Studying the Process of Optimal Positioning of Field Concentrator in the Microwave Applicator

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Abstract **–The heating in a microwave field with ceramic materials at the frequency of 2,45 GHz provides solutions for creating some applicators with field concentrator made up of ceramic material.In this paper we present a study concerning the optimal positioning of the field concentrator inside the microwave applicator.The field concentrator from the applicator is made up of ceramic material and has well-established parameters.The study of optimal positioning in a field concentrator in the microwave applicator was made by using the set of programs Ansoft – HFSS 10 (High Frequency Structure Simulator) and a program "farăsarc.for" in Fortran and "cusarc.for" in Fortran.**

Keywords: ***Microwave, Dielectrics,Electromagnetic field***

I. INTRODUCTION

In comparison with the classical heating procedures, the great advantage of using microwaves is the fact that a uniform heating is obtained and that power is distributed in the whole mass of the charge, from inside towards the outside, in a brief period of time and with a lower consume of energy.

The Ansoft – HFSS 10 (High Frequency Structure Simulator) package of programs helped us to determine the mathematical modeling of heating processes in an electromagnetic field, but this involves the solving of complicated problems in an electromagnetic field, alongside with thermic diffusion problems.

Coupling the transfer phenomena in the electromagnetic and in the thermic field from the drying processes in a microwave field, and their mathematical modeling can be achieved only with the knowledge of the dependence of the dielectric material properties upon temperature, frequency and power.

Modeling the heating processes is very useful since it allows us to establish the parameters that are necessary in order to obtain an efficient heating. In terms of these parameters, the characteristics of the heating installation project results. In this paper we have established the optimum heating speed of the applicator with concentrator in a field made up of ceramic materials while analyzing the positions of the field concentrator (the charge of the applicator) in relation with OX, OY and OZ of the applicator box, for which different heating speeds are obtained

II. THE SIMPLIFIED PROCEDURE FOR THE EFFICIENT POSITIONING OF THE FIELD CONCENTRATOR WITHIN THE APPLICATOR

The experimental results concerning the determination of the optimal heating speed of the field concentrator and the experimental measurement have been obtained on the stand of the laboratory of "Microwave Technologies" , at the Faculty of Electric Engineering and the Information Technology.

In relation with the different positioning of the applicator's charge, which in this particular case has been the field concentrator, we can obtain different values of the heating speed. While analyzing the values that are obtained for the heating speed, at certain stages marked on the coordinates of the box, we can choose the best position for the field concentrator within the applicator.

The optimal position of the field concentrator is in fact the position for which the best heating is obtained. In order to obtain the best results in the numerical modeling of the optimal positioning of the field concentrator, we shall follow the stages:

Stage 1. With the help of The Ansoft – HFSS 10 the imposed electromagnetic field problem is solved, following the steps from the flow chart of the program.

Stage 2. With the program written in Fortran "fărăsarc.for", we read from the disc the file of effective values of E and we introduce the parameters of materials of the field concentrator: ε=8,2 and tgδ= 0,004, C = 1014100 J/m^3 °C

Stage 3. The results obtained as a result of using the program in Fortran farasarc.for the files are saved and named viteza.txt and optim.txt.

Stage 4. Knowing the first 5 efficient stages for the heating and the optimal positioning of the microwave concentrator, with material parameters ε=8,2 ; tgδ= 0,004 and the heating capacity of C = 1014100 J/m^3 °C are presented in table 1.

Table 1. Efficient positions for the heating and the optimal positioning of the microwave concentrator

Stages at which the heating speed is obtained				The coordinates of the box (the corner of the box) at which we obtain the heating speed			The heating speed
N	mx opt	my opt	mz opt	Xopt [mm]	Yopt [mm]	Zopt [mm]	dtetaopt [°C/min]
1	1	15	12	120	280	252	134
2	1	14	12	120	271	252	134
3	14	1	12	172	150	252	133
4	9	1	12	152	150	252	133
5	8	1	12	148	150	252	133

The diagrams from the figures 1-3 show the dependence of the heating speed, expressed in Celsius degrees/minute in table 1, in relation with the steps of getting forward on the axes, with the coordinates: Ox optim, Oy optim and Oz optim expressed in millimeters, for the first three positions in the table.

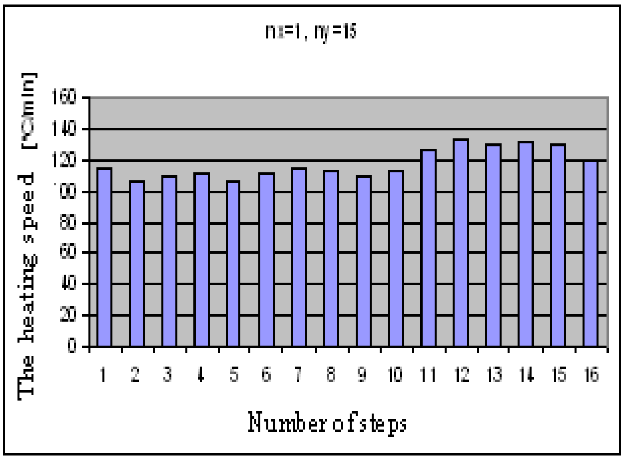

Figure 1. The dependence of the heating speed in relation with the stage on the Oz axis, at seps nx=1 and ny=15 form the Ox and respectively Oy axes.

