PARAMETER VARIATION IN THE DRYING PROCESS OF THE THURINGIA BARLEY SEEDS

Vicaş Simina*, Sopronі Darie, Hathazi Francisc I. **, Arion Mircea ****

** University of Oradea, Faculty of Environmental Protection, Departament of Physics, Chemistry and Informatics, 26 Gen.Magheru Street, Oradea, 410059, Romania, e-mail: simina_vicas@yahoo.com*
*** University of Oradea, Faculty of Electrical Engineering and Information Technology, Department of Electrical Engineering, Electrical Measurements and Electric Power Use, 1 Universităţii Street, Oradea, 410087, Romania,*
E-mail: vsoproni@uoradea.ro , puiu_hathazi@yahoo.co.uk, marion@uoradea.ro

Abstract

This paper presents the influence that microwave heating with hot/cold air stream has on the barley seeds .The main problem we follow is the optimum formula between applied energy and material humidity so that the material can be dried without his structure to be affected.
By heating volumetrically, microwave processes have several advantages over conventional heating processes. The main advantage is the increase of process rates and thus improving the quality of microwave heated products.

Keywords: barley seeds, germination, humidity, drying, microwave

INTRODUCTION

Microwaves are part of the electromagnetic spectrum and are considered to be that radiation ranging in frequency from 300 million cycles per second (300 MHz) to 300 billion cycles per second (300 GHz), which correspond to a wavelength range of 1 m down to 1 mm. This nonionising electromagnetic radiation is absorbed at molecular level and manifests as changes in vibrational energy of the molecules or heat (Maghiar and □oproni, 2003), (Stroshine et.al, 1984).

The advantages of microwave processing that determine choosing this technology in spite of classic one's are: to improve the properties of treated seeds, the smaller space occupied by the installation in comparison with other classic models and the growth of the productivity (Metaxas and Meredith, 1983), (□oproni et.al, 2009).

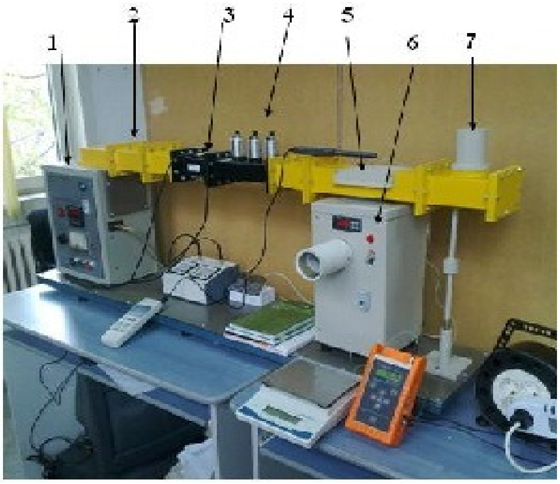
MATERIAL AND METHODS

During our studies we used an installation, microwave system, within the laboratory of microwave Technologies, Electrical Engineering department, faculty of Electrical Engineering and Information Technology, University of Oradea (see Figure 1).

This microwave system has three base components: a microwave generator with a maximum power of 850W, waveguide and applicator. The microwave system also has a absorbent charge, a directional coupler and a impedance adapter with 3 divers.

The stand is supplied at the tension of 220V±5%, 50 Hz frequency. The microwave generator has adjustable power and an included Wattmeter used for the supply power that is being adjusted with a potentiometer, a time programming, an on/off button, a fusible safety for overflow, Signaling for the presence of charging tension of the generator, a command key, a start button, a stop button, and a thermal protection of the magnetron.

The Directional Coupler – his role is to determine that the energy goes to the charge and not to the magnetron, in this way protecting the magnetron. In the coupler there are 2 ports: one for the direct power and one for the reflected power. In the microwave system is necessary that the microwave generator discharges all his power to the absorbent charge.



1.Microwave generator
2.Wave Guide
3.Directional coupler
4.Impedance adapter with 3 divers
5.Monomode applicator
6.Hot air source with regulation of the temperature
7.Absorbent charge

Figure 1- Lab. Installation used for microwave/hot air processing of granular dielectric materials

Impedance adapter-through the variation of the 3 divers it protects the microwave system by determining the movement of the microwaves in a single direction. There are three divers in the circulator: one is connected to the microwave generator, the other is connected to the applicator and the last to the artificial charge. (The generated power=absorbed power)

Hot air source with regulation of the temperature is composed of a air temperature controller, air admission, safety, signal lamp and a switch.

