BUILDING THERMAL COMFORTS WITH VARIOUS HVAC SYSTEM AND OPTIMUM CONDITION : A REVIEW

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Abstract

Energy-related issues reduced thermal comfort. Emerging economies like India have energy use issues. Researchers discuss buildings with optimal HVAC systems, but HVAC consumes most building energy. Only temperatures can't be used to measure human thermal comfort. It depends on the person and the physical activity. Environment affects thermal comfort. This research seeks the best ways to achieve thermal comfort in smart city buildings. This review examines research papers on building thermal comfort. The research focused on techniques to achieve building thermal comfort. Air-temperature, heat-generating devices, air-quality, moist, garment level, and movement affect building energy usage and thermal comfort. Tests showed that nocturnal ventilation increases diurnal temperature variations, especially for lightweight construction, while high thermal mass and closing exterior blinds reduce them. Deep reinforcement learning controls multi-zone HVAC thermal comfort. Implementation and evaluation of a modern HVAC system that incorporates occupant thermal profiles. The Pareto solution was used to generate optimal building design options (NSGA-II). Designers use thermal comfort assessments. Thermal comfort models are described. Thermal comfort requirements protect human and building health.

Keywords: HVAC, Building, Thermal Comfort, chiller, Air-Conditioning, Energy, Heat, optimisation

1. INTRODUCTION

Thermal comfort is the state of mind that expresses satisfaction within the thermal environment [1, 2]. Thermal comfort can't be measured in degrees or a range. Environmental and energy problems are global [3, 4]. The VRF system cools or heats air-conditioned spaces by controlling refrigerant flow with an inverter-controlled variable speed compressor [4, 6]. Modern compressors, like the twin rotary compressor, can close the metering mechanism to restrict refrigerant flow between indoor and outdoor units [7]. Temperature-priority lists improve HVAC load dispatch to maintain indoor temperatures and load diversity [8]. Realistic intra-hour load balancing signals analyse HVAC load characteristics under varying external and internal temperatures. The ideal zone temperature set-point schedule minimises running costs, CO2 emissions, and occupant thermal discomfort [9]. A comfort-preserving energy-saving approach is more popular and easier to implement [10, 11]. Microencapsulated PCM in wallboards reduced Darwin's cooling demand. Using artificial lighting regression models and artificial neural network (ANN) models with an Energy Plus model database, a meta-model was created to predict building energy performance. [12]This study examines how light shelf affects thermal comfort and energy use in residential buildings. Cooling/heating loads were hand-calculated until the mid-1960s [13].

2. Research Methodology

Various research papers find the effect of energy efficiency on thermal comfort. This research used these methods:

Step I: Collected various research papers Scopus, science direct, Google Scholar, and Web of Science were searched for relevant papers published in the past 5 years and new research in the same field.

Step II: Choosing only relevant research relevant physical and human body research papers were filtered, shortlisted, and considered based on their abstract, results, and conclusion.

Step-III: Extracting Data Coziness. The study included 100 research papers on thermal comfort of HVAC system activities in buildings. Methods, Technologies, problems, questionnaire and thermal comfort of HVAC systems in various buildings were reviewed.

Air Temperature	Easily influenced by Mechanical, passive heating and cooling
Mean Radiant Temperature	It defines operative temperature, a key thermal comfort factor.
Humidity	Air moisture. High or low humidity might cause pain.
Air Velocity	Measures room airflow. Rapid air velocity changes may cause draught complaints.
Physical Activity	Human body heat, which affects temperature perception.
Clothing Level	Body insulation. Higher clothing levels reduce skin heat loss and make the region stays cool.

3. Outcomes of Paper Review

This study compared HVAC and building temperatures. Residential Buildings, offices, hospitals, universities etc. had the most thermal comfort due to convection heat, air velocity, air heat, moist, clothing level, and physical movement. Demand response reduces a building's AC load by 40% and saves 26.8% energy. DR events covered 70% of peak energy [14]. Low occupancy (10%), off-air conditioning, and open windows reduce interior air temperature [15]. Composite PCMs improve thermal properties. Temperature isn't the main factor in regulating thermal comfort in HVAC systems [16, 17]. Personalized cooling, heating, and ventilation with a lower cooling set point (24℃) can save 60% energy [18]. Building sensors in HVAC system helps to measure thermal comfort, visual comfort, indoor air perfection, and future problems for improving building interior environmental quality and energy efficiency with close examination [19, 20]. AI2CC ventilation used less power than ICC and it's energy-intensive. AI2CC was 6.4% more comfortable than ICC but used more humidifier energy [21, 22]. SCHX VRF systems have 8.5% more CPF at equivalent outside temperatures. When SCHX passes 5.27% of refrigerant, evaporator mass flow rate drops [23]. PMV-based control and ASHRAE comfort range management reduce energy consumption by 25.4% and 27.0%, respectively [24]. Nano-insulation reduces cooling and heating energy by 2.85 to 3.6%, they reduce total energy consumption by 5.68 to 6.25%. [25]. A green retrofit design ideally saves 4% energy and improves comfort level [26]. Pipe diameters, length, and EEV control for larger airflow air handlers and a smaller wall unit improves operation and reliability of VRF system. Modern air-conditioning systems are more suitable to achieve desired comfort level with advance features [27].

