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HUMIDITY RELATIONSHIP DETERMINATED IN THE DRYING CEREAL SEED FLUIDIZED BED

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Abstract: *In this paper considering the passage of moisture from the layer of product to another and from the surface to the environment, the difference in moisture and the drying agent the ability to take the form of moisture vapor overheated.*

Key words: *the drying, plant oil,*

1. General

The drying of wet materials, which include seed and grain, it is difficult mathematical relations included because it is the result of a joint effect of the transfer of heat and mass, changing properties and drying agent material, contraction and deformation of material along the way. For this reason, the drying process should be studied by combining theoretical results with experimental ones.

To know the exact behavior of the wet driers by radiation and convection, the most commonly encountered in practice, experimental research is needed so as to reveal the influence of temperature (t $_0$C), relative humidity (% U) and speed of drying () a unit of mass flow, the drying technology, $\dot{m}[kg/m^2 \cdot s$ lead to the drying time and energy. For this purpose, as experimental, is determined by drying curves, which indicate the temperature and humidity changes in the material time and speed drying (fig.1). ABCDE curve shows a decrease of seed moisture (drying curve) curve A1B1C1D1E1 show increased seed temperature (temperature curve), and the curve shows the variation A2B2C2D2E2 speed drying absolute humidity in percent per minute (rate of drying curve). Variation of seed mass subject experiments allow determination of average humidity, at the time, using the relationship:

$$U_{\mathrm{j}} = \frac{M_{\mathrm{aj}}}{M_{\mathrm{usc}}}, \left[\frac{\mathrm{kg}}{\mathrm{kg}}\right] or \left[\frac{\%}{100}\right] \qquad (1)$$

where is the mass of water in the material at the $M_{aj}\tau_j$ time. Measuring the temperature inside the material during the drying curves obtained in the form of fig. 1 which are distinguished the following phases:

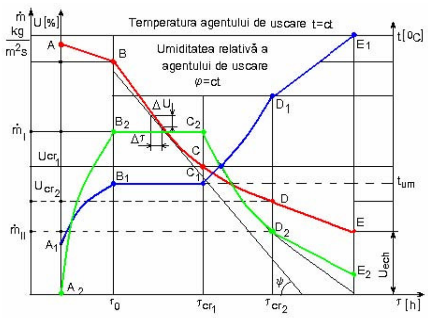

Fig.1

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a. Phase corresponding to the beginning of heating process of drying, AB portion, when the heat received by the seed is used for heating and water inside, the humidity decreases little by evaporating water, the segment AB, and speed of drying increases from zero to a maximum corresponding point B_2, while heating the seed is relatively short.

b. Phase velocity of the drying constant, where the intense humidity decrease, the segment BC, the drying rate constant segment B_2C_2, seed and the temperature remains approximately constant segment B_1C_1.

c. Drying descending phase in two areas:
- The first area, after touching a seed moisture content (first point), humidity evaporation becomes slower, the temperature of seed drying and the speed decreases linear segment C_2D_2 in paragraph D_2 reaches the second critical point in the second phase (after the second critical point) drying rate drops sharply, and the temperature increase than seed, tinder like the drying agent temperature (t_a). In this phase is related osmotic removal of water. $U_{cr.1}(U_{cr.2}, \tau_{cr.2})$

Hygrometric equilibrium phase begins when the seed moisture to reach equilibrium, the drying rate becomes zero and the drying process is terminated. Humidity corresponding material point C, when the surface moisture reaches the value hygroscopic bears the name of critical moisture. Moisture balance can be reached only after a theoretically infinite period of drying, practically, it is reached but after a defined period of time.

It is necessary for the final seed moisture out of the dryer should be chosen according to their destination, to improve or maintain the qualities of germination (the seed for sowing) or nutritional and bread (for seeds intended for consumption).

When the material reaches equilibrium moisture U_{ech} drying rate becomes zero and the process terminates.

Drying curves can be used to determine the speed of drying, indicating the variation of drying rate with moisture given by the relationship:

$$m_j = \frac{1}{S} \cdot \frac{dM_{aj}}{d\tau} \cong \frac{M_{usc}}{S \cdot 100} \cdot \frac{\Delta U}{\Delta \tau} \text{ [kg/m}^2\cdot\text{s]} \quad (2)$$

where S is the surface drying.