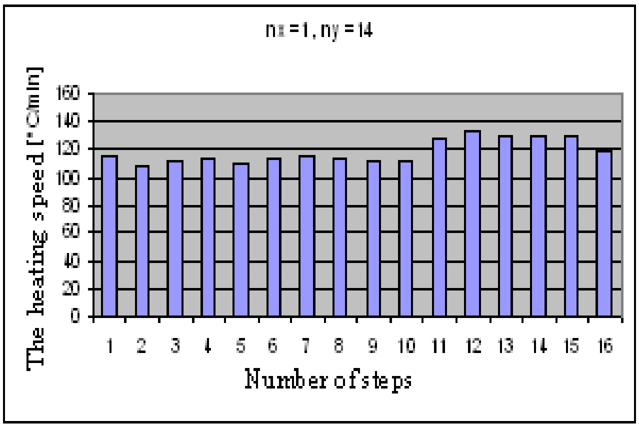

Figure 2. The dependence of the heating speed in relation with the stage on the Oz axis, at seps nx=1 and ny=14 form the Ox and respectively Oy axes.

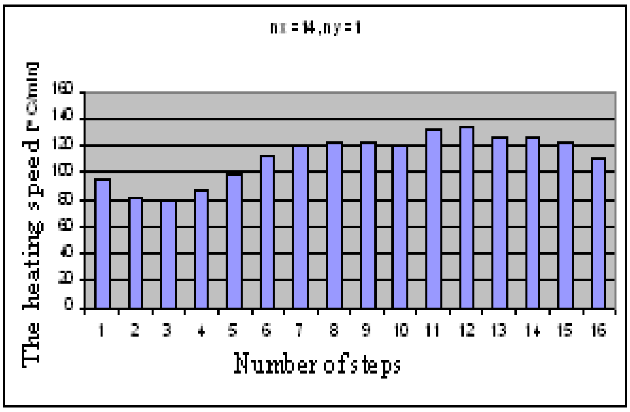

Figure 3. The dependence of the heating speed in relation with the stage on the Oz axis, at seps nx=14 and ny=1 form the Ox and respectively Oy axes.

The analysis of these diagrams indicates the fact that the most efficient positions, for which the optimal heating is obtained, are indicated in figures 1 and 2.

Next we shall analyze more carefully the positions 1 and 5 from table 1.

III. DETERMINIG THE HEATING SPEED OF THE FIELD CONCENTRATOR

The files that contain the effective values for the field concentrator have been taken from Ansoft-HFSS 10 and processed with the program cusarc.for.

After ruling the program cusarc.for in Frotran, for position 1 of the field concentrator for the axes Xopt=120mm; Yopt=280mm; Zopt=252 mm, with parameters from the table below, we shall obtain the heating speed for the field concentrator (the charge).

Table 2. The heating speed and the optimal positioning of the field concentrator

Heating capacity [J/m^3 ºC]	ε (teps)	tg δ (ttgd)	OX_{optim} (xc0) [mm]	OY_{optim} (yc0) [mm]	OZ_{optim} (zc0) [mm]	The heating speed.(dt) [ºC/min]
1014100	8.2	0.004	120	150	1 50	36

After ruling the program in Frotran, for position 5 of the field concentrator for the axes Xopt=148mm Yopt=150mm; Zopt= 252 mm, with parameters from the table below, we shall obtain the heating speed for the field concentrator (the charge), which is rendered in table 3.

Table 3. The heating speed and the optimal positioning of the field concentrator

Heating capacity [J/m^3 ºC]	ε (teps)	tg δ (ttgd)	OX_{optim} (xc0) [mm]	OY_{optim} (yc0) [mm]	OZ_{optim} (zc0) [mm]	The heating speed.(dt) [ºC/min]
1014100	8.2	0.004	120	150	150	9

Analyzing the results obtained in tables 2 and 3 we can see that the highest value for the heating speed is obtained when the field concentrator is found on position 1 inside the applicator box, more exactly on the Xopt = 120 mm; Yopt = 280 mm; Zopt = 252 mm axes.

IV. CONCLUSIONS

This paper has analyzed the positioning of the field concentrator with fixed parameters inside the applicator box, with the view of choosing the latter's optimal position in relation to the coordinates of the box.

The optimal position of the field concentrator represents the position for which the heating speed of the concentrator is highest.

The heating speed also depends upon the quality of the ceramics, in other words upon the dielectric properties of the ceramic material, from which the concentrator is made.

The numerical optimization of the applicator's cavity , in other words its positioning on the three coordinating axes of the field concentrator box has been done by using the Ansoft – HFSS 10 program, which analyses the distribution of the high frequency electromagnetic field in the guide-cavity systems. Our personal contribution has been the elaboration of a numerical calculating algorithm and 2 "farasarcina.for" programs, fro the 'Simplified procedure for the efficient positioning of the field concentrator within the applicator'' in Fortran, and the second program is cusarc.for, used for "The determination of the heating speed of the field concentrator", using Fortran.

The optimal position of the field concentrator, chosen as a result of our study, is associated with position 1, namely the axes Xopt = 120 mm; Yopt = 280 mm; Zopt = 252 mm.

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