COMPARISON OF l\1EASURED AND PREDICTED PERFORMANCE OF DITFERENTHEATSTORAGESYSTEMS

M.M. EI- Kassaby

Mechanical Eng. Dept., Faculty of Engineering,
University of Alexandria, Alexandria, Egypt.

ABSTRACT

A.A. Ghoneim

Math. & Physics Dept., Faculty of Engineering,
University of Alexandria, Alexandria, Egypt.

The present paper presents a comparison between the measured and the predicted performance of different sensible heat storage units. Also, a comparison between the performance of water and air based heat storage systems has been conducted. In the air based systems, natural soil available at Mu'tah site, Jordan is used as a sensible heat storage material. Experimental set up is designed for three different storage systems namely water storage system, unstratified air storage system, and stratified air based system. The performance of the storage units, i.e. the heat accumulated by the storage material (soil in air storage systems, and water in water storage system) is calculated. A computer program is developed to determine the temperature distribution of the air based storage systems. The numerical model uses finite differences techniques to solve the governing equations for both the storage material and the circulating fluid. The results showed that the computer model is in a good agreement with the experimental results. Also results showed that the stratified tank performs better than the unstratified one and the water system is superior in storage energy inspite of its harmful corrosion effect.

INTRODUCTION

Solar energy is available only during a certain time of the day. So, a heat storage unit is necessary to store the energy from a heat source for later use when there is a heat demand. Energy storage is usually in the form of sensible energy of a fluid or solid medium, energy associated with the phase-change of a material, or energy released from reversible chemical reactions.

In latent heat storage, a material undergoes a phase change, usually from a solid to a liquid. Such a phase change is accompanied by the absorption or the release of relatively large amounts of thermal energy. Usually, the latent heat thermal storage systems have higher energy storage densities than the sensible heat systems. On the other hand, phase-change energy storage has two major drawbacks. Phase-change materials are more expensive than rock or water. Also, these units must contain a heat exchanger since neither the circulating fluid is the same as the storage medium as the case in water based system, nor the storage medium is always a solid as the case in the pebble bed storage system.

The main advantages of air based systems are: (1) the availability, and relatively low cost of the storage material, (2) the direct contact between the fluid and the solid material which results in a small temperature gradient, (3) the low thermal conductivity of the solid in the radial direction which reduces the requirement for system insulation, (4) unlimited storage temperature. On the other hand, the main disadvantages of such systems are : (1) large storage

volume due to their low heat capacities, (2) large pressure drops which require large fans, (3) charging and discharging can not be done simultaneously [1,2,3].

The main advantages of water based systems are : availability, nontoxicity, high density, high specific heat, and low cost. The major drawbacks of water based systems are freezing or boiling of water, corrosion, and storage temperature is limited to 100°C [3].

In an early trial to use pebble bed as a storage system, Hughes et al [4] had introduced a theoretical model to