ANALYSIS FOR OPTIMAL POSITIONING OF KITCHEN VENTILATION FAN

By

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

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STUDY ON THE OPTIMAL POSITION OF VENTILATION FAN IN TYPICAL KITCHEN AREA

By

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December 2004

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Faculty : Engineering

This aim of the study is to determine the optimal position of ventilating fan in a kitchen. Experiments were conducted in a kitchen of a double-storey house at Subang Jaya and a constructed chamber inside Thermodynamics Laboratory, Universiti Putra Malaysia. The purpose of this study was to determine the best location for a kitchen exhaust fan and to prove the effectiveness of the use of fan. The experiment in Subang Jaya was based on the CFD (Computational Fluid Dynamic) result and the fan was moved to the midway above the window. The chamber at UPM had seven position of fan frames hence the fan could be removed from one frame to another to determine the optimum position to install the fan. Both experiments used CO_2 as tracer gas to measure the air exchange rate. CO_2 was injected into space in excess of 1000 ppm, and advanced to mixed with the air with the help of fan for ten minutes, before determining the value of air exchange rate. The data was taken every 5 minutes within 30 minutes to one hour. The Location of ventilating fan is crucial for effectiveness of contamination removal in

kitchen. From CFD and experiments, it is concluded that the best location for ventilating fan in the kitchen is mid-way above the window on external wall.

The result of the chamber at the lab showed that at height 3.6m the air exchange rate ranged from between 2.3 – 2.0 $h^{-1}$for door fully opened and 2.1 -1.8 h^{-1} for door closed. At height 3.0m the air exchange rate ranged from between 2.3 – 2.0 h^{-1} for door fully opened and 1.9 – 1.7 $h^{-1}$for door closed. And at height 2.5m the air exchange rate ranged from between 1.8 – 1.6 h^{-1} for door fully opened and 1.6 – 1.5 $h^{-1}$for door closed. Use of extract fan could increase the air exchange rate from 0.3, which was the obtained result from the measurement of the chamber in its original condition, when the fan off and the door is closed to 1.5 h^{-1} which was the worst result obtained with the fan on when the measurement was taken with the door closed and at lowest height of the wall. That was an increase of 4 – 5 times. The best fan position is on the highest mid point for all wall height of 3.6m, 3.0m and 2.5m. The CFD trend and result for chamber at different heights showed that the best fan location is at the highest mid point of the wall. Those experiments proved that the result is consistent for both laboratory and site experiments.

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

KAJIAN TERHADAP KEDUDUKAN OPTIMUM DARIPADA KIPAS PENGALIHUDARAAN DI KAWASAN DAPUR TIPIKAL

Oleh

Tezara Cionita

Disember 2004

Pengerusi : Profesor madya Ir. Nor Mariah Adam, PhD

Fakulti : Kejuruteraan

Kajian ini tertumpu kepada keberkesanan mengguna kipas pengalihudaraan di dalam ruang dapur. Ujikaji telah dijalankan di dalam ruang dapur sebuah rumah teres dua tingkat di Subang Jaya dan juga di dalam sebuah bilik ujikaji di makmal Termodinamik, Universiti Putra Malaysia. Tujuan kajian adalah untuk menentukan kedudukan terbaik bagi kipas penyedut udara (extract fan). Untuk kedua-dua kajian, CO_2 (carbon dioksida) dijadikan gas pengesan. CO_2 disuntik ke dalam ruang, dicampur selama sepuluh menit, kemudian disukat nilai kepekatan CO_2 bagi tujuan mendapatkan nilai pertukaran udara. Nilai kepekatan diambil setiap lima minit untuk tempoh 30 – 60 minit. Kedudukan kipas pengalihudaraan yang sesuai amat penting untuk mengeluarkan kontaminan daripada ruang dapur. Daripada Komputasi Dinamik Bendaalir (CFD) dan ujikaji, di atas dapat dirumuskan kedudukan yang paling sesuai adalah di tengah tingkap dinding luas.

Untuk bilik ujikaji pada ketinggian 3.6m, kadar pengalihudaraan berada pada julat 2.3 – 2.0 h^{-1} untuk pintu terbuka dan 2.1 – 1.8 h^{-1} untuk pintu tertutup. Pada ketinggian 3.0m,

kadar pengalihudaraan berada pada julat 2.3 –2.0 h^{-1} untuk pintu terbuka dan 1.9 – 1.7 h^{-1} untuk pintu tertutup. Pada ketinggian 2.5m, kadar pengalihudaraan berada pada julat 1.8 – 1.6 h^{-1} untuk pintu terbuka dan 1.6 – 1.5 h^{-1} untuk pintu tertutup. Penggunaan penyedut udara dapat menaikkan kadar pengalihudaraan dari 0.3 hingga 1.5 h^{-1}, yang mana merupakan 4 –5 kali peningkatan. Posisi kipas yang terbaik ialah pada titik tengah tertinggi pada dinding dengan ketinggian 3.6m, 3.0m dam 2.5m. Penggunaan CFD dan hasil percubaan pada bilik dengan ketinggian berbeza menunjukkan bahawa kipas paling baik diletakkan pada titik tengah tertinggi dari dinding. Percubaan telah membuktikan bahawa hasil yang didapat untuk percubaan dalam lab dan rumah percubaan adalah konsisten.

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APPROVAL

I certify that the Examination committee meet on 2004 to conduct the final examination of Tezara Cionita on her Master of Science in Mechanical Engineering thesis entitled "Study of The Effectiveness of Ventilating Fan in Kitchen' in accordance with Universiti Pertanian Malaysia (Higher degree) act 1980 and Universiti Pertanian Malaysia (Higher degree) Regulation 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This Thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory committee are as follow:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

TEZARA CIONITA

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