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Review

An overview of thermal energy storage systems

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ABSTRACT

Due to humanity's huge scale of thermal energy consumption, any improvements in thermal energy management practices can significantly benefit the society. One key function in thermal energy management is thermal energy storage (TES). Following aspects of TES are presented in this review: (1) wide scope of thermal energy storage field is discussed. Role of TES in the contexts of different thermal energy sources and how TES unnecessitates fossil fuel burning are explained. Solar power generation, building thermal comfort and other niche applications of TES are presented. (2) Insight into classes of TES storage materials with details like their physical properties, cost, operational performance and suitability to application requirements is provided. (3) Insight into types of TES systems is presented. TES systems are classified using different types of criteria. Most common TES systems like seasonal TES systems, CSP plant TES systems, TES systems of domestic solar thermal applications, heat and cold storages of building HVAC systems etc are described. Active TES systems like thermocline, packed bed, fluidized bed, moving bed etc are analyzed. Passive TES systems implemented in buildings, textiles, automobiles etc are presented. TES systems operating in cold, low, medium and high temperature ranges are listed. Design parameters, operational issues and cost model of TES systems are discussed.

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1. Introduction

Discovery of fire is regarded as the most important milestone in the evolution of mankind. Simple activity like cooking food is one of the first applications that humans discovered for thermal energy. Thermal energy was readily available in nature even before human existence. Our bodies require a minimum ambient temperature to be alive. Due to such realities of our life, a strong need for thermal energy exists. Freely available solar thermal energy from sun helps to maintain the favorable ambient thermal condition needed to sustain our lives on earth. However the availability of solar radiation varies across different locations on the planet resulting in