**Introduction:** This paper intends to bring out the effect of natural convection phenomena for thermal analysis of transportation casks by considering a validation problem reported in open literature.

**Numerical Approach:** To model the phase change phenomenon, enthalpy-porosity technique has been employed; the density variations in the liquid region are modeled using Boussinesq approximation to account for the natural convection in the melted region.

**Energy eq:**

\[
\frac{\partial (\rho H)}{\partial t} + \frac{\partial (\rho u H)}{\partial x} + \frac{\partial (\rho v H)}{\partial y} = \frac{\partial}{\partial x} \left( \alpha \frac{\partial H}{\partial x} \right) + \frac{\partial}{\partial y} \left( \alpha \frac{\partial H}{\partial y} \right) + S_h
\]

**u-momentum eq:**

\[
\frac{\partial (\rho u)}{\partial t} + \frac{\partial (\rho u u)}{\partial x} + \frac{\partial (\rho v u)}{\partial y} = \frac{\partial}{\partial x} \left( \mu \frac{\partial u}{\partial x} \right) + \frac{\partial}{\partial y} \left( \mu \frac{\partial u}{\partial y} \right) - \frac{\partial p}{\partial x} + A u
\]

**v-momentum eq:**

\[
\frac{\partial (\rho v)}{\partial t} + \frac{\partial (\rho u v)}{\partial x} + \frac{\partial (\rho v v)}{\partial y} = \frac{\partial}{\partial x} \left( \mu \frac{\partial v}{\partial x} \right) + \frac{\partial}{\partial y} \left( \mu \frac{\partial v}{\partial y} \right) - \frac{\partial p}{\partial y} + A v + S_h
\]

**Continuity eq:**

\[
\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u)}{\partial x} + \frac{\partial (\rho v)}{\partial y} = 0
\]

For studying the effect of natural convection during melting, two cases have been studied: Case 1 involves effect of natural convection while Case 2 is solved without considering the density variations in the melted (liquid) region so as to make buoyancy (natural convection) effects inactive. The density variations in the liquid region are modeled using Boussinesq approximation to account for the natural convection in the melted region. The transient analysis was carried out by using appropriate source terms in commercial multiphysics code COMSOL 4.0.

**Results:** The melt fronts obtained at various times have been compared with experimental and shown in Fig. 2. It is observed that both the qualitative behaviour and acute morphology of the experimental melt fronts have been realistically obtained in the numerical study.

**Conclusions:** Natural convection with the help of user defined source terms incorporating Enthalpy-Porosity technique is modeled. An important conclusion drawn from the present study is that conduction analysis alone (neglecting natural convection) is not adequate to accurately model the phase change problems. The future studies will involve to model the actual cask geometry considering natural convection with the help of enthalpy porosity technique.

**References:**
