RESEARCHES REGARDING THE DESIGNING, ACHIEVEMENT AND TESTING OF A LABORATORY TEST RIG FOR DRYING AGRICULTURAL AND FOOD PRODUCTS

CERCETĂRI PRIVIND PROIECTAREA, REALIZAREA ŞI EXPERIMENTAREA UNUI STAND DE LABORATOR PENTRU USCAREA PRODUSELOR AGROALIMENTARE

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Abstract. *The drying process is affected both by the complex thermo physical processes (diffusion, thermal diffusion etc.) that take place inside the particles forming the product which is dehydrated and by the mass and heat transfer in the boundary layer that separates the surface of the solid body from the thermodynamic agent, also called drying agent. In order to study the drying process of the agricultural and food products and to optimize the parameters of the dehydration process a laboratory test rig was designed and built. The rig allows the surveillance of the parameters involved in the drying process of the solid state agro-alimentary products. The following parameters are continuously measured and recorded: ambient air temperature and humidity, the temperature and humidity of the drying agent, the weight of the sample to be dried. The unit is equipped with a specialized microprocessor which allows the continuous adjustment of the speed of the drying agent and also the administration of the working process data, including their transfer to an external PC.*
Key words: drying, laboratory test rig, solid agro alimentary products

Rezumat. *Mecanismul uscării depinde de procesele termofizice complexe care au loc în interiorul particulelor produsului supus deshidratării (difuziune, termodifuziune) şi de transferul simultan de masă şi căldură din stratul limită ce separă suprafaţa corpului solid de agentul termodinamic, care este denumit agent de uscare. Pentru studiul mecanismului uscării produselor agroalimentare, în vederea optimizării parametrilor de deshidratare, s-a proiectat şi realizat un stand de laborator complex. Prin intermediul acestui stand se pot monitoriza toţi parametrii care concură la realizarea procesului de lucru pentru uscarea produselor agroalimentare aflate în stare solidă. Astfel, instalaţia permite măsurarea şi monitorizarea continuă, atât la intrare cât şi la ieşire, a următorilor parametri: umiditatea şi temperatura aerului, umiditatea şi temperatura agentului de uscare, masa probei supusă uscării. Instalaţia este echipată cu un microprocesor specializat, care permite reglarea continuă a vitezei agentului de uscare, dar şi gestionarea datelor privind procesul de lucru (inclusiv transferul de date către un PC exterior).*
Cuvinte cheie: uscare, stand de laborator, produse agroalimentare solide.

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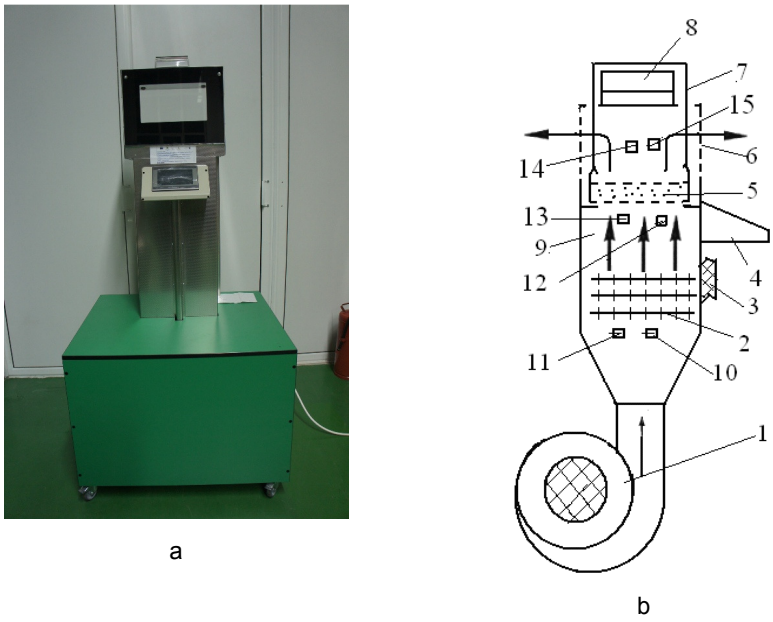
INTRODUCTION

Drying operation based technology is reducing the water content, respectively substance soluble concentation growth to levels that stabilize food storage. Removing water from foods should be directed so that hydrophilic colloids to maintain rehydration capacity. If fruits and vegetables, drying natural moisture content is reduced to a level that would prevent activity of microorganisms without tissue damage or to depreciate the value of their food.

