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FLOW CHARACTERISTICS STUDY IN KITCHEN HOOD USING ANSYS

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Abstract: Commercial kitchen hood ventilation system is a device used to capture and filtered the plumes from cooking activities in the kitchen area. In the recent years, it is very important in an industrial sector such as restaurant and hotel to provide hygiene food. The purpose of this study is to identify flow characteristics in the commercial kitchen hood ventilation system and to observe the effect of capture jet technology. The ANSYS 14.5 (FLUENT) Software is the tool used to simulate the kitchen hood system with capture jet and without capture jet technology. The design model has a dimension of 700 mm width, 1600 mm length and 555 mm height. The comparisons are made between Water Wash/Water Mist kitchen hood with capture jet and without capture jet, in order to observe the effect of the capture jet technology through flow characteristics analysis. Three different cases are tested which are Case A (1.071 m/s), Case B (0.871 m/s) and Case C (0.671 m/s) set at inlet capture jet. Results show that kitchen hood with capture jet technology has improved the flow characteristics in the kitchen hood system which helps to increase the average velocity and control flow in kitchen hood system. Case A with the velocity of 1.071 m/s has the highest average velocity compared to the Case B, 0.871m/s and Case C, 0.671m/s. Overall Case A provided better flow characteristic based on its characteristic of spreading the fresh air in workspace area. The more spreading of fresh air, it will cover more area in kitchen space thus its helps to provide better thermal condition in the kitchen space. It can be conclude that the inlet capture jet velocity plays an important role in order to help the system efficiently vent out the plumes from kitchen area at the same time to provide better Indoor Environmental Quality (IEQ) in kitchen space.

Introduction

A Professional Kitchen is a very challenging and demanding environment. Ventilation plays an important role in providing comfortable and productive working conditions and in securing contaminant removal [1]. Commercial kitchen hood ventilation system is device used to filter the plumes during the cooking activities. The purpose of commercial kitchen hood system is to capture the heat plume rise up from the cooking equipment [2]. Nowadays, the use of the kitchen hood is widely used and very popular in the industry especially hotels and restaurants. Each part in the kitchen hood has difference purpose and benefits such as energy efficiency, Indoor Environmental Quality (IEQ), security, and so the level of air purification [3]. Therefore, significance grease filter were used in modern kitchen hood to filtered unclean air. Grease filter is an important component in the kitchen hood, this because the efficiency of kitchen hood system depends on the type of filter being used. Grease filter is a device installed in the exhaust hood in any way to remove the oil from the air exhausted by the trapping the grease [4]. The efficiency of commercial kitchen ventilation filtration system is measured based on how many particles could be capture by the filter [5].

Methodology

ANSYS Software is used to simulate flow characteristics in the Water Wash/Water Mist kitchen hood system. The model was constructed by using SOLIDWORKS 2013 software which divided into four parts which are exhaust, supply, side panel and middle roof part. The dimension of Water Wash/Water Mist kitchen hood is 700mm length, 1600mm width and 553mm height.

Figure 1 show the illustrated the full model of Water wash/Water Mist kitchen hood system. The exhaust part has a dimension 598mm length x 598mm width x 553mm height and connected with the ducting system with has a the dimension 400mm length x 200mm width x 10mm height. The cyclonic KSA filter with a dimension 1966mm length x 330mm width x 48mm height is placed with angle of 45 degree from y-axis. Pipe with the dimension 20mm diameter, 598mm length is connected to the water wash and water mist in front KSA filter. The fresh air supply from the ambient will pass through the inlet of the supply part which automatically connected to the side panel which has 140 with the diameter of 10mm. Figure 2 shows the illustrated different between kitchen hood with capture jet technology and kitchen hood without capture jet technology.

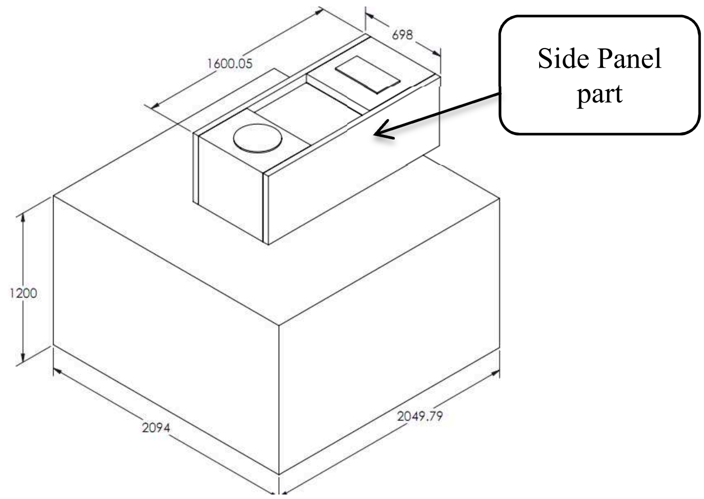


Fig 1: Full model of commercial kitchen hood system.

