CFD Analysis of Air Conditioning in Room Using Ansys Fluent

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Abstract: - The primary goal of this study is to investigate the air cooling and temperature variations in the room. Performance of the air conditioner is showed for different location of duct positions. In this work CFD simulation of forced ventilation on A.C. room was conveyed and thermal comfort of the person is considered utilizing ANSYS Fluent. Three case study of Air conditioning rooms are taken into consideration case 1 we placed one AC duct at 9 feet above from base floor, in case 2 we placed two AC duct placed in front of each other of same mass flow rate, In Case 3 Ac duct separated into two-part and both part of duct placed on the roof having 9 feet distance to each other. Also, final results optimized and made evaluation of Room 1, Room 2 and Room 3 temperatures are found.

Keywords: air-conditioning control, thermal comfort, FEM, CFD Analysis.

I. Introduction

The science which manages making a controlled in indoor space is alluded to as cooling. Prior days the cooling wind up regarded as a luxurious, anyway in gift situation because of substitute in natural conditions the cooling framework has risen as an integral part of human ways of life. In tropical and subtropical nations cooling by utilizing cooling is fundamental capacities of front-line advancement. In this manner, it is important to create present day cooling framework to meet the necessities comfort conditions. As the noteworthiness of refrigeration and cooling is expanding day by day there might be need to examine about the thermal comfort at any assortment of natural circumstances. The cooling market on the planet has developed impressively over the most recent couple of years. It proceeds with its exceptional development in accordance with the numerous private and business industry occurring especially in creating nations. As rivalry increases in the worldwide private cooling market, costs will in general fall. This pattern should open markets to new end-clients who couldn't beforehand bear the cost of cooling since it was viewed as an extravagance thing. By expanding end-client introduction to cooling in shops, workplaces and vehicles, there is a progress among purchasers to a cooled way of life. Ordinarily, the forced air system area does not coordinate that expressed by the maker's determinations. In the event that appropriate refrigerant charging isn't performed amid establishment, the execution and productivity of the unit is debilitated. Climate control system makers for the most part make rough, brilliant items. In the event that a forced air system is introduced effectively, or if real establishment issues are found and settled, it will perform proficiently for a considerable length of time with just minor routine maintenance. [6]

II. Computational Fluid Dynamics

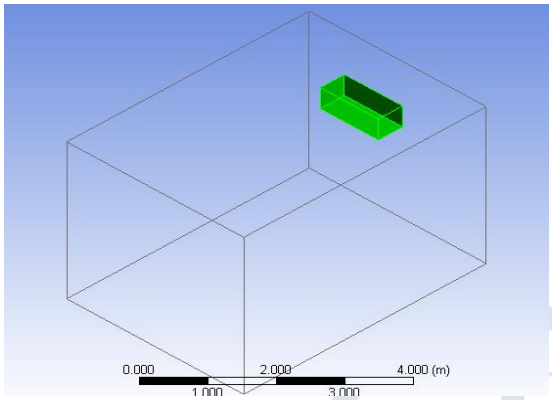
Computational Fluid Dynamics (CFD) is a powerful tool for fluid elements and thermal plan. Computational liquid elements include the numerical discretization of the administering conditions of liquid mechanics to simulate liquid flow, heat exchange, and related procedures in a given domain. Computational liquid elements codes are organized around the numerical calculation that can handle liquid stream issues. With the end goal to give simple access to their fathoming power all business CFD bundles incorporate refined UIs to include issue parameters and to inspect the outcomes. CFD is normally acknowledged as alluding to the wide theme enveloping the numerical arrangement, by computational strategies. These administering conditions, which portray fluid stream, are the arrangement of Navier-Stokes condition, continuity condition and any extra conservation conditions, such as, energy or species focuses.

