ISSN : 2455-9679
Impact Factor : 2.865

IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"A REVIEW ON THERMAL ANALYSIS OF SWIRL DIFFUSER"

Mitesh Kumar [1], Prof. Ravindra Mohan [2]

[1]M-Tech Scholar, Department of Mechanical Engineering, IES, College Bhopal, MP, India
[2]Assistant Professor, Department of Mechanical Engineering, IES, College Bhopal, MP, India

ABSTRACT

Air swirl diffusers employed in air-conditioning system will produce higher air mix to boost indoor air quality and facilitate in achieving higher human comfort. The change It temperature in air conditioning system depends powerfully on the flow characteristics made by the diffuser outlet that modify significantly between different modeling set ups. In company sector it's vital to calculate the result of change in diffused air temperature from floor swirl diffuser with and without heat load. With the improvement of standard of living, air-conditioning has widely been applied. However, health problems associated with air-conditioning systems and indoor air quality appear more frequently. In this paper, recent research is reviewed on air-conditioning systems and indoor air quality control for human health. The problems in the existing research are summarized. A further study is suggested on air-conditioning systems and indoor air quality control for healthy indoor air environment.

Key Words: Swirl Diffuser, Modelling, Air, Heat Load, Indoor, Air-Conditioning

I. INTRODUCTION

Air diffuser is device that is designed to prove uniform air flow to throughout a room. It works to increase the efficiency of air conditioning units by dividing and distributing cooled air. It provides greater comfort to occupants when the even air flow is maintained. Air diffuser is mostly mounted on ceilings and sometimes on walls. The type, size and location of the diffuser depend on many factors. This includes the layout of building or room, location of doors and windows and a type of air conditioning system being used. Air diffusers are device that suffer as the end point for HVAC unit. Diffusers circulate fresh air into rooms and are found in both residential and commercial buildings. Common referred to as air diffusers to as air vents. Diffuser comes in several shapes and

size are often found in floors and ceiling. Diffuser is also sometimes referred to registers.

According to Alantsupply.com .they can be made of metal or wood, though wood is less common are usually found in the home. The concept of air diffuser is relatively simple, air flows naturally through a duct. The diffuser capture this air, as it come through the air conditioning system and splits the forced air into smaller streams. The tiny current of air is then directed in an even flow throughout the room. This stream cannot typically be the felt while the air is circulating. When this air conditioning devices is placed in a room, the temperature will usually drop faster than when one is not used. Since the room can be cooled quickly, the thermo state may be turned up more at night in order to save energy. It is important for a humid weather. It is bit costly but easily installable. It is customizable and can be made in any color as per the décor. It is the common air diffuser to be installed at home.

Those that cover vents in walls are somewhat larger than other residential type and are preferred when and air conditioning vent is along the lower edge a wall.

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Air diffuser helps air conditioning units more efficiently. They do not need a power source in order to operate. They are large any looking to efficiency of an air conditioning unit and provide even air temperatures in both commercial and residential environment.

II. CRITERIA FOR COMFORT

ASHRAE (American society of heating, refrigerating, and air conditioning engineering) has developed an industry related standard to describe comfort requirements in buildings. The standard is known as ASHRAE Standard 55-2004 Thermal Environmental Conditions for Human Occupancy. The purpose of this standard is to specify the combinations of indoor thermal environmental factors and personal factors that will produce thermal environmental conditions acceptable to a majority of the occupants within the space. The Standard allows the comfort charts to be applied to spaces where the occupants have activity levels that result in metabolic rates between 1.0 met and 1.3 met and where clothing is worn that provides between 0.5 clo and 1.0 clo of thermal insulation. The comfort zone is based on the PMV values between -0.5 and +0.5.clo: a unit used to express the thermal insulation provided by garments and clothing ensembles, where 1clo = 0.155 m2 °C/W (0.88 ft2•h•°F/Btu). An ASHRAE standard helps us to design a perfect comfortable environment which provides satisfaction to occupants to do their moderate work efficiently. Various standards have been made by American society of heating,

2.1 Floor-based Diffusers

Floor air diffusers are used by and large in air-conditioning systems for movement of formed air inside a room and the air scattering is particularly depends upon the qualities of different diffuser structures. For floor-level air supply systems, swirling diffusers are most extensively used. Showing of the diffuser expect a critical activity in anticipating airflow structure in the room. Swirl diffusers are usually mounted into the underfloor air dealing with room [1]. This contraption passes on adjusted air at floor level to the space and empowers the occupant to physically control both the volume and orientation of the air flow. The diffuser is worked of an intense, high influence, polycarbonate material. Passing on air from the floor has a great position of giving new, cool, clean air direct into the expended zone of the space, so warmth and defilements are not steadily flowed inside the space as it happens in an overhead air scattering system. It will realizes dispersing of warmth and less centralization of toxic substances in the expended space in the lower level than those at the upper degrees of the space. Ventilation is done through expulsion as opposed to debilitating.