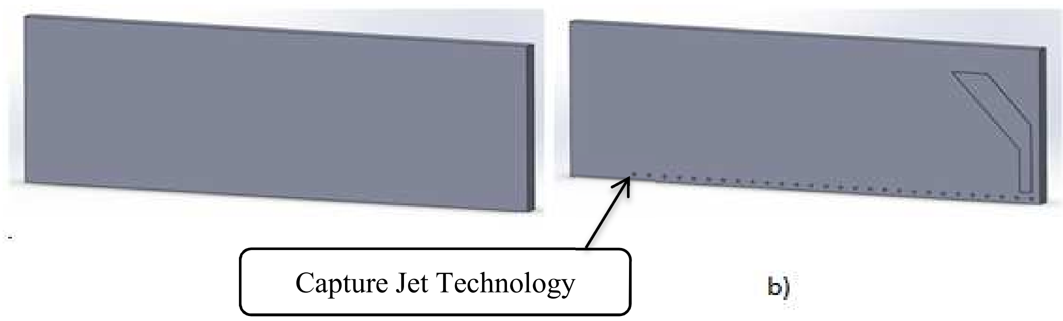


Fig 2: Side panel without capture jet (a) technology and with capture jet technology (b).

The computational domain consists of two inlets velocity and one outlet. The temperature and velocity set at the burner for inlet is 299 K and 0.235 m/s. Meanwhile, for the second, the inlet velocities are 1.071, 0.871 and 0.671 m/s and the temperature is 288K. The turbulent model for this simulation is Re-Normalization Group (RNG) k-ε. The RNG k-epsilon has been selected in this simulation because it suitable to study the flow characteristics in the kitchen hood and useful to analyse the interior of the region. Besides that, RNG k-epsilon has good moderately complex behaviour like impingement, separating flow, swirling flow and secondary flows.

Results and discussion

ANSYS 14.5 Software (FLUENT) was used to simulate the flow characteristics in kitchen hood with capture jet technology and without capture jet technology. There were three different captures jet velocities were tested which are 1.071 m/s (Case A), 0.871 m/s (Case B) and 0.671 m/s (Case C). All cases are discussed and analyzed based on graph, contour and velocity vector flow distribution. Figure 3 shows the quantitative values for velocity versus distance for kitchen hood with capture jet and without capture jet. It shows the kitchen hood with capture jet technology has higher average velocity which is 0.65m/s compared to kitchen hood without capture jet which is 0.21m/s. It indicated that by installing capture jet technology, its help to increase the average velocity of air in the system.