Sizes (S and M_{usc}) are known from measurements, and values (U) and in [%] and $(\Delta\tau)$ determining the drying curves (fig.1). Humidity (U_j) corresponds to the average interval of time $(\Delta\tau)$.

2. The Drying

In the laboratory thermotechnics of the Faculty of Mechanical Engineering of Craiova, was designed, developed and tested a pilot model for grain drying using two alternative sources of heat, solar energy or fuels, depending on atmospheric conditions or place The drying process occurs. In the case of solar and especially those used as carrier fluid heat air for storing surplus heat produced from solar captures solution bed of rocks is most favorable and economical.

Using model plant for drying dual power source, and solar electrothermics have made a series of experimental research on drying of cereal seeds (wheat, corn), plant oil (sunflower) and pumpkin.

Since the drying of wet materials such as seeds and cereal and technical plants, it is difficult mathematical relationships contained in effect due to the transfer of heat and mass properties change agent and drying of materials, contraction and deformation of material on course, you need a combined theoretical and experimental.

To know about the phenomena to the behavior of plants in wet drying by convection or radiation is needed experimental research to highlight the influence of their specific parameters such as:

- the temperature inside the drying chamber;
- relative humidity of the drying agent;
- moisture balance of subject material drying;
- speed of movement of the drying agent.

Based on knowledge of these parameters, which affect the drying-out technology, it is possible to achieve an optimization of the process leading to the determination of optimum drying time and minimum energy consumption.

To determine the moisture balance of dry material, the experimental measurements, obtained a series of drying curves, which indicate the variation of material temperature and humidity over time. Determination of equilibrium moisture of the materials submitted drying from the drying box was made indirectly by using moisture sensor - temperature hygrometric digitally inserted into the mass of seeds. Thus, the sensitivity of transducer was practically in permanent contact with the mass of seeds, as seen in figure 2.

As can be seen in the figure, the average interstitial distance between the sensitivity of transducer and seeds in the immediate neighborhood is very small, but sufficient moisture to be measured on the seed coating.

It is noted that the temperature of hot air circulating through the plant reaches the drying box, metal box in the sewer at a maximum temperature of 55..65 0C. From here, via holes and metal on this website is directed across the mass of seeds. Sent hot air into the mass of seeds with a speed appropriate fluidity, and these penetrate to exit reaches a temperature of 30 ÷ 40 0C. In this way, humidity hygrometer is indicated by relative humidity and warm moist air from the immediate vicinity of the seed. To convert the data thus obtained to determine the moisture balance of dry material, it is necessary to use diagrams called the isothermic sorbtions.

Capillary-porous bodies, the category which are also seeds of cereals and technical plants have a large outdoor area in relation to their volume, and the physical phenomena occurring in adsorption, condensation of water vapor and moisture evaporation mass contained in them.

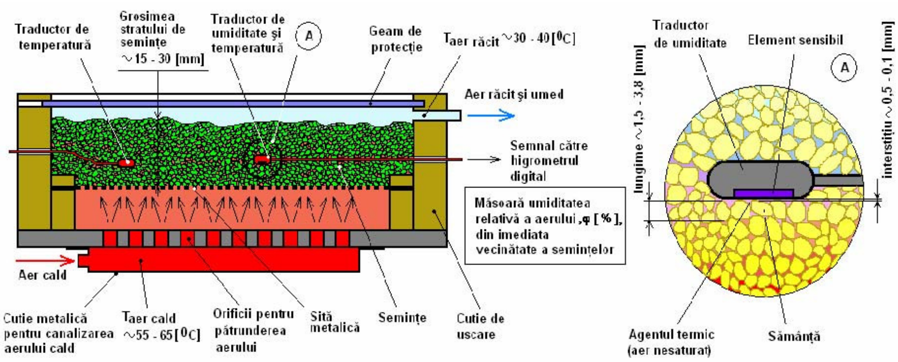


Fig. 2

The humidity of material in this case is called the equilibrium moisture U_e. Moisture balance is a characteristic of dry material (seeds) and depends on temperature and relative humidity φ air, so, $U_e = f(t, \varphi)$. If the curve is the variation $U_e = f(\varphi)$ in a system of rectangular axes U_e-φ, for a constant temperature air, to obtain an equilibrium curve or a curve sorbtion. Since the seed and moisture is not uniform, isotherm of sorbtions have an indicative value, but may be used for technical calculations usual. Based on analysis of these curves can establish a set of data necessary for designing drying facilities to determine the technological parameters of process and optimization in general.

