NUMERICAL ANALYSIS OF MICROWAVE HEATING OF LIQUID MATERIALS

C. M. Sabliov*[1]

[1] Biological and Agricultural Engineering Department, Louisiana State University

Continuous thermal processing of liquids using microwaves as a source of energy is emerging as a viable commercial alternative for high temperature short time processing of thermo-sensitive materials. The goal of this project was to simulate the temperature profile in liquid materials undergoing microwave heating using finite element analysis.

The influence of dielectric properties on the heating pattern of low, medium, and high dielectric loss products was assessed for a system of defined geometrical dimensions using numerical modeling. Maxwell's equations were solved and power loss was calculated using the High Frequency Electromagnetics Module of the commercially available Finite Element Package, ANSYS (ANSYS Inc., Pittsburgh, PA).

An algorithm was developed to couple the high frequency electromagnetics module with the thermal module of ANSYS (ANSYS Inc, Pittsburgh, PA). The algorithm was used to determine the temperature change in a stagnant column of liquid material processed in a 5 kW continuous microwave unit at 915 MHz based on the power loss calculated above. Temperature distribution showed a similar pattern for low and average loss tangent products, with the highest temperature in the center of the column and lowest temperature at the walls. For high loss tangent products, the highest temperature was skewed toward the wall, indicative of a less-uniform outlet temperature.

In conclusion, the behavior of liquids subject to high-frequency fields in a system of defined geometrical dimensions was evaluated using numerical methods. The present analysis can be a valuable tool in providing guidelines on the optimum system and process conditions required for the production of high quality products using a continuous microwave food processing system.