Evaluation Of Decentralized Fans Effectiveness In Office Building Ventilation System

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ABSTRACT – This research aimed to evaluate the effectiveness of decentralized fan to the centralized air conditioning system for a small office as current reports claimed that air conditioning system is the biggest power consumption in office buildings. In this research, a duct trainer kit is developed and the temperature distribution, face velocity of the diffuser and power consumption of two cases with damper and two cases with decentralized fan with minimum and maximum speed of centralized fan respectively are compared. Result shows that decentralized fan with maximum centralized fan speed has the higher face velocity at the diffuser and shorter temperature distribution period but has slightly higher power consumption compared to other three cases.

1. INTRODUCTION

Heating, ventilation and air conditioning system have a significant influence on the energy consumption of a building. Based on studies done by past researchers [1-2], 50% of the total electricity consumption in Malaysia is contributed by the air conditioning system. Therefore, significant steps to reduce further energy usage in air conditioning system is a challenge for heating, ventilation and air conditioning professionals nowadays. Currently, most studies to reduce energy consumption of air conditioning system focused on the compressor and the system control[3].

In this research, a method to reduce power consumption for a small unit office building that used fan coil unit and dual branch duct work as it's main air conditioning system is introduced. Damper that is used in most ducting system is replaced with decentralized fan. As damper cause reversed air flow and high pressure drop in ducting system, it forced fan to use higher energy to produce higher flow rate in order to cool better. As previous study focus on one sided branch ductwork[4-6], this study will focus on face velocity, power consumption and temperature distribution period of a two sided branch ductwork. A trainer kit is developed with four rooms using dual branch ductwork and result will be compared between decentralized fan and damper.

2. METHODOLOGY

Duct trainer kit with dual branch ductwork and four rooms are designed and developed as shown in Figure 1 below. A centrifugal fan is located at the end that acts as a air handling unit and damper is located at each diffuser of the room. The duct work used in this trainer kit is a rectangular type made from Perspex. The main duct size is 7 x 2.5 cm and 5 x 2.5cm , while the branch size is 3.5 x 2.5 cm. The length of the branch from the main duct of branch A and B is 4cm and for branch C and branch D is 5 cm. The damper is replaced with decentralized fan from axial type to compare both method. The speed of the decentralized fan is fix.

Figure 1 Duct trainer kit

The experimental work is divided into four cases as the following:

a) Damper with minimum main fan speed
b) Decentralized fan with minimum main fan speed
c) Damper with maximum main fan speed
d) Decentralized fan with maximum fan speed

Figure 2 and Figure 3 shows the experiment setup experiment for damper and decentralized fan. The experiment is done by the following procedures:

1. The main fan speed is set up to minimum speed and run for 30 minutes. The minimum speed is set up with experiment with damper and then decentralised fan.
2. The parameter of the research is measured. The face velocity is measured at the diffusers outlet using anemometer while the temperature is measured using thermocouple by placing the probe in the four room. The power consumption of the main fan is measured by multimeter
3. The reading of the temperature is taken every 2 minutes.
4. Then the main fan speed is set to maximum speed and run for 30 minutes. The step with minimum speed is repeated

Figure 2 System with damper

Figure 3 System with decentralized fan

3. Results and Discussions

Figure 4 shows the face velocity in the room from the experiment conducted. Based on the bar chart, the decentralised fan increased the face velocity of the system. While Figure 6 shows the analysis of power consumption by the fan. The trend of the result is the same for every room. It can be clearly seen when the system used decentralised fan, the face velocity increased.

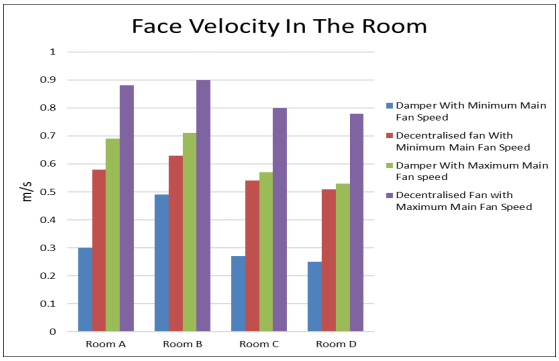

Figure 4 Face velocity in each room

Based on the bar chart, the time for the room to cooled is faster when decentralised fan is use in the system but the energy use is slightly higher compared to system with damper, for both maximum and minimum fan speed cases. However since the cooling time for decentralized fan with minimum fan speed is 50% shorter than the cooling time for damper with minimum fan speed, the increase of 4.5% power consumption is acceptable. The same trend can be seen for decentralized fan with maximum speed that takes 30% shorter time than with damper but have 9% higher power consumption. These results shows that using decentralized increase face velocity of the room, and cool room faster than using damper with the same main fan speed but have slightly higher power consumption. However, as cooling time is shorter than cases with damper, this could save more energy is a long run.

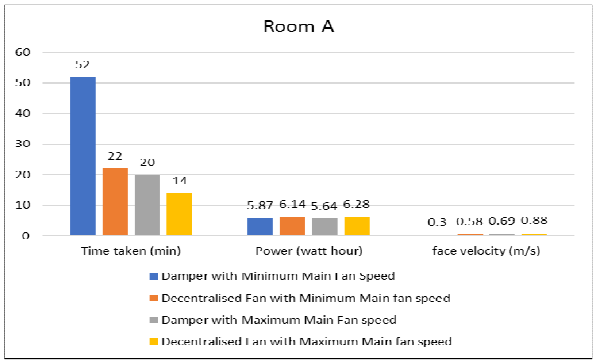

Figure 5 Time taken to cool, power consumption and face velocity for room A

4. CONCLUSIONS

With the ducting trainer kit built, the effect of the decentralised in the ducting system can be analysis. The decentralized fans at the branches of the ducting had increase the face velocity at the diffuser of the room. Other than that, the temperature distribution when using decentralised fan is better compared to damper. The temperature drop in the room is rapid compared to damper. Lastly, the power consumption by the system is more efficient when using decentralised fan compare to damper in a long term run.

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