UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN EXPERIMENT STUDIES ON PARTITION'S EFFECT IN SELECTED TERRACE HOUSE USING COMPUTATIONAL FLUID DYNAMICS (CFD)

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) of the Bachelor of Mechanical Engineering Technology (Refrigeration and Air Conditioning Systems) with Honours.

by

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DECLARATION

I hereby declared this report entitled "An Experiment Studies on Partition's Effect in Selected Terrace House Using Computational Fluid Dynamics (CFD)" is the results of my own research except as cited in references.

Signature	:	………………………………………….
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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Refrigeration and Air Conditioning Systems) with Honours. The member of the supervisory is as follow:

……….…………………………….

(Amir Abdullah Bin Muhamad Damanhuri)

ABSTRAK

Pembahagi dinding dalam bangunan memainkan peranan penting dalam membahagikan ruang di dalam rumah. Oleh itu, aliran udara semula jadi memberi kesan oleh lokasi pembahagi dinding. Seperti yang kita tahu, satu ruang dengan kualiti udara dalaman yang tidak baik boleh menyebabkan pelbagai masalah kesihatan jangka panjang dan jangka pendek. Jadi, sangat penting untuk mereka bentuk ruang yang mempunyai pengudaraan yang baik, sama ada secara semula jadi atau oleh bantuan dari mesin, bantuan mekanikal untuk mengekalkan keselesaan penghuni. Ia juga amat penting bagi setiap ruang untuk mencapai keselesaan manusia. Keselesaan haba ialah keadaan di mana manusia yang berasa puas hati dengan persekitaran haba dan dinilai dengan penilaian subjektif. Mengekalkan taraf keselesaan haba bagi penghuni bangunan atau rumah adalah salah satu matlamat penting bagi jurutera reka bentuk HVAC. Di beberapa kawasan di dalam bangunan atau rumah, pembahagi dinding adalah penting untuk kitaran aliran udara. Kajian ini tentang aliran udara di kawasan tertentu, mengenai kedudukan pembahagi dinding yang akan menjejaskan aliran udara di dalam rumah atau bangunan. Kajian ini dilakukan pada sebuah rumah teres satu tingkat bertujuan pengumpulan data. Kajian ini menilai kualiti udara dalaman rumah. Tujuan projek ini adalah untuk memantau keadaan parameter dan kualiti udara dalaman. Oleh itu hasil dari data yang dikumpul, terhasil simulasi dinamik bendalir pengiraan (CFD). Terdapat beberapa parameter dikumpul dan hasil kumpul parameter digunakan untuk kegunaan simulasi. Berdasarkan kajian ini, hasil daripada simulasi CFD menunjukkan kelakuan aliran udara di dalam rumah. Pembahagi dinding disusun dan dipasang di tempat dan kedudukan yang betul. Aliran udara masuk melalui salur masuk, beredarkan dalam ruang rumah, kemudian keluar melalui alur keluar. Udara di dalam rumah menghasilkan aliran keadaan yang baik.

ABSTRACT

Partition in building plays the significant role in dividing space in the house. Therefore, natural air flow affects by the location of partition. As we know, a space with poor indoor air quality can cause a variety of short term and long term health problems. So, that's why it's very important to design a space to have good ventilation, whether it naturally or by the machine, mechanical support to maintain occupants comfort. It's very important for every space area to achieve human comfort. Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation. Maintaining the standard of thermal comfort for occupants of buildings or other enclosures is one of the important goals of HVAC design engineers. In some area in building or house, partitions are important for the cycle of air flow. This is research about the study of air flows in the same area regarding the position of the partition affect the air flow inside the house or building. This study selects a single-storey terrace house for data collection. This research evaluates the indoor air quality by indoor monitoring. The purposes of this project are to monitor indoor air quality parameter. Hence verify with a simulation of Computational Fluid Dynamics (CFD). There are several parameters collected and the parameter is used for the results. Based on this study, the result of a simulation of CFD shows the air flow behaviour in the house. The partition is arranged and installed in the right place and position. The air flow enters through an inlet, circulated in the house space, later exit through an outlet. The air inside of the house produces a good behaviour.