The essential of a conventional air dissemination structure is to supply immaculate and outside air with less assortment in temperature with stature and different zones to give warm comfort and high air quality. In Asian and European countries, 30-portion of occupants have medicinal issue by virtue of dreadful air assignment system. Pretty much 30-40% of the essentialness conveyed has been spent on air scattering system in by far most of the making countries [11].
Swirl diffusers are proposed to give amazing indoor air scattering through remarkably arranged swirl redirection bleeding edges to convey an especially blustery winding air flow plan that will start better mixing of room air. This also achieves quick temperature night out to give stable room conditions with least temperature tendencies. The awesome high qualities of air from swirl diffusers enable engineers to go for a high estimation of Air Change Effectiveness (ACE) [11]. Swirl diffusers have starting late ended up being especially standard since they produce radially high induction swirl air flow by drawing room air up into the supply air guide to impel overwhelming air mixing. Better mixing strategies better ACE.

It is along these lines required to contemplate the traits of air spread structure with floor swirl diffuser under different working and flow conditions with high warm load. Floor-based diffusers can be situated anyplace inside an office plan, as all models are intended to be introduced in a solitary raised access floor board, commonly 0.6 m (24 in.) square [8]. This design permits most extreme adaptability in putting a floor diffuser, provided the location of any underfloor HVAC components is taken into account.

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Fig.2.1 Swirl Diffuser

Fig.2.2 Constant Velocity

Fig.2.3 Linear Floor Grills

A few diverse diffuser plans are at present available. Swirl floor diffusers are the most normally introduced sort of diffuser in UFAD frameworks, different alternatives incorporate square-barbecue diffusers. Inside every diffuser sort (for example round swirl/steady speed/direct floor) various models are accessible, shifting in configuration as indicated by the specific producer. Swirl diffusers are commonly introduced as aloof diffusers, requiring a pressurized underfloor plenum. Other uninvolved diffusers incorporate an as of late presented consistent speed floor diffuser and standard straight floor barbecues. Direct barbecues are regularly utilized distinctly in edge zones, as appeared in the picture at left, and frequently consolidate finned-tube warming components for winter warming periods [11]. For more data on the job of diffusers in the general example of air appropriation inside the workspace, see our average office area and going with content. Every single detached diffuser can likewise be introduced as dynamic (fan-driven) diffusers. Other fan-driven diffusers incorporate a floor supply module, work area air supply platform, under work area flame broil, and segment based barbecue. For more data on diffuser kinds see 'Applying the Technology' for our structure rules.

2.2 Floor Swirl Diffuser

Swirl diffusers are intended to make a revolving swirling movement to the supply air release, which quickly prompts the room air to rapidly diminish the speed and temperature distinction of the supply air [13]. The air turning out through swirl diffuser is compelled to move in a fine stream with a winding or spinning movement which results in fast blending of diffused air inside the room and variety in temperature at various areas decreases.

2.3 Types of floor Swirl Diffuser

2.3.1 Floor "Swirl" Diffuser

Floor "Swirl" Diffusers are intended for use in raised access floor air circulation frameworks, where the floor pit is utilized as a pressurized supply air plenum. The NFD center structure creates a low speed helical "swirl" release air design. The plan accomplishes high induction paces of room air which improves blending for most extreme solace conditions.

A compositionally engaging face configuration compliments any contemporary stylistic layout and is accessible as standard in a dark or dark completion just as a wide assortment of custom hues [13]. Permitting outrageous adaptability in space arranging, the diffuser, once introduced in the entrance floor board, can be immediately moved to accommodate changing conditions and floor layouts.

2.3.2 Aluminum Floor "Swirl" Diffuser

Aluminum Floor "Swirl" Diffusers are intended for use in raised access floor air dispersion frameworks, where the floor hole is utilized as a pressurized supply air plenum. The uniquely structured ANFD center creates a low speed helical "swirl" air design [12]. This plan accomplishes high induction paces of room air which streamlines blending for greatest solace conditions.

