

An Experimental Investigation of Free Space Cooling by Phase Change Material (PCM)

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Abstract—In free space cooling PCM at suitable melting point is solidified by using night time cold air. During day time room air is passed over the solid PCM which absorbs Latent heat from it and melts. As a result room air gets cooled. In the present work suitable double pipe heat exchanger is designed and manufactured for the experimentation. The inner pipe is made up of copper and outer pipe with acrylic for visualization of phase change. PCM LatestTM29T (hydrated salt) is filled in annular space and atmospheric air is passed through inner tube. Air flow velocity is measured by hot-wire anemometer. 8 RTD sensors are placed at different location, 2 for inlet and outlet temperature and 6 are inserted in the PCM at different radial locations. The real time temperature data is captured by 8 channel Data Acquisition System at an interval of 15 minutes. A 90 W Centrifugal blower with VFD controller is used for passing the air with different velocities. The experimentation consists of passing cold outside air in the copper pipe during late night hours until PCM solidifies and measurement of solidification time. During day time hot room air is passed through tube and melting time and temperature drop of air is measured. It is observed that about 90% of PCM solidifies in about 7 hours when the night time ambient temperature is 22°C with air velocity of 12 m/s. During day time melting hours of PCM are found to be 6.5 hours with inlet average temperature of air to be 34°C, with 4m/s velocity and average temperature drop of 0.8 °C is observed.

Index Terms -Free space cooling, Phase change material (PCM).

I. INTRODUCTION

Energy required by the buildings comprises about 40% of world's total energy consumption, and from that 10-20% of energy is required by HVAC equipment [1,2]. Considerable amount of energy is needed for air-conditioning of buildings. Today demand of fossil fuel is increasing day by day but sources are limited. Use of fossil fuel results in greenhouse gas emission which causes global warming. Earlier researchers were working on cost reduction of energy, but nowadays researchers are working on minimizing energy needs like the concept of green building. Green building consumes minimum amount of energy and the energy from renewable energy sources.

Passive cooling is the type of cooling that focusses on heat gain control and heat dissipation in a building with very less energy consumption. In passive cooling free space cooling (nocturnal cooling) is the type which works on diurnal temperature variation. In this system night time cold is stored and it is utilized during day time. For storing cold conditions during night time phase change material is used because of high storage capacity [3]. The concept of free space cooling using PCM is explained below.

Free space cooling with PCM working principle

a) Discharging process (heat absorption): During day time hot air from the room is circulated around solid PCM, which results into melting of PCM as inlet air temperature during day time is more than melting point of PCM. As latent heat of fusion is absorbed from the air by PCM for changing its phase, cooling effect can be achieved at the outlet of storage unit. This cooled air can be circulated in the room [3].