PARAMETER VARIATION OF WHEAT SEEDS DRIED IN MICROWAVE FIELD

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Abstract:
The aim of this study is to determine the effects of the thermal treatment with microwaves on the germination of wheat seeds, type Apache × Renan for different processing parameters. The problem that is being followed is to find out the optimum formula between applied energy and material humidity so that the material can be dried without his structure to be affected.

Keywords: wheat, microwave, germination, dielectric properties, drying parameters

INTRODUCTION

The combination between the microwave energy and the convective air drying became a good idea that would eliminate the disadvantages associated with the application of each method alone. Drying and treating agricultural seeds in the microwave field represents a new technology that is able to offer to the material developer a new instrument, powerful and totally different, with which there can be processed materials that usually couldn't be treated through conventional methods or which can improve the material characteristics (Metaxas and Meredith, 1983), (Bandici and Molnar, 2007).

Drying crops is a process that implicates simultaneous heating and mass transfer in which the material humidity content is being reduced at a certain level for a better storage. In the hot and arid countries the solar energy and airising with air can be used for drying of crops. Instead, when talking about countries with a wet climate, the artificial drying can be used (Eric St.Denis, 1998), (Stroshine et.al., 1984).

The agricultural cultures may tolerate high temperatures of the hot air in the first stage of the drying process. This tolerance is limited to the temperature at which the germination is affected (Gowen et.al., 2007), (Nelson, 1995).

MATERIAL AND METHODS

Dielectric properties of materials at microwave frequencies are very affected by their chemical composition, in some extent by the physical structure of the product, and totally influenced by the water (Datta, 2001).

Dielectric properties of materials are defined in terms of their relative complex permittivity (ε):

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

Where the real part, $\varepsilon^{'}$, is the dielectric constant, the imaginary part, $\varepsilon^{''}$ is the dielectric loss factor.

Dielectric constant is associated with the potential for electrical energy storage in the material, while dielectric loss is related to the electrical energy dissipation in the material.

For determining the percentage of humidity of the dried seed sample we used the mass of the seed before drying, m_i, and after drying m_u (Maghiar and Soproni, 2007):

$$U\ [\text{Humidity}] = \frac{m_i - m_u}{m_u} \times 100[\%] \qquad (2)$$

In the research we made in the Electrical Engineering Lab, using lab installation with microwave system we analyzed the variation of parameters – temperature, humidity, power – in the process of drying the wheat seeds that were preliminary moisturized using a mixed process microwave / hot and cold air stream.

This microwave system has three base components: a microwave generator with a maximum power of 850W, waveguide and applicator. The microwave system also has an absorbent charge (in this case we talk about an artificial charge - the water), a directional coupler and an impedance adapter with 3 divers.

The stand is supplied at the tension of 220V±5%, 50 Hz frequency.

During our study, we analyzed with the help of the measurement devices the next parameters: the initial and final mass of the seeds, the humidity and the temperature from the seed bed, the humidity eliminated from the seed bed, the direct and reflected power, the temperature of the hot/cold air stream which is set so that it doesn't exceed 55^0C±5%, the energy consumption.

RESULTS AND DISCUSSIONS

In literature, we often found studies that utilized rewetted cereals, instead of fresh material. This seems to be common practice when freshly harvested grains are not available for the desired study (Manickavasagan, 2006).

During our studies we used rewetted wheat seeds, in the absence of fresh harvested seeds.

The experimental data followed two drying cases:

1. For the first sample we used a constant power of 0.5W/g for 10 minutes, applying only the power of the microwaves, without air stream;
2. For the second and third sample we used the same quantity of wheat seeds, applying the power of microwaves with a constant power of 0.33W/g first with hot air stream, and than with cold air stream.

After the drying process was finished we analyzed the rate of germination of the seeds and we underlined the differences obtained regarding the variation of the drying parameters: humidity, power, temperature.

1. For the first sample we had an initial mass of wheat seeds of 100 g, that were dried in the microwave field for 10 minutes, using a power of 0.5W/g. After the drying period we obtained a final mass of seeds of 96 g, so there were eliminated from the seed bed 4 g of water. The humidity eliminated from the seed bed is U= 4.16%. The output air humidity had a big growth in the first three minutes from the value of 41% to 92.2% (see Fig.1). During the period of drying we observed the variation of output air humidity, that increase and decrease, with big value differences; this phenomenon is being explained by the fact that the process of "boiling water" appeared in the seed bed, because we didn't used air stream to eliminate the water from the dielectric material (Molnar et.al, 2008), (Soproni et.al, 2009). The output air temperature had a constant growth from 23.6^{0}C to 49.6^{0}C.

