INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING & APPLIED SCIENCES

ISSN: 2322-0821(O) VOLUME 9 ISSUE 4
ISSN: 2394-9910(P) Oct 2021 - Dec 2021

www.irjeas.org

STUDY OF PERFORMANCE OF CEILING SWIRL DIFFUSER PLACEMENT IN INDOOR ENVIRONMENT

***Paresh Korde[1], Dr. Shailendra Dwivedi[2]**

[1]*M. Tech Scholar, Department of Mechanical Engineering, LNCT, Bhopal, India*
[2]*Professor, Department of Mechanical Engineering, LNCT, Bhopal, India*

**Corr. Author - kamalkordelnct@gmail.com*

DOI - 10.55083/irjeas.2021.v09i04006

Abstract - An air diffuser while placing in an indoor office space has been the most important consideration for human thermal comfort.To obtain a maximum thermal comfort in an open indoor space the velocity of air and swirl produced by diffuser also has a huge impact.In this thesis we have worked to obtain a better temperature distributed in an indoor space as well as to get a better effect of swirl. We have observed the performance of placing a ceiling swirl diffuser by placing it on a diffuser angle of 9º,10º,11 in an indoor space. Swirl produce by diffuser depends on it angle and proper swirl mixing with air produce better temperature distribution inside the room to obtain thermal comfort so by this experimental work we just want to evaluate and analysis the proper flow of air by swirl diffuser to design more angle validated ceiling diffusers.

Keywords – Air Conditioning, Ceiling Swirl Diffuser, Air Distribution System, Indoor

I. INTRODUCTION

India's economy and the population are rapidly expanding; meeting the nation's energy demand requires future planning, better policies, and implementation of energy efficient system. Total constructed area (building stock) in 2005 was around 2,100 million square meters and is predicted to grow five-fold to reach around 10,400 million square meters in 2030 in India (Figure 1). India's forecast towards growth in the building sector is a large expansion; therefore, new buildings need to be made more efficient and existing buildings energy consumption needs to be optimized. Building energy includes all the energy consumption associated with building such as Heating Ventilation and Airconditioning (HVAC), lighting (interior and exterior), water heating, elevators, and escalators, as well as the operation of electric and electronic equipment. India's forecast towards growth in the building sector is huge, and the heating ventilation and air conditioning (HVAC) system application for the building space would require a significant energy use. In such a scenario it is high on priority to optimize the energy consumption towards the HVAC system and come up with more energy efficient HVAC system. Within the commercial building, HVAC systems are the most energy consuming components. HVAC systems consume about 31% of the energy used by commercial buildings in India.Striving for energy efficient buildings does not mean to overlook thermal comfort as people stay most of the time indoors.

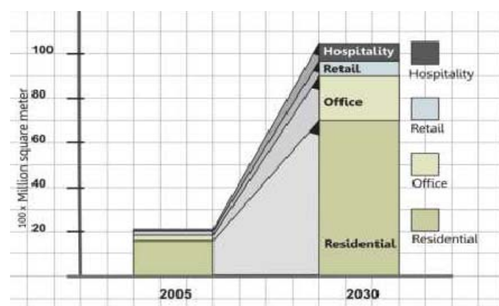

Fig 1. Growth Estimation

Scope of Air Conditioning

To the average person, air conditioning simply means "the cooling of air". For our purposes, this definition is neither sufficiently useful nor accurate, so we will use the following definition instead. Air conditioning is the process of treating air in an internal environment to establish and maintain required standards of temperature, humidity, cleanliness and motion.

