Positioning Optimizationof AC mounted in CAD Lab for better Cooling Using Computational Fluid Dynamics analysis in fluent

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***Abstract* - In the present work computational fluid dynamics analyses have been performed for a CAD Labinstalled in CIST, Bhopal using ANSYS fluent to investigate the effects of better thermal comfort by changing of AC position. For that four different three dimensional CADmodelshave been created using the CATIA software with approximate dimension.Producedmodels are AC attached on same wall, AC attachedon opposite wall, AC attachedon adjacent wall & AC mounted on corner. Results show that the AC mounted on adjacent wall achieved the comfort temperature inside CAD lab much quickly as compared to other positioning of AC and gives better cooling in 250 sec at 1.7 m/sec which reduce 16.67% cooling time as compared with AC mounted on same wall.**

***keywords* - Air conditioner, Optimization, Cooling Performance, computational fluid dynamics etc.**

I. Introduction

Warming is a state of the heart that expresses happiness in a warm environment and is measured by temperature. Thermal neutralization is controlled by allowing the escape of heat generated by human metabolism, thereby controlling the thermal conductivity of the surrounding environment. The foremost factors influencing thermal conductivity are those that regulate rise and fall, i.e. metabolism, insulation rate, global warming, average radiation temperature, weather stress, and relative humidity. Poor moods, as people's expectations, also affect warming.

Two types of heat pump models are available worldwide (ASHRAE 55-2017 standard); the thermal stability model (industrialized by Fanger in 1970) was also tested on PMV / PPD and accustomed heat deduction models. The first model is ideal for air conditioning in a home where passengers cannot control their immediate surroundings for later, lively and immediate interaction. Now the breathingatmosphere is well positioned and people are in a more general attitude, bodily and emotional development. Compared with functional buildings the fan's PPD / PMV model which disregards the exterior temperature is important to govern the right temperature.

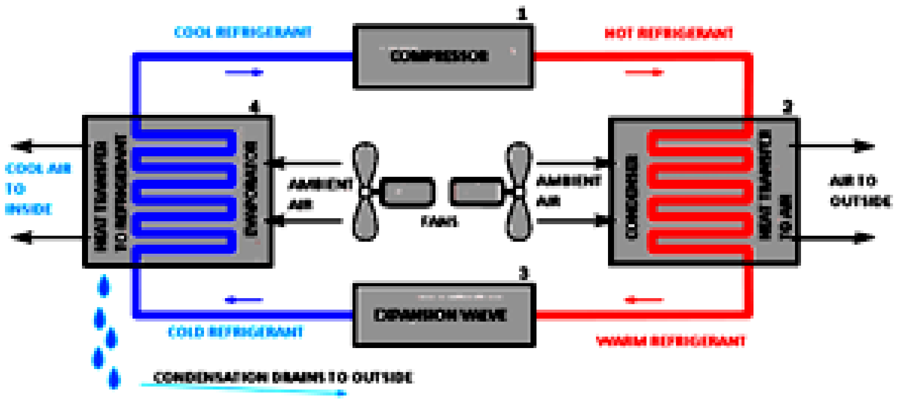

Figure1: Working Principle of Air Conditioner

The simplest heat transfer model is the linear distribution of the indoor air temperature directly over the outdoor air temperature located below the dividing surface.

$$T_c = 0.31T_{out} + 17.8$$

Where

$T_c$is indoor comfort temperature

T_{out} = *outlet temperature*

The air conditioner further refrigerates the air from the cooled interior; the refrigerator structure cools it down and returns it to, the same interior space that it freezes. Due to the constant collision, cooling and renewal processes of the cooling systems, the air conditioning system maintains a lower temperature range than the cooling necessities. When transformed to air conditioning, the components of thermostat sensorpanels 120V AC to the fan and fan body. The pumping unit as compressor compresses the working fluid in the form of oil into a condensing system at the back of the room where the gas enters hot water. When the employed fluid is passed over a connection between the compressing unit and the conductor where it transmits the liquid fluid over the evaporator spirals the front evaporator leads to coils. As the coolant enters the coils, it covers the oil, which cools the coils. The gas streams through the spirals into the drawing line, connects to the compressor, converting the oil into a liquid and continuing cooling. However, the propellers rotate with a surface that draws air hooked on the air through the evaporator before being re-circulated to the room. In addition, it operates condenser fans that blow the outer air over the existing air to cool them.