The seed bed temperature had an important growth, from 20^{0}C to 157.5^{0}C, which represents a very high temperature for the seeds, their structure being destroyed by the big heat from the seed bed.

The germination rate obtained for this sample is low; we had 67% death seeds and 33 % anomalous. The power of 0.5% was too big for the dielectric material and the fact that we didn't use air stream contributed to the destruction of the structure of wheat seeds (Thierer, 1971).

The rate of germination obtained for the witness sample is G=95%, 3% were death seeds and 2% were anomalous seeds.

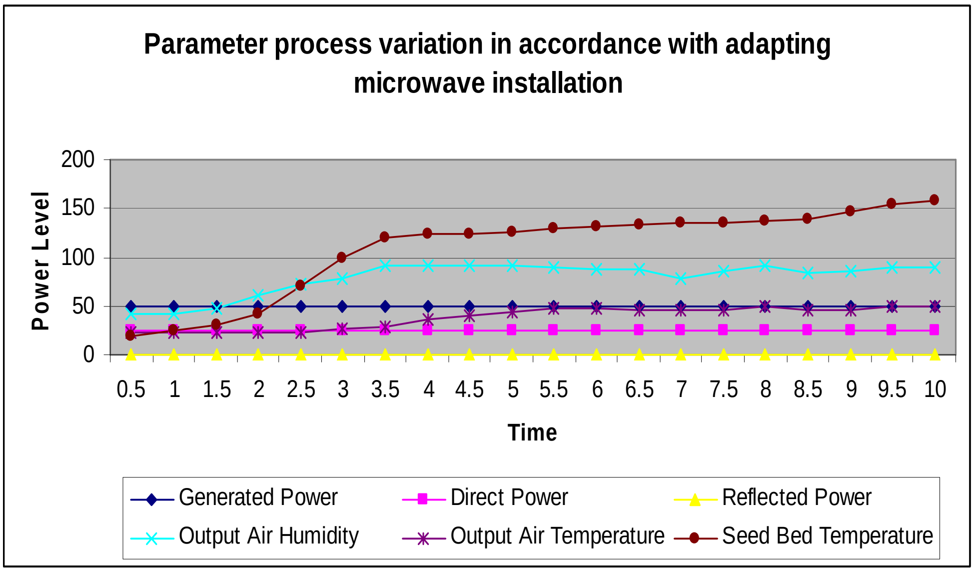

Fig. 1 Drying parameters in constant heating
0.5W/g, U=4.16%
Using microwave power

2. For the second sample we used 100 g of wheat seeds that were dried in the microwave field using hot air stream for 10 minutes and a power of 0.33W/g. After drying the final mass was 90 g of dried wheat seeds, so we had a difference of 10 g of evaporated water from the seed bed. The humidity eliminated from the seed bed is U= 10 %, which represents a very good value of the water evaporated from the dielectric material. The big value of U is being explained by the thing that we used hot air stream to eliminate the water from the seed bed. During the period of drying the output air humidity dropped from 70% to 15.5%, and the output air temperature had a constant growth from 20.2^{0}C to 41.9^{0}C (see Fig.2). The seed bed temperature had a constant growth from 22.2^{0}C to 49.5^{0}C. For this sample we had a very good rate of germination of 97% with seeds that presented a good development and a percentage of 3 % of anomalous seeds.