The monomode applicator has parallelepiped form with interior sizes of 109.22*54.6*150mm.

The monomode applicator is designed so that the hot/cold air stream may enter from downwards upwards in the seeds bed in order to eliminate the water on the surface of the seeds, to avoid the hot spots from the bed and so to insure the homogeneity of the temperature in the entire mass of the seeds.

Within this experiment we wish to monitore the drying process parameters of the barley seeds, type Thuringia, in the microwave using hot/cold air stream. Our aims are to find out the closest formula between the applied energy of the microwaves and the humidity content so that the structure of the seeds is not affected.

As a result of the achievement of the drying process of the seeds in the microwave field we want to study their germination percentage.

With the help of the measurement devices we monitored the parameters of the process: the power of the microwaves, the direct power, the humidity and the temperature of the hot/cold air stream at exit, the temperature from the seed bed.

The temperature from the seed bed was determine with a thermometer with optic fiber and the humidity and the temperature of the outside air using the humidometer Lutron YK-90HT.

At the end of each experiment the seeds were marked and placed into paper bags and sent to a specialized lab for determining the germination rate. In the study we made, we followed the highest rate germination of the samples so that in the future we center on the validation of the “optimum drying prescription”.

RESULTS AND DISCUSSIONS

In the research we have made we used treated barley grains, type Thuringia. The seeds were treated with Divident Star, a substance that doesn’t influence the structure of the seed, it only kills the pests. After drying the seeds in the microwave field the seeds were placed for germination, in a specialized lab, and the rate of germination was determined after 14 days. Then we compared the rate of germination of the sample with the rate of germination of the witness sample.

For determining the percentage of humidity of the dried seed sample we use the mass of the seed before drying, m_i, and after drying m_u (Maghiar and oproni, 2003):

$$U\ [\text{Humidity}] = \frac{m_i - m_u}{m_u} \times 100[\%] \qquad (1)$$

A set of experimental data was made using the microwave drying with hot/cold air stream and a variable power.

1. For the first sample we used 100 g of wet barley seeds, obtaining after drying in the microwave field with hot air stream and using a variable power (260W-200W-150W/13.5minutes), a quantity of 68.7 g of dried barley. After drying we obtained a difference of weight of 31.3 g, that represent the water that evaporated from the seed bed. The humidity eliminated from the seed bed, calculated with formula (1) is U=45.56%.

During our testing the outside air temperature had a growth from 16^0C to 48^0C, and the humidity of the outside air temperature decreased from 42% to 9 % (see Figure 2). The decrease of the humidity can be explained by the thing that when using a high power from the beggining the water is being evaporated rapidly, so the humidity will start to decrease.When using a power of 200- 260 W we noticed that the air humidity decreases in the 2.5 minute from 40% to 29% and the output air temperature increased from 16 ^{0}C to 36.4^0C.By stabilizing the power at a value of 150W, the temperature and humidity reverted to its normal value.

For this sample we've got a very good rate of germination of G=80%, in the witness sample case being of only G=61%.

2. For the second sample we used the power of the microwaves with cold air stream, having an initial mass of wet barley seeds of 100.29 g. After drying for 14 minutes we obtain 62.52 g of dried barley, being remarked a difference of 32.77 g pf evaporated water from the seed bed. The humidity eliminated from the seed bed is U=48.57 %. Because we used a high power from the beginning, of 300W-350W-200W/14 minutes, the seed bed temperature rised from 29.9^0C to 66.1^0C (see Figure 3). In minute 3.5 we can see that the air humidity falled from 50% to 22.5%, because of the big power of 350W. In the 14 minute we had to stop the installation because the water from the absorbent charge started to boil, fact that is caused by the big residual power. The rate of germination for this sample is only G=47%, the seeds presenting a low develop.