III. Modelling of Air conditioning Room design in Ansys Fluent

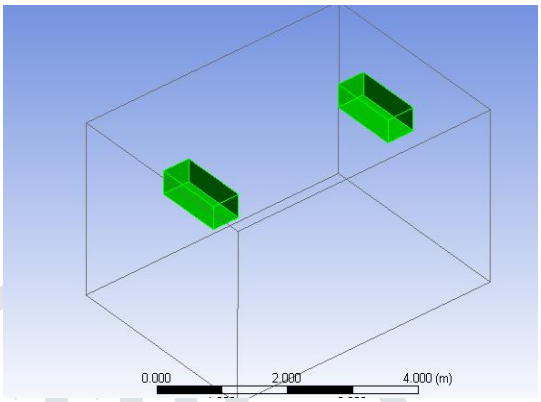
The ANSYS Design Modeler is a entrance to design coping with for an ANSYS analysis. Geometry created the usage of ANSYS Design Modeler software that is particularly designed for the creation and education of geometry for simulation. In engineering simulations, the geometry consists of info now not wished for simulation. Only the physics involved is to be included, simulating such a fully designated version will boom solver run times. the geometry created of A. C. Room with duct region and diverse functions of Design modeler and description tree with Air conditioning room with dimension of room are described in table.

Table 1: Dimension Parameters

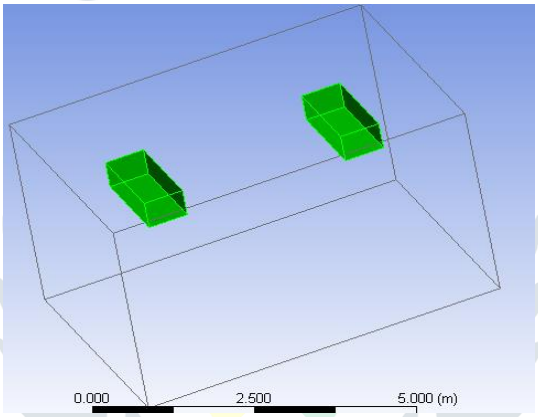
Parameters	Room dimensions (meter)	Dimension of Duct (meter)
Length	4	0.5
Width	3.65	1.5
Height	6	0.65



(a) Case 1



(b) Case 2



(c) Case 3

Figure 1 : Air conditioning rooms design in Ansys Fluent with various duct positions

IV. Results and Discussion

Study of Air conditioning rooms are taken into consideration case 1 we placed one AC duct at 9 feet above from base floor, in case 2 we placed two AC duct placed in front of each other of same mass flow rate, In Case 3 Ac duct divided into two-part and both part of duct placed on the roof having 9 feet distance to each other.