Let us investigate how each of these conditions is controlled:

1. Temperature. Air temperature is controlled by heating or cooling the air.
2. Humidity. Air humidity, the water vapor portion of the air, is controlled by adding or removing water vapor from the air (humidification or dehumidification).
3. Cleanliness. Air cleanliness, or air quality; the removal of undesirable contaminants using filters or other devices or by ventilation, the introduction of outside air into the space which dilutes the concentration of contaminants. Often both filtration and ventilation are used in an installation.
4. Motion. Air motion refers to air velocity and to where the air is distributed. It is controlled by appropriate air distributing equipment.

www.irjeas.org, ISSN(O): 2322-0821,Volume 9 Issue 4, Oct-Dec2021, Page 20-24DOI - 10.55083/irjeas.2021.v09i04006

AIR DISTRIBUTION SYSTEM

It covers the widest form of present HVAC applications where different types of designs are manufactured in all sizes and specifications to meet the market demand and customer satisfaction. Architectural appearance has been considered because it is an important issue being adopted during its design phase for the suitability of decorated areas whether by different shapes and types. High Performance is necessary however no matter what type of application uses in as due to high precision in manufacturing and the selection of the most durable Aluminium Profiles and dimensions they are manufactured.

II. LITERATURE REVIEW

Morteza Taheri et al (2021) The objective of the present study was to investigate the effect of swirl angle on the distribution and deposition of contaminant particles in a chamber with swirl diffuser in an under-floor air distribution (UFAD) system. In the desired model, the analysis of flow field and particle distribution for swirling diffusers at four angles 30°, 45°, 60°, and 90° has been conducted by OpenFOAM® with Eulerian-Lagrangian approach. The results show that under uniform initial distribution condition for particles, the percentage of inhalable particulate matter in the breathing zone decreases faster for the rotation angles of 45° and 60°.

Ganpati C. Arjune et al (2021) Effect of swirl on static pressure evolution, total pressure, velocity component recirculation zones and wall shear stress such parameters in conical diffuser flow is studied. Higher pressure recovery is attained with swirl addition at the exit of the diffuser without addition tailpipe. Generally, swirling may not prevent boundary layer separation due to an intermediary recirculation zone appears hence tailpipe is suitable to allow a large-scale mixing for enhancing pressure recovery process.

K. Ashok Reddy (2018) performed investigation by different velocities of fluid 0.25m/s, 0.5m/s & 0.75m/s heat transfer coefficient, heat transfer rate are the main investigation parameters. Author performed thermal analysis by allowing for materials of diffuser such as Copper, Aluminum and Nickel alloy to find out the heat fluxes and compare them each other.

Rachamarla Pradeep Kumar et al (2017) inspected the performance of different of floor swirl diffuser. Author made the different models with slot difference, angles of 60, 80 and 100 in Creo 2.0. Finally CFD analysis is shown on the various models by considering different velocities of fluid to conclude heat transfer coefficient, heat transfer rate. Finally analysis has been performed by using various materials of diffuser Copper alloy, Aluminum alloy 6061 and Nickel alloy to determine heat fluxes.

E.T.V Dauricio (2017) studied conical diffusers flows by considering different flow parameters such as static pressure, recirculation zones and wall shear stress. FEM analysis is done by considering various turbulence models with an enhanced wall treatment. In this work Reynolds number is 105, with an aspect ratio of 7 and vary the divergence angle 16°, 24°, 40°, and 60°. He noticed that swirl velocity component progresses as a Rankine-vortex type or a forced-vortex type. Swirl produced isn't enough to avoid boundary layer separation in first phase, and a tailpipe is recommended mixing to augment the pressure recovery process.

M Jaszczur (2016) provided the effects of experimental research of air flow thru diffusers. He investigate laboratory model just like real system and changed into made in a geometrical scale 1:10. Simplifying refers each to the geometry of the item and situations of air glide. The aim of the look at is to determine the real pace fields of air flowing out of the swirl diffuser. The consequences obtained for the diffuser various settings are offered. We've got tested diverse go with the flow fees of air. Stereo particle photograph velocimetry changed into used to degree all velocity vector additives. The experimental effects allow figuring out the real penetration depth of the deliver air into the room. This could permit for higher definition of the conditions of air flow in homes.

