Microwave Radiation to Cure Cork Stoppers Using a Conventional Turntable Configuration

D. Fidalgo[1], J. Monteiro[1], L. Costa[1]

[1]I3N and Physics Department, University of Aveiro, Aveiro, Portugal

Abstract

This work presents an alternative curing method based on the microwave radiation, which is energetically more efficient, where it is possible to accelerate the rate of reaction and hence the cure time comparatively with conventional curing methods. COMSOL Multiphysics® was used to simulate the heating microwave process. The microwave energy is directly introduced in the volume of the dielectric material and as consequence, the quality of the process is highly dependent on the uniformity of the electromagnetic field distribution along the material.

The configuration is shown in Figure 1 and was created for a 1 kW TEKA® oven. The cavity has dimensions 42×39×21 cm and within this, 32 cork granulate composite samples are placed in a rotating PEEK Ketron® mold. The samples are composed by 82% cork granulate, 16.4% polyurethane adhesive and 1.6% water. A magnetron, labeled by P1, with an output power of 1 kW radiate to the interior of the oven at initial temperature of 23°C, with a frequency of 2.45 GHz over 50 seconds. The feeding port consists of a WR-340 waveguide, which has been excited with the fundamental mode TE1,0.

COMSOL Multiphysics® has been able to solve simultaneous electromagnetic and heat transfer equations for a rotating object in a microwave oven. The effect of rotation of the turntable was modeled using 'Translation Motion' available in the Microwave Heating interface. The object was rotated according to

$vx=-2\pi yN$

$vy=2\pi xN$

where N is the number of turns per second, 0.1 1/s and x and y are the position coordinates of the rotating object.

Figure 2 shows thermal distribution profiles at the top, bottom and middle sample layers, after 50 seconds of microwave heating. We can observe a reasonably homogeneous heating of the samples. The maximum temperature achieved was 129°C, which corresponds approximately to the cork stoppers cure temperature. However, at the bottom and at the top, the temperature values for samples nearest to the center are lower. The temperature gradients are acceptable for the curing process, as this can be compensated by the heat generation from the cure process.

With this system, it is possible to cure cork stoppers, demonstrating that the microwave radiation is a very good alternative to the conventional technology. However, rotating systems may not be practical or adequate in many industrial applications. Thus, it is imperative the study of others variables, as the arrangement and the number of magnetrons to apply this process at the industry.

Figures used in the abstract

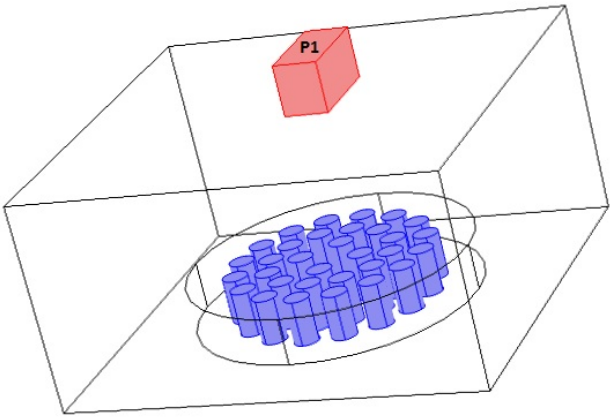

Figure 1: Microwave oven model

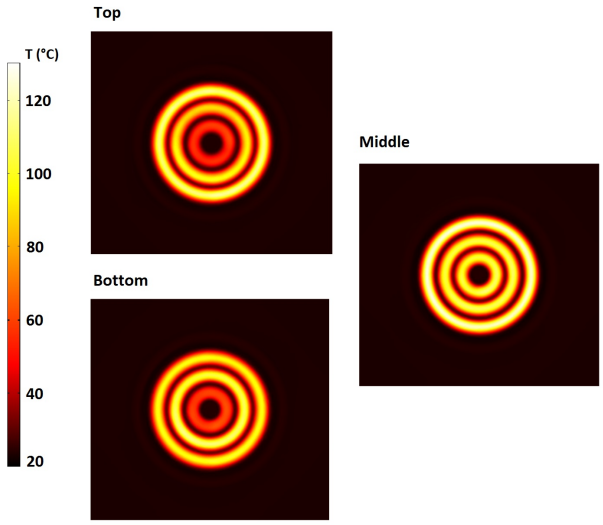

Figure 2: Thermal distribution profiles at the top, bottom and middle samples layer, after 50 seconds of microwave heating