

Post Harvest Cold Chain Optimization of Little Fruits

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Abstract

This paper presents heat transfer 2-D and 3-D models of a passive refrigeration system, called Icepack, used to improve the shelf life and the quality of the perishable fruits. Little fruits like blueberries, raspberries and blackberries need to be refrigerated as soon as possible after the harvest, to preserve the structural integrity and the nutritional and organoleptic properties (Figure 1). The Icepack is a polystyrene box (42.5x33.5x12 cm) with a plastic hermetic bag filled of water (about 1.0 kg) placed on the bottom. The bag is stored at -20° until the moment of the use. The heat flux from the outside is absorbed by the fusion of the water keeping the temperature inside the Icepack almost constant, to 0°C , for a long period of time. Experimental data to validate the model were obtained both in laboratory, on an empty Icepack subjected to a convective heat flux from ambient for 20 hours, and on field during the blueberries' harvest for 15 hours . A multi-step study was performed: a 3-D heat transfer model on the empty box; a 3-D heat transfer model on the box containing a slab with apparent thermal properties obtained from the air and the fruit ones; a 3-D heat transfer model on the box filled with randomized diameter spheres, simulating the fruits, created with an original MATLAB® script and imported in COMSOL Multiphysics. The temperature profile inside the box and the melting time of the ice slab were studied, as shown in Figure 2, Figure 3, and Figure 4. Results of the models agree with experimental data. The modeled melting time of the empty Icepack gives an error of about 7%. Modeled temperature profile inside the box filled with fruits reflects real temperature profile.

Figures used in the abstract



Figure 1: View of blueberries field and icepack.

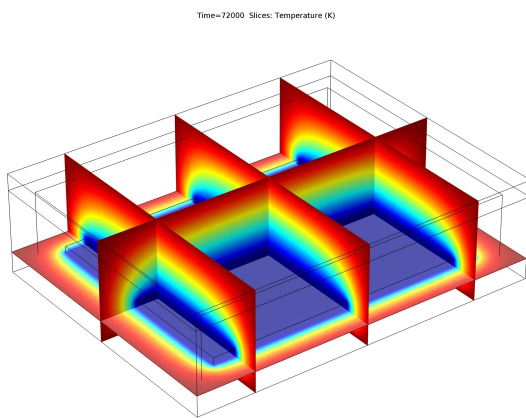


Figure 2: Temperature slices of empty icepack at 20 hours.

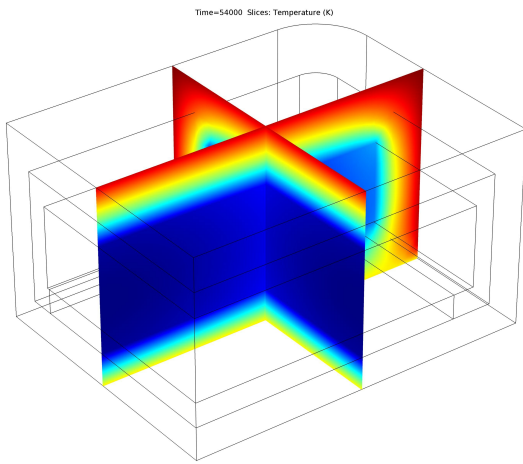


Figure 3: Temperature slices of slab step of icepack at 15 hours.

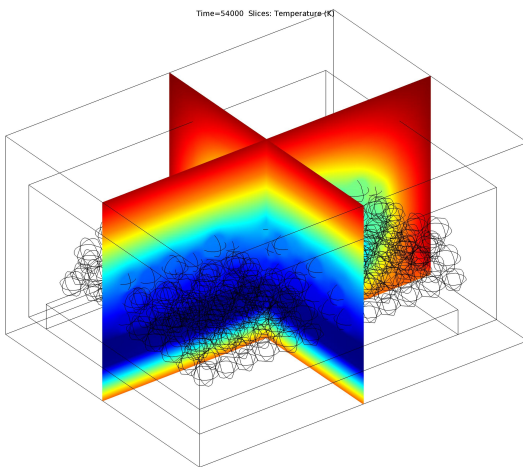


Figure 4: Temperature slices of randomized blueberries at 15 hours.