III. AIR DISTRIBUTION SYSTEM AND TYPES OF AIR FLOW PATTERNS

Air Distribution System

Air distribution systems are characterized by an extensive air distribution network, that has to be built in an environment with finite degrees of freedom. The ductwork layout, i.e., the network structure of the ducts, as well as the number and location of the fans, has a large impact on the total cost and performance of the air distribution system. Nevertheless, existing air distribution system design methods are limited to the sizing of each duct (and fan) in the network. The layout itself is considered predetermined, and thus not explicitly taken into account for optimization. In this research, we meet this shortcoming by presenting the air distribution network design optimization method, that is able to calculate the optimal air distribution system configuration, i.e., the optimal layout and duct and fan sizes, while minimizing the total cost of the air distribution system. A multi-start local search algorithm is developed, consisting of a constructive and a local search phase. In the first phase, multiple air distribution system configurations are generated, and evaluated for feasibility. In the local search phase, all feasible solutions are further optimized in terms of material costs by decreasing and increasing the duct diameters following the steepest descent/mildest ascent approach. An application of the algorithm on a realistic test case demonstrates its usefulness in practice. The design of the air distribution system was based on flow elements from the diffuser, a maximum velocity assumption, and a critical vertical temperature graph in the room. By checking the temperature difference and the appropriate conditions for the supply flow rate the air distribution systems are showed. Architectural appearance has been

International Research Journal of Engineering & Applied Sciences, IRJEAS
www.irjeas.org, ISSN(O): 2322-0821,Volume 9 Issue 4, Oct-Dec2021, Page 20-24DOI - 10.55083/irjeas.2021.v09i04006

considered because it is an important issue being adopted during its design phase for the suitability of decorated areas whether by different shapes and types.

High Performance is important however no matter what type of application used in as due to high precision in manufacturing and the selection of the most durable Aluminum Profiles and dimensions they are manufactured. Velocity and temperature conditions are generated by air distribution system at same and higher loads with ceiling-mounted air terminal units. A vertical ventilation system, a mixing ventilation system with wall-mounted diffuser, and a displacement ventilation system with a low-velocity wall-mounted diffuser.

- mixing ventilation into wall-mounted diffuser
- displacement ventilation into wall-mounted low-velocity diffuser
- vertical ventilation into ceiling-mounted textile terminal
- mixing ventilation into ceiling-mounted radial diffuser
- mixing ventilation into ceiling-mounted swirl diffuser

IV. CHARACTERISTICS OF AIR DISTRIBUTION

Air has a tendency to "scrub" surfaces. When the Total Air covers all the walls and ceiling in a thin film is a near perfect situation that can be imagined. The space will be closed with conditioned air from the smudging standpoint, to keep the Total Air off ceiling surfaces; good air distribution usually requires that all surfaces be used. As the total air is getting affec3ed by other factors, analytical treatment should not get complete. But, air uniqueness for cooling and heating in a blank space is expected. When the air doesn't come in contact with ceiling or walls till the airstream is of low velocity a condition is created. The following are important terms to remember when selecting outlets and applications.

V. EXPERIMENTAL INVESTIGATION AND RESULTS

The ultimate goal of our study is to study the air flow pattern and its distribution through swirl diffusers with different slot angles which was installed at the floor in air-conditioned chamber. Basically, our investigation was carried out with the aim of expecting the nature and behavior of air diffused by three different types of swirl diffusers having slot with draft angle of 9°, 10° and 11° under changed operating and flow conditions. Also in our study we obtained the cooling comfort formed in a room equipped with heat load of 1500 W load capacity with different swirl diffusers and temperatures were recorded at different height and present their performance graphically. The graphs are schemed between temperature recorded with vertical height from the floor level.

VI. EXPERIMENTAL SETUP

It contains an acrylic sheet wooden room 3.5 by 3.5 by 4.5 feet with dissimilar models of swirl diffuser of ceiling level. The air is supply through a base of the duct to increase the air flow velocity through the diffuser. A heater of 1500W is put in room to provide a heat load at location X2. Measure the temperature at 6 locations vertically at a distance of 0.7 feet a temperature sensing instrument is placed with six thermocouple wires. There are four exhaust vents at the top surface of the wooden block through which ventilation is carried out inside the room.

