A review on cool thermal storage technologies and operating strategies

Y.H. Yau*, Behzad Rismanchi
Department of Mechanical Engineering, University of Malaya, Kuala Lumpur, Malaysia

A R T I C L E   I N F O
Article history:
Received 2 January 2011
Accepted 8 September 2011
Available online 4 October 2011

Keywords:
Thermal energy storage (TES)
Off-peak air conditioning (AC)
Cool thermal storage systems
HVAC&R

A B S T R A C T
The thermal energy storage (TES) system for building cooling applications is a promising technology that is continuously improving. The TES system can balance the energy demand between the peak (daytimes) and off-peak hours (nights). The cool-energy is usually stored in the form of ice, phase change materials, chilled water or eutectic solution during the nighttimes and used in the daytime. A well-designed TES system would effectively decrease the electricity demand with a reasonable cost. This paper summarizes the findings, investigations and analysis of the TES systems for the space cooling applications. In this regard, different types of storage technologies, as well as various operating strategies, are discussed and some of the outstanding case studies are presented. Since the TES system can provide any portion of the required cooling load, the designer must focus on the best practical and economical solution, which is mainly influenced by localized parameters. It is evident that to improve the available designing standard, a sustainable investigation on localized parameters such as the electricity demand trend, the peak and off-peak hours, the climate change profiles, the electricity tariff rate and the system setup costs are still required.

© 2011 Elsevier Ltd. All rights reserved.

Contents
1. Introduction ................................................................. 787
2. Cool thermal storage system ............................................. 788
3. Chilled water storage techniques ....................................... 789
4. Ice thermal storage technique .......................................... 790
5. Different types of TES systems ......................................... 791
5.1. Ice harvesters ......................................................... 791
5.2. Ice slurry ............................................................. 791
5.3. Encapsulated ice ...................................................... 791
5.4. External melt ice-on-coil storage systems ......................... 792
5.5. Internal melt ice-on-coil storage systems ......................... 793
6. Operation strategies of cool TES systems ......................... 793
6.1. Full storage strategy ............................................... 793
6.2. Partial storage strategy ............................................ 793
7. Case studies .............................................................. 794
8. Concluding remarks ..................................................... 796
Acknowledgements .......................................................... 796
References ................................................................. 796

1. Introduction

Before 19th century as there was no mechanical refrigeration system, any artificially cooling would be possible by using natural phenomena like ice, snow, underground cold water or natural evaporating cooling [1]. Nowadays, as the cool generator systems are becoming more developed, the existence of the storage devices is unavoidable. Generally, Thermal Energy Storage (TES) systems help reserving the energy in thermal reservoirs for later usage. They are designed to store either the higher (heat) or the lower (cold) temperature in comparison with the environment [2]. The energy might be charged, stored and discharged daily, weekly, yearly or in the seasonal cycles [3]. The cool energy is usually stored in the form of ice, chilled water, phase change materials or eutectic solution during the low