A structurally engaging face configuration compliments any contemporary stylistic theme and is accessible as standard in a dim or dark finished completion just as a wide assortment of custom hues [12]. Permitting outrageous adaptability in space arranging, the diffuser, once introduced in the entrance floor board, can be immediately migrated to suit changing conditions and floor formats.

Fig.2.4 Floor Swirl Diffuser [13]

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2.3.3 VAV Floor "Swirl" Diffuser with Actuator

Floor "Swirl" Diffusers with actuators are proposed for use in raised access floor air scattering systems, where the floor gap is used as a pressurized supply air plenum. An essential adjusting actuator gives variable air volume control in cooling applications for definite zone temperature control. The NFD-VAV focus plan makes a low speed helical "swirl" discharge air structure [9]. The arrangement achieves high induction paces of room air, which overhauls mixing for most noteworthy comfort conditions. A fundamentally captivating face arrangement compliments any contemporary expressive design and is open as standard in a dull or dim fruition similarly as a wide combination of custom tones. Allowing incredible versatility in space masterminding, the diffuser, once presented in the passageway floor board, can be immediately moved to oblige changing conditions and floor formats [10].

Fig.2.5 Aluminium Floor Swirl

2.3.4 VAV Aluminum Floor "Swirl" Diffuser with Actuator

Aluminum Floor "Swirl" Diffusers with actuators are designed for use in raised access floor air distribution systems, where the floor cavity is used as pressurized supply air plenum. An integral modulating actuator provides variable air volume control in cooling applications for precise zone temperature control. The core design produces a low velocity helical "swirl" discharge air pattern [9]. The design achieves high induction rates of room air, which optimizes mixing for maximum comfort conditions. An architecturally appealing face design compliments any contemporary decor and is available as standard in a gray or black textured finish as well as a wide variety of custom colors.

Fig.2.6 VAV Floor Swirl Diffuser with Actuator

Fig.2.7 VAV Aluminium Floor Swirl Diffuser with Actuator [13]

III. LITERATURE SURVEY ON AIR DIFFUSER

1. H.T. Xu and J.L. Niu in 2003 use CFD strategy to research the airflow design and the effect on warm comfort in the close spout area of a floor level swirl-type diffuser. The fundamental reenactment results demonstrate that re-course locale in the close spout must be sensibly anticipated by incorporating the swirling gadgets in the count area . The outcomes will be additionally approved with tests, and the technique is required to be utilized to help streamline diffuser structures.[1]

2. Josephine Lau in 2006 examined the presentation of floor-supply removal ventilation with swirl diffusers or punctured boards under a high cooling burden (almost 90W/m2). The trial was completed in a full-scale natural chamber to get solid information on the floor-supply uprooting ventilation for the approval of a computational-liquid elements (CFD) program . Numerical reenactments utilizing CFD program were to assess the presentation of the framework for a huge workshop. The effects of a few parameters, for example, the air change rate, number of diffusers, diffuser area, tenant area, furniture course of action, segment area, and game plan of depletes, on the indoor condition were researched dependent on the warm solace level and indoor air quality. [2]

3. Liu Jinping, Wu Yanfang in 2010 examined dynamic normal for underfloor air supply terminal unit, an IFV900A hotwire anemometer was utilized to gauge the relating speed field. Disturbance force and power range thickness type of air speed sign were broke down. The outcome demonstrated that the outlet speed dissemination of underfloor air supply terminal unit was uniform. With addition of stature, the speed dissemination patterns to be uniform. Two speed

ISSN : 2455-9679
Impact Factor : 2.865

lessening areas show up during airflow advancement [8]. Choppiness power changes clearly with stature. It is lower than that of mechanical breeze. Disturbance power goes up with the augmentation of flying separation. [3]

4. Jae Dong Chung in 2010 concentrated the warm stratification which is urgent to framework structure, vitality productive activity and solace execution of Underfloor Air Distribution (UFAD) frameworks with a point of looking at effect of mean brilliant temperature (MRT) on warm comfort. Clear clarification of the advantage of UFAD frameworks has been appeared by contrasting it with the conventional overhead air conveyance frameworks . Keeping a similar degree of agreeable condition in the involved zone, UFAD frameworks require a lot higher temperature of supply air, which speaks to critical vitality reserve funds. [4]