VII. RESULTS

The results of experiments are presented in two parts: requirement of the air conditioner size for the particular room condition by thermal comfort environment and cooling load calculation according to the temperature variation inside the room with different diffusers. Due to different slot angle geometry of swirl diffusers, the flow patterns of diffuse air changes. The air is circulated inside the room through different diffusers. So the temperature of air in room changes to which we have recorded at five different locations. The change in temperature with respects to height is tabulated for each swirl diffuser without load and with load under two different conditions. The two conditions are when only single exhaust vent is open and when all the exhaust vents are opened. The study helps to perform comparison of different swirl diffusers under different operating conditions. From the graphs plotted it is showed that minimum variation in temperature is obtained with 10º swirl diffuser and the uniformity in temperature is obtained when all the exhaust ports are opened.

Various data has been recorded with different swirl diffusers under different operating conditions and are tabulated as shown below in the tables.

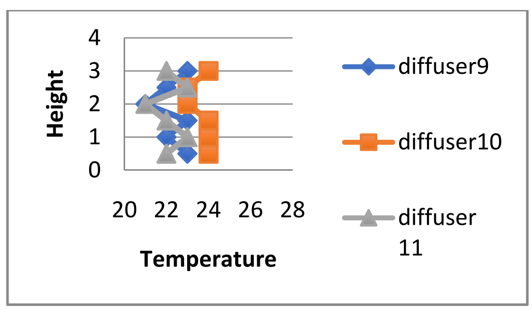

Fig 2. Variation in temperature versus height at location X1 without load

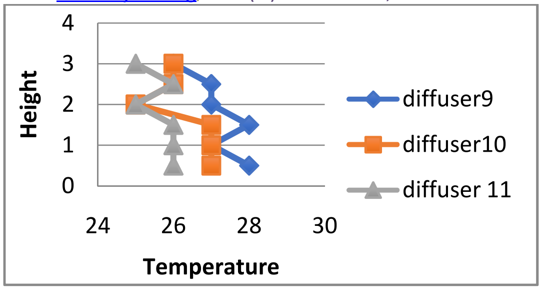

Fig 3. Variation in temperature versus height at location X1 with load 1500W.

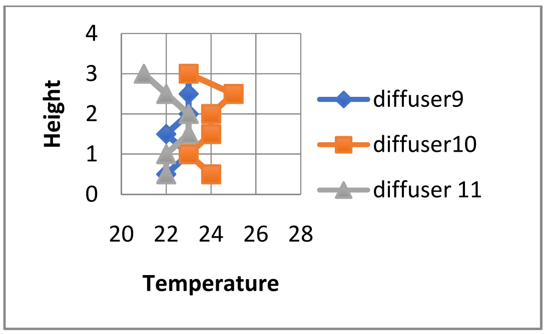

Fig 4. Variation in temperature versus height at location X2 without load

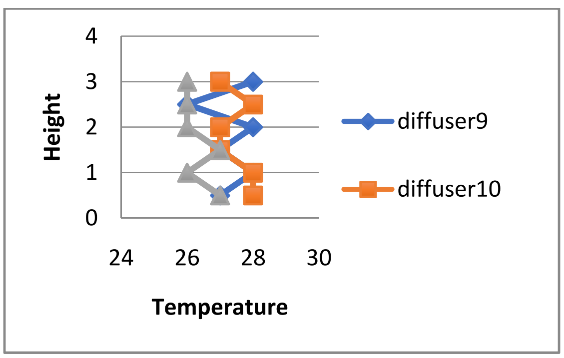

Fig.5 Variation in temperature versus height at location X2 with load 1500W.

VIII. CONCLUSION AND FUTURE SCOPE

Conclusion:

The results from this dissertation work indicates that using floor level ventilation using swirl diffuser we can increase indoor air quality because the containment attentiveness in the inhalation zone low than of mixing system. It benefits us in associating the performance several types of swirl diffuser with different slot .The maximum variation in temperature is obtained at location X2. This happens due to presence of heater of load capacity 1500 W near location X2. By moving away from the heat, variation in temperature reduces and we obtained almost uniform temperature at the upper region of set up. We have compared the performance of different swirl diffuser models having slot with draft angle 9°, 10° and 11° under different operating conditions and the best performance is obtained with 10° swirl diffuser.

