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REVIEW PAPER ON AIR CONDITIONING SYSTEM FOR OPERATION THEATRE IN HOSPITAL USING CFD

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Abstract - *Computational Fluid Dynamics (CFD) simulation inside an Operation Theatre (OT), considering real world conditions such as temperature and airflow movement in the OT environment is carried out. Simulation is carried out using Phoenics software to predict the flow velocity and temperature distribution inside the OT. Parametric study is done to determine the most suitable inlet and outlet configuration. Results indicated that the entire ceiling inlet for further studies to be carried out considering contaminants.*

The economic problems multiplying due to the deterioration of environmental conditions and the exhaustion of fossil based energy sources in today's world brings into questionendeavors' towards designing environmentally compatible hospital buildings that causes less carbon emissions to the nature and that reduces the construction and management costs of the buildings and that considers energy efficiency for the hospital buildings as well covering different functions and requirements. However, in the operating room units where the hospital comfort requirements have been utilized to the utmost level, endeavors' for providing green criteria and energy efficiency have remained limited. The objective of this study is to determine other studies to be undertaken in compliance with green building criteria in the operating room units having complicated design characteristics in relation to the other hospital units. The green design criteria for operating rooms in line with national and international studies were researched within the context of this study and the raise in efficiency was explained using examples.

***Key Words*: *Heating, Ventilation and Air Conditioning (HVAC), Computational Fluid Dynamics, Flow velocity, Temperature distribution, Deterioration of environmental conditions, Exhaustion, Airflow movement*, etc…**

1. INTRODUCTION

This in the present days, as the population increases the need for the comfort also increases. The human being needs more comfort because of inferior environment (like light, sound, machine which produce heat). Sound, heat and light affect human comfort a lot. They may adversely affect the human comfort positively or negatively. Researchers suggest that, human body is lower or higher than this temperature of 22'Cto 25'C. When the temperature of room is lower or higher than this temperature, then the human body feels uncomfortable. This is because, the human body is structured in a way that, it should receive a certain amount of light, failure to which it can cause sunburns and other skin conditions. There are many types of air conditioning systems like window air conditioners, split air conditioners, etc… but these AC systems are used in small room or office where cooling load required is low. When the cooling load required is very high like multiplex building, hospital, etc… central AC systems are used. In central AC's system the cooled air is directly not distributed to rooms or spaces to be cooled in order to provide comfort condition. When the cooled air cannot be supplied directly from the air conditioning equipment to the spaces to be cooled, then the ducts are installed. The duct systems circulate the cold air from the air conditioning equipment to the proper air distribution point and also carry the return air from the room back to the air conditioning equipment for recirculation and reconditioning. As the duct system for the proper distribution of cold air, costs nearly 20% to 30% of the total cost of the equipment required. Thus, it is necessary to design the air duct system in such a way that the capital cost of the ducts and the cost of running the fans is lower [1].

1.1 HVAC (Heating, Ventilation and Air conditioning)

Heating, Ventilation and air conditioning (HVAC) system is designed to achieve the environmental requirements of the comfort of occupants and a process. These HVAC systems are commonly used in different areas such as industrial, commercial, residential and institutional buildings. The main mission of HVAC system is to satisfy the thermal comfort of occupants by adjusting and changing the outdoor conditions, the outdoor air is to drawn into the buildings and heated or cooled before it is distributed into the occupied spaces, then it is exhausted to the ambient air or reused in the system. The selection of 2 HVAC systems in a given building will depend on the climate, the age of the building, the individual preferences of the owner of the building and a designer of a project, the project budget, the architectural design of the buildings. HVAC systems can be classified according to necessary processes and distribution process. The required processes include the heating, cooling and ventilation process. Other processes can be added such as humidification and dehumidification process. These processes can be achieved by using suitable HVAC equipment such as heating systems, air-conditioning systems, ventilation fans, and dehumidifiers. The HVAC systems need the distribution system to deliver the required amount of air with the desired environmental conditions. The distribution system mainly

varies according to the refrigerant type and the delivering method such as air handling equipment, fan coil, air ducts, and water pipes [12].

2. LITERATURE SURVEY

S.M. Gheji et.al in his paper entitled "Basic Classification of HVAC Systems for Selection Guide", concluded that air conditioning means providing out of air within the atmosphere to sustain the temperature, moisture, air excellence, air gesture and ventilation. Temperature is controlled either by cooling or heating the air. Moisture is controlled either by eliminating or addition of the moisture to air. Air eminence is preserved by purification which avoids admission of dust and particulate substance and provides clean air and ventilation is attained by supply of acceptable renewed outdoor air. Occasionally sound stages are too condensed by acoustic linings or sound attenuators [1].

Md Sadiqul Hasan Talukder In his paper entitled "Heating, Ventilation and Air Conditioning (HVAC) systems" concluded that it cannot be imaginable to use warning/alarm system everywhere. The pressure cascade for each capacity should be individually judged therefore time cannot be consumed. Though it has restrictions but modern era is very reliable on these. Especially in the medical segment these are very active. Hence, all kinds of safety for human is possible by this HVAC system. So, this system is undeniably welcome for modern age [2].

