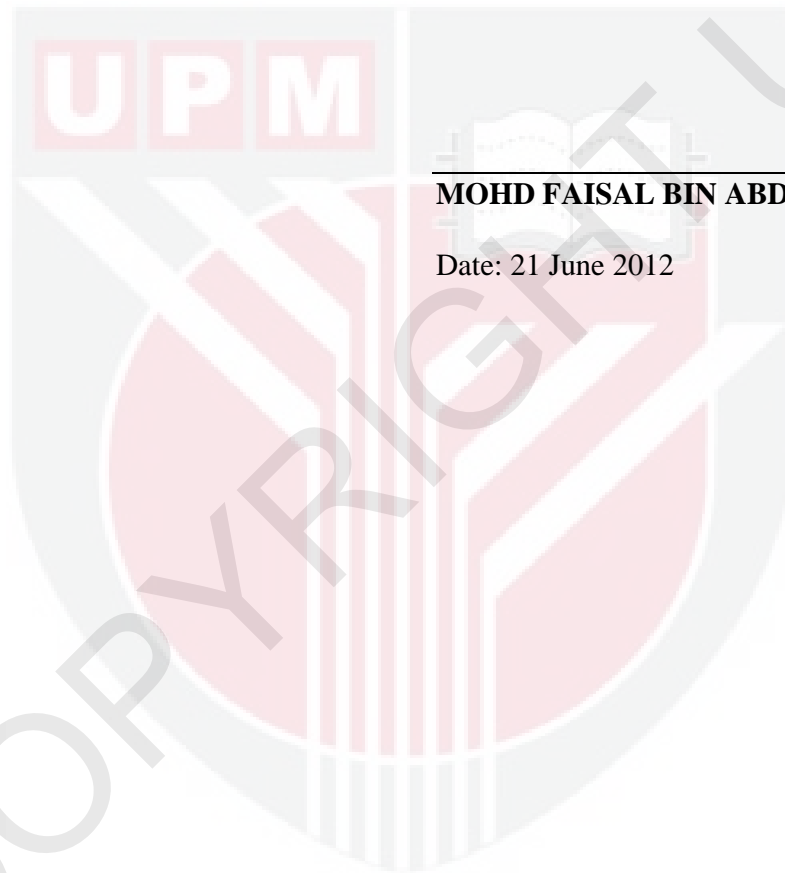
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DECLARATION

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.



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