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ABSTRACT:

Progress in the Modelling of heat Transfer in Packed Beds of Encapsulated Phase-change Materials

Anthony G. Straatman, Ph.D., FCSME, P.Eng.

Packed beds are commonly used in industrial systems and appear in chemical, biochemical, petrochemical and pharmaceutical processes. Depending on the application, the function of a packed bed can be to facilitate chemical reactions, to serve as heat exchangers or mass transfer devices, or to act as filtration devices. Of special interest for this presentation is the application of packed beds in thermal storage. Typical packed bed thermal energy storage devices/systems currently used in industry almost exclusively rely on sensible heating, and suffer from relatively low thermal efficiencies, meaning that they can only store a small fraction of the thermal energy that they are exposed to. Packed beds of encapsulated Phase-Change-Materials (PCMs) are of greater benefit in terms of thermal efficiency because they store both sensible and latent heat. Packed beds of PCM provide the benefit of high thermal storage capacity with the additional benefit of high surface area for transferring heat. Another important and useful property of PCM beds is their near-constant temperature during charging and discharging, a property which is important for many applications in process heating. Computational modelling of PCM packed beds relies on accurate characterization of the melting and solidification processes within the bed and can be extremely computationally expensive. The current research describes progress towards an approach for computational modelling of a packed beds of PCM by considering detailed simulations of a single encapsulated PCM and its extension to large-scale packed beds. The proposed method results in a significant reduction in computational resources that would otherwise be required to simulate phase change in all encapsulated spheres in the packed bed, while also simulating the thermal exchange between the packed bed elements and heat transfer fluid. Sample results are presented to demonstrate the proposed method.