ABOUT DIELECTRIC LOSS IN MICROWAVE FIELD

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Abstract
The microwave heating is son alternative for the exceeding of the difficulties generated by the classical technologies, with a high energy consumption. Last year has determined the intensification of the concern for the microwave utilization in the heating processes with industrial applications. The experts foresee a progressive growth of the industrial utilization of the microwave owing to the microwaves technology improvements and inventions of the new technologies.

Key words: loss factor, microwave field, load.

INTRODUCTION

The conception of dielectric loss is asociated with the material capacity to absorb a part of electromagnetic energy. This energy is dissipated in heat form in the interior of material at the coresponded dielectric relax frequencies (Foster K., Ayyaswamy P., 1982)

ε'' – the loss factor measure the efficiences of heating transformation of transported energy by electromagnetic wave. This loss is attached to dieletric loss and maximum dissipated heat quantity when ε'' has maximum value.

Is known the fact that the dielectric loss is an phenomena of dielectric material heating in microwave field. This consequencies is a part of fact that this material is not perfect isolated. On the other part of the polarisation phenomena is dipolar loss.

MATERIALS AND METHODS

The dielectrical total loss from an dielectric compliant of the action of electromagnetic field with high frequencies are related by next relation:

$$P = P_d + P_c \qquad (1)$$

where: P_d – dipolar loss due to the polarization phenomena

P_c – conduction loss

From Maxwell equation with successive derivation and integration we obtain the medium dissipated power in dielectric material volume unit, P (W/m^3):

$$P = \omega\varepsilon'' E^2 + \sigma E^2 = P_d + P_c = \omega\varepsilon_0\varepsilon''_{ef} E^2 \qquad (2)$$

Or accomplish the replacement:

$$P = 55{,}63 \times 10^{-12} f\, \varepsilon''_{ef} E^2 \qquad (3)$$

We can write:

$$P = 55{,}63 \times 10^{-12} f\, \varepsilon' tg\delta_{ef} E^2 \qquad (3')$$

where: f – is the frequencies (Hz)

ε' – the relative dielectric permittivity of the material

$tg\delta_{ef}$ – tan of the loss angle

E – electric intensity field (V/m)

The relation shows that for a given electric field the dissipated power is dependent by the direct frequencies and the dielectric permittivity, the tan of loss angle and material electrical properties. This is the optimal result by using the microwave in electro thermal process (Hippel A., 1983)

The dissipated power in dielectric volume is limited by the maximum values of applied electric field intensity. The advance of this maximum values bring to unpleasant cases like the destroying of heated material (Leuca Teodor , 2006)

In microwave case the heat is not transmitted from the material surface to the material interior, is direct generated in material by applied exterior electric field.

Also the abstracted heat is bigger when the loss factor is high. That is the reason to known the dielectric properties of materials at the microwave frequencies and the temperature variation.

RESULTS AND DISCUSSION

The variation measurement of $\varepsilon^{'}$ and $\varepsilon^{''}$ is in function by the humidity content.

The making measurement above the variation dielectric properties with humidity and electric field, (the frequency on this experiment is 2450 MHz), is corresponding with the microwave application in industries. That is parallel and perpendicular with the material plane and is presented in figure 1.

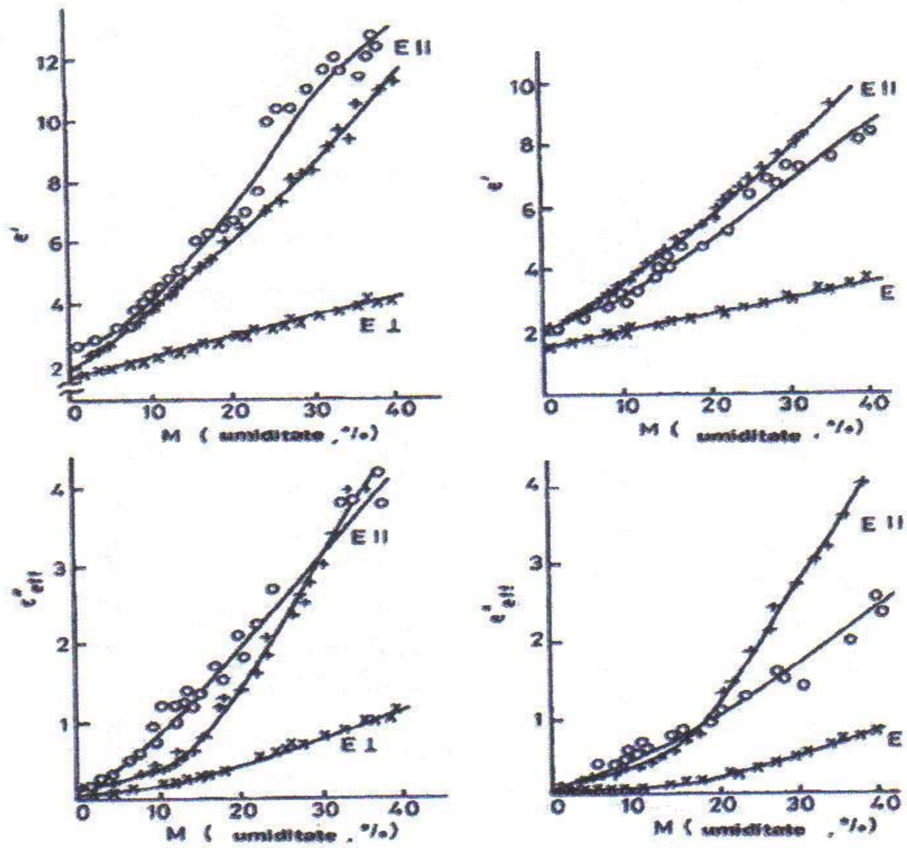

Fig. 1 – The dielectric properties of the wood and paper in humidity function for two field orientation

The humidity variation and loss factor from figure 1 is accentuate a constant growing of this, making difficulty in identification of critical humidity M_c, the case of pronounced growing loss factor.

The measurement make on the paper with perpendicular oriented electric field in the paper plan is present reduce values for $\varepsilon^{'}$ (dielectric permittivity) and $\varepsilon^{''}$ (loss factor with humidity) (Lefeuvre S., 1982)

DISCUSSIONS AND CONCLUSIONS

From the graphics analysis we can observe that the material present first a growing of dielectric permittivity ($\varepsilon^{'}$) follow by an important relative drop of the intensification. This follow thermal agitation movement of molecular dipol can be follow the plolarity chancing in microwave field.

The loss factor ($\varepsilon^{''}$ and tg δ) present more growing or less accentuate with temperature that was presented in this workpaper.

We must see that if the frequencies is growing, the maximum values of the loss factor we obtain for higher temperature. In the case of non omogen material we obtain more maximum values.

An important aspect for industrial aplication in microwave heating is the packing effect or uncontrolled growing of the temperature with the string to it condition. The ambiental medium temperature at the dielectric with low factor became very dissipated with the string in temperature. The pronunced growing follows the avalanche phenomena.

To process a material in microwave must present accentuate dielectric loss in frequencies domain at 2,45 Ghz.

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