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Corrosion effect of phase change materials in solar thermal energy storage application

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ABSTRACT

The thermal energy storage (TES) system using phase change materials (PCMs) has been studied since past three decades. PCMs are widely used in heat storage applications due to their high storage density, as well as the wide range of melting and solidifying temperatures. Nevertheless, the main disadvantage of PCMs, especially salt hydrates, is their corrosive behavior with container materials. PCMs are normally encapsulated in containers, hence the compatibility of the container materials with PCM plays an important role. As such, this paper summarizes the investigations made on the corrosion behavior of PCM in various applications, besides suggesting ways to reduce (or rectify) the effect for long term successful energy storage. Moreover, PCM-storage material interaction in the latent heat TES system is important as the issue of corrosion affects the life of the container, as well as the performance of TES. The compatibility of the most commonly used PCMs with several major container materials was reviewed and it was revealed that stainless steel has emerged as the most compatible storage container material among others. On the other hand, aluminum was found to be corrosive when it is used with salt hydrates. Nonetheless, some contradictory articles are reported that several salt hydrates demonstrated compatibility with container materials. Corrosion causes thinning of cross sectional area of materials, making it brittle thus leading to an easy collapse. This situation is even more critical mainly in large scale concentrating solar thermal power plants. Hence, with the fact that there are currently large scale power plants employing TES under operation and under construction; issues pertaining to PCM-storage material compatibility should be properly and accurately addressed. Therefore, more research work is recommended in the area of finding new eutectics and less corrosive container material(s).