II. Literature Review:

Ren C & Cao S-Jie [1] A 2D linear temperature ventilation model and an artificial neural network have been integrated to control indoor air quality for online thermal wellbeing, with a low-dimensional linear temperature exemplary and room climate coefficient to offer reliable sustenance for online HVAC control. Two steps had taken, taking into consideration the pollution reactions and temperature.

Lu zhang at el. [2] In this article, they have proposed a semi-linked CFD exemplary that combines the advantages of a fully connected CFD model with a separate CFF model. In this CFD model the flow and temperature fields are first solved by a fully coupled simulation with the transient initiating period and then different CFDs are engaged to numerically analyze the temperature intensification for transient calculation. Xiaofang Shan at el. [3] This study included CFD analysis and remote flow quantities to measure the distribution of PMV decoder samples. Dissemination of ecological characteristics: voltage, temperature, temperature, inside the operating room with fan coil unit speed. Depending on these distributions PMV amounts are obtained to maximize heat output.

Wooyoung Jung & Farrokh Jazizadeh [4] This article examines how thermal elasticity is considered in terms of temperature selection and overall efficiency of a finite element. They also assessed the consequence of temperature alteration on the temperature of the factors, assuming that better solutions can help achieve overall improvement warming techniques. They were consulted by the Managing Agent on testing the multi-location system, managed by an HVAC representative, to deliver air conditioning to various agents through our workflow to pair each other and compare the recommendations.

Xinyu Zhang ar el.[5] In this paper, we define and define an efficient parameter through CFD modeling and simulation including velocity arenas temperature contours and heat transfer characteristics of CO_2 and air fluid under dissimilar operating conditions.

Jéssica Kuntz Maykot at el. [6] This work focuses on examining gender interactions in terms of the need for workplace comfort. The statistics were acquired from 83 field inspections conducted in 2014 at our office in Florida, South of Brazil. One of the construction has air conditioning and the other two functions are less mixedi.e. the transition from cooling to ventilation.

Jindal A [7] This research Show, Indian data during the rainy and summer of 2015-16, to examine residences and heat in the classrooms of a government school in the temperate region of Ambala.

Földváry V at el. [8] In 2014 the ASHRAE Global Thermal Well-beingRecord II was established under the direction of the university, distinguishing the worth of undergraduate research in HVAC imaging and science development. University of California at Berkeley for the made environment and the inside environment of the University of Sydney Internet of Things.

M.T.H. Derks at el. [9] Mixed studies were steered with nurses in Hospital Theater as partakers. Comebacks were unruffled three weeks in summer and four weeks in fall. Study of follow-up reports inside nurses and temperature monitoring indoors showed that the equipment was warm (varying from 20 to 25 ° C) at room temperature for over seven hours.

Ricardo Forgiarini Rupp, Richard de Dear & Enedir Ghisi [10] The thermal well-being of mixed-use buildings has been investigated in order to better understand this type of construction and its effect on living thermal sensing. Yet, there is quiet no agreement among researchers as to whether mixed-mannerconstructions should be assessed separately for each mode and whether adaptive thermal well-being theory applies to both modes.

Shilei Lu, Bo Pang, Yunfang Qi & Kun Fang [11] A thermal test for various types of houses in Hainan and in the thermal well-being zone of 1944 was carried out after about two months. The survey outcomespredicts that high humidity did not have a significant impact on human comfort.

Elena Barbadilla Martat el. [12] The simplest modifications used for experimental buildings in the current study was used as a 17-month study in an office in Spain. The use of the procedure in HVAC control systems allows the assessment of energy efficiency achieving savings of 27.5% and 11.4% during both cooling and heating respectively.