- **Case 1 of AC Room**

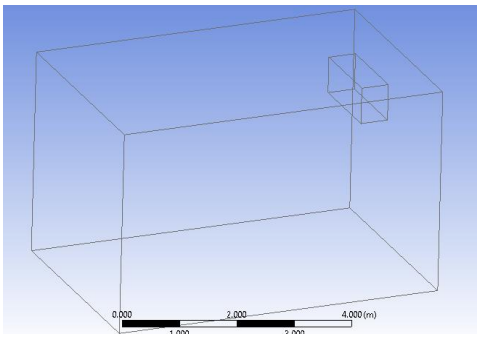


Figure 2: Room 1 Designed in ANSYS

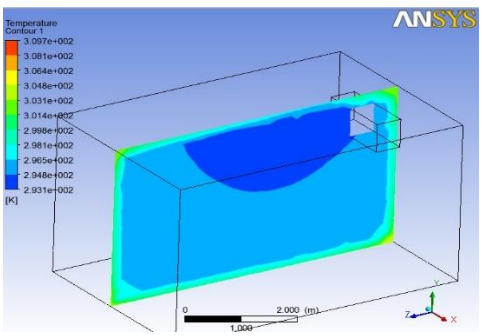


Figure 3: Temperature variations in Room 1

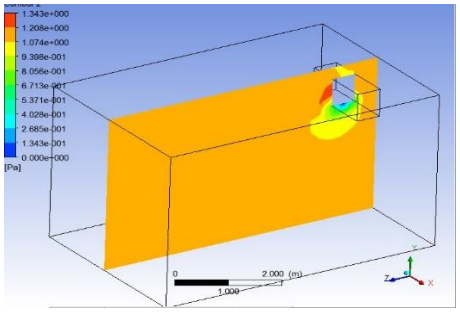


Figure 4: Pressure due to Air flow in Room 1

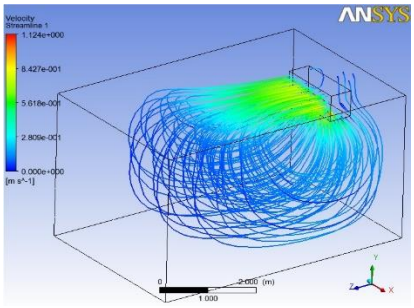


Figure 5: Streamline of Air flow in Room 1

- **Case 2 of AC Room**

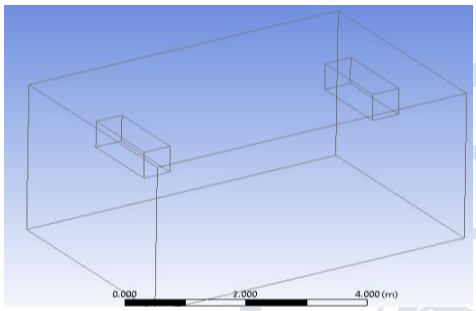


Figure 6: Room 2 Designed in ANSYS

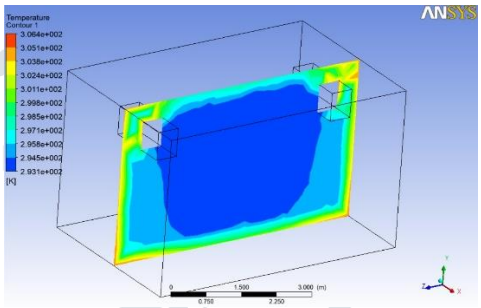


Figure 7: Temperature variations in Room 2

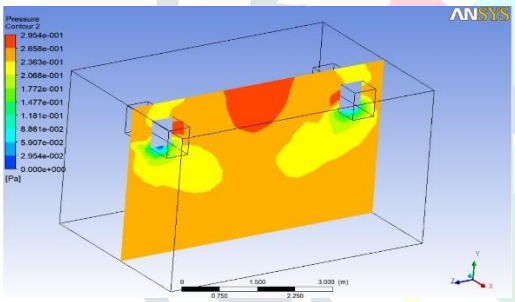


Figure 8: Pressure Generated due to Air in Room 2

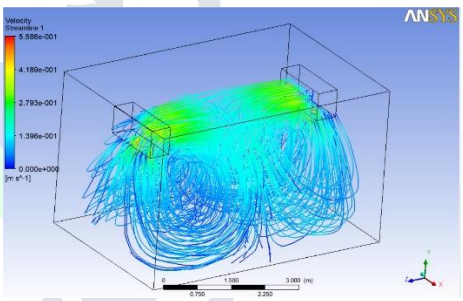


Figure 9: Streamline of Air flow in Room 2

- **Case 3 of AC Room**

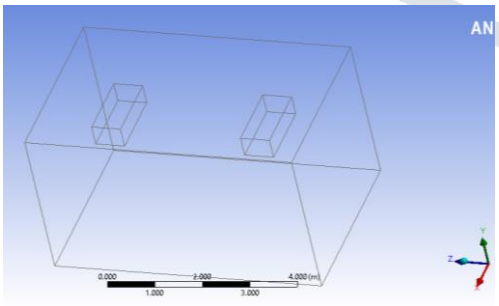


Figure 10: Room 3 Designed in ANSYS

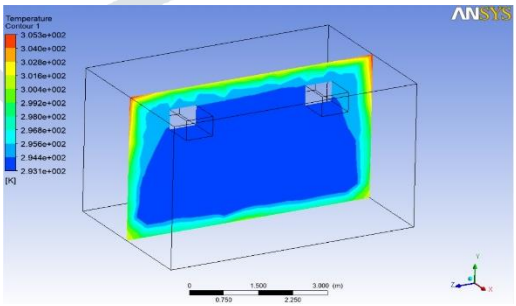


Figure 11: Temperature variations in Room 3

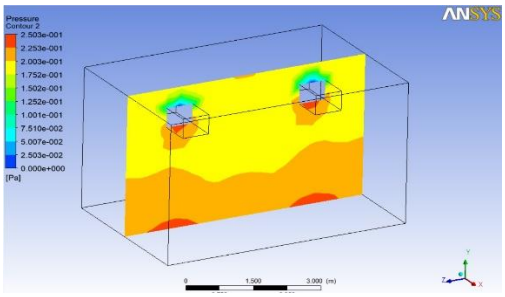


