INFILTRATION AND SOLID-LIQUID PHASE CHANGE IN POROUS MEDIA

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ABSTRACT

Many natural phenomenon and engineering systems involves phase change and infiltration in porous media. Some examples are the freezing of soil, frozen food, water barrier in construction and mining processes, chill casting , slab casting, liquid metal injection, latent-heat thermal-energy storage, laser annealing, selective laser sintering (SLS) and laser drilling, etc. These various applications are the motivation to develop a fast and reliable numerical model that can handle solid-liquid phase change and infiltration in porous media. The model is based on the Temperature Transforming Model (TTM) which use one set of governing equations for the whole computational domain, and then solid-liquid interface is located from the temperature distribution later. The first step was to create a model for solving Navier-Stokes and energy equation. The model was tested by solving a flow inside an enclosure problem. The next step was to implement TTM into the model to make it also capable of solving melting problem and then the program is tested with several phase change materials (PCM). The third step is to simplifying the complicated governing equations of melting and solidification in porous media problems into a simple set of equation similar to the Navier-Stokes equation, so that the program from previous step can be used. The final model was successfully validated by comparing with existing experimental and numerical results. Several controlling parameters of the phase change in porous media were studied. Finally, a one-dimensional infiltration process that involves both melting and resolidification of a selective laser sintering process was carefully investigated.