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Calibrated Simulation Analysis for Integration of Evaporative Cooling and Radiant Cooling System for Different Indian Climatic Zones

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Abstract

Radiant cooling system (RCS) has proven to be an energy efficient system for meeting a building's cooling requirements. RCS is energy efficient and provides better thermal comfort compared to conventional all-air heating ventilation air conditioning (HVAC) system. To further improve the efficiency of RCS, a parallel evaporative cooling system (cooling tower) is coupled with RCS and analyzed for different climatic condition using calibrated model. A statistical analysis of weather files (based on wet bulb temperature), was used to identify the availability of useful water for cooling tower integration with RCS. A comprehensive simulation feasibility study of the application of cooling tower in RCS was performed for different cities to cover every climatic zones of India. It was found that in summer, the wet bulb temperature (WBT) of different climatic zones, except warm-humid, is suitable for the integration of cooling tower with RCS. An experimental setup was designed and developed for integration of parallel chiller and cooling tower with panel-based RCS for cooling and a dedicated outdoor air system (DOAS) for dehumidification and ventilation. Experiments were conducted for chiller and cooling tower operated RCS in Composite climate of Jaipur, Rajasthan, India. Building Energy Models (BEM) were developed for both the chiller-operated RCS and cooling tower-operated RCS in EnergyPlus and calibrated with the measured data. Using the calibrated models, performance of the system was analyzed for different climatic zones of India. A chiller-operated RCS was considered as a baseline to compare the annual energy saving potential and monthly performance of the cooling tower integrated RCS. In the cooling tower–operated RCS, a total annual savings of 7% in hot and dry climates, 11% in composite climates and 20% in temperate climates was achieved compared to the chiller-operated RCS.

Introduction

Buildings consume about one third of the global primary energy consumption [1][2]**.** Heating Ventilating and Air Conditioning (HVAC) systems are responsible for almost 50% of the whole building annual energy consumption. Most of the HVAC systems in the buildings are conventional all-air system, which use air as a medium for meeting both ventilation as well as