Figure 12: Pressure Generated due to Air in Room 3

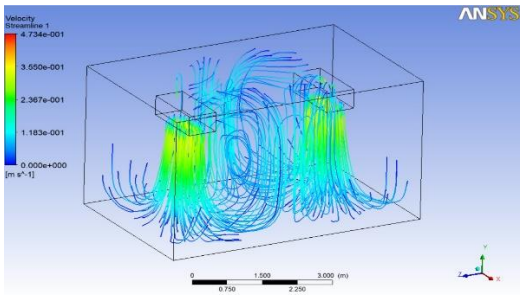


Figure 13: Streamline of Air flow in Room 3

Above figures shows the variations of AC Rooms temperatures, Pressure of Air in Room and effects of room during Air circulation by AC duct. Three types of case study of room designing in which room duct is place at different locations and same mass flow rate duct is divided into two section of half mass flow rate of each duct. Finally, optimized results by comparing all three-room temperature results. Above graph and figures shows the variations of AC Rooms temperatures, Pressure of Air in Room and effects of room during Air circulation by AC duct. Table1 shows the comparison of All three cases of room study with different Duct positions

Table 6.1: Comparison of Results with all three cases of AC Room

Rooms	Minimum Temperature of Room (^{0}C)	Pressure (MPa)
Room 1	36	1.34
Room 2	33	1.12
Room 3	32	0.99