Vitor E.M. Cardoso at el. [13] Thegoal of this paper is to represent a relationshipamid thermal relaxationsassessments methods employed in a unrestrictedcontinuously running bus station situated in a mild weather country. Data was unruffled in arenaof measurements and reviews were done on 240 passengers concentrating warm season operation conditions.

Hye-Jin Cho & Jae-Weon Jeong [14] The main objective of this study is to evaluate the thermal environment in commercial real estate, served with 100% external air systems with the aid of fluid desiccant and with straight and unintended evaporation and with straight and direct evaporative cooling. This study offers a method for estimating ambient heat with a series of energy simulators using the TRNSYS 17 program, integrated with an engineering equation solution.

Andrei Claudiu Cosma & Rahul Simha [15] In this work, the use of non-invasive thermal imaging cameras was explored to shape the human mind in a modified way and use records from 30 vigorous subjects verified in an office environment at a temperature of 21.11 ° C and 27.78 ° C. Workplace temperature, temperature, coating temperature and outfit temperature were measured above normal roughly 27 min per person used distance sensors and avoid contact with the subject.

III.Objective:

The crucial objective of the present work to investigate the special effects of thermal well-being in CAD lab by changing air outlet positions which exposed in the same thermal conditions. There are following objective have been set for this work.

1. Study of air conditioning system for thermal well-being.
2. Prepare the different 3D CAD model of CAD lab and placement of AC outlet.
3. Perform the CFD analysis for all above models with same thermal conditions.
4. Compare the results and present the best position of AC outlet for better thermal well-being.

IV.Methodology:

In the present work three CDA models of CAD Lab is created using CATIA designing software. For creating the model imprecise dimension were considered. Computational fluid dynamic analyses have been performed for all four models at different air mass flow rate, the position of all models are as follow.

1. AC outlet in CAD Lab on same wall.
2. AC outlet in CAD Lab on opposite wall.
3. AC outlet in CAD Lab on corner.
4. AC outlet in CAD Lab on adjacent wall.

Computational fluid dynamics analysis of CAD Lab for different AC mounting positioning:

CAD geometry:

Four CDA model of cad lab is created using the CATIA software with approximate dimension. Four geometry models were made AC attached on same wall, AC attached on opposite wall, AC attached on adjacent wall & AC attached on corner and a three dimensional views of CAD lab with AC attached in different position is shown in figure No. 02, 03, 04 & 05.