DEDICATION

To my beloved parents,
Mr. Mohd Nasir Haron and Mrs. Noor Aini Sairi

To my talented supervisor,
Mr. Amir Abdullah Damanhuri

To my supportive Co-Supervisor
Mr. Muhammad Nur Othman

My beloved and caring,
Siblings and the One.

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To the institute where I laid and study for almost 4 years, Universiti Teknikal Malaysia Melaka, is the place where I finishing my Bachelor's Degree Mechanical Engineering Technology (Refrigeration and Air Conditioning System) and to all staffs who give the opportunity to be educated without any cost.

To my parents, for their love and support, for providing all my needs, financially and morally, for their patience and understanding during my time at university. It's always a pleasure and thankful to be your child.

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Finally, thanks to who involved during my Final Year Project directly and indirectly.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In some area in building or house, the partition is important for the cycle of air flow. The study about the air flows in the same area which the position of the partition will affect the air flow inside the house or building. Good indoor air quality (IAQ) is required for the healthy indoor work environment. Poor indoor air quality can cause a variety of short-term and long-term health problems (DOSH 2010). It's important to design buildings to have ventilation systems that are energy efficient, cost effective and maintain occupants comforts (Detaranto, 2014).

In the middle of the high economy, the urban population has increased 57% from 1960 to 2010 and with more than three-quarter of the Malaysia overall population estimated to settle in urban. Moreland will develop for urbanization to fulfill housing settlement due to the increasing national population. Malaysia is one of the most developed countries among in south East Asia. Malaysia located in the equatorial region, the weather is warm and humid all year. The climate characterized as high temperature and humidity. The relative humidity ranges from 74-86 % with evenly distributed rainfall from the whole year and usually occurs with thunderstorm and lighting. Air movement is low and sometimes become unpredictable (Azzmi & Jamaludin, 2014).

Ventilation is the flow of the air onto and out of a space. Divided into two, purpose provided ventilation and air infiltration and exfiltration. Purpose provided ventilation is the process which cleans the air and intentionally provided to space and removes stagnant air. The energy to cool and ventilate buildings is expected to grow and with the energy comes a rise in costs and a buildings carbon footprint. As more of the world develop into economically strong regions, the amount of energy needed to ventilate building will increase worldwide (Detaranto, 2014).

1.1 Problem Statement

Some house, which installs the partition maybe without considering air flow through the building. Then, the partition which affects the air flow will cause in some area in the house with bad air flow and will give bad thermal comfort to occupants. Partition is important for the cycle of air flow. So, it is very important to consider the position of the partition and need to study further about the position of the partition which gives effect to air flow. By natural air flow, the air will flow through the building, and circulate in the building. If the houses are installing with mechanical support, the air flow will circulate by the help of the mechanical ventilation.

1.2 Objectives

- To monitor air quality parameter in selected terrace house.
- To study natural air flow by using Computational Fluid Dynamics (CFD) simulation in selected case study, area or parameter of terrace house.

1.3 Scope

For this project work scope's, single-storey terrace house is selected to be a suitable site to chosen.

Several parameters related to Indoor Air Quality (IAQ) involve:

- Temperature (Indoor and outdoor)
- Indoor air velocity

Others, indoor air quality monitor during day and night, 8 hours each. Amounts of:

- Carbon dioxide
- Humidity
- Dew Point

Area of parameter and site specifications involve:

- Located at Taman Muzaffar Heights, Ayer Keroh, Melaka.
- The length of the house 70 feet, width is 30 feet and 12 feet tall of the ceiling.
- Each window is a size 4 feet height and 2 feet width, while for each dimension for the doors are 6.5 feet height and 3 feet width.
- Temperature between 26 to 33 °C, air velocity between 0.5 to 0.8 m/s, relative humidity is between 77 to 83 %.

CHAPTER 2

LITERATURE REVIEW

2.1 Indoor Air Quality

The energy to cool and ventilate buildings is expected to grow and with the energy comes a rise in costs and a buildings carbon footprint. As more of the world develop into economically strong regions, the amount of energy needed to ventilate building will increase worldwide (Detaranto, 2014). Indoor Air means the air inside a building, including air which is within a room and air which is removed from a room by mechanical means (DOSH, 2010).