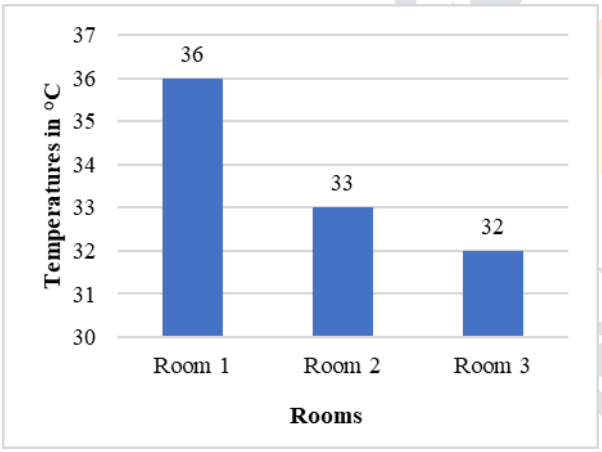


Figure 6.14: Comparison of Temperature b/w All Room

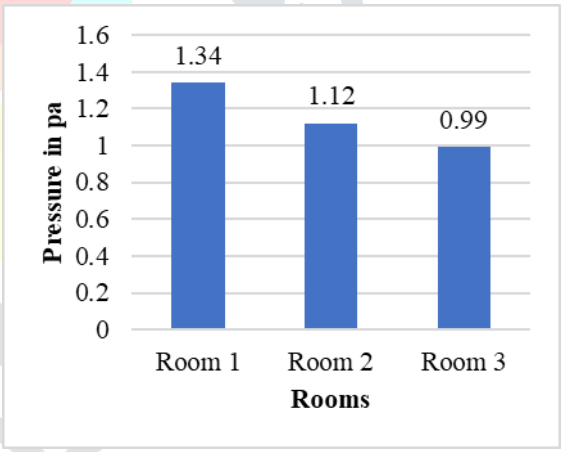


Figure 6.15: Comparison of pressure b/w All Room

As per Above Study it is concluded that Room1 having minimum cooling temperature found that is 36 ^{0}C. In Room 2 double duct used in front of each other and minimum temperature found 33 at middle of room. In Room 3 conditions double duct used for air flow but mass flow rate of air kept constant so after study in room 3 minimum temperature 32 ^{0}C found. So as per as study it is found that case 3 Room with double AC duct but same mass flow rate is better arrangement for fast cooling system in minimum time.

As per above graph it is found that Room 1 having high pressure inside the room with comparison to others. And room 3 has minimum pressure to other rooms. So, shows better air circulation with cooling in room 3.

As per ANSYS histogram graph we optimize the maximum temperature drop in rooms. figure shows the temperature drop in rooms. Temperature of air flow through duct is 293 K (20°C) and wall rooms having temperature 40° C.