5. Jae-Hyung Kim and Heuy-Dong Kim in 2010 uses computational liquid elements (CFD) strategy to explore the impact of the diffuser point on the release coefficient of smaller than normal basic spouts. In calculations, the throat width of a basic spout differed from 0.2 to 5.0 mm, and the diffuser edge changed from 2° to 8°. The computational outcomes were approved with some accessible trial information. The release coefficient is extensively affected by the diffuser point as the throat measurement of the spout decreases beneath a specific worth . This infers smaller than expected basic spouts ought to be structured with cautious thought of its belongings. [5]

6. P. K. Sinha and B. Majumdar in 2011 explored the circulation of mean speed, static weight and all out weight tentatively on an annular bended diffuser of 37.5° edge of turn with a territory proportion of 1.284 and centerline length was picked as multiple times of channel distance across. The test results at that point were numerically approved with the assistance of Fluent and afterward a progression of parametric examinations are led with same focus line length and delta measurement however with various zone proportions differing from 1.15 to 3.75. The estimations were taken at Reynolds number 2.15 x 105 dependent on channel width and mass normal gulf speed. Anticipated consequences of coefficient of mass found the middle value of static weight recuperation (31%) and coefficient of mass arrived at the midpoint of all out weight misfortune (21%) are in great concurrence with the exploratory aftereffects of coefficient of mass arrived at the midpoint of static weight recuperation (27%) and coefficient of mass arrived at the midpoint of all out weight misfortune (17%) individually. Standard k-ε model in familiar solver was picked for approval. From the parametric examination it is seen that static weight recuperation increments up to a territory proportion of 2.86 and between the region apportion 2.86 to 3.75, weight recuperation diminishes relentlessly.

The coefficient of complete weight misfortune nearly stays steady with the adjustment in region proportion for comparable delta conditions. [6]

7. B. Sajadi in 2011 researched the impact of geometric parameters on the exhibition of a particular kind of swirling air diffuser. The outcomes demonstrate that despite the fact that the diffuser openings geometry, to be specific their edge and perspective proportion, is amazing on the diffuser execution, it isn't as significant as the swirling sharp edge and the presentation is practically consistent in a wide scope of spaces details . The outcomes likewise exhibit that the diffuser execution and the resultant indoor airflow appropriation profoundly rely upon the sharp edges point and their affectability is shockingly noteworthy when the edge is somewhere in the range of 30◦ and 35◦. It is additionally worth referencing that the ideal point of 32◦ is practically free of the diffuser airflow rate. [7]

8. Kwang Ho Lee in 2012 concentrated the point by point entire structure vitality reenactment program, EnergyPlus rendition 6.0, was utilized to play out the examination on the effect of SAT on the UFAD framework execution, for example, vitality, stickiness and solace under Korean climatic condition. Things being what they are, raising AHU SAT causes expanded HVAC vitality utilization because of warming and fan vitality increment regardless of the cooling vitality decrease. [8]

9. Xue, G., Lee, K 2012 reports on the continued study of the thermal environment in indoor spaces with under-floor air distribution systems with a focus on the determination of supply airflow rate. Supply airflow rate of Under-floor Air Distribution (UFAD) needs to be carefully determined to achieve thermally comfortable conditions in an occupied space. The design parameters, such as airflow rate, temperature of supply air, and types and number of diffusers need to be properly calculated to ensure an acceptable vertical temperature difference between the head and ankle of occupants. This study introduced an empirical model to predict the vertical temperature difference between the head and ankle of occupants and calculated the supply airflow rate for UFAD design. This investigation developed the model based on a database summarizing vertical temperature distributions that correspond to various airflow and thermal conditions. The model used dimensionless numbers to group design parameters in order to represent the two driving factors of thermal stratification, namely, inertial and buoyance forces. Linear regression analysis was conducted to correlate the empirical equations of stratification for swirl, square, and linear diffusers. With the model, this study developed an airflow

ISSN : 2455-9679
Impact Factor : 2.865

calculation method for UFAD as well as a graphical interface for designers [9]

10. Ehsan Tavakoli in 2012 concentrated the violent flow structures, mass exchange and ventilations attributes in the most distant field of swirl diffusers at various swirl edges ($45^\circ \leq \alpha \leq 65^\circ$) . The outcomes are acquired through a second request limited contrast plan and enormous swirl reproduction (LES) with the dynamic Smagorinsky methodology in sub-framework scale displaying. In like manner, the momentary and normal speed conveyances, transient advancement of the mass exchange, and the by and large and neighborhood air characteristics are explored. [10]