3. For the third sample we used the same quantity of seeds as previous case, but we dried the seeds using microwave field with hot air stream. After drying for 10 minutes, using a high power of 300W, we obtained 64.66 g of dried barley; 35.69 g of water were evaporated from the seed bed. The humidity eliminated from the seed bed is U=55.19%. The humidity of the air at exit rised in the first minute till the value of 93%, decreasing until the 9 minute to 6.8%. (See Figure 4). The rate of germination for this sample is G=48%. We noticed that in this case when using hot air stream the value of U is bigger, than the previous sample, because the temperature of the air stream caused this evaporation. It is important to underline the fact that using high power (like in the cases 2 and 3) it affects negative the structure of the seeds, their germination.

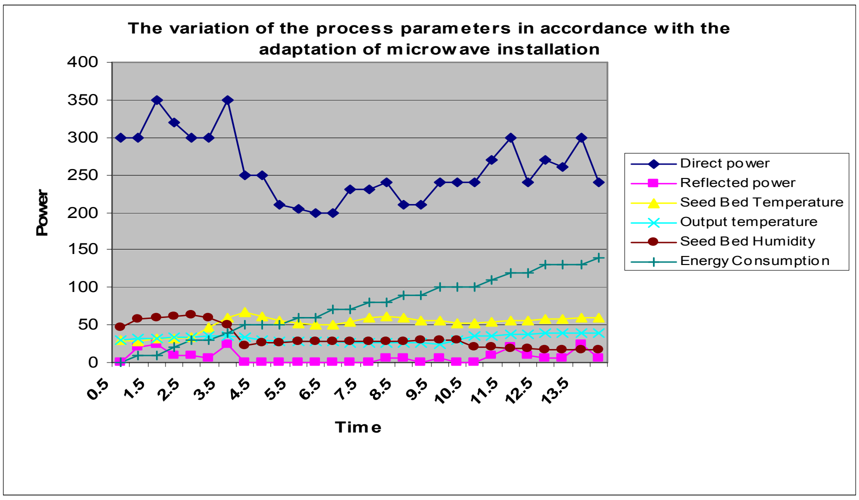


Fig.2 Parameter variation using a variable power
260-200-150W/13.5min., U=45.56%, G=80%,
Using the power of microwaves with hot air stream

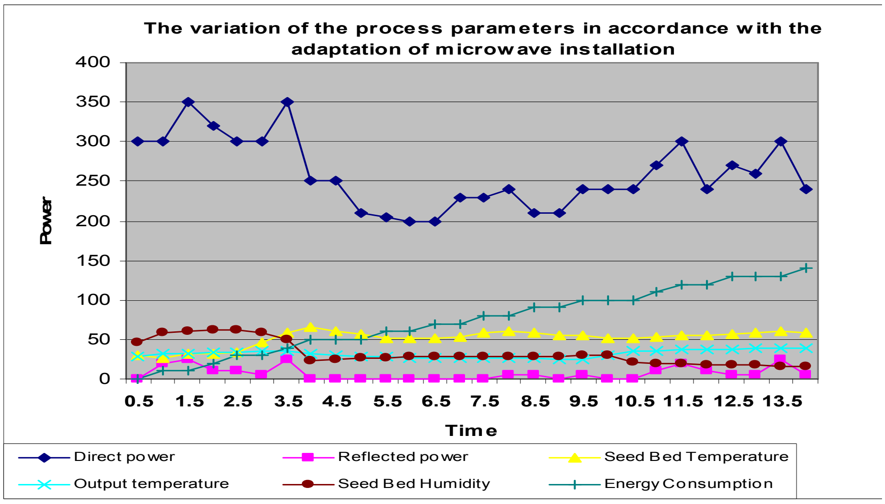


Fig.3 Parameter variation using a variable power
300-350-240W/14min., U=48.57%, G=47%,
Using the power of microwaves with cold air stream

