Solution for Using the Microwave Energy in Order to Improve the Quality for Agricultural Seeds. Generation and Processing Microwave System

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Abstract ***– This paper deals with the analysis of the electromagnetic field question into the microwave system. The study regarding the heating question for the agricultural seeds and quality are also studied. This application has the character of an applicative research, and the obtained results being of practical use together with the experimental results and has as the main purpose to optimize the working parameters for the mixed microwave and hot air system in order to improve the quality of the stored agricultural seeds.***

Keywords: ***microwave energy microwave drying system, agricultural seeds.***

I. INTRODUCTION

Studies regarding the use of electromagnetic energy at high frequencies for insects eradication from the agricultural products has been realized in the last decades with good results. In this sense Nelson present its results obtained in 50 years of studies, values concerning the susceptibility for different types of insects which live into the stored cereal seeds, as well as the treatment methods by using microwaves energy and radiofrequency. An optimized technique for drying process by using microwaves has been developed through the combination between the microwave in volume drying technology and the conventional drying through convection, so the products sensible to high temperatures and fast dry can be processed with respect to this innovation by ensuring the storage and even the improvement of the agricultural products cropped. More information's regarding the microwave equipments can be found in the literature [1], [2].

The mixed system, microwave energy and hot air spurt, used into industrial applications to increase the quality and decontamination of agricultural products has several advantages: A considerable decrease in drying time for the agricultural seeds dried in microwave field by using different levels for the microwave energy; the humidity at the equilibrium for the seeds increase once with the increase of the air spurt velocity and decrease once with the increase of the absorbed energy; the diffusion coefficient will increase with the absorbed energy and decrease with the air spurt velocity; Microwave energy does not produce any chemical contamination after the treatment. It means that we have a green treatment method with minimal impact against the environment and operators.

Unfortunately the microwave treatment of agricultural products has to pass different stages to be used without reserves in industrial applications regarding it's highly costs and energy consumption as well as the no uniformity of the heating for the processed product.

The microwave system developed and presented in this paper is designed and has as destination the drying and decontamination of agricultural seeds which represent the preliminary stage in the storage process for agricultural seeds in order to ensure them a superior quality by using the mixed microwave and hot air spurt system for the insects and pathogen factors eradication through selective radiation into the grain bed. In this case has been chose the treatment of agricultural seed placed upon a conveyor transparent to microwave which allow the hot air spurt to pass through the grain bed from the inferior side to superior side of the equipment. [3]-[5].

II. THE MIXED MICROWAVE AND HOT AIR SPURT SYSTEM

The mixed microwave and hot air spurt drying equipment is using wave guides to transport the microwave energy from the generator to the applicator where the microwaves will be absorbed by the agricultural product. The main scheme of the equipment designed for to dry the cereals granules under microwave radiation is presented in figure 1. This contains a hyper frequency generator (800W, 2.45GHz) of variable power, a circulator, a monomode cavity that acts as an applicator.

The microwave applicator used in this study consists in a continuous wave guide systems made of couple of small cavities in serial connection. The wave guide system consist in wave guides, where the agricultural seeds are placed on the in motion conveyor exposed to the microwave radiation. The greatest part of the microwave energy is absorbed and the rest part of the energy is absorbed by loads placed at the entry and exits gates of the drying system. This type of applicator can be used even without loads in good condition and no damages.