Author, type of job :: Major part	**Paper summary**
Q. Zhao at al. (2020) [28], Thermal Comfort model's developments, **::** Improve Human thermal comfort and balance.	Earlier sleep thermal models included body part emotions with Overall cool and hot feelings measure thermal comfort and human thermal balance.
S. U. Rehman et al. (2020) [29], predict thermal sensation votes, **::** conventional and deep learning algorithms	According ASHRAE RP-884 Analyses, machine learning and deep learning predict the thermal comfort. Personalized Comfort predicts thermal voting with 85% accuracy, 8% higher than studies.
S. K. Sansaniwal (2020) [30], human thermal comfort **::** Local culture and adaptation.	Study found a weak link between thermal comfort and indoor air quality, which depends on occupant behaviour.
T. Kuczyński et al.(2021) [31] , Night ventilation and window shading effects **::** Effect of night ventilation, window shading and thermal mass	High thermal mass and closing external blinds reduce diurnal indoor temperature variations, with good night ventilation and lightweight construction.
Y. Yao and D. K. Shekhar (2021) [32], review on model predictive control (MPC) **::** MPC design parameters and its uses in HVAC	MPC optimizes plant response using a model, prediction horizon, and optimization tools. After widespread use in industrial process control, MPC is growing in HVAC (HVAC).
L. Xiong et al. (2021) [33] K-nearest-neighbours (KNN) algorithm **::** In contrast to static thermal comfort models	In this study a KNN-based thermal relief model creates based on environmental factors. 34 volunteers will test KNN-based thermal relief. The KNN model with 1000

	training sets achieved 88.31% accuracy.
G. Halhoul Merabet et al.(2021) [34], Intelligent building control systems :: Artificial Intelligence-based techniques.	Evaluated AI-based building control system outputs, implementations, and energy efficiency. AI technologies for power and comfort relief include identification, recognition, optimization, and predictive control.
Z. Ding et al. (2022) [35], Energy-efficient control :: Thermal comfort in and SVR-DNN model HVAC	SVR-DNN model is used and results indicating this method can improve thermal comfort by 20.5% in complex HVAC system compared with other models.
S. A. Mansi et al. (2022) [36], human thermal comfort decoding via physiological signals :: Physiologic signal via decoding of human thermal comfort	Physiological signal can distinguish between cold and warm thermal sensations. Physiologic signal processing identified thermal perception when combined, signals show excessive heat.
H. Fitriani, M. Rifki (2022) [37], Investigation of Energy Saving :: Network theory models	Thermography Laplace transfer models of HVAC and controls applied. Determining radioactive and convective load transfer functions. Convective heat input increases concrete-floored rooms' first-order time constants by 80%.
B. K. Jeon et al. (2022) [38] White-Model Predictive Control :: Multi-zone MPC evaluation.	Multi-zone MPC benefited from Energy Plus's thermal comfort and energy savings. The simulation for thermal comfort and power savings optimization showed suggested framework can reduce current TOU fees by over 55%.

4. RESULT

Table summarises literature review results.

Commercial buildings, hospitals etc. are required the highest thermal comfort. Temperature, air quality index, heat-generating devices, humidity and personal characteristics like clothing level and movement affect thermal comfort. Different technology like artificial intelligence-based techniques, machine learning driven models and MPC design parameters are used to achieve the more thermal comfort and energy management in smart cities. Reduced buildings AC load and save 26.8% energy by using demand response management. Energy efficient HVAC system with PMV –based control systems and ASHRAE comfort range management can reduce consumption of energy by 25.4% and 27%. SVR–DNN model improve thermal comfort by 25.5% in complex HVAC system with other models.

5. Conclusion

This paper analysed building thermal comfort and HVAC systems. The study found that buildings, offices, hospitals etc. requires maximum thermal comfort. Air heat, mean convector heat, air velocity, moist, clothing level, and physical movement affect thermal comfort and building energy uses. Now a day, HVAC uses most building energy. According to studies, plan orientation and design can improve building energy and temperature issues. Many industries with good job prospects undervalue thermal comfort. We can achieve more thermal comfort and save more energy by using different-different technology. Future research should focus on building and other energy-saving tasks. Future research could focus on small, medium, and large building thermal comforts, optimal conditions, energy consumption, and costs.

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