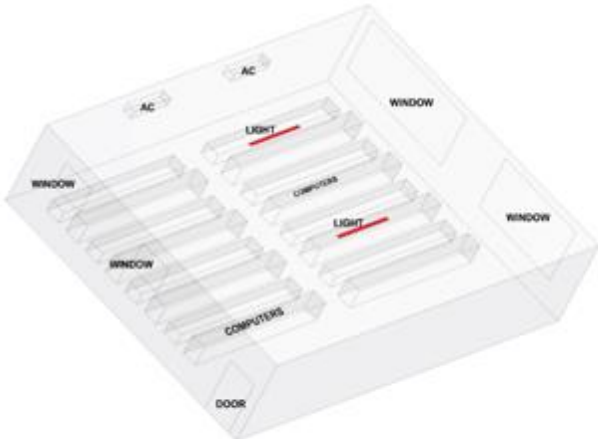

Figure02: Three dimensional CAD geometry of model-1

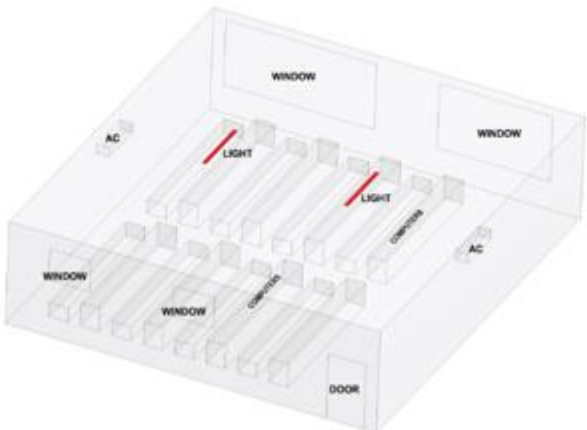

Figure03: Three dimensionalCAD geometry of model-2

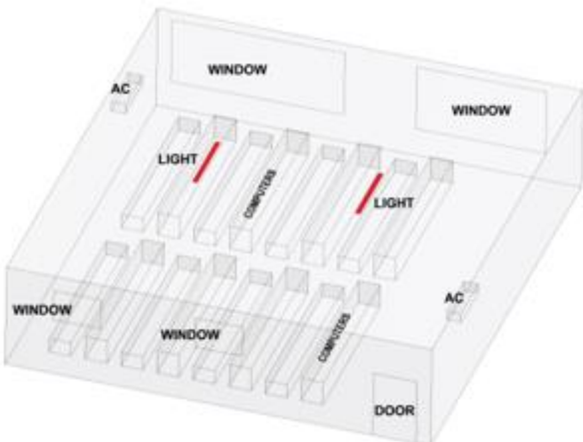

Figure04: Three dimensionalCDA geometry of model-3

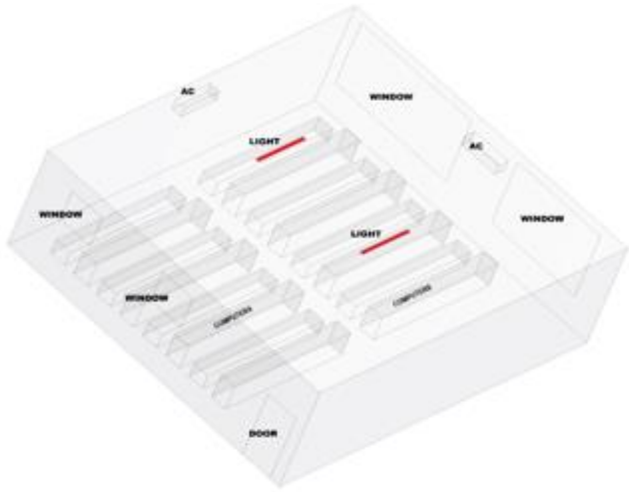

Figure05: Three dimensionalCAD geometry of model-4

Meshing: After completing the CDA model of CAD Lab is imported in ANSYS workbench for further computational fluid dynamics analysis where next step is meshing. Meshing is a precariousprocedure in finite element analysis in this process CAD model is separated into huge numbers of minor pieces called mesh. Types of cells used are hexahedral, wedge and tetrahedral which is a rectangular/triangular in shape with four and three nodes on each element.