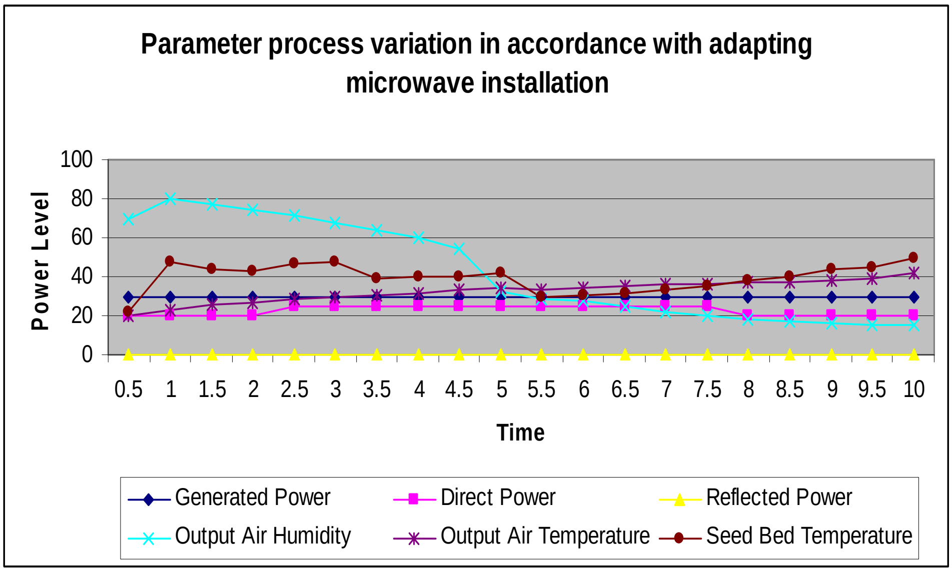

Fig. 2 Drying parameters in constant heating
0.33W/g, U=10%
Using microwave power/hot air stream

3. For the third sample we had 100 g of wet seeds that were dried for 10 minutes using a constant power of 0.33W/g with cold air stream. After the period of drying we obtained 89 g of dried wheat seeds, so we noticed a difference between the initial and final mass of 11 g of evaporated water from the seed bed. The humidity eliminated from the seed bed is U=12.35%, which is a better value than we obtained in the previous sample, when we used hot air stream. The output air humidity and temperature had constant values during the period of testing. The seed bed temperature in the first three minutes grew to the value of 80^0C, but than got stabilized and decreased to the value of 44.5^0C (see Fig.3).
The rate of germination for this sample is a good one, we obtained 97% germinated seeds and 3% death seeds.

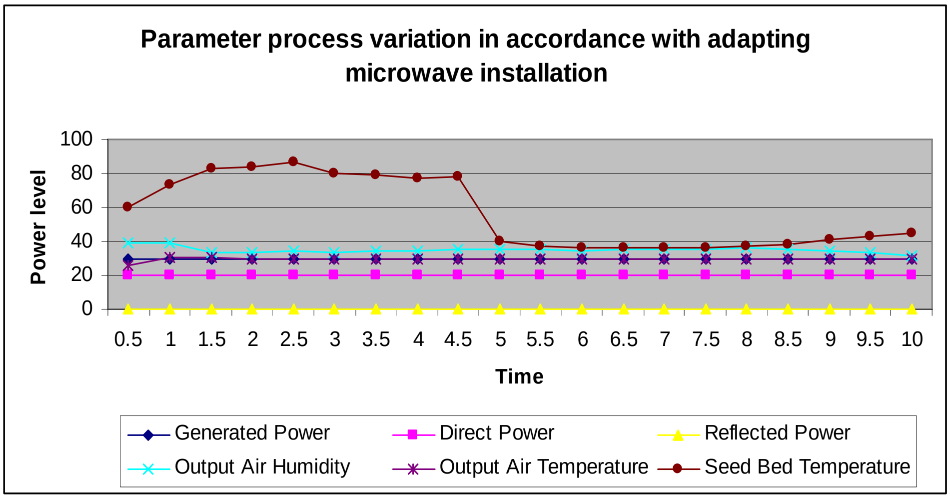

Fig. 3 Drying parameters in constant heating
0.33W/g, U=12.35%
Using microwave power/cold air stream

The germination was determined with germinators of type Linhard, sterilized; one uses filter paper moistened with tap water, kept under niche at 20^0C±2-3^0C (Boldor et.al, 1981), (Davidescu, 1981).

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 , 1981).

CONCLUSIONS

We obtained the highest rate of germination for the last two samples, where G=97% and the witness sample was G=95%.

A constant temperature and humidity has a good influence on the germination rate of the wheat seeds. Using air stream is important to eliminate the water from the seed bed and to avoid the hot spots, so there could be a homogenous medium in what concerns the temperature in the whole mass of the seeds.

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