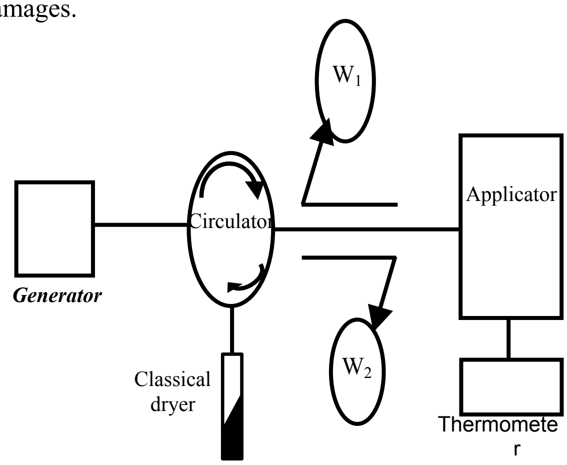

Fig. 1. General scheme of the microwave installation

The incidental and reflected power is performed continuously, thanks to a bi-couple, two hyper frequency-detecting diodes and two wattmeters. The temperature of the sample is measured with the help of a thermometer, which does not inflict significant changes on the sample to be measured.

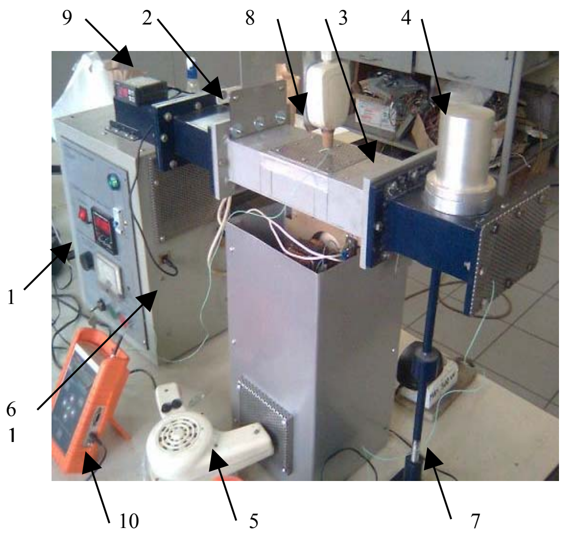

Fig. 2. Experimental equipment used to study the behaviour of agricultural seeds in a mixed microwave field and hot air spurt

In figure 2 we present the constructive form of the stand, where the following main sub ensembles can be identified: 1 – microwave generator; 2 – wave guide; 3 – monomode applicator; 4 – absorbing load; 5 – hot air source; 6 – electrical interbottoming; 7 – adjustable support, 8 – humidity probe, 9 – humidity indicator. 10 – in bed thermometer.

III. EXPERIMENTAL RESULTS

In order to detect the optimal functioning regime for the mixed microwaves and hot air spurt system where performed a serial of experimental runs.

The considerate monomode applicator has a parallelepiped form with the interior sizes of 109,22×54,6 ×300 mm. The experimental equipment is supplied from the power system at 220 V ± 5% and frequency of 50 Hz. All temperature maps obtain during drying process was captured by using the FLUKE Ti20 infrared camera. Some of the obtained results are presented in the following figures. Parameters obtained for temperature inside the applicator and the grain bed, microwave power and humidity were measured by using sensors. Table I present the results obtained for the mixed drying process.

Combined drying process microwaves and hot air applied for 30 min, during which the temperature of the wheat increased but does not have to exceed 70 ^{o}C. The control of the temperature is made by adjusting the microwave power. As part of the drying procedure of 4 distinct cases we will see exactly which the real power/g is. The temperature of the blown air is of 35.7 ^{o}C.

In order to determine the percentage of the extract water during the drying of a probe of seeds we weight the probe before mi and after the drying mu. (STAS 10349/1-87 The drying of timber at temperatures under 100°C)

$$U = \frac{m_i - m_u}{m_u} = \frac{26 - 21,2}{21,2} = \frac{4,8}{21,2} = 22,7\% \quad (1)$$

TABLE I. RESULTS OBTAINED FOR THE MIXED DRYING PROCESS

	Microwave power [W/g]	Exposure time [ms]	Ventilation power [kW]	Mass temperature [˚C]	Initial humidity [%]	Extracted humidity [%]
A	0.38	30	1.5	59.2	27.2	5.7
B	0.45	30	1.5	60.3	27.2	6.0
C	0.50	30	1.5	64.9	27.2	6.5
D	0.75	30	15	68.2	27.2	7.4