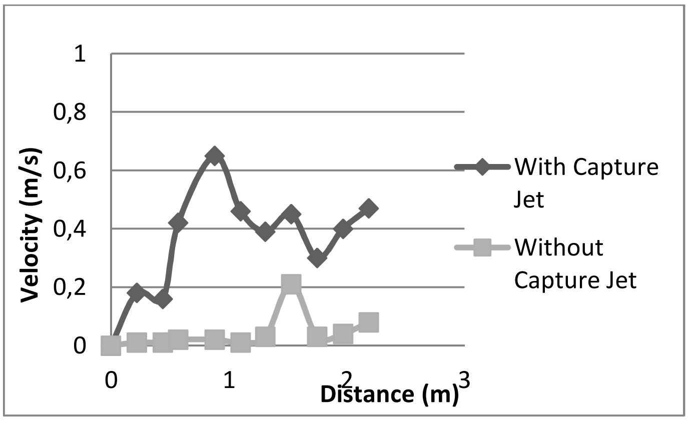
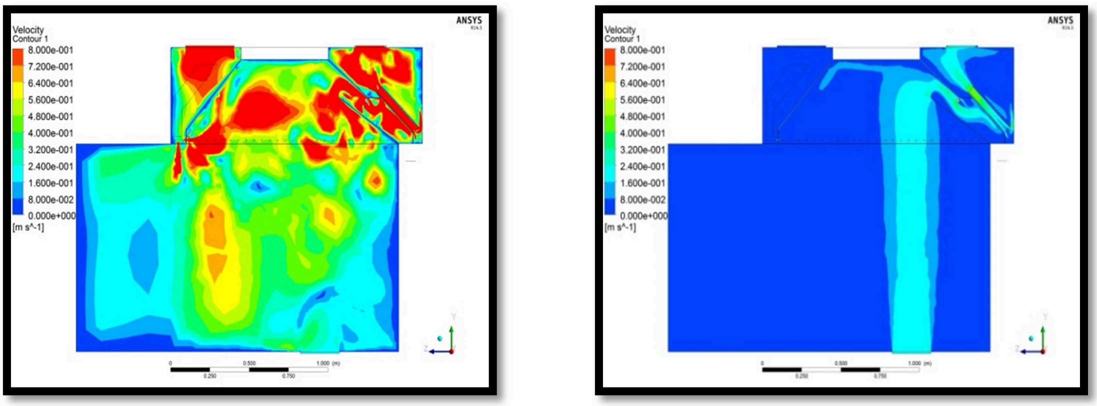


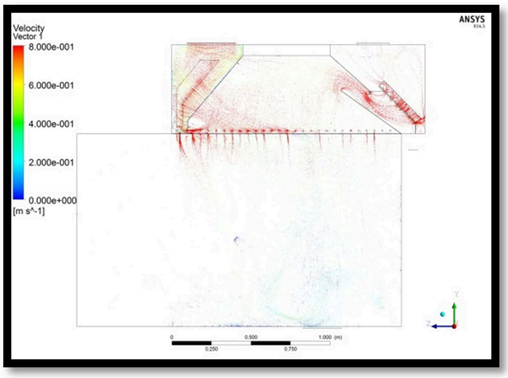
Fig 3: Graph of velocity (m/s) versus distance (m) for kitchen hood with and without capture jet technology at velocity inlet stove 0.235 m/s.

Figure 4 shows the velocity contour of commercial kitchen hood with capture jet and without capture jet technology installed in kitchen space. From the figure, for kitchen hood with capture jet technology, the air velocity from the capture jet helps to increase the average velocity in the system. This phenomena happened because of the fresh air from capture jet spreading randomly and cover more area with high velocity thus its help to pushing the plumes which comes from the stove to flows with high velocity to the exhaust part, meanwhile for kitchen hood without capture jet technology, the plumes will rise up to the outlet of the system with almost uniform velocity.

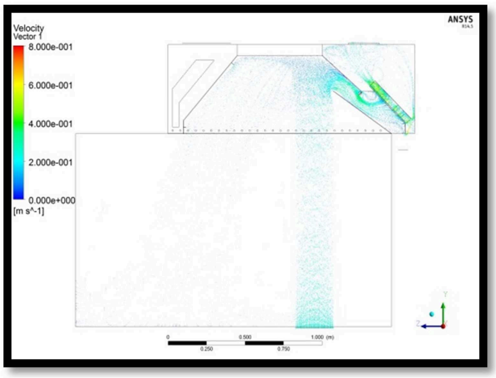


With capture jet technology (a) Without capture jet technology (b)

Fig 4: Velocity contour (m/s) for kitchen hood system with capture jet technology (a) and without capture jet technology (b) (yz-plane).



With capture jet technology (a)



Without capture jet technology (b)

Fig 5: Velocity vector (m/s) for kitchen hood system with capture jet technology (a) and without capture jet technology (b) (yz-plane).

The velocity vector shows the particle movement in the kitchen hood system for both cases. Figure 5 shows that the baffle panel at the exhaust part is affected flow characteristic in both cases. It is clearly shown that once the particle is rise up from the stove, it will hit the edge of baffle panel thus result the jetting effect. This jetting effect at the baffle panel will increase the particle velocity and change the flows direction at the entrance of exhaust part. Moreover, this particle will hit the second obstacle which is exhaust part wall thus results the decreasing of velocity because of friction between the particle flow with the exhaust part wall. The position of the nozzle pipe also plays an important role to produce better flow structure of velocity.