IX. FUTURE SCOPE

In the present dissertation work investigation are made on the thermal behavior produced by the diffused air from swirl diffuser on ceiling level. In this work we have observed the change in air temperature from air conditioner at various locations with load and without heat load. The difference in temperature is also observed when one exhaust vent is opened and when all four exhaust vents are opened.

It is proposed that the flow rate of air effects and air velocity on the enclosed thermal environment should also be determined experimentally. Velocity distribution pattern is made by measuring air velocity at different locations. Humidity percentage can also be measured at different locations. We have kept the supply air conditions constant in the present work. The effect of thermal environment at indoor can be analyzed by varying the supply air conditions in future.

REFRENCES

[1] Morteza Taheri et al.(2021),The influence of air inlet angle in swirl diffusers of UFAD system on distribution and deposition of indoor particles ,Building and Environment, Science Direct.Vol-191.

[2] Ganpati C. Arjune et al (2021),Analysis of swirling and choking in diffuser using CFD analysisMaterials Today: ProceedingsVolume 45 (2), P: 2678-2681.

[3] K. Ashok Reddy(2018), Thermal Analysis of Swirl Diffuser at Eight Degree Slot Angle Using Ansys with Different Materials, International Journal of Mechanical Engineering and Technology, 9(6), PP: 1093–1097.

[4] Rachamarla Pradeep Kumar, P. Saritha, J. Pradeep Kumar (2017), Design and Performance of Under Floor Swirl Diffuser at Different Operating Angles Using FEA, International Journal & Magazine of Engineering, Technology, Management and Research, 4(11), 102-107.

[5] E.T.V Dauricio (2017), Numerical Analysis of Swirl Effects on Conical Diffuser Flows, Journal of Aerospace Technology and Management, 6(2), 112-119.

[6] M Jaszczur (2016), Experimental analysis of the velocity field of the air flowing through the swirl diffusers, 7th European Thermal-Sciences Conference, 1-9.

[7] Dinesh Singh, Pankaj Mishra (2015), Swirl Diffuser Design and Performance Characteristics for Air Flow in Air Conditioning of an Automobile-A Review, International Journal of Innovative Research & Development, 4(8), 67-75.

[8] Rahul Pandey, Anil Kumar Rao, Vinay Yadav (2015), Comparison Between Simulation and Experimental Technique Inside an Air Conditioned Room to Analyse the Performance and Flow Characteristics of Ceiling Swirl Diffuser under Different Operating and Flow Parameters, International Journal of Engineering Sciences & Research Technology, 4(11), 424-431.

[9] Omprakash Ahirwar, Neeraj kumarAhirwar, Ishwar Singh (2014), Experimental and Simulation based comparative analysis of UFAD and OHAD in Air-

International Research Journal of Engineering & Applied Sciences, IRJEAS
www.irjeas.org, ISSN(O): 2322-0821,Volume 9 Issue 4, Oct-Dec2021, Page 20-24DOI - 10.55083/irjeas.2021.v09i04006

conditioning of room, International Journal of Scientific & Engineering Research, 5(9), 640-649.

[10] Suraj, V.N. Bartaria, Performance and Flow Characteristics of Floor Swirl Diffuser under Different Operating and Flow Parameters, International Journal of Mechanical Engineering and Technology, 4(4), 154-165.

[11] Ramazan (2013), CFD Simulation of Swirling Effect in S-Shaped Diffusing Duct by Swirl Angle of 10˚, IOSR Journal of Mechanical and Civil Engineering, 6(2), 11-19.

[12] P. K. Sinha, A.K. Das and B. Majumdar, Numerical Investigation of Flow through Annular Curved Diffuser, International Journal of Mechanical Engineering and Technology, 2(2), 1-13.