The mechanism for drying process it is determined by some complex thermophysical processes occurring inside the particles undergo dehydration product (diffusion termodiffusion) and simultaneous mass and heat transfer in the boundary layer separating the solid body surface thermodynamic agent, which is called drying agent (hot air, flue gas or a mixture of gas and air etc). This determines that the work is complex and dynamic drying time. (Baehr and Karl, 2006; Incopera et. al., 2007).

MATERIAL AND METHOD

Laboratory test rig (fig. 1) for drying various products (cereals, vegetables, fruits) is based on heat transfer by convection.



a b

Fig. 1 - Laboratory test rig to study drying food products:
a – general view; b – Functional diagram dryers.

1 – fan; 2 – electric resistance air heating; 3 - insulation, 4 - operator interface "touch screen", 5 - box dried product, 6 - windows evacuation drying agent used; 7 - box support rods; 8 - electronic scale; 9 - inside the dryer; 10, 12 and 15 sensors for measuring ambient air temperatures, and hot air drying agent used; 11, 13 and 14 - sensors for measuring humidity of the ambient air, hot air and agent used drying.

The dryer is a confection made of steel sheet lined with stainless steel, ceramic insulated externally with cotton resistant to high temperatures, thus creating an enclosure vertically. This site is provided at the bottom with a centrifugal fan and air heater and 3 electrical resistance of kantal embedded in stainless steel tubes. Squared vertical upper chamber is located drying chamber, where the product has dried box. This box is suspended on an electronic balance for weighing continuous product undergoing drying (Țenu, 2012).

Drying test rig is serviced by a complex electrical installation, which is managed by a microprocessor type controller "touch screen" that allows control and monitoring of the drying process (fig. 2).

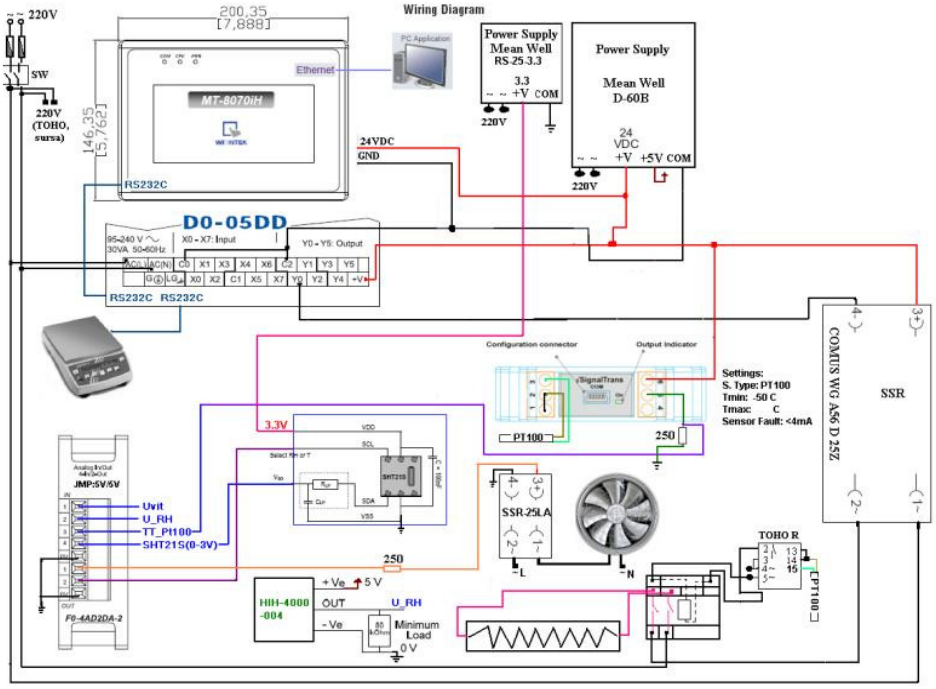


Fig. 2 - Electrical installation the laboratory test rig to study the working process of drying food.

