Simulation of Beverage Refrigeration with Dependence on Container Shape, Material and Orientation

S. Bekemeier[1], L. Fromme[1], A. Genschel[1], K. Kröger[1]

[1]University of Applied Sciences Bielefeld, Department of Engineering Sciences and Mathematics, Bielefeld, Germany

Abstract

Adequate cooling of beverages is a major issue in planning of several types of events, e.g. poster sessions at conferences. One crucial factor is the time needed to cool beverages from its initial temperature to the desired drinking temperature. We present a way to determine a close approximation for the cooling behavior of three types of commonly used beverage containers using COMSOL Multiphysics®. The commercially employed typologies of beverage containers long-neck bottle, aluminium can and PET bottle are investigated, including the influence of the container orientation.

The studied cooling process can be described using the two physics interfaces Heat Transfer in Fluids and Laminar Flow. Thus, the process is governed by the energy equation for heat transfer, conservation of mass and the Navier-Stokes equation for fluid dynamics. In the model the convective heat flux is given as the condition for all outer boundaries. All inside faces are set as 'No Slip' walls, an additional 'Slip' wall condition is placed at the interface between liquid and air to prevent liquid 'flowing' into the air domain and vice versa.

The designed application (Figure1) allows the user to simulate the cooling behavior for the mentioned liquid beverage containers, within a considerable temperature range. By selecting a preset container configuration and its orientation (Figure 2), default parameters are applied, but can also be customized for its material properties. Boundary conditions and simulation parameters can be customized in a suitable range. The section for the cap material is disabled for other containers than the longneck bottle (Figure 3). The Simulation status is displayed using an info card stack, the numerical results are shown in a temperature over time diagram (Figure 4). Values can be transferred to a history table and diagram, allowing the direct comparison of several simulation results.

Figures used in the abstract

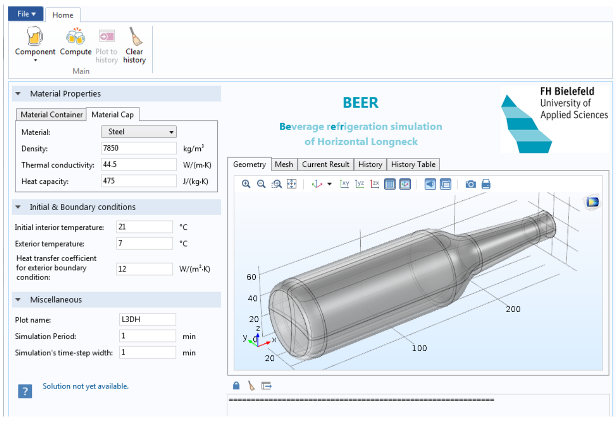

Figure 1: Visualization of the main graphical user interface of the COMSOL application.

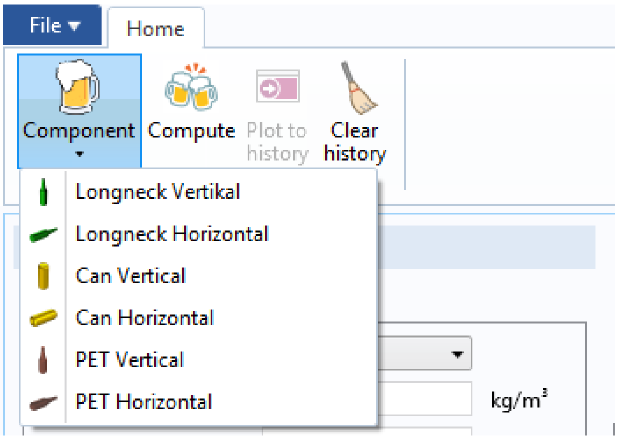

Figure 2: Component selection list.

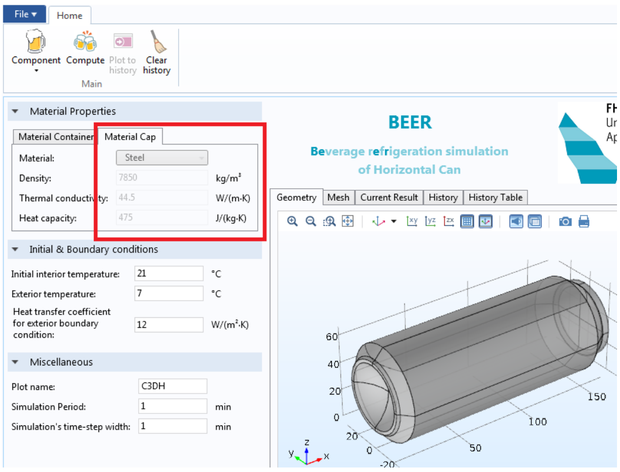

Figure 3: Disabled material properties section.

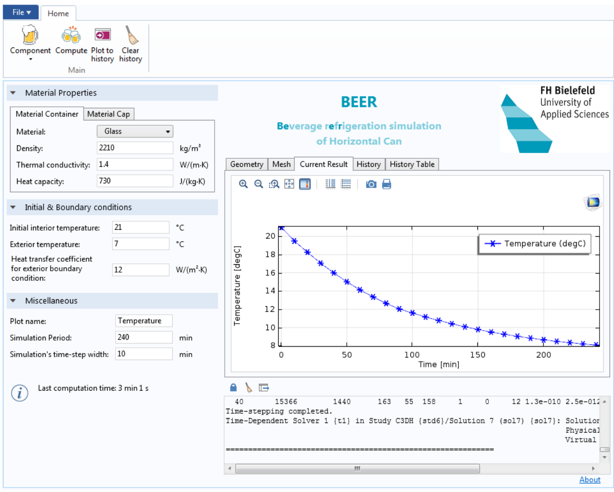

Figure 4: Result plot diagram.