Gonzalo Sánchez et. Al (2019) Design parameters of HVAC installations in high-performance hospital operating theatres were evaluated according to UNE 100713, ASHRAE Standard 170, and pre-standard EN 16244-2. All of them establish a range of values for thermo hygrometric conditions. It was found that ASHRAE Standard was the most tolerant in values proposed for room overpressure. Pre-standard maintains the minimum value proposed by UNE standard but does not define a maximum, so in both, the value of this parameter is at designer criteria. ASHRAE Standard recommends a smaller number of filtering stages and less efficiency. The pre-standard adds an additional level of pre-filtering over UNE standard [3].

M N Rahman. Y et. al (2018) The CFD simulation result for Minor Operation Theatre demonstrated differences in real measurement about 19% for air flow velocity and for the 0.04% temperature. The errors that occurred due to the uncontrolled mesh density and wall of Minor Operation Theatre in actual Minor Operation Theatre which hard to be quantified for CFD simulation. Based on the observation, better location of AC unit must be proposed for better distribution of air flow in Minor Operation Theatre and it reveals that ANSYS Fluent can be utilized for air simulation in Minor Operation Theatre [4].

Muneera Abs Farj et.al (2014) they were also ineffective in reducing the OT temperature, the presence of recirculation zones was most prominent and this might trap the contamination inside the OT. The effect of adding two inlets at the bottom showed enhanced flow inside OT. The temperature in the zone of the interest was also reduced significantly. The major advantage of all the three-horizontal inlet setup is that the airflow is not blocked by the primary and secondary light sources. Vertical Inlet Generally vertical inlet cases outperform the horizontal inlet cases, both in terms of velocity and temperature distribution inside the OT. The room was effectively cooled in both the cases, the only drawback was the presence of recirculation zone room. Also Slight increase in temperature in the central region was noticed. It effectively maintain the room temperature, reducing the recirculation zones and good velocity distribution throughout the room. This case will be used for further analysis, to effectively track the contamination removal inside OT [5].

Carla Balocco et.al (2014) Numerical simulations of airflow, thermal fields and contaminant concentration distributions were carried out for a real OT under different ventilation schemes for supplying and recovering indoor air. Our investigation provides better understanding of which ventilation scheme can guarantee the best compromise between IAQ levels and comfort requirements under real use conditions of the OT (i.e. incorrect use, mainly due to the door being open during surgical operations). Results confirm the strong effects of a correct ventilation system design and location of the air supply diffusers on compliance of microclimatic conditions with the suggested standard limits, thermal comfort and IAQ levels guarantee and also on satisfactory contaminant removal results, with noticeable low contamination levels at the wound site [6].

Clive B. Begg et. al (2012) from the foregoing discussion, it is clear that ventilation systems for general wards and patient rooms are specified using criteria that differ little from those used for nonclinical spaces. The guidelines in both the United Kingdom and the United States avoid any discussion of the risks posed by airborne microorganisms, but focus on providing a comfortable environment. This is understandable, given that patient comfort is of great importance and that the clinical risk posed by many airborne pathogens is unclear. Nonetheless, there is growing evidence that the aerial dispersion of some nosocomial pathogens is seeding widespread environmental contamination that may be promoting CFD [7].

M N Shami R et. al (2018) The CFD simulation result for Minor Operation Theatre demonstrated differences in experimental result are about 3.06% for RH. The errors that occurred due to the uncontrolled mesh density and wall of Minor Operation Theatre in actual Minor Operation Theatre which hard to be quantified for CFD simulation. Based on the study observation, it reveals that ANSYS Fluent can be utilized for RH simulation in Minor Operation Theatre [8].

Giuseppe Petrone et.al (2012) Results obtained from CFD transient simulation applied to the two ventilation schemes studied are consistent with experimental data of recent

literature. As a matter of fact, efficiency and efficacy of the unidirectional vertical air flow, improved with the air curtains application, are in good compliance with those reported in the recent literature. Our proposed ventilation schemes, equipped by unidirectional vertical downward air flow, comply with those pointed out by some important researches on this argument that demonstrate as this kind of ventilation system provides an ultra-clean environment and the better comfort conditions for all the OT zones. Therefore, our investigation shows that the horizontal air flow system, can be an important alternative to the vertical one in the OT only if the supply and return diffusers are located on the opposite site of the same lateral wall and their position is chosen taking into account the location and height of the operating table, medical equipment's, instruments tables and other obstructions, compared with the distance of the plenum and air inlet grilles [9].

Muhammad Idrus Alhamid et. al (2014) the existing condition showed to have ACH value at 8 ACH. In order to comply with air discharge standard of 20 ACH, the fresh air discharge required by the operating room was 1,525 ft3/ min (2,585 m3/ h). The air flow in the operating room of the existing condition was not very good for sweeping the particles towards RAG because turbulence flow brought back the particles to the operating table. In the redesign condition, the airflow turbulence was minimized by lowering speed and increasing number of RAGs in the room [10].

3. CONCLUSION

From the above literature survey considering all the conditions such as temperature and airflow movement in the operation theatre environment should be carried out. Simulation should be carried out using analysis software to predict the flow velocity and temperature distribution inside the operation theatre. Parametric study is to be done to determine the most suitable inlet and outlet configuration. The entire ceiling inlet and outlet are carried out considering contaminants.

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