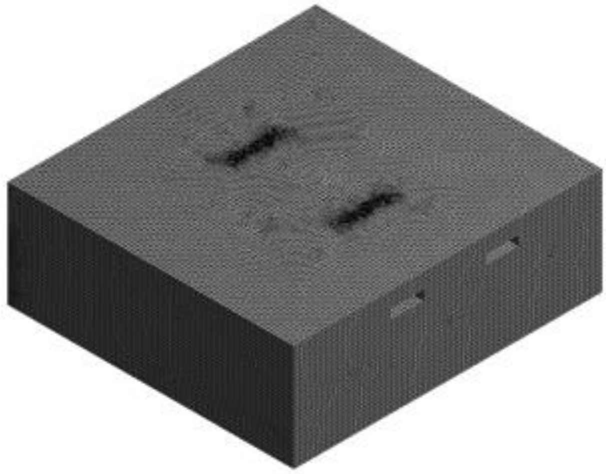

Figure06: Meshing of model-1

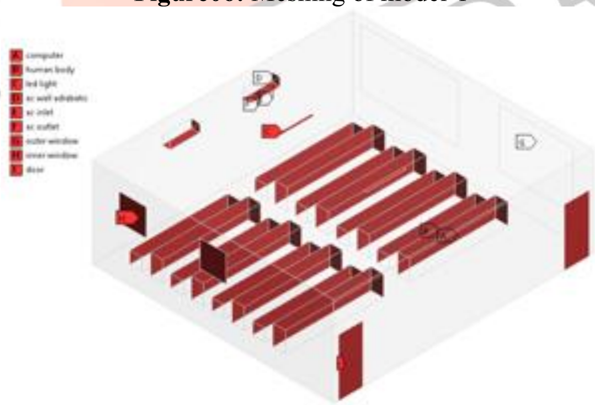

Figure07: Different boundaries of CAD Labmodel-1

Boundary conditions:

Boundary conditions are assigned to create a virtual environment of the real life working of the system. The boundary conditions at different location of the CAD Labare explained below.

1. Define the solver settings as pressure based transient and enable gravity option in y direction with the value of -9.81 m/s$_2$.
2. Working fluid set as air with density 1.22 kg/m3, Specific Heat 1006.43 J/kg K, Thermal conductivity 0.24 W/m$_2$-K
3. Set viscose model as K-epsilon realizable model with enhanced wall treatment
4. Cold air inlet inside the CAD Lab at different velocity such as 1.2, 1.5, &1.7 m/sec at 16 $_o$C
5. To determine the temperature distribution need to on energy equation.
6. For the outlet boundary condition the gauge pressure needs to be set as zero.
7. Under Discretization, select standard for Pressure, and second order for Momentum and Energy equation.
8. The Fluent solver is used for CFD analysis.

Computational fluid dynamic analyses at different air velocity:

After performing computational fluid dynamic transient analyses with absolute velocity formulation using pressure based solver. The temperature distribution inside the CAD lab have been analyzed at different air inlet velocities such as 1.2 m/sec, 1.5 m/sec and 1.7 m/sec and temperature contour diagram shown in below figure 08 to 19. The cooling time is monitored till reaching room temperature 25 $_{o}$C.

Temperature distribution for AC mounted on same wall at different air velocities:

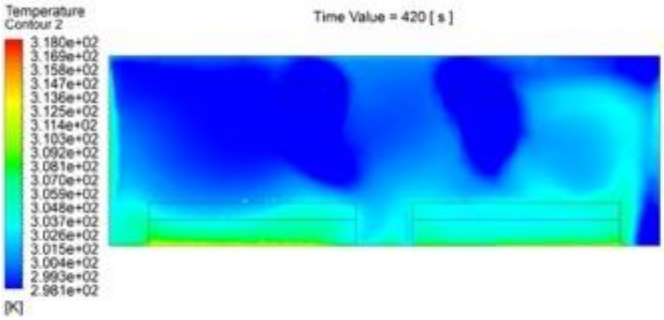

Figure 08: Temperature distribution for AC mounted on same wallat 1.2 m/sec air velocity

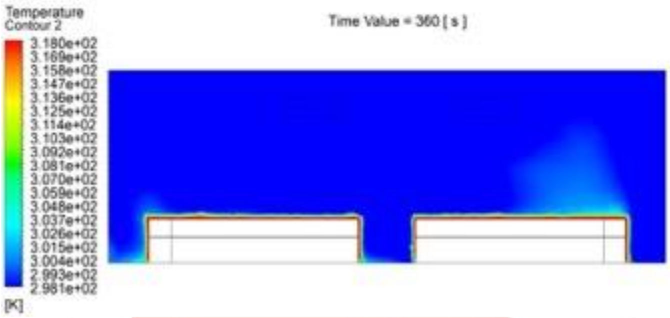

Figure 09: Temperature distribution for AC mounted on same wallat 1.5 m/sec air velocity

