Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

The gain in temperature during freezing of mixtures: an effect of permeability on natural convection VIRKESHWAR KUMAR[1], Department of Mechanical Engineering, Indian Institute of Science Bangalore, India, G S ABHISHEK, ATUL SRIVASTAVA, SHYAMPRASAD KARAGADDE, Department of Mechanical Engineering, Indian Institute of Technology Bombay, India — Permeability of mushy zone plays a significant role during natural convection dominated solidification of mixtures. Permeability is strongly influenced by the solid fraction, morphology of the solid, and the length scale between growing solid structures. In this study, in situ water-salts bottom-cooled solidification observations are reported. During freezing, salt is the primary solidifying component and grows as either a dendrite or a facet, while the less dense water is rejected into the bulk. Dendritic growth has higher permeability than faceted. During the dendritic growth, the rejection of less dense solute forms plumes as convective patterns, and temperature continuously decreases at a nominal rate. Faceted solids are more packed in nature and have a higher solid fraction, which led to random convective patterns. This results in homogeneous mixing in the bulk and the temperature is reduced at a considerably faster rate. The convection becomes weak eventually, and a gain in temperature at the onset of eutectic growth was observed. A similar gain in temperature was also observed during solidification of the ternary systems, where faceted was the primary solid. Additionally, we have described a scaling analysis to correlate the role of permeability with flow behaviour.

[1]Department of Mechanical Engineering, Indian Institute of Technology Bombay, India

Virkeshwar Kumar
Department of Mechanical Engineering, Indian Institute of Science Bangalore, India

Date submitted: 02 Aug 2020 Electronic form version 1.4