3. Experimental Data

For the record of the processes that takes place at grain drying have used samples of wheat, corn, sunflower and pumpkin. Conditions have been conducted experiments are presented in the following tables for each sample separately. Observed a slight decrease in the relative humidity φ of the air at the beginning of drying, due to increasing air temperatures of the drying box.

As the temperature increases wheat, relative air humidity varies in the same direction. Starting transfer moisture to wheat. After a while, when the lease humidity starts to decrease, a decrease in relative air humidity is explained by high temperature drying agent that is able to stockpile a large amount of water vapor in the form of overheated. Chart identifies the period of constant drying rate, when water evaporates with constant speed on the surface of grains. Process analogous to the flow of water evaporation from a free surface.

Duration of the drying process with constant speed in the end point A, figure 3. During this period the whole process of drying is controlled by the difference between the partial pressure of water vapor on the surface of grains and the partial pressure of water vapor in the environment.

The following is the period of stagnation, when the grain moisture content reaches the temperature at which the partial pressure difference causes the migration of grain. Relative humidity of the drying agent decreases sharply. After establishing a balance between the heat transferred grains moisture diffusion and the amount of their surface water taken from the drying agent increases again, the BC level chart, entering into a new phase of drying speed constant level CD. During the lowering of moisture diffusion in drying agent of the area is completely dry grains and the speed of drying depends on the diffusion of water surface. The starting point of the moisture transfer rate constant depends on the initial humidity and temperature of grains. At low temperatures there is a delayed phase moisture transfer. If we analyze the variation depending on the humidity of the drying temperature is found that the relative humidity of drying agent temperature drops to the point A because of the ability to retrieve moisture at temperatures higher.

When the difference between partial pressure of water vapor on the surface of grains and their partial pressure of the drying agent is sufficient to initiate a transfer of mass (in the form of water vapor) in the damp air. It is the beginning phase of the drying constant speed. Curves of variation of humidity of air drying in the box to the period of drying, and by the drying temperature are shown in figures 3 and 4. Changes in wheat seed moisture depending on drying time and temperature in the drying box is shown in Table 1. Curves of sample drying wheat with solar energy are presented in figure 5, and the variation of time, drying temperature and humidity, in figure 6.

Table 1

No. crt.	HOUR	t_{11} [^{0}C]	φ [%]
1	10	*25*	*80*
2	10.15	25	80
3	10.3	25	80
4	10.45	25.1	80
5	11	25.3	80
6	11.15	25.7	81
7	11.3	26.2	81
8	11.45	26.7	81
9	12	*26.8*	*75*
10	12.05	26.7	73
11	12.1	26.7	72
12	12.15	26.7	72
13	12.2	26.7	71
14	12.25	26.7	70
15	12.3	26.8	70
16	12.35	26.9	70
17	12.4	27	69
18	12.45	27.2	69
19	12.5	*27.3*	*54*
20	12.55	35	42
21	13	42.3	31
22	13.05	*45.4*	*31*
23	13.1	49.7	27
24	13.15	52.2	24
25	13.2	54.4	21
26	13.25	56.1	20
27	13.3	*57.4*	*19*
28	13.35	56.6	51
29	13.4	55.1	56
30	13.45	53.9	57
31	13.5	52.8	58
32	14	*49.9*	*60*