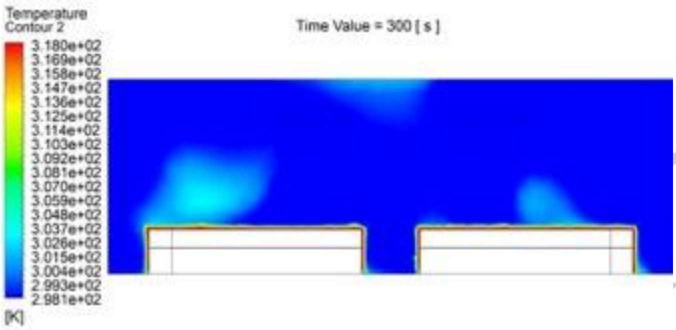

Figure 10: Temperature distribution for AC mounted on same wallat 1.7 m/sec air velocity

Temperature distribution for AC mounted on opposite wall at different air velocities:

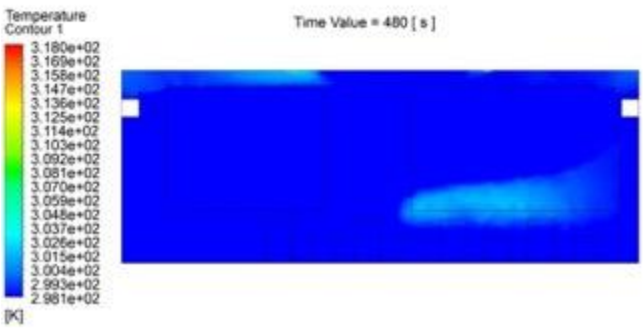

Figure 11: Temperature distribution for AC mounted on opposite wallat 1.2 m/sec air velocity

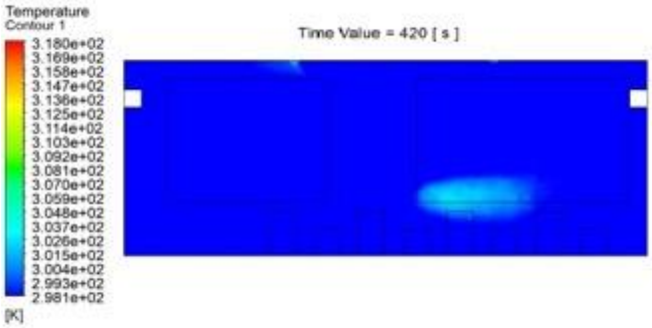

Figure 12: Temperature distribution for AC mounted on opposite wallat 1.5 m/sec air velocity

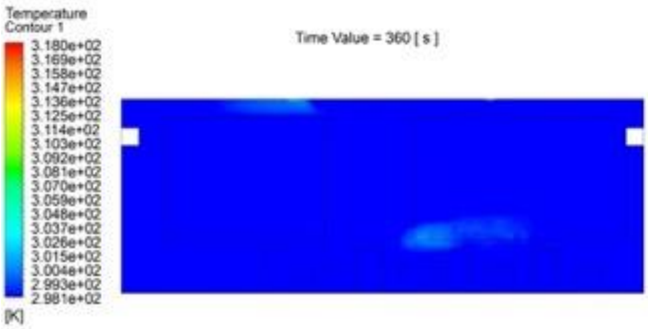

Figure 13: Temperature distribution for AC mounted on opposite wallat 1.7 m/sec air velocity

Temperature distribution for AC mounted on corner at different air velocities:

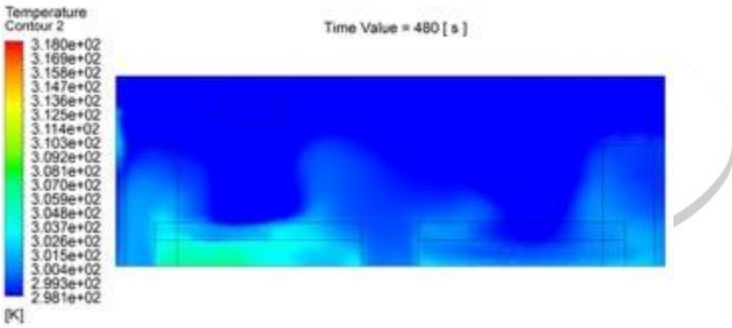

Figure 14: Temperature distribution for AC mounted on corner at 1.2 m/sec air velocity

