THE VARIATION OF THE PARAMETERS IN THE DRYING PROCESS WITH MICROWAVES OF WOODY MATERIAL

Lucaci Codruța, Coman (Vicaş) Simina, Cheregi Gabriel, Șoproni Darie**, Galiş Ioan, Lustun Liana, Fetea Marius, Derecichei Laura**

* University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea, Romania,
** University of Oradea, Faculty of Electrical Engineering and Information Technology, 1 Universitatii Street, 410087 Oradea, Romania

Abstract

The purpose of this study is to find out the influence that drying with microwaves/ cold/hot air has on the wood's humidity. 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.

The applications that will have a future success at industrial scale are the ones that will take advantage of all unique microwave characteristics (Maghiar, 1999).

Key words: acacia wood, drying, microwave field, dielectric properties, divers, variation.

INTRODUCTION

Treating and drying with microwaves represents a technology that offers our material processors (in our case the material is wood) a new tool, powerful and totally different which can be used to process materials that cannot be treated using the conventional methods or which can improve the characteristic performances of the existent materials (Roussy et.al., 1992), (Brodie, 2008).

The wood in a living tree contains large quantities of water. After the tree is harvested, the weight of water in the wood is often greater than the weight of the wood itself. This water must be removed to some degree to make the wood usable. The process of water removal is called drying. The dried wood is then said to be seasoned (Reeb, 1997).

MATERIAL AND METHOD

Water is found in wood in three forms. Free water is found in its liquid state in the cell cavities or lumens of wood. Water vapor may also be present in the air within cell lumens. Bound water is found as a part of the cell wall materials (Reeb, 1997).

It is very important to know which temperature and power is favorable to wood drying (Harris et al, 2011). If the relative humidity is kept constant, the higher the temperature, the higher the drying rate (Metaxas and Driscoll, 1974), (Leuca, 2006). Temperature influences the drying rate by increasing the moisture holding capacity of the air, as well as by accelerating the diffusion rate of moisture through the wood (Hansson, 2007), (Xianjun, 2010).

During our research we used the stand within the laboratory of microwave Technologies, EMUEE department within the Faculty of Electrical Engineering and Information Technology, University of Oradea, during the period 15.06.2011-20.07.2011.

This installation is composed of the following: Microwave generator with maximum power of 850 W, waveguide, monomode applicator, absorbent charge, hot air source with regulation of the temperature, electrical inter-blockage, impedance adapter with 3 divers, directional coupler. The stand is supplied at the tension of 220V±5%, 50 Hz frequency.

The monomode applicator has parallelepiped form with interior sizes of 109.22*54.6*150mm (Soproni et.al., 2009).The monomode applicator is designed so that the air stream may enter from downwards upwards in the material bed of the dielectric in order to eliminate the water on the surface of the wood, to avoid the hot spots from the bed and thus to insure the homogeneity of the temperature in the entire mass of the dielectric (Hathazi and Maghiar, 2003), (Champman et al, 1992), (Vongpradubchai and P. Rattanadecho, 2011).

The absorbent adapted charge situated at the end of the installation eliminates the energy of the residual high frequency electromagnetic field. In case the dielectric material does not absorb efficiently the energy of the microwaves, a sizable quantity of energy may be reflected towards the microwave generator (Metaxas and Meredith, 1983).

With the help of the measurement devices we monitored the parameters of the process: the power of the microwaves, the direct power, the humidity of the air stream at exit, the position of the divers at the adaptation of the charge impedance, the temperature of the air stream which is set so that it does not exceed 55^0C±5%, the temperature from the microwave bed and in the close proximity of the system.