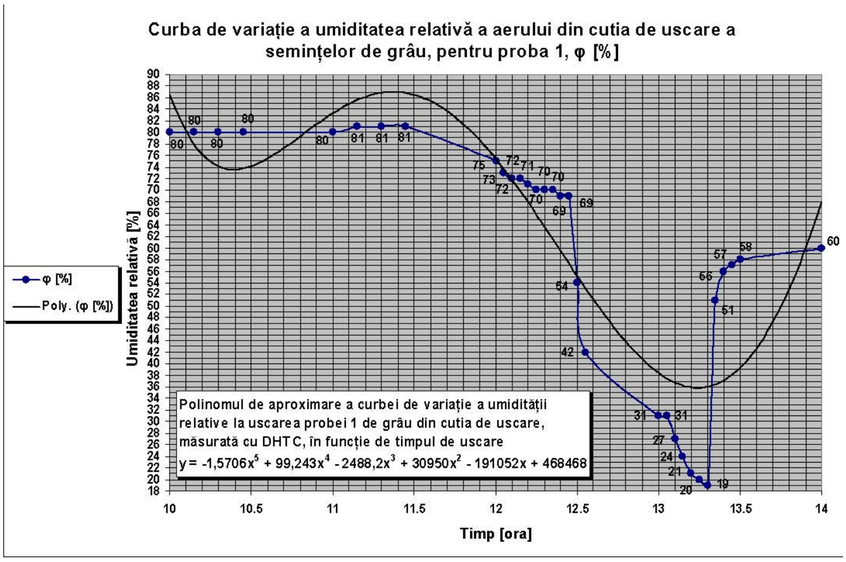


Fig. 3

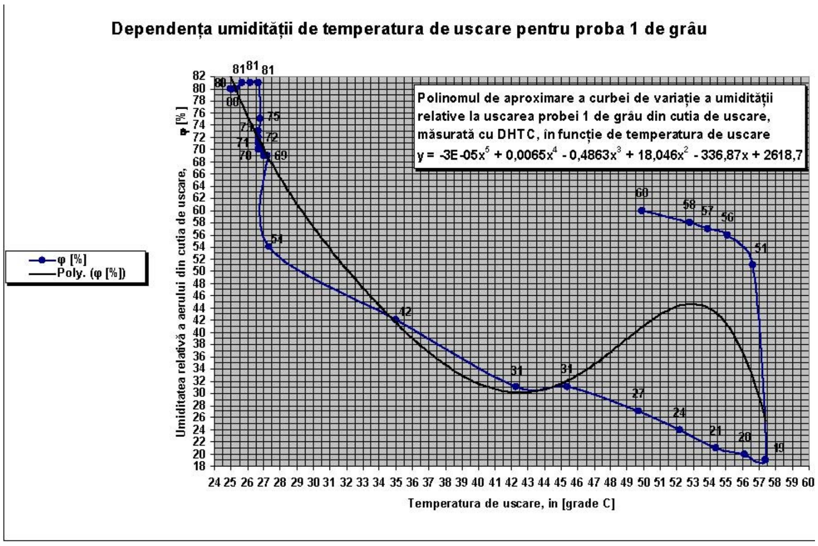


Fig. 4

Experiments were conducted in two stages: a stage of drying seed without control and order parameters specific technological process of drying, and a second stage in which they used devices and systems for command and control of technological parameters of process drying.

In the model used by the installation of drying equipped with devices and systems for command and control of process parameters were measured following parameters of the drying process:

- time to carry out the process of drying in hours and minutes; - temperatures of the drying box with hygrometric (t_{11}) in [$_0$C];
- temperatures of the drying box with electronic thermometer,[$_0$C];
- temperature drying of the box with the thermostat in [$_0$C];

- temperatures inside the box with rocks in [0C];
- temperatures of the solar detecting element in [0C];
- relative air humidity in the immediate vicinity of seed drying box with hygrometric (φ), in [%];
- consumption of electricity to heat source electrothermics in kWh;
- energy consumption of the engine fan for external recirculation air box with the rocks in [kWh];
- energy consumption of the engine fan external recirculation air for the drying box in [kWh];
- differences in height of liquid branches manometric tube with U-type column for measuring the speed of air entering the fan external in [mm];
- outside-temperature, measured with a digital thermometer in 0C;
- number of divisions in the weighing system with transducer electro-tensometrics, deck tensometric, XY recorder and computer electronic, in division;
- temperature source electrothermics measured internal thermometer, measured [0C].