Ventilation is a process of supplying or removing air from a space for the purpose of controlling air conditioned levels, humidity or temperature in the space as suggested as shown in table 2.1 (DOSH, 2010).

Table 2.1: Acceptable range for specific physical parameters (DOSH, 2010).

Parameter	Acceptable
Air Temperature	23 – 26°C
Relative humidity	40-70%
Air Movement	0.15-0.50 m/s

2.2 Thermal Comfort

Thermal comfort is subjective, subject to varying temperatures. Internal and external temperature sensing is integrated into many ways that will affect the result either towards body temperature or away from it. A good or cold situation will be pleasing when the body feel uncomfortable. At the same time, the temperature of the skin is by no uniform. There are also variations in different parts of the body which reflect the body.

Wearing clothes also will give effect the skin and body temperature. Thermal comfort for a human is one of the issues right not. Providing thermal comfort for occupants in the building is really hard and quite challenging because thermal comfort is not only influenced by temperature but also factors like relative humidity, air velocity, environment radiation, activity level and type of clothes (Auliciems & Szokolay, 2007). These are most of the reason for thermal comfort:

- Relative Humidity
- Air temperature
- Radiant Temperature
- Air velocity

2.2.1 Relative Humidity

The human body has sensors that are efficient in sensing heat and cold, but they are not very effective in detecting relative humidity. Relative humidity creates the perception of an extremely dry or extremely damp indoor environment. This can then play a part in the perceived temperature and their thermal comfort. The recommended level of indoor humidity by ASHRAE is in the range of 30-60%.

The wetness of skin in various territories additionally influences saw warm solace. Humidity can build wetness on various ranges of the body, prompting a view of distress. This is typically confined to various parts of the body. The neighbourhood warm solace limits for nearby skin wetness vary between various skin areas of the body. The limits are a great deal touchier to warm inconvenience from wetness than the storage compartment of the body.

Although neighbourhood warm inconvenience can be brought about from wetness, the warm solace of the entire body won't be influenced by the wetness of certain parts.

As of late, the impacts of low relative dampness and high air speed were tried on people in the wake of showering. Scientists observed that low relative dampness induced warm uneasiness and in addition the impression of dryness and tingling. It is prescribed to keep relative dampness levels higher in a lavatory than different rooms in the house for ideal conditions (Auliciems & Szokolay, 2007).

2.2.2 Radiant Temperature

The perfect standard for warm solace can be characterized by the agent temperature. This is the normal of the air dry-globule temperature and of the mean brilliant temperature at the given spot in a room. Moreover, there ought to be low air speeds and no "drafts," little variety in the brilliant temperatures from various headings in the room, and stickiness inside an agreeable extent.

The agent temperature interims changed by the kind of indoor area. ASHRAE has postings for proposed temperatures and wind current rates in various sorts of structures and diverse natural circumstances (Auliciems & Szokolay, 2007).

2.2.3 Air Velocity

The speed of air development is measured by anemometers of different sorts. The hand-held propeller sort is utilized for directional wind stream, for example, in ventilation or aerating and cooling frameworks. The container sort is for the most part utilized where it is pole mounted, in the mix with a wind vane. These two sorts are somewhat inconsistent for low air speeds (beneath 1 m/s).

In wind burrow concentrates on the Pitot-tube anemometer is most frequently utilized (this quantifies the distinction amongst static and element weights, which is an element of air speed). For low speed and arbitrary air developments the Kata, thermometer was utilized as a part of the past, yet this has essentially vanished and the hot-wire anemometer assumed control. Both these are actually measuring the cooling rate, which is proportionate to the air speed (Auliciems & Szokolay, 2007).

2.2.4 Human Thermal Comfort

Human thermal comfort is defined as the state of mind that expresses satisfaction with the surrounding environment. Maintaining the thermal comfort for the occupant of buildings or other enclosures is one of the important targets of the Heat, Ventilation, and Air-conditioning (HVAC) engineers. Thermal comfort will be maintained when the heat generated by human metabolism is allowed to dissipate, thus a person will maintain thermal equilibrium with the surroundings (Tap et al., 2011).

2.2.5 Thermal Comfort on a Residential House

The house comprises of several regions namely the hall, stack, and kitchen. The house is not furnished with an air-conditioning system and is naturally ventilated and both the front and the rear doors opened. Figure 2.2 below shows a CFD model of residence house (Tap et al., 2011).