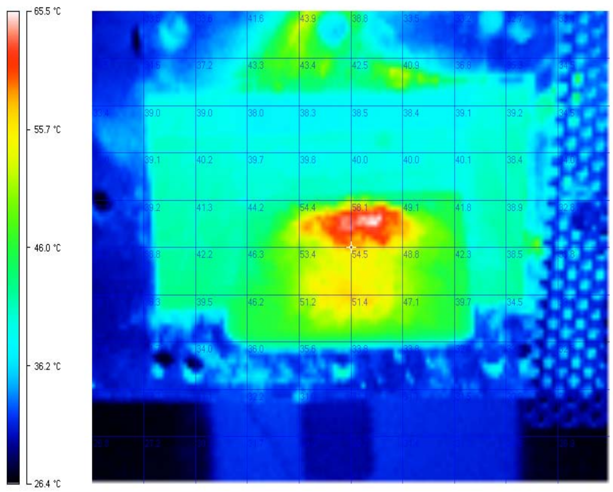

Fig. 3. Temperature map of the grain bed placed in the mixed microwave and hot air spurt system during drying process.

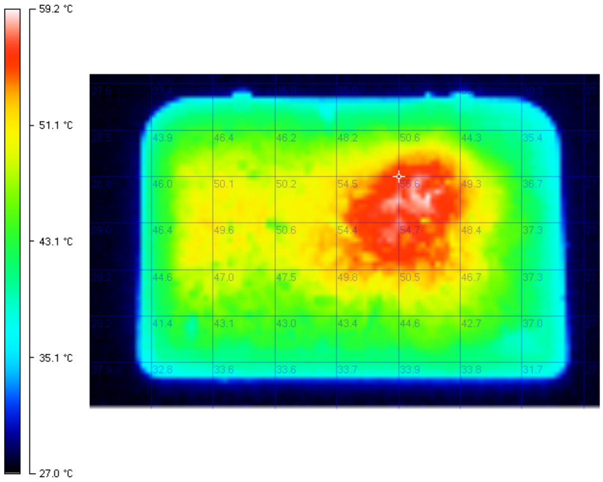

Fig. 4. Temperature map of the grain bed placed in the mixed microwave and hot air spurt system at the end of the drying process for the A case.

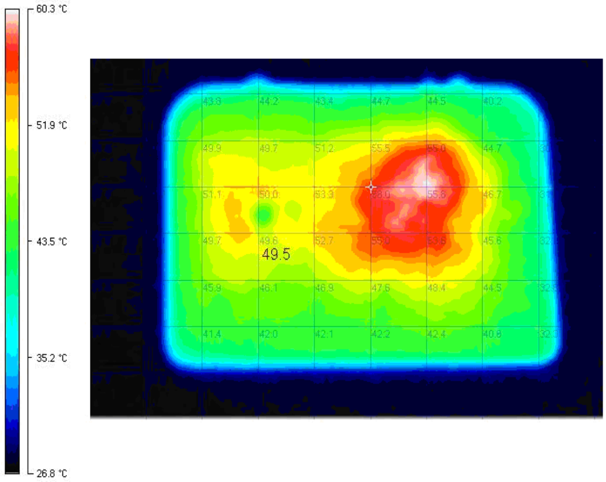

Fig. 5. Temperature map of the grain bed placed in the mixed microwave and hot air spurt system at the end of the drying process for the B case.

