Title:

A computational fluid dynamics (CFD) model intended for fluid flow prediction inside amodified atmosphere packaging container.

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Extended abstract:

Safety and freshness are two key issues of a customer's view of a packaged food. Modified atmospheric packaging (MAP) is one of the techniques used to maintain the safety and freshness of product inside a package. In this technique the atmosphere inside the package is modified and further maintained during the life of the product. The initial distribution of gases inside a package plays an important role in the determining the final product shelf life. A food container used for packaging food products in a MAP machine was simulated in the present work. Schematic of computational geometry is shown in Figure 1. All dimensions are in centimeters. The size of inlet and outlet are 0.5 and 0.8cm, respectively and denoted by incoming and outgoing arrows.

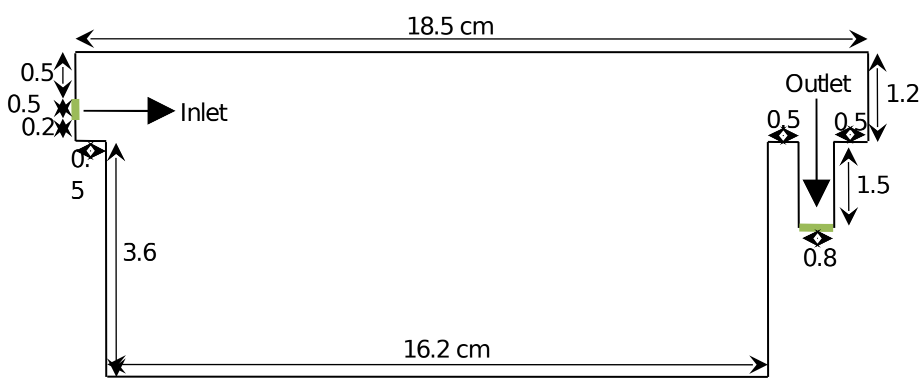

Figure 1: Schematic of computational geometry

The geometry of the empty food container is divided in variable hexahedralmeshes to predict the fluid flow behavior. Two cases of inlet air direction and variation in flow rate were analyzed inside the atmospheric enhancement with the proper circulation of a disinfecting gas. Fluid flow patterns were obtained in terms ofvector plots of velocity and streamlines contours plots. The flow field inside the container was generated by directly solving the Navier-Stokes equations over the finite volume method for an incompressible Newtonian fluid with constant viscosity. A reverse flow field was generated at the outlet, and it was concerned with iteration correction, error criteria and relaxation factors. A separate flow field was generated by initializing the solution at outlet for inverse CFD simulation. Results were compared for inverse and constant flow solutions. Figure 2 shows a filled velocity plot at steady state for the computational geometry. The inlet port is located on the left side of the container while the outlet port is on the right side. The gas was injected through the inlet port at a particular angle and circulates throughout the container. The average velocity profile shows a very low velocity zone in the middle, right boundary and outlet region of the container after attaining steady state. It also depicts a diffusion of gas from inlet to outlet port.

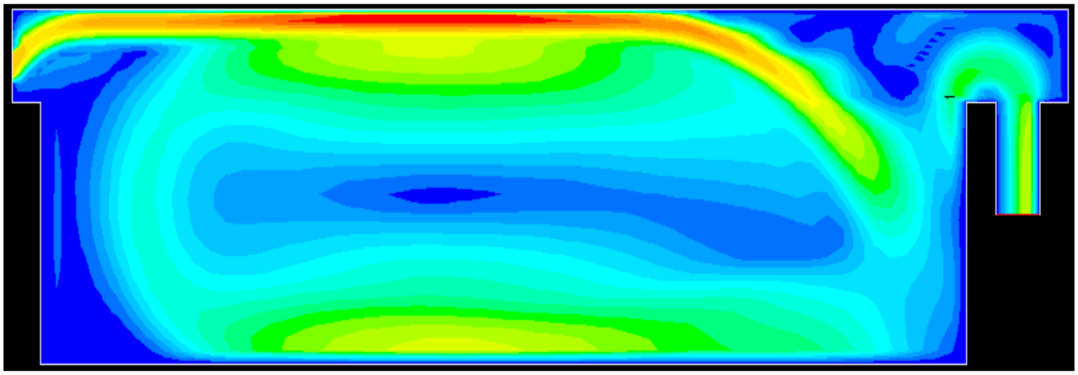

Figure 2. Velocity plots at Re = 454 for the computational geometry for constant flow conditions

CFD predictions from analysis shows that the angle of injecting the gas plays an important role while designing the food packaging container. Flow fields were also obtained for variations of flow rate and direction angle.Formation of small vortices near the outlet area was observed in the inverse flow field. The CPU time is slightly different for individual cases of direct flow and inverse flow conditions. A good combination of velocity and angle is necessary for proper recirculation of gas inside the container and it may enhance the shelf life of food products.

References

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