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A Modular Reactor for Thermochemical Energy Storage Examination of Ettringite-Based Materials

Authors : B. Chen, F. Kuznik, M. Horgnies, K. Johannes, V. Morin, E. Gengembre

Abstract : More attention on renewable energy has been done after the achievement of Paris Agreement against climate change. Solar-based technology is supposed to be one of the most promising green energy technologies for residential buildings since its widely thermal usage for hot water and heating. However, the seasonal mismatch between its production and consumption makes buildings need an energy storage system to improve the efficiency of renewable energy use. Indeed, there exist already different kinds of energy storage systems using sensible or latent heat. With the consideration of energy dissipation during storage and low energy density for above two methods, thermochemical energy storage is then recommended. Recently, ettringite ($3CaO•Al_2O_3•3CaSO_4•32H_2O$) based materials have been reported as potential thermochemical storage materials because of high energy density (~500 kWh/m³), low material cost (700 €/m³) and low storage temperature (~60-70°C), compared to reported salt hydrates like $SrBr_2·6H_2O$ (42 k€/m³, ~80°C), $LaCl_3·7H_2O$ (38 k€/m³, ~100°C) and $MgSO_4·7H_2O$ (5 k€/m³, ~150°C). Therefore, they have the possibility to be largely used in building sector with being coupled to normal solar panel systems. On the other side, the lack in terms of extensive examination leads to poor knowledge on their thermal properties and limit maturity of this technology. The aim of this work is to develop a modular reactor adapting to thermal characterizations of ettringite-based material particles of different sizes. The filled materials in the reactor can be self-compacted vertically to ensure hot air or humid air goes through homogenously. Additionally, quick assembly and modification of reactor, like LEGO™ plastic blocks, make it suitable to distinct thermochemical energy storage material samples with different weights (from some grams to several kilograms). In our case, quantity of stored and released energy, best work conditions and even chemical durability of ettringite-based materials have been investigated.

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