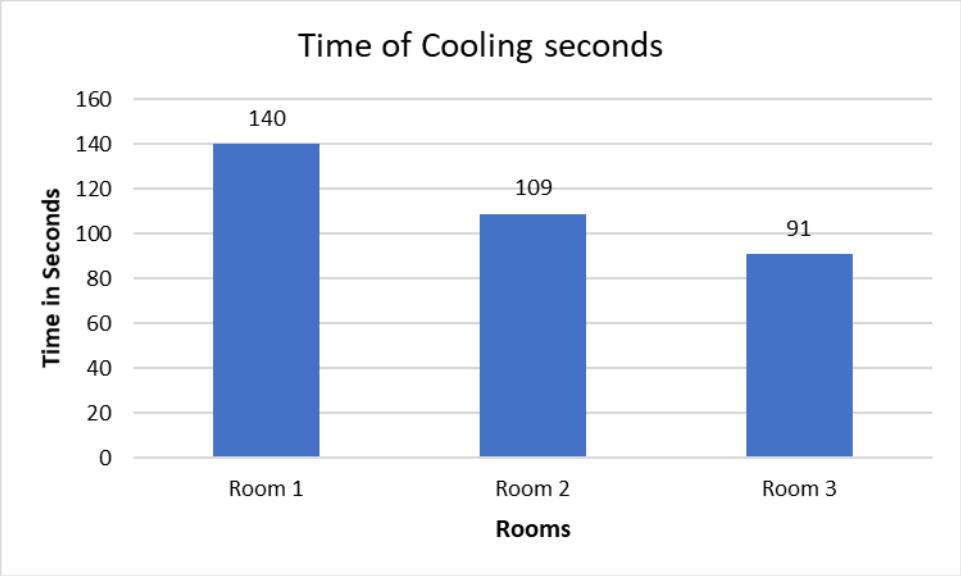


Figure 6.19: Time of Cooling in Seconds

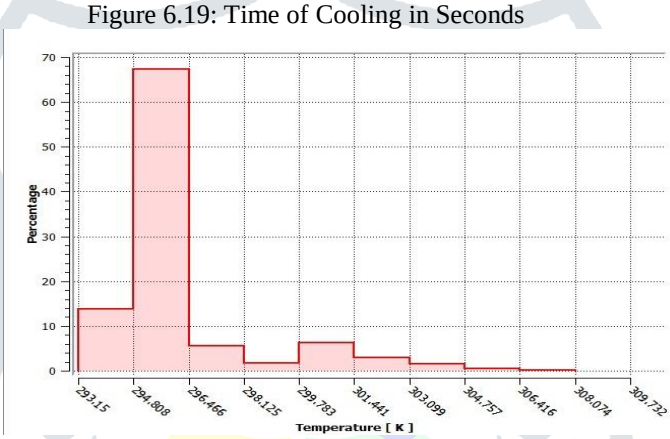


Figure 6.16: Histogram Graph of temperature distribution in Room 1

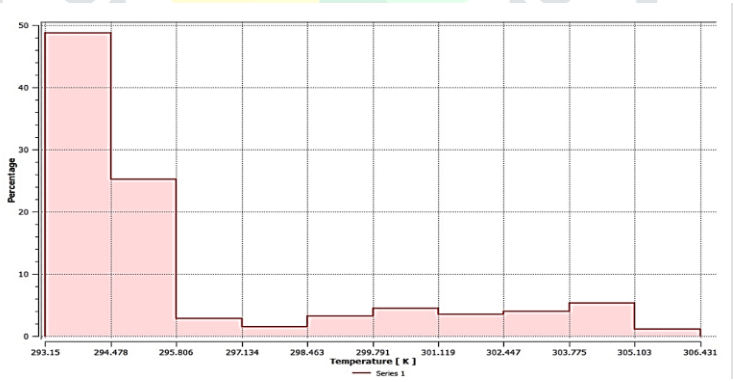


Figure 6.17: Histogram Graph of temperature distribution in Room 2

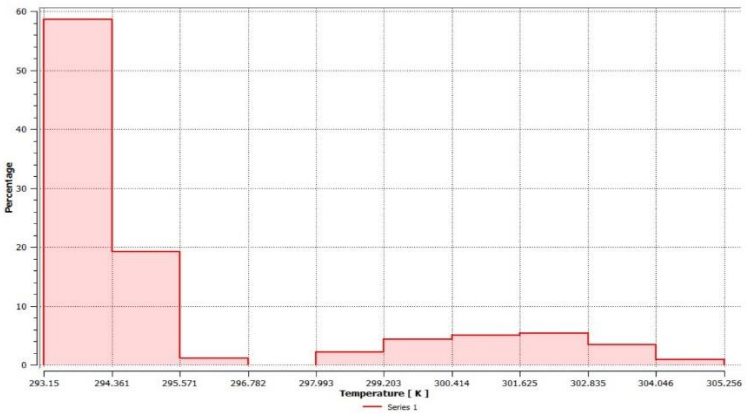


Figure 6.18: Histogram Graph of temperature distribution in Room 3

Figure 6.16, 6.17 and 6.18 shows temperature variations in room at constant time or in same time. All temperature shows in kelvin.

Room1 having minimum cooling temperature found that is 36 ^{0}C. In Room 2 conditions double duct used for air flow but mass flow rate of air kept constant so after study in room 2 minimum temperature 33 ^{0}C found. In Room 3 double duct used in front of each other and minimum temperature found 32°C, at middle of room.

V. Conclusions

In the present work, an extensive data analysis has been made to study the cooling potential for AC Duct location, using the three different location of duct in Same dimension rooms, optimize suitable method of cooling by comparing the outcomes of this investigation. Following conclusions are made as per above study:

- While there are several experimental investigations performed by researchers regarding the air conditioning of Rooms. On the basis of 3-D finite element modeling of conventional room design. The obtained data showed how room temperature drops with respect to percentage volume during CFD analysis using FLUENT was considered. The modeling, meshing, preprocessing and analysis portion of the work is performed in ANSYS V14.0.
- As per above study, it is concluded that in Case 1 around 58% volume is maintained between temperature drop from 40°C to 36°C, in Case 2 the room volume is maintained between temperature range 40°C to 33°C and in Case 3 around 70% volume is maintained between temperature range 40°C to 32°C. Thus Room 2 is best arrangement of AC because, in this arrangement maximum volume of room is maintained at minimum temperature and it provides uniform cooling also in the room at minimum temperature.
- As per calculation of time taken in cooling Room 3 has given best result, it takes less time as compared to other.
- So it is concludes that Room 3 has better cooling conditions so our this design is best for cooling system.

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