



HVAC (HEATING, VENTILATION AND AIR-CONDITIONING) -REVIEW

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ABSTRACT

HVAC (Heating, Ventilation and Air-Conditioning) is a system of achieving thermal comfort in any closed space. This comfort level of heat is needed in every kind of workspace and offices. Nowadays, to attain this comfort level, even vehicle compartments are designed in such a way to improve the thermal comfort. This paper presents a review of methods which have been researched in scientific papers in last couple of years. Most papers focus on one of the following trends: improving "classical" control methods; use of predictable control based on models; use of intelligent control method.

Keywords—HVAC systems, control, review, Classic Control, Predictive Control, Intelligent Control.

INTRODUCTION

The internal environment is controlled by the HVAC (Heating, Ventilation, and Air-Conditioning) systems for the whole year so that the comfortable facilities can be ensured under offices, homes along with the commercial services. The HVAC systems are creating a very healthy and wealthy life for humans also more prolific. However, in a suitably controllable environment, a various number of products can be created keeping in mind about the economy, superiority also quickly for the use. The developed countries from all over the world, there is an year-round that is taking place for controlling the environment in residential place, commercial areas, institutions, and industrial sectors.

The preservation of mass and energy is utilized in the models of HVAC systems so that the

demands of a variety of elements in respect to heating, cooling along with electric energy can be computed. The elements that are involved in the system includes, pumps, mixing boxes, fans, coils, chillers, humidifiers, ducts, boilers and other HVAC apparatus. ES programmes are using various complex methods for the computation of required energy that are fully based on each and every implementation in the system. Below Figure 1 explain the process of air conditioner.

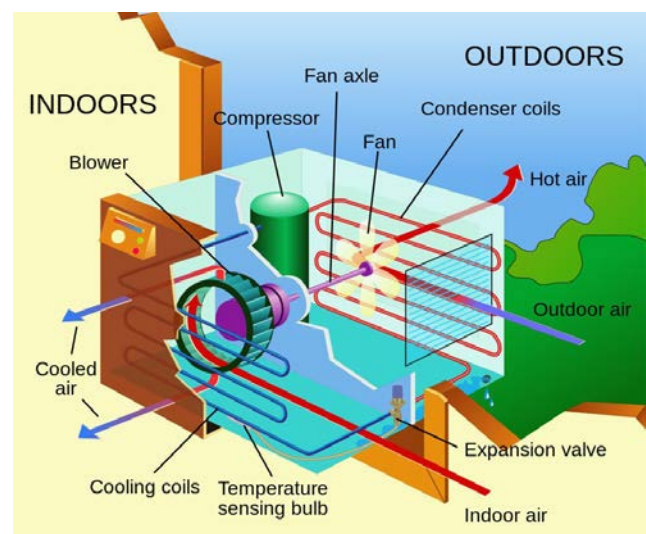


Figure 1 Air conditioner

The HVAC regulates the Room temperature, humidity of the room, air purification as well as air flow in a given room. These factors are described below:

- **Room Temperature:** Inside the passenger compartment, the temperature is controlled by room temperature with the help of measurement device that is working according to the needs or the requirement of the passenger.

- Humidity: The system of HVAC are controlling the humidity temperature inside the passenger compartment to ensure the level of humidity for a comfortable state for the passenger.
- Air Purification: The air is purified and eradicated the bacteria and dust from the environment from the passenger compartment so that the passenger can found their level of comfort.
- Air Flow: From the passenger compartment, the air is absorbed from the compartment and then it filters the air and blows it back in the compartment of passenger.

LITERATUREREVIEW

(Mohamad Kanaan, 2019)[1] Researchers nowadays, are focusing on reducing the amount of waste heat that occurs from heating, ventilation and air conditioning system or can be called as HVAC systems. Various researches have contributed towards providing a mechanism or technique to reduce the energy consumption in HVAC system. One of these methods include the recirculation of the already used gas or air to preheat the fresh air, so that heating loads can be reduced to a substantial amount. But as everything has a limitation, this too comes with a cost. Over preheating may reduce the quality of the fresh air and thus Indoor Air Quality might become unfit for further circulation.

The study suggests that the model that has been created for the CFD analysis can further be implemented for further use in assessing the maximum quality return of air while minimizing the energy consumption. Not only this, but this is quite helpful in computing the minimum requirement of UV rays to disinfectant the air and remove the bacteria from the HVAC system, so that there occurs no need of additional fresh air to maintain the quality of the breathing zone.

(Lu Zhang, 2019)[2] The use of heat pump and other electrical equipment to maintain a thermal comfort in a required space is widely used all over the world. Various studies were performed to optimize the use of electrical energy for maintaining thermal comfort and transient thermal temperature of the indoor space. Usually, CFD has been used for the computation of precise results for the simulation

of transient indoor space. But there comes a high cost of using it. In CFD, transient flow and temperature fields can be coupled to produce results with utmost preciseness but at the cost of the so much of time and cost itself. Thus, in this study, an optimum method is utilized to compute the results of simulation in less time consumption and with utmost preciseness. This study concludes and proposes the CFD semi-coupled model to have the advantages of both CFD fully-coupled and segregated model and is optimum to use in these situations.

(Xiaofang Shan, 2019)[3] It has been observed that people generally spend 90% of their time at their homes and just because of this, HVAC systems gain a lot use in houses. HVAC systems are used to maintain a thermal comfort zone in any required space. Every human body feels sensations and thus have thermal comfort zone according to each individual's body temperature. Although there is no considerable difference between different body's temperature. A new method which evaluates the thermal sensations of the people in the considered space is used in this study, known as PMV (Predicted Mean Vote). The main aim behind finding out the distribution of PMV is because it signifies that the cooling system can maintain the thermal comfort in required space with the help of wireless sensors put inside the office room or houses. Environmental parameters that decide on the distribution of PMV are an important factor to consider. These factors are velocity, temperature, radiant temperature as well. It also goes inside an office room with a coil unit inside fan. Thus, this study concludes and provides much information to be useful for HVAC system designer of engineer to carry out their work with more information.