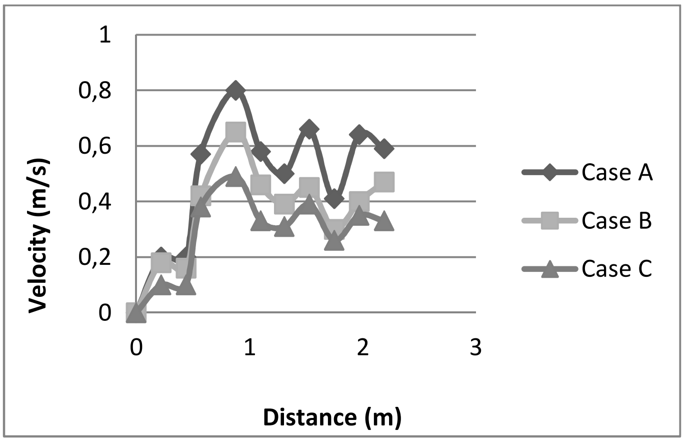
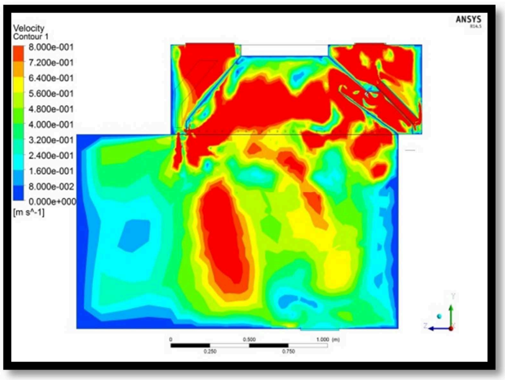
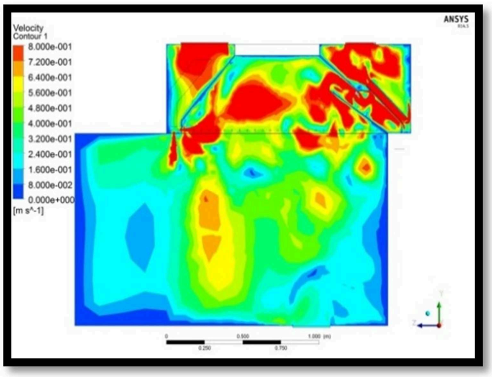


Fig 6: Graph of comparison of velocity (m/s) versus distance (m) for kitchen hood with capture jet between Case A, Case B and Case C.

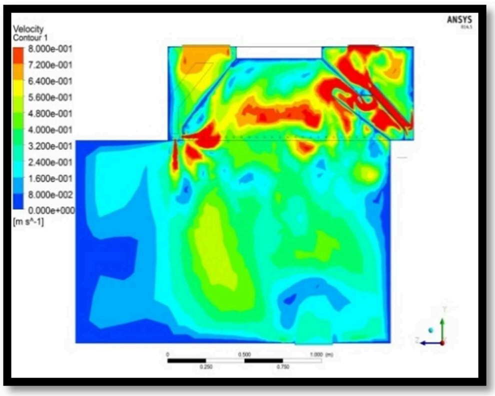
Three cases were tested in this study which are Case A (1.071 m/s), Case B (0.871 m/s), and Case C (0.671 m/s) to observe the effect of the inlet velocity of capture jet to the average velocity in the kitchen hood system. Based on the graph in figure 6, its shows that in Case A has the highest average velocity follow by Case B and Case C. It concludes that by increasing the inlet velocity of capture jet do affect to the average velocity in the system significantly. Figure 7 shows the velocity vector for Case A, Case B and Case C.



Case A (a)



Case B (b)



Case C (c)

Fig 7: Velocity contour (m/s) for inlet capture jet with velocity for Case A (a), Case B (b) and Case C (c).

Summary

Three difference inlet velocities of capture jet and kitchen hood without capture jet were tested. The result shows by embedded capture jet technology to kitchen hood system, its helps to increase the velocity and control the flow in the system. It shows by the characteristic of the fresh air spreading in the systems which cover larger area. By embedded this system and increasing inlet velocity of capture jet, the high velocity of fresh air will pushing the plumes to move to the exhaust part with higher velocity. As a conclusion, by installing the capture jet technology in commercial kitchen hood system, it helps to improve flow performance of the system and at the same time it will provide comfortable work place in the kitchen area. Noted that the value of inlet capture jet velocity play an important role in order to get better thermal condition in kitchen area.

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