11. **Rachamarla Pradeep Kumar in 2017** In this thesis, the variation in temperature of conditioned air and improvement in thermal human comfort by adopting different models of floor swirl diffuser are investigated. Different models of floor swirl diffuser having different slot angles of 6°, 8° and 10°are modeled in Creo 2.0 software. CFD analysis is performing on the models by varying velocities of fluid 0.25m/s, 0.5m/s & 0.75m/s to determine heat transfer coefficient, heat transfer rate. Thermal analysis is performing on all the models by considering materials of diffuser Copper alloy, Aluminum alloy 6061 and Nickel alloy to determine heat fluxes. Analysis is done in Ansys 14.5.[11]

12. K. Ashok Reddy in 2018 Floor swirl diffusers employed in air-conditioning system will produce higher air mix to boost indoor air quality and facilitate in achieving higher human comfort. The change in temperature in air conditioning system depends powerfully on the flow characteristics made by the diffuser outlet that modify significantly between different modeling set ups. In company sector it's vital to calculate the result of change in diffused air temperature from floor swirl diffuser with and without heat load. CFD analysis is performing on the models by varying velocities of fluid 0.25m/s, 0.5m/s & 0.75m/s to determine heat transfer coefficient, heat transfer rate. Thermal analysis is performing on all the models by considering materials of diffuser Copper alloy, Aluminum alloy 6061 and Nickel alloy to determine heat fluxes. Analysis is done in Ans 14.5. [12]

IV. CONCLUSION

Based on the present investigation following conclusion have drawn for the present paper. High velocity fluids shifted and accumulated at the concave wall of the exit section.In our work we will take different angle base diffuser used for air flow study.

REFERENCES

1. H.T. Xu, and J.L. Niu “A NEW METHOD OF CFD SIMULATION OF AIRFLOW CHARACTERISTICS OF SWIRLING FLOOR DIFFUSERS” Eighth International IBPSA Conference Eindhoven, Netherlands August 11-14, 2003.

2. Josephine Lau, Qingyan Chen, Floor-supply displacement ventilation for workshops, January 2006, ELSEVIER, Science Direct.

3. Liu Jinping, Wu Yanfang, Experimental study on airflow fluctuation characteristic of an underfloor air supply terminal unit, July 2010, ELSEVIER, Science Direct.

4. Jae Dong Chung, Hiki Hong, Hoseon Yoo, Analysis on the impact of mean radiant temperature for the thermal comfort of underfloor air distribution systems, 2010

5. Jae-Hyung Kim and Heuy-Dong Kim, Effect of diffuser angle on the discharge coefficient of miniature critical nozzles, May 2010, Springer.

6. Prasanta K. Sinha, Bireswar Majumdar “Computational Investigation of Performance Characteristics throughAnnular Diffuser” International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.comVol. 1, Issue 3, pp.830-836

7. B. Sajadi, M.H. Saidi, A. Mohebbian, Numerical investigation of the swirling air diffuser: Parametric study and optimization, January 2011, ELSEVIER, Science Direct.

ISSN : 2455-9679
Impact Factor : 2.865

8. Kwang Ho Lee, Sang Min Kim, Jong Ho Yoon, Supply air temperature impact in underfloor air distribution systems under Korean climatic conditions: Energy, humidity and comfort, October 2012, ELSEVIER, Science Direct.

9. Xue, G., Lee, K., Jiang, Z. and Chen, Q. 2012. Thermal environment in indoor spaces with under-floor air distribution systems: 2. Determination of design parameters (RP-1522).Submitted to HVAC&R Research.

10. Ehsan Tavakoli, Reza Hosseini, Large eddy simulation of turbulent flow and mass transfer in far-field of swirl diffusers, December 2012, ELSEVIER, Science Direct.

11. Rachamarla Pradeep Kumar "Design and Performance of Under Floor Swirl Diffuser at Different Operating Angles Using FEA" International Journal & Magazine of Engineering, Technology, Management and Research, Volume 4 Issue 11, 2017, Page 102-107.

12. K. Ashok Reddy "Thermal Analysis Of Swirl Diffuser At Eight Degree Slot Angle Using Ansys With Different Materials" International Journal of Mechanical Engineering and Technology (IJMET) Volume 9, Issue 6, June 2018, pp. 1093–1097