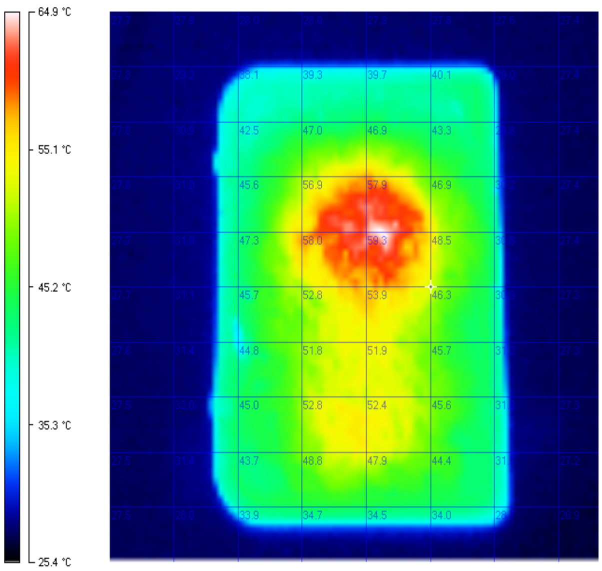

Fig. 6. Temperature map of the grain bed placed in the mixed microwave and hot air spurt system at the end of the drying process for the C case.

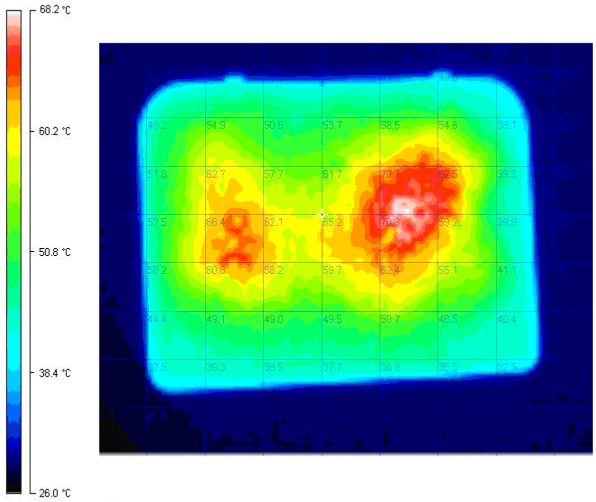

Fig. 7. Temperature map of the grain bed placed in the mixed microwave and hot air spurt system at the end of the drying process for the D case.

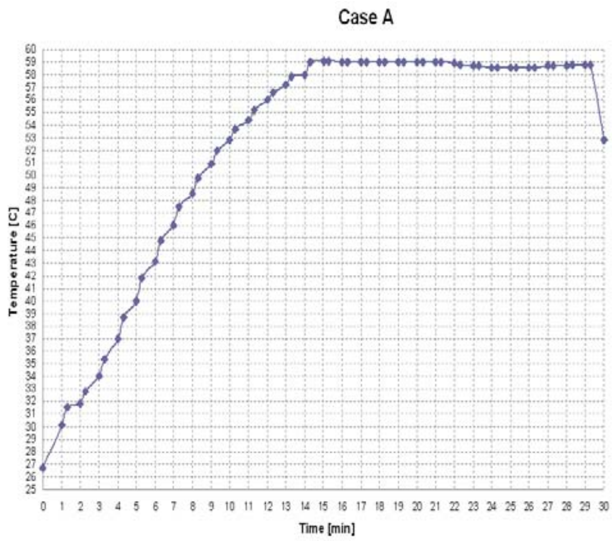

Fig. 8. Temperature evolution in the grain bed during mixed drying process for the A case.

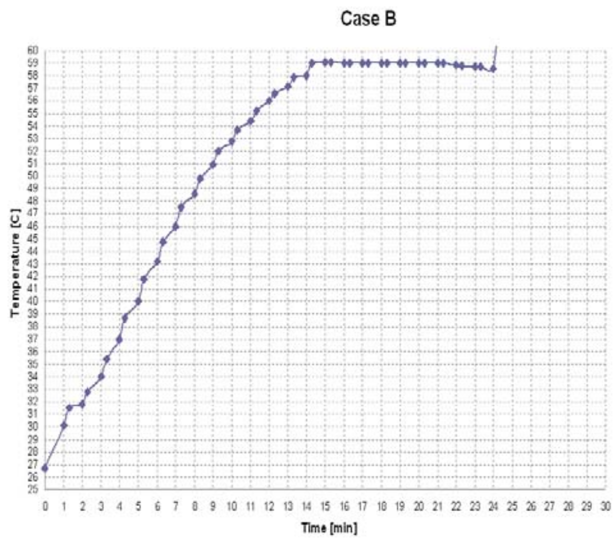

Fig. 9. Temperature evolution in the grain bed during mixed drying process for the B case.

