Natural Refrigeration System Design

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Abstract

Natural refrigeration is an age old process and the recent interest in it, is due to the green and alternate energy initiatives. The phase change physical phenomenon is an effective approach to engineer thermal energy for innovative engineering applications. Melting, freezing, vaporization, condensation and sublimations are different terms of phase change. One of the major applications of phase change is a natural refrigeration system. Refrigeration is the process of transferring heat from one source to another as per requirement for desired application. Natural refrigeration process comes with various technical challenges. Considering the difficulties and limitation of the process, a team of engineers sought to advance the performance of natural refrigeration system for consumer application. In this paper, a simple natural refrigeration system is designed utilizing phase change physical principles for better performance and cost effectiveness. An evaporative cooling phenomenon plays a major role in cooling of liquid particles in this natural refrigeration system design.

For modeling evaporative cooling, three physical phenomena have been taken into account: turbulent flow of air around the refrigerator, heat transfer in all domains, and transport of water vapor into air. For this experiment, turbulent flow, heat transfer and transport of diluted species interfaces of COMSOL Multiphysics software have been used to solve the coupled physical problem. A storage volume of 0.14 cubic meters was designed in 2D environment with axisymmetric feature to reduce the convergence time and for better accuracy. Appropriate multiphysics coupled physical interface is applied to respective domain and solved in stationary and time dependent study environment. Figure 1 and Figure 2 shows the temperature and velocity contour plots, respectively. As a result from evaporative cooling physical phenomena, a desired cooling environment has been achieved for natural refrigeration application, refer Figure 3.

This computational investigation demonstrates the potentials of natural refrigeration system design for consumer application, for example, perishable food storage container. Further for better performance, the change in design and shape optimization will be reported. This study can play a key role in the growth of refrigeration industry for commercialization of low cost natural refrigerator.

Reference

1.Refrigeration and Air Conditioning" [Book] by C.P. Arora.
2.Textbook of Refrigeration and Air Conditioning" by R.K. Rajput.

Figures used in the abstract

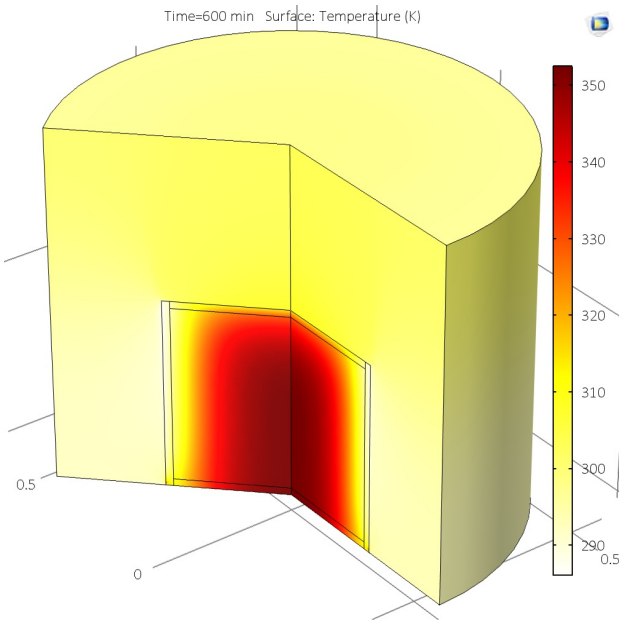

Figure 1: Temperature Contour Plot.

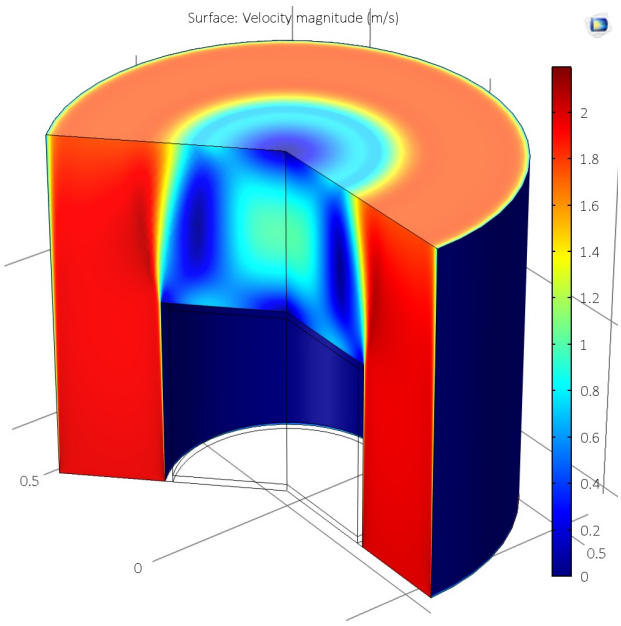

Figure 2: Velocity Contour Plot.

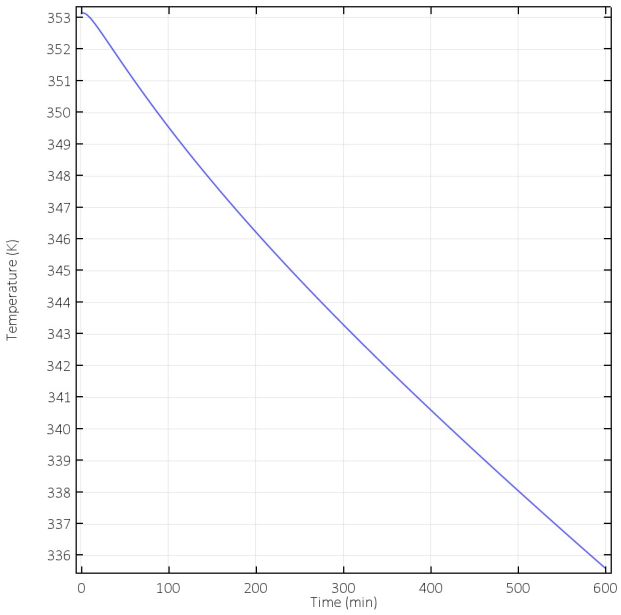

Figure 3: Time vs Temperature Result.