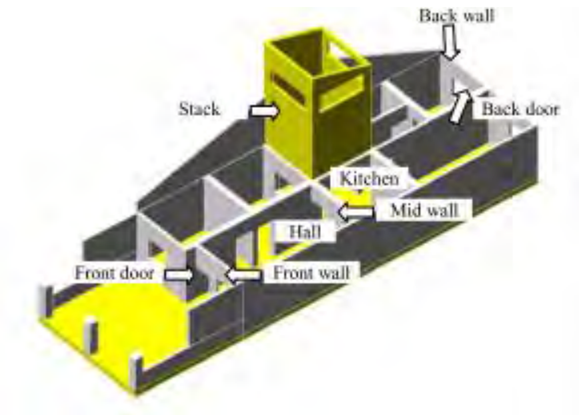

Figure 2.1: A CFD model of a residence house considered with air flow.

To assess the level of thermal comfort in the house, we carried out measurements to acquire the average temperature of the ambient air, the relative humidity of the air and the average velocity of the air inside the house.

A variation of the average temperature of the ambient air inside the various sections of the house represents in figure 2.2 when the house is naturally ventilated (Tap et al., 2011). The air temperature in all sections decreases from about 29°C at 12AM to about 27°C at 6AM. Thereafter, the air temperature increases and reaching the highest value of about 31°C at 6PM. Also, shown in the figure are limits of air temperature for an acceptable level of thermal comfort as specified by the ASHRAE standard. At any given time, the average temperature of the ambient air inside the house is well outside the limits of acceptable thermal comfort.

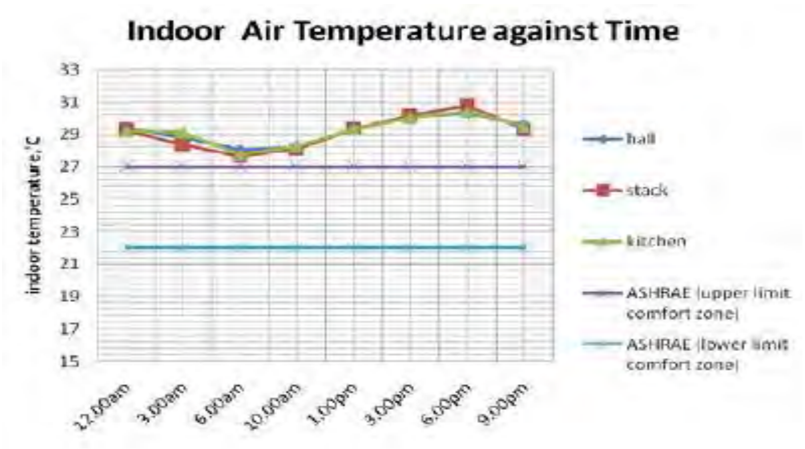

Figure 2.2: Variation of the average temperature of the air inside of the house.

A variation of the relative humidity of the ambient air inside the house as illustrates in figure 2.3 (Tap et al., 2011). It also shows the limits of the relative humidity for an acceptable level of thermal comfort as specified by the ASHRAE standard. The figure shows that the relative humidity of the air fluctuates within the range from about 71% at 10AM to 81% at 3AM. At any given time, the ambient air inside the house is too humid, and this condition would cause thermal discomfort to the occupants.

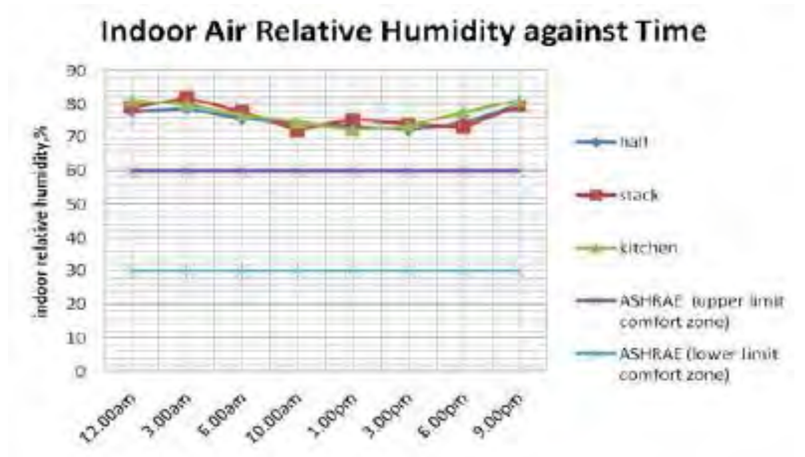

Figure 2.3: The variation of relative humidity of the air inside the house.