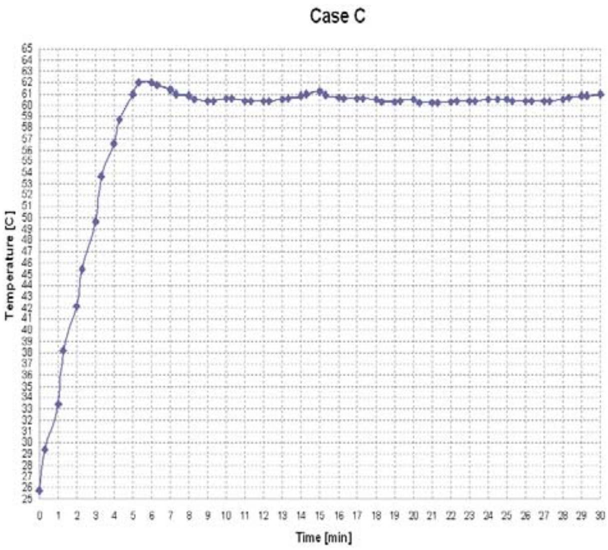

Fig. 10. Temperature evolution in the grain bed during mixed drying process for the C case.

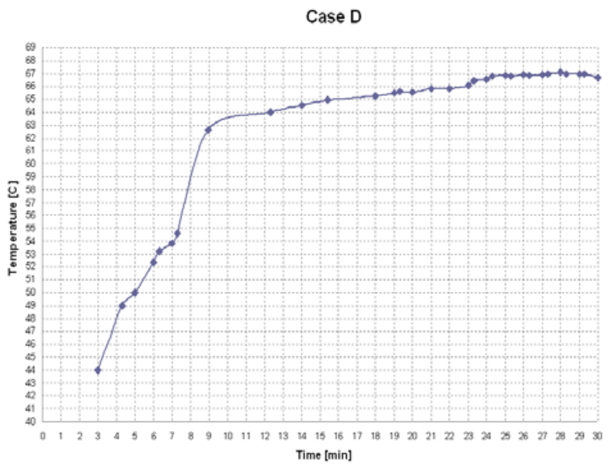

Fig. 10. Temperature evolution in the grain bed during mixed drying process for the C case.

IV. CONCLUSIONS

The obtained results show that the seeds granules are reaching high temperatures under the action of microwave power and we surely could notice that the microwave can be successfully used in the drying, disinfection and decontamination process of cereals granules. The only limiting phenomenon is the absorption of microwaves which is reduced whenever the water is less free, that is here at the very end of the drying when there is only capillary water.

Artificial drying of cereal seed is made in drying systems, by using combined microwave-hot air spurt. The method use the microwave for bringing the water from the inside of the seeds to migrate to the surface wherefrom with the hot air spurt in the pre-heat sector of the dryer is accomplish the seeds perspiration during the drying to obtain the vaporization and water disposal and in the next sector following occurs cooling with the atmospheric air of the seeds.

Drying of cereals granules did not put in evidence any other limitation than the absorption of microwaves by hygroscopic water. Drying kinetics is closely linked to the evolution of the absorbed power. With this kind of unsaturated porous media pressure gradients are not high enough to deteriorate the product. In the future, it would be interesting to go further in the permeability effect investigating lower pore diameters.

AKNOLEDGEMENT

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