NUMERICAL MODELLING OF MICROWAVE DRIED AVOCADO

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Abstract

In the present study, using the numerical modeling software Ansoft HFSS (High Frequency Structure Simulation) was analyzed the distribution of electromagnetic field, inside a microwave field, having as dielectric material the avocado fruit. Nowadays, the study of drying fruits in microwave field has become a very important and used issue, with great opportunities to be studied.

Key words: avocado fruit, electromagnetic field, Ansoft HFSS, dielectric properties, drying

INTRODUCTION

Electrical properties of fresh fruits, known as dielectric properties, can be rapidly sensed with suitable measurement instruments that employ microwave fields for this purpose.

Therefore, if adequate correlations can be found between the dielectric properties of such fruits and their quality factors, it may be possible to develop new instruments for rapid nondestructive quality determination. (Wen-chuan Guo et al 2007)

The process of drying materials in the microwave field has become a new, powerful, and significantly different tool which has significant advantages in front of the drying conventional methods (Metaxas and Driscol, 1974), (Molnar et al, 2008). The conventional heating methods require heat conduction from the material's surface inward, they are slow and inefficient for materials that conduct heat poorly (Khraisheh, 2004).

The electromagnetic energy directly interacts with commodities to raise the interior temperature and significantly reduce treatment times as compared to conventional hot-water immersion and heated air methods.

MATERIAL AND METHOD

Permittivity describes dielectric properties that influence reflection of electromagnetic waves at interfaces and the attenuation of the wave energy within materials.

The complex relative permittivity ε^* of a material can be expressed in the following complex form:

$$\varepsilon^{"} = \varepsilon' - j\varepsilon'' \quad (1)$$

The real part ε' is referred to as the dielectric constant and represents stored energy when the material is exposed to an electric field, while the dielectric loss factor ε'', which is the imaginary part, influences energy absorption and attenuation, and $j = \sqrt{-1}$.

Mechanisms that contribute to the dielectric loss in heterogeneous mixtures include polar, electronic, atomic and Maxwell–Wagner responses (Metaxas & Meredith, 1993, S. Wang et al 2003).
At microwave frequencies of practical importance and currently used for applications in material processing (microwave frequencies of 915 and 2450 MHz), ionic conduction and dipole rotation are the dominant loss mechanisms (Ryynänen, 1995):

$$\varepsilon'' = \varepsilon''_d + \varepsilon''_\sigma \quad (2)$$

where
subscripts *d* and σ stand for contributions due to dipole rotation and ionic conduction, respectively; σ is the ionic conductivity (S m^{-1}) of a material, *f* is the frequency (Hz), and ε_0 is the permittivity of free space or vacuum (8.854 ×10−12 F m^{-1}). Dielectric lossy materials convert electric energy microwave frequencies into heat. (S. Wang et al 2005).

RESULTS AND DISSCUSIONS

The existence of special software's permit that before practically making an installation, it can be numerical simulated. In this way when creating the installation there will be known a part of the phenomenon's that characterize the installation, and so there will be eliminated some of the unknown's of the problem.

In the process of developing technologies based on microwave energy, an important step is creating experimental models, lab, that could permit a real analyze of the phenomenon's in any moment and conditions of the heating process with microwaves and also determining the specific parameters of the problem.

The existing resonant cavity was numerically simulated using the commercial software Ansoft HFSS, and the obtained results are being presented below.

The monomod aplicator has a parallelipiped shape, made of aluminium walls and is being excited by a magnetron at a frequency of 1,8 GHz. Electromagnetic waves transmission from the magnetron to the cavity is being made through a rectangular waveguide, in which prolongation is placed the applicator.

The commercial software Ansoft HFSS is a interactive software that allows electromagnetic field determination inside passive structures at high frequencies. ANSYS is the leading provider of electromagnetic field, circuit and system simulation software for the design of high-performance electronic equipment and electromechanical devices.

To analyze the electromagnetic field inside the microwave system was introduced in this half of avocado fruit which has undergone drying, processing time is five minutes.

Accordingly to the specialty literature the values for the relative permittivity and loss factor for wet avocado fruit are $\varepsilon' = 58{,}6$ and $tg\delta = 27{,}7$.(S. Wang, et al., 2005). Below are being presented the obtained results after simulating the heating process of the wet avocado fruit in the microwave field.

Figure 1 shows the electric field distribution is observed with maximum and minimum points for.

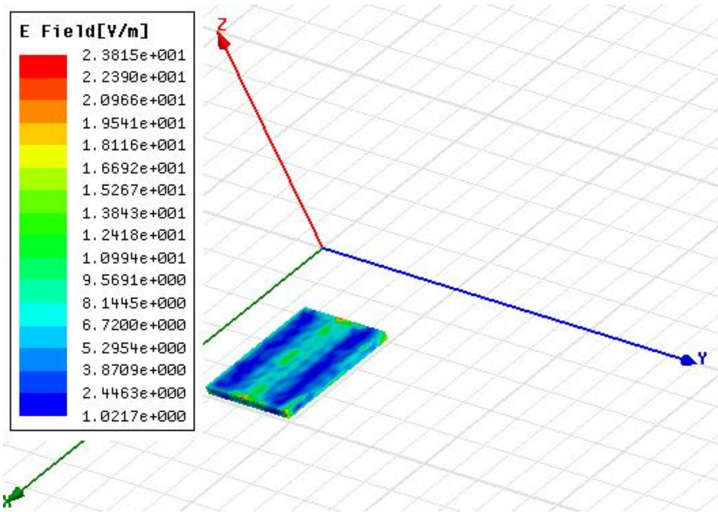

Fig.1 Distribution of electric field on the dielectric

To better highlight the electric field in Figure 2 was performed numerical modeling of the electric field on the bottom of the cavity.