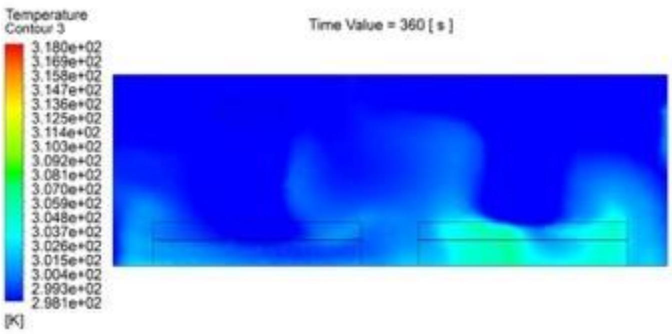

Figure 15: Temperature distribution for AC mounted on corner at 1.5 m/sec air velocity

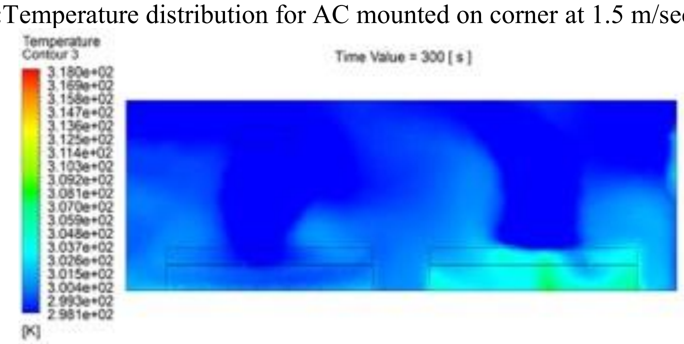

Figure 16: Temperature distribution for AC mounted on corner at 1.7 m/sec air velocity

Temperature distribution for AC mounted on adjacent wall at different air velocities:

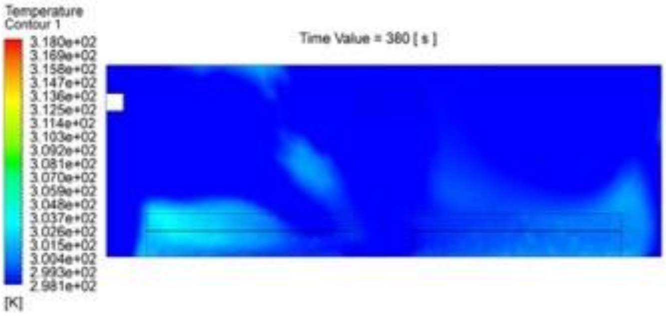

Figure 17: Temperature distribution for AC mounted on adjacent wallat 1.2 m/sec air velocity

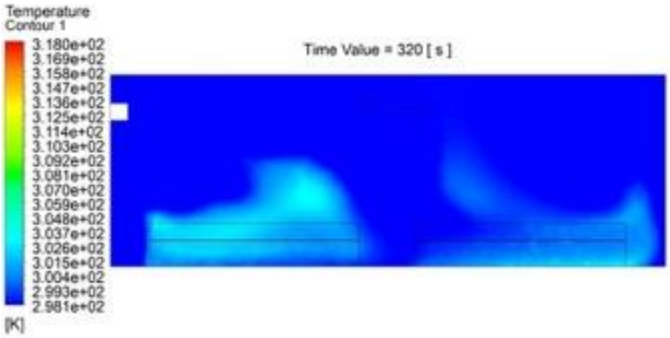

Figure 18: Temperature distribution for AC mounted on adjacent wallat 1.5 m/sec air velocity

