THE DISTRIBUTION OF POWER DENSITY IN VOLUME AT DRYING CHESTNUT FLOUR IN A MICROWAVE FIELD

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Abstract

In this experiment with the help of the HFSS program it was possible to simulate the distribution of power density in volume of the chestnut flower. For the heating to be uniform, radiating slots in series have been introduced in the guide and then it was possible to see the difference in distribution of power density in the chestnut flour volume when the radiating slots in series were introduced as opposed to when they were not.

Key words: Ansoft HFSS, microwave drying, dielectric properties, numerical modeling, flour chestnut, Power density distribution in volume

INTRODUCTION

The design and realization of a radiant system requires first the determination of the total power in the microwave, the second stage being the realization of this power for each slot.

The profile of the distributed power is conditioned by the number of radiant guides, the number of radiant slots, the dimensions, and how they are located on the surface of the waveguide.

The balance of radiated power transmitted and reflected by a system of radiation depending on the inclination of the slots allows the optimization of radiation.

The existence of corporate software allows, however, to study and model the installation numerically, before practically building it. By doing this it will be possible to already acknowledge a part of the phenomena that characterize the installation and also to remove a number of uncertainties of the problem before building the installation. (Molnar C., 2006)

MATERIAL AND METHOD

Data on the dielectric properties are important because they provide loss-factor values, and , which they depend on, along with other parameters, such as electric field and frequency, the microwave power that can be dissipated in a volume of given material. This fact is highlighted by the average microwave power dissipated in the volume unit of the material.

$$P_{dis} = kfE^2\varepsilon'' \quad \left[W/m^3\right] \tag{1}$$

Where:

k – Numerical constant
f – Microwave frequency [Hz]
ε” – Electric loss factor
E – Intensity of the electric field [V/m]

If the dielectric permittivity values and the values of the loss factor are higher and rise together with the temperature and humidity of the materials, then the power level of microwaves dissipated in the material is higher as well. (Maghiar Teodor, Soproni D, 2003)

In general, the values of the loss factor of materials smaller than 10^{-2} require very high intensities of electric field in order to ensure a reasonable rate of increase in the temperature of the material in question; such reduced factors of loss require fundamentally resonant mode applicators, distinct from those with travelling wave or with multimode applicators. (Nicolae Voicu, 2004)

On the other hand, material showing factors of loss greater than 5, can pose problems in terms of penetration depth because the material is very absorbent in matters of microwave energy, so most of the incident energy is absorbed and attenuates inside at a few millimeters from the surface of the material, leaving the core of the material untouched by the effect of the microwave field. (Leuca Teodor, 2006)

The effect of this situation is uneven heating.

For the heating to be uniform, radiant slots have been introduced in the waveguide and it was possible to observe the difference in the distribution of power density in the volume of the chestnut flour with the introduction of radiant slots and without it.

RESULTS AND DISSCUSIONS

To analyze the power density in volume inside the microwave system, chestnut flour was introduced in this, material which has undergone a drying processing time of five minutes.

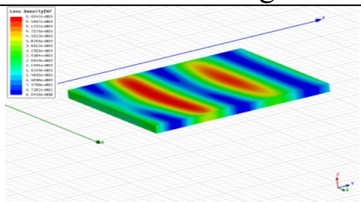
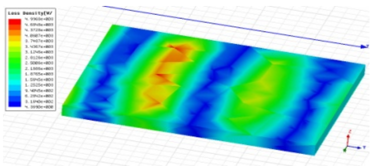
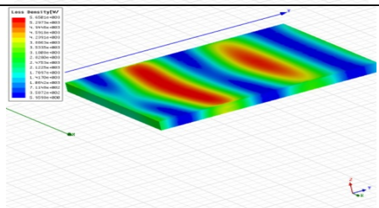
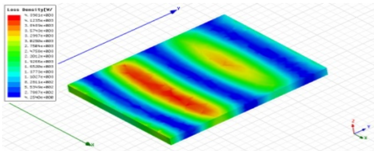
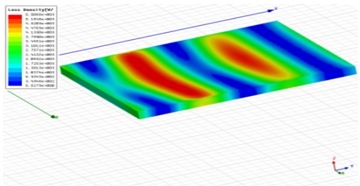
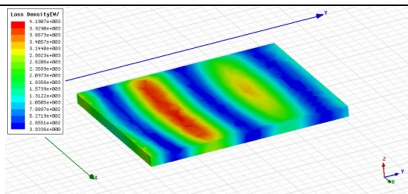
The obtained results after simulating the heating process of the wet chestnut flour in the microwave field are being presented below.

The results of numerical simulation of the microwave heating process of chestnut flour is presented in the table; on one hand, in the waveguide several radiating slots have been introduced and on the other hand the results of numerical simulation with no radiating slots introduced in the waveguide.

According to material taken from literature the values of relative permittivity and loss factor for chestnut flour at a temperature of 20^0 C are $\varepsilon' = 12{,}4$ and $tg\delta = 2{,}60$.(Wenchuan Guo, Xiaoling Wua, Xinhua Zhu, Shaojin Wanga, 2011).

Table 1

Power density distribution in volume

	The power density distribution in volume with several radiating slots introduced in the guide	The power density distribution in volume with no radiating slots introduced in the guide
20^0 $\varepsilon' = 12{,}4$ $tg\delta = 2{,}60$		
40^0 $\varepsilon' = 14{,}3$ $tg\delta = 2{,}00$		
60^0 $\varepsilon' = 18{,}8$ $tg\delta = 1{,}4$		

CONCLUSIONS

The research has aimed the introduction of a radiating system on a waveguide, which makes it possible to ensure uniform heating of the material processed. Analyzing the results a homogeneous distribution of power is expected, so that the heating is to be effective. The problems that arise during practical implementation of microwave applicators are linked with the choice of shape and dimensions of the cavity, so that the heating process is uniform, rapid, and efficient and does not destroy the dielectric quality of the material being heated or dried. It is observed that the homogeneity of the chestnut flour by warming in microwave without a waveguide with radiating slots is not satisfying and this is why the radiating slots have been introduced, which makes the power density distribution in the amount of chestnut flour to be more homogenous and therefore the drying to be more uniform.

In the process of promotion of electro-technology based on microwave energy, an important step is the creation of experimental laboratory models, to allow a real analysis at any time and in all circumstances of the heating process phenomenon inside a microwave field and along with it, the determination of some specific parameters of the problem.

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