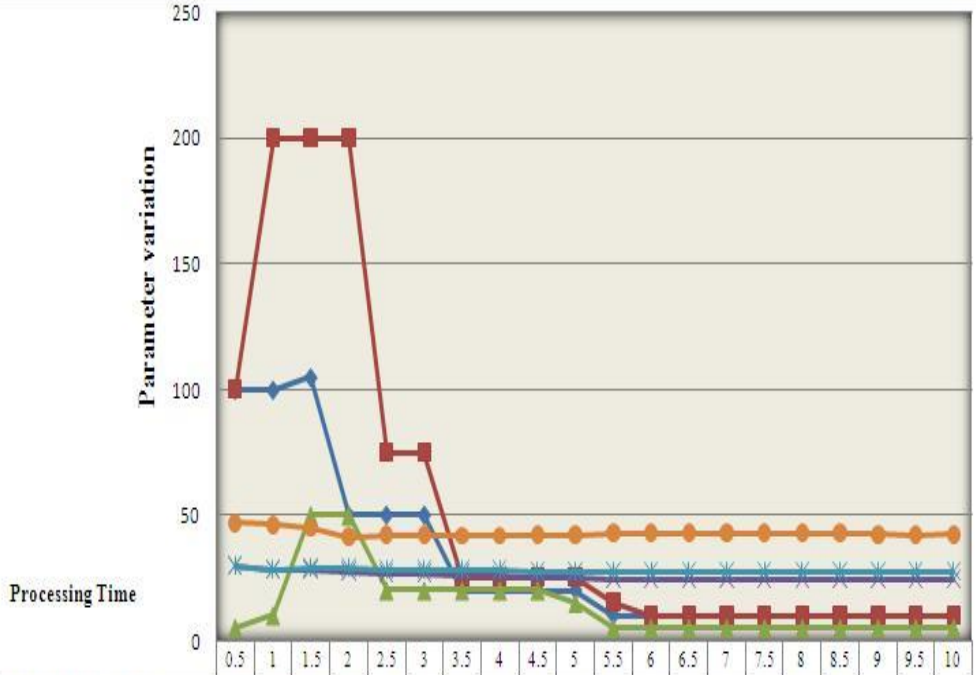
The temperature of the wood was taken with a special device - Material Moisture Wood Building Materials - Type Testo 616.

RESULTS AND DISSCUSIONS

During our study we followed two drying cases using the same type of wood, that is acacia wood, with its natural moisture.

For the first sample we used only the shell of the acacia wood with an initial weight of G=32.24g and a humidity of U=49%. At the beginning of our test we positioned the wetter part of the shell in the down part of the applicator, in the cold air stream direction for better ventilation and drying. After 10 minutes of drying with cold air stream using a variable power of the microwaves 100W-50W-10W we obtained a final mass of the wood of G=25.9g with a humidity of U=33%.

In figure 1 it is presented the variation of the drying parameters which shows us that, from minute 5 till 10, the variation of the parameters is constant and does not affect the structure of the wood.



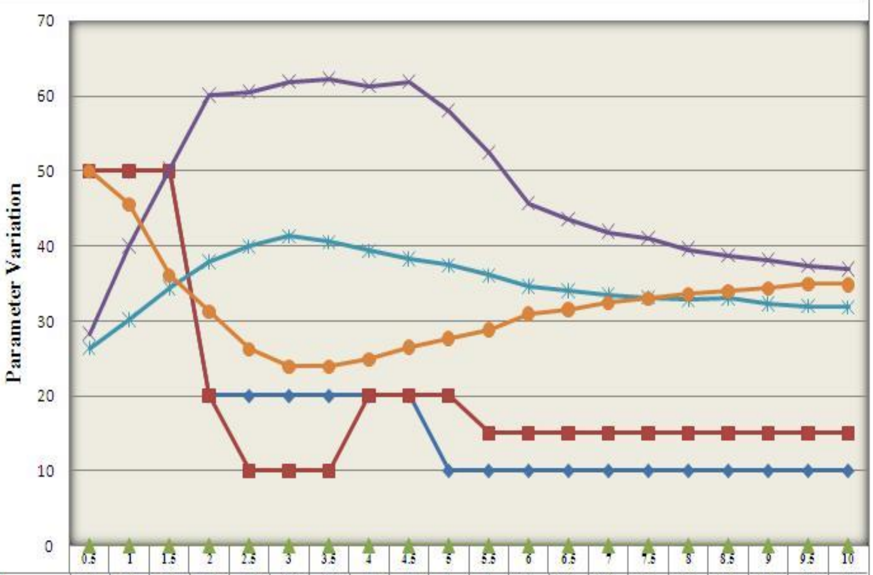
	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Supply Power[W]	100	100	105	50	50	50	20	20	20	20	10	10	10	10	10	10	10	10	10	10
Direct Power[W]	100	200	200	200	75	75	25	25	25	25	15	10	10	10	10	10	10	10	10	10
Reflected Power[W]	5	10	50	50	20	20	20	20	20	15	5	5	5	5	5	5	5	5	5	5
Wood Temperature[°C]	30	28.5	28.2	27.7	27.1	27.1	26.5	26	25.4	25.2	24.9	24.7	24.6	24.6	24.6	24.6	24.7	24.7	24.8	24.8
Output Air Temperature[°C]	30	28.7	28.9	29	28.5	28.3	28.5	28.2	27.9	27.8	27.8	27.7	27.7	27.7	27.7	27.8	27.8	27.9	27.9	28
Output Air Humidity[%]	47	46.3	45	41.3	42	42	41.8	41.8	41.9	42.3	42.8	42.9	42.9	42.7	42.6	42.6	43	42.5	42.3	42.4