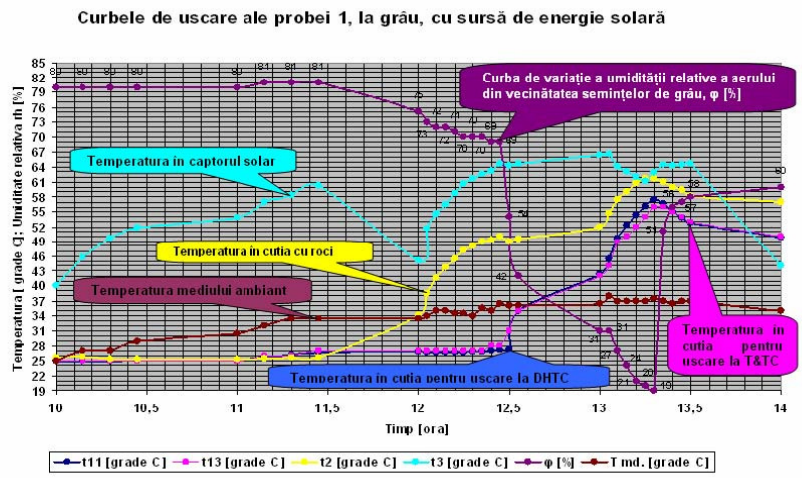
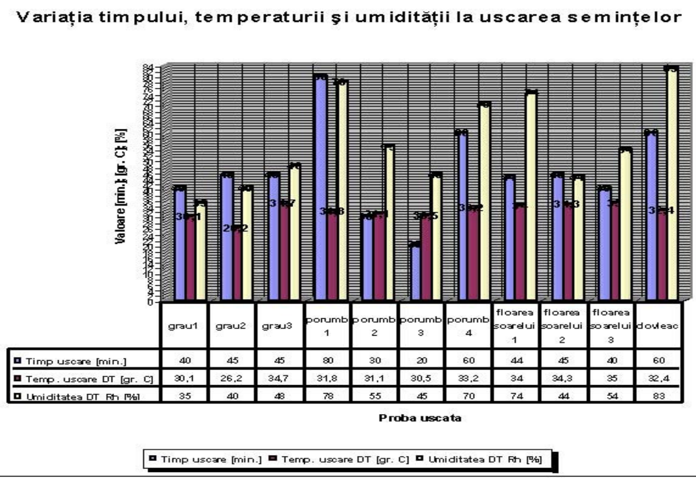


Fig. 5



	grau1	grau2	grau3	porumb 1	porumb 2	porumb 3	porumb 4	floarea soarelui 1	floarea soarelui 2	floarea soarelui 3	dovleac
Timp uscare [min.]	40	45	45	80	30	20	60	44	45	40	60
Temp. uscare DT [gr. C]	30,1	26,2	34,7	31,8	31,1	30,5	33,2	34	34,3	35	32,4
Umiditatea DT Rh [%]	35	40	48	78	55	45	70	74	44	54	83

Fig. 6

4. Conclusions

Analyzing histograms of previous figures are observed following aspects: - drying of the wheat seed is comparable in both cases drying with solar energy and electricity;

- variation-temperature drying, the difference between the minimum temperature at which the process begins and the temperature maximum is reached in the mass of product subject to the drying process, values are equally sensitive to all types of seeds, regardless of quantities, the initial moisture and values on which temperatures reach;
- in the case of what is the difference between the initial humidity, maximum and minimum humidity is reached during the process, the values differ depending on the type of land, are lower to higher wheat and maize, sunflower and pumpkin;
- subject variation in seed drying weights representing the quantities before and after the process, values are approximately equal in all cases, differences are apparent depending on the subject product, if wheat, this difference is approximately equal as in the case of maize, but greater for sunflower seeds and pumpkin; - graph analysis of variance shows that humidity and maximum and minimum values is observed that most were well behaved samples of wheat, which at the end of the process reached an absolute humidity corresponding optimal storage conditions, seed corn, due to a higher moisture content, final moisture content were higher than normal, which indicates that to achieve normal values of conservation is necessary to resort to three variants: increasing drying temperature, increasing the time for drying or the use of a predrying initial stage followed by drying itself.

Of those listed above, detach a conclusion on the process of drying of seeds in fluidized layer, using a dual energy sources, which can be considered that the installation completed and tested and meet requirements leads to corresponding results on some types of dry seeds of the most diverse, with different amounts of moisture and the quantity of water, a drying temperature and the quantity of material drying process.

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