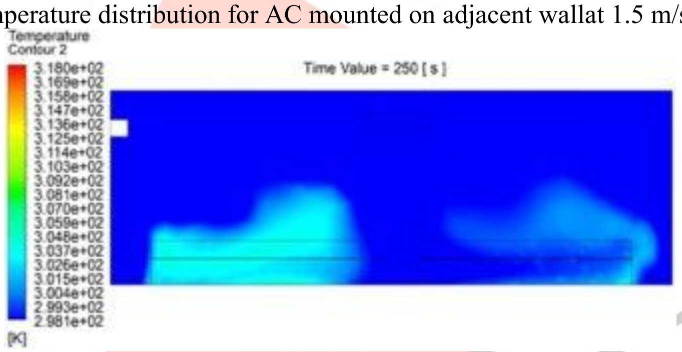

Figure 19: Temperature distribution for AC mounted on adjacent wallat 1.7 m/sec air velocity

It has been observed that the cooling time changing for different model of CAD lab, cooling time for AC mounted on same wall is 420, 360 & 300 sec at air velocity 1.2 to 1.7 m/sec, for AC mounted on opposite wall is 480,420 & 360 sec at air velocity 1.2 to 1.7 m/sec, for AC mounted on corner is 480, 360 & 300 sec at air velocity 1.2 to 1.7 m/sec and for AC mounted on adjacent wall is 380, 320 & 250 sec at air velocity 1.2 to 1.7 m/sec.From the above results it has been observed that the AC position mounted on adjacent wall gives quick cooling response as compared to others mounting positioning of AC.

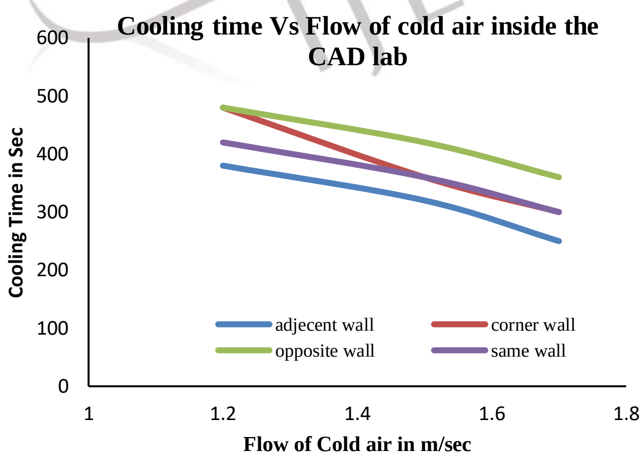

Figure 9: Cooling time Vs Flow of cold air inside the CAD lab

Figure 9 shows the cooling performance time with respect to different air velocity, it has been observed that as the air velocity increase the cooling response time reduces. In the present studysmallest cooling time of 250 sec have been recorded for AC mounted on adjacent wall.

V. Conclusion:

In the present work computational fluid dynamics scrutiny have been made for Cad lab installed in CIST, Bhopal using ANSYS fluent to investigate the special effects of better thermal ease by changing of AC outlet position in lab. For that four CDA model of cad lab is created using the CATIA software with approximate dimension. Four models were created AC mounted on same wall, AC mounted on opposite wall, AC mounted on adjacent wall & AC mounted on corner. It has been concluded after performing computational fluid dynamic transient analyses with absolute velocity formulation using pressure based solver for AC mounted on same walltotal cooling time of 420, 360 & 300 sec respectively at different air velocity ranging from1.2 to 1.7m/sec. For AC mounted on opposite wall the total cooling time of 480,420 & 360 sec respectively at different air velocity ranging from1.2 to 1.7m/sec. For AC mounted on corner. The total cooling time of 480, 360 & 300 sec respectively at different air velocity ranging from1.2 to 1.7m/sec and for AC mounted on adjacent wall the total cooling time of 380, 320 & 250 sec respectively at different air velocity ranging from1.2 to 1.7m/sec.It have been observe from the above conclusion that theAC mounted on adjacent wall achieved the comfort temperature inside CAD lab much quickly as compared to other positioning of AC and gives better cooling in 250 sec at 1.7 m/sec which reduce 16.67% cooling time as compared with AC mounted on same wall.

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