Fig. 1. Parameter Variation in Variable Heating using cold air stream

For the second sample we used the middle of the wood, without the shell, with its natural moisture. The mass of the wood is G=42.2g and the moisture content is U=42%. We dried the wood using the variable power of the microwave 50W-20W-10W/10 minutes with hot air stream. Even though we used hot air stream to eliminate more water from the dielectric, the results show us that the difference of weight and moisture is not considerable: final mass is G= 39.66g and moisture U=38.5%.

Because the second sample represents a more compact dielectric material it is shown from the results achieved during the experiment that the evaporation is less than in the case of the first sample where we had a porous material with greater chance to lose water (Moschler and Hanson, 2008).

In figure 2 it is presented the variation of the drying parameters with the experimental data obtained. Through the variation of the 3 divers we successfully achieved on keeping the value of the reflected power at 0.



	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Supply Power[W]	50	50	50	20	20	20	20	20	20	10	10	10	10	10	10	10	10	10	10	10
Direct Power[W]	50	50	50	20	10	10	10	20	20	20	15	15	15	15	15	15	15	15	15	15
Reflected Power[W]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood Temperature[°C]	28.3	40	50.3	60.1	60.6	61.9	62.3	61.4	61.9	58.1	52.5	45.7	43.5	41.9	41	39.6	38.7	38.1	37.4	36.9
Output Air Temperature[°C]	26.34	30.12	34.41	37.9	40	41.3	40.6	39.42	38.3	37.37	36.05	34.6	34	33.5	33.13	32.78	33	32.25	31.99	31.81
Output Air Humidity[%]	50	45.6	36.16	31.3	26.34	24	24	24.9	26.6	27.7	28.86	31	31.6	32.5	33.09	33.61	34	34.36	34.97	34.9

Fig. 2. Parameter Variation in Variable Heating using hot air stream

CONCLUSIONS

The air injected in a high frequency dryer usually insures the transfer of the vapors from within the enclosure to the exterior. By recirculation the evacuated vapors, which ensure the heating of the air pumped into the drying enclosure, a large part of the latent heat of the vapors can be transferred to the air flux which enters the applicator, determining a substantial increase in the efficiency of the used drying chamber (Nelson, 1995), (Molnar et al., 2008).

The technology used during this experiment is complex and innovative, having future perspectives regarding implementation and promotion because it protects the environment and is often used in European and World Industry offering a high stage of protection and safety (Li et al., 2008), (Galperin, 1990).

In conclusion, we may say that the installation that uses the high frequency technique combined with conventional technologies (mixed drying – microwave/air stream) is a clean process, meeting one of the most important objectives of research-development.

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