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Freezing of pcms in cylinders under conduction control

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Freezing is an important thermal phenomenon in Latent heat Energy Storage Systems with applications in renewable energy. Freezing of a pure material at its melting point occurs on a cooled surface, conduction controls freezing rate . The material used is known as Phase Change Material (PCM). From literature, it is known that interface during progression of freezing may vary from smooth to rough surface depending on the PCM which significantly influences partial/total freezing times.For example, freezing of n-Octadecane in cylinders and annuli, the interface is covered with crystals. The density difference between solid and liquid causes a hollow core during freezing. The rate of freezing and total time vary on several factors including Stefan number, solid- liquid density ratio and interface behavior even for Conduction –Controlled freezing.

In the present work, experimental data of freezing mass –time are obtained for freezing of PCMs in vertical cylinders under isothermal conditions.

The range of experimental variables is as follows:

PCMs :

Lauric Acid (M.P: 44C)

Capric Acid (M.P: 31C)

Paraffin Wax (MP: 58-60C)

Diameter of Cylinders: 25mm -100mm

Volume of material used: 50cc -500cc

Temperature drop across PCM: 5-50C

The collected experimental data are studied for the following aspects:

- Visual observations on the interface nature during the progression of freezing
- Comparison of frozen mass vs. time data with semi- analytical and numerical solutions from literature.
- Data correlations and comparison for the individual PCM.
- Entire data correlation on mass fraction vs. Fourier number and Stefan number with discussions on trends and deviations.

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