(Chen Ren, Shi-Jie Cao, 2019) [4] As the need of the energy and demands are increasing day by day, exploration of number of energy resources are rising day by day. So many techniques are being already employed and are further optimized to minimize the electrical energy consumption so that maximum output can be obtained from HVAC systems. This technique combined with suitable ANN and CRI (contribution ratio of indoor climate) to help in getting the distribution of temperature in indoor air. These techniques increase the database of CFD simulation to compute the precise temperature distribution in an occupied

space. These techniques help in rapid computation and simulation process as Linear Ventilation Model (LVM) and Linear Temperature Model (LTM) are applied really well. By this research, it has been observed that HVAC energy consumption through ventilation models are reduced by 50% and same through air conditioning loads are reduced by 32%. And thereafter this research opens new possibilities of smart controlling strategy and optimization for the same.

(Popovici, Hudişteanu and Cherecheş, 2018)[5] reviewed the current situation of the HVAC system in a theatre. A case study was done and for this, a theatre has been selected which was "VasileAlecsandri" National Theatre of Jassy. HVAC system in this theater was studied using the CFD 2D model. Air temperature, velocity and its relative humidity were major aspects that were observed and noted in this study and further were presented in the form of comparison graphs of parameters that were major aspects.

(Zhijian Liu, 2018)[6] As the world is seeing more and more worldwide spread of HVAC system for achieving thermal comfort in the houses and buildings. It becomes more vulnerable to the microbial contamination as well. In the history of human kind, SARS, MERS, H₇N₉, and so many other epidemics were the reason of mass population reduction of the world. These diseases are spread with the help of air or water may be. This study concludes on the engineering counterpart and epidemiologists counterpart, about the design factors along with other implementation factors need to be considered to prevent the growth of microorganisms inside the HVAC system.

(Aliahmadipour, Abdolzadeh and Lari, 2017)[7] presented a numerical model and then carried out the experiment and measured the temperature distribution for the comfortability of the passengers in a passenger coach. This numerical simulation was done at the time of summer. The HVAC system of the passenger coach was compared after some design modifications which came after studying the present condition and air flow in the passenger coach. Another case was performed in which first passengers were absent and present in the coach and design was optimized accordingly. On comparison, it was found that just because of designing inappropriateness, HVAC system

was not able to create thermal comfort zone for the passengers slept or seated.

(Suárez et al., 2017)[8] carried out the CFD analysis for a railway vehicle passenger coach of a tram focused on air distribution inside the compartment. A similar model was created such as tram with the establishment of every possible detail in the model to be precise as much as possible. This work concludes about the thermal comfort views and perspectives of the people that were considered in the tram and for achieving it, which factors contributes in a way to affect the most.

(Zhou et al., 2017)[9] In recent times, it has been widely observed that, HVAC system is get quite more common and everywhere. HVAC is in itself an energy management thing. Energy management is of a huge significant for the household. . In this CFD model, Navier-Stokes equation in two dimensions is used along with MPC (model predictive control) algorithm and formed into CFD-based MPC (CFDbMPC) system. In this first, CFD analysis is done on a two dimensional model for simplification and then with the help of MPC algorithm, computational cost is highly decreased. Finally, both of the methods were integrated with support of successive linearization method.

(Ahmed Kabir, Kanagalingam and Safiyullah, 2017)[10] Conventional HVAC systems effectiveness comes with too much cost. This cost is not only financial but also as the environmental cost, complexity in design. A CFD technique is used for reducing time and wastage possibilities and getting as precise results as can be obtained near to practical situation. To make the simulation a bit more realistic, atmospheric boundary layer was formed at inlet and standard k-epsilon turbulence model is used to simulate results. This study also focuses on the evaluation of viability to use heat demand.

DISCUSSION

Energy-efficient HVAC system designs depend on new configurations of traditional systems that make better use of existing parts. One effective way of achieving energy efficiency has been the design of HVAC system configurations that combine a range of different traditional HVAC system components. Recent research has demonstrated that a combination of existing air conditioning technologies can offer effective solutions for energy conservation and thermal comfort. Each HVAC discipline has

specific design requirements and each presents opportunities for energy savings. It must be understood, however, that different configurations in one area may augment or diminish savings in another.

CONCLUSION

As explained in introduction, as standard of living is growing, so does the amount of energy used for heating, ventilation and air conditioning. This signifies that methods for efficient control of HVAC systems will only be more important in future. Conventional HVAC systems rely heavily on energy generated from fossil fuels, which are being rapidly depleted. This together with a growing demand for cost-effective infrastructure and appliances has necessitated new installations and major retrofits in occupied buildings to achieve energy efficiency and environmental sustainability. Therefore, finding novel ways towards green buildings without compromising comfort and indoor air quality remains a challenge for research and development. The overall attainable reduction in energy consumption and enhancement of human comfort in the buildings are dependent on the performance of HVAC systems. One proven way of achieving energy efficiency in HVAC systems is to design systems that use novel configurations of existing system components. Recent research has demonstrated that a combination of existing air conditioning technologies can offer effective solutions for energy conservation and thermal comfort. In this paper various energy saving strategies for HVAC systems were investigated and their potential to improve the system performance were discussed.

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