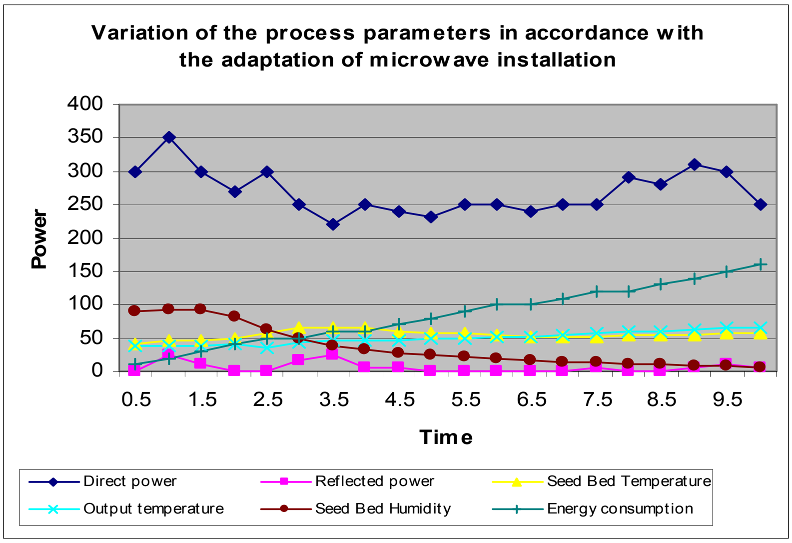


Fig.4 Parameter variation using a variable power 300-350-250W /10min., U=55.19%, G=48%, Using the power of microwaves with hot air stream

One notices that using microwave field drying with hot air stream is more efficient than the one which uses cold air stream because we need the air stream to eliminate the high humidity (Molnar et.al., 2008).

The variation of the absorption of the microwave energy by the seeds bed appears due to the variation of the properties of material with temperature and humidity (Hathazi and Maghiar, 2003), (Bandici and Molnar, 2007).These parameters are: electric permittivity and permeability, which implies a variation tgδ the factor of dielectric loss.

The dielectric properties of a material are given by (Nelson, 1995):

$$\varepsilon=\varepsilon'-j\varepsilon'', \qquad (2)$$

where ε = complex permittivity, ε'= relative permittivity, ε''= loss factor.

As soon as the water disappears, the coefficient of losses tends towards zero and the conversion of the energy of the electromagnetic field in the heat is no longer made, the body cools down even if is left further on in the oven (Niculae et.al., 1997), (Otten et.al., 1984). The estimation of the energy consumption is important in the evaluation of the drying process of the cereals in microwave field. One notices the increase in energy consumption by 10 W/1 minute (see Figure 2, 3, 4).

The germination is determined with germinators of type Linhard, sterilized; one uses filter paper moistened with tap water, kept under niche at 20^0C±2-3^0C. We used 160 seeds of each sample, which we distributed evenly in straight, equidistant rows; the germinators were covered with bottle lid, they were labeled and placed in a glass drawer at constant humidity and temperature. The germination is considered finished when the root has a length equal to the length of the seed, and the stem has ½ this length (Boldor et.al., 1981), (Davidescu and Davidescu, 1981).

With the help of the colleagues from the University of Oradea, Electrical Engineering Faculty, new samples were made in Bucharest using an installation, microwave system, for processing and drying seeds. The microwave system developed through a project is for the treatment of storage seeds against pest.

We recall the fact that the elaboration of this project would not be possible without the help of the Ministry of Education and Research, who financed the project PNCDI II Partnerships 51082/2007 "Modern technologies used for the improvement of quality of agricultural seeds stored", coordinated by the University of Oradea and having as partners research institutions and agricultural producers as beneficiaries.

The experimental results were made with wheat, barley, corn and oat using a variable generation regime of the microwave power.From the samples that were made we could say that there have to be used high levels of the power as long as the drying power is big enough. Then there should be applied a power with lower values for the rest of the drying period. By modifying the power value from 0.75 or 0.50 W/g to 0.25 W/g the drying period rises and so it results a bigger necessar of energy at the variable regime operation.

The installation used for these experiments is presented in the next figure:

a – microwave source;
b – Operation engine;
c – Control and Command Panel;
d – ventilation air system;
e – Seed feeding system;

Fig. 6 Microwave system for drying seeds

CONCLUSIONS

It is important to use hot air stream to eliminate the water from the seeds surface and to avoid the hot spots from the wheat bed so there can be homogeneity of the temperature in the whole mass of seeds.

With the work we have done using microwave field and air stream we obtained results that are useful for the drying processes in a microwave field, helping users to determine the power of the microwave source at the initial stage of drying and also the optimum drying time, taking care so that the structure of the grains is not affected.

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