The variation of average air velocity in various sections of the house is shown in figure 2.4 below (Tap et al., 2011). It has shown also the limits of air velocity for an acceptable level of thermal comfort, as specified by the ASHRAE standard.

The air velocity in the hall and stack sections is constant at about 0.1m/s from 1PM to 6PM. The air velocity in the kitchen area appears to fluctuate from 0.1 m/s to 0.2 m/s. at any given time, the average velocity of the inside of the house is the acceptable level thermal comfort specified by ASHRAE standard.

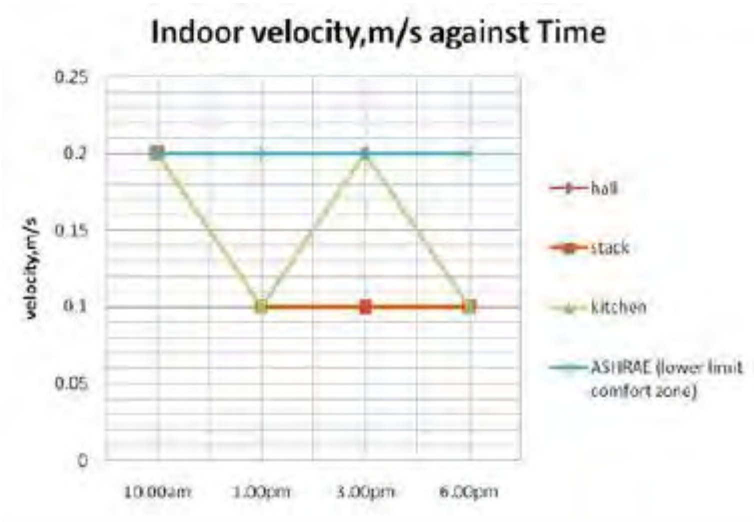

Figure 2.4: Variation of the average velocity of the air inside the house.

2.3 House Design

A prototype for a typical house in Thailand was designed based on the analysis and result from the site plan. Obviously, Thai houses need two cooling systems: an active system with conventional air-conditioning for hot months, and a passive system with natural ventilation in cool months. House designs using natural ventilation require appropriate climates. It is well known that natural ventilation can work in a moderate climate, such as those in western and northern Europe, California, and others.

However, Thailand is located between the 6 and 20°N latitudes and has a typical tropical climate. In general, Thailand is hot and humid, with small seasonal changes throughout the year. There are three recognizable, although not completely distinct, seasons. The hot summer months from March to June are characterized by a high sun angle, high temperature, and moderate south wind.

The rainy season from July to October has a lower temperature but a higher humidity than the summer months. The remaining months, November to February, are the winter months, where the sun angle is the lowest and the temperature is moderate. The air temperature for the year ranges from 21 to 35°C, while the relative humidity varies from 45 to 95% (Tantasavasdi, Srebric, & Chen, 2001).

The most common building materials for housing are cement or clay bricks for the wall construction, concrete floors and concrete or clay roof tiles. These materials have a tendency for fabric heat gain into the building. The typical plastered brick wall used in the local housing development has a high heat storage capacity, which means large amounts of heat gain will be released into the room at night and warming the interior space (Faizal, 2015).

2.3.1 Terraced House in Malaysia

In the middle of the high economy, the urban population has increased 57% from 1960 to 2010 and with more than three-quarter of the Malaysia overall population estimated to settle in urban. More land will develop for urbanization to fulfill housing settlement due to the increasing national population. The most common typologies of residential buildings in Malaysia are terraced houses. Terrace house is the most living quarters in the mass housing scheme for urban areas. The house is reasonably cheap and common housing alternative in Malaysia.