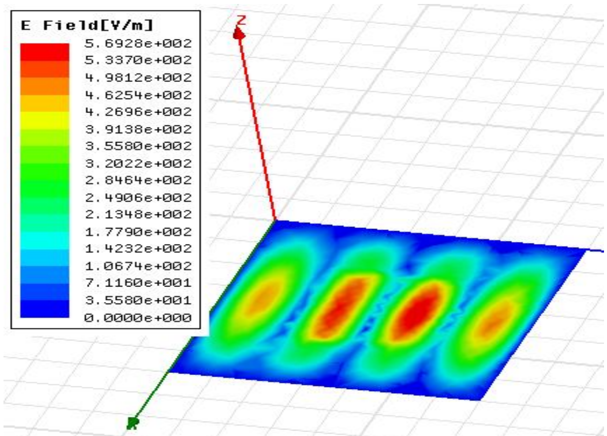

Fig.2 Electric field distribution on the bottom of the cavity

Figure 3 shows the electric field distribution on cavity faces pointing out the maximum electric field at the harbor entrance.

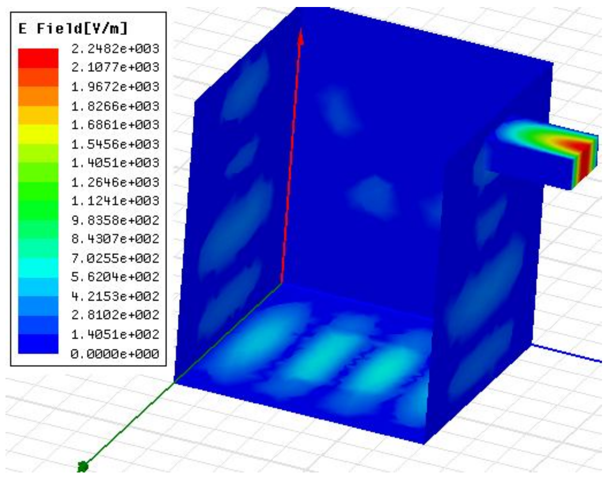

Fig. 3 Electric field distribution on cavity faces

The figure above shows the distribution of the magnetic field being able to notice dielectric maximum and minimum field.

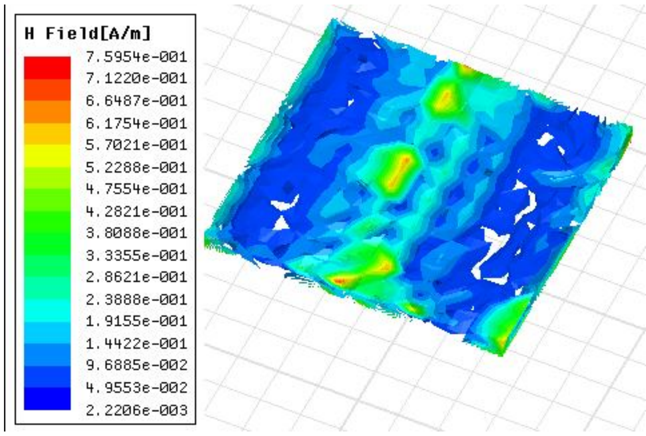

Fig.4 Distribution of magnetic field dielectric

Magnetic field distribution in the cavity and the dielectric faces shown in Figure 5.

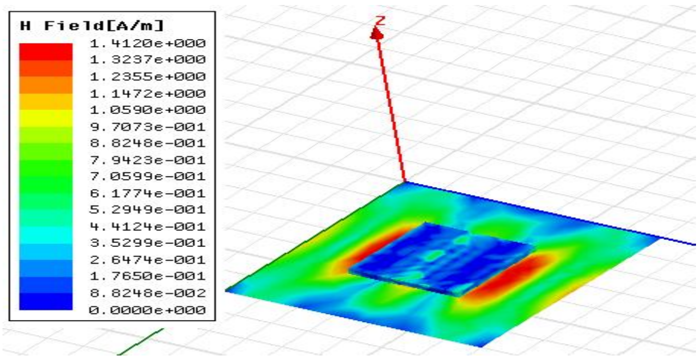

Fig. 5 Magnetic field distribution in the cavity

CONCLUSIONS

Area development consisted mainly dehydration by improving technology, equipment, management automatic drying.

Thus with HFSS software could simulate electric and magnetic field distribution that affect drying fruit that we used.

Through this simulation we have seen how to do a fruit dehydration, which is the main method of preserving fruit.

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