RESULTS AND DISCUSSIONS

Laboratory test rig is a complex installation that can optimize workflow parameters, namely: drying temperature, drying time, drying speed, etc. for various agricultural and food products.

Registration experimental data can be transferred to external PC, including the development graphics respect to temperature and humidity inlet and outlet drying agent (fig. 3).

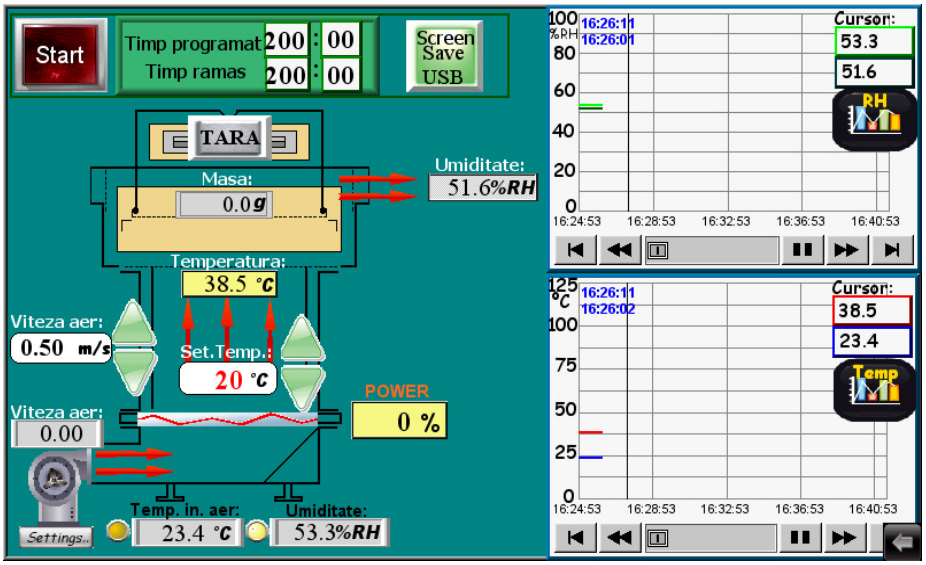


Fig. 3 - Monitoring workflow parameters
by a microprocessor type controller "touch screen"

Table 1

Monitoring workflow parameters

Parameter	Working range	Observations
Air velocity (m/s)	0.5 – 2.5	Set by speed electric motor.
Air inlet temperature (°C)	0 – 150	Ambient temperature.
Inlet air humidity (%RH)	0 – 100	External humidity environment.
Air temperature during drying (°C)	20 - 120	Temperature of the air entering the drying box.
Air humidity out of the dryer (%RH)	0 – 100	Humidity coming out of the dryer.
Load energy factor (%)	0 – 100	Depending on fan speed and temperature of the drying.
Weight (g)	0.0– 1000.0	Continuous measurement of mass product drying box

The laboratory test rig achieved can be used for both dry grain and vegetables and fruit.

If the initial grain moisture at harvest depends on weather conditions and harvesting. Such moisture can be 11 to 14% for cereals harvested when fully ripe and dry weather, and in case of harvesting during rainy humidity can reach 18 to 22%. To ensure conservation conditions, grain moisture should be below 14 to 15%. By entering the box product migrates outwards and grain moisture from the surface by evaporation. During drying occur simultaneously two distinct processes, namely a internal diffusion and external diffusion. Drying is all these two basic processes and speed the drying time of the slowest speed of elementary processes.

Diagram convective drying kinetics is variation in time of drying parameters. The analysis of the two graphs in (fig. 4) shows that the breast drying three distinct phases:

- The time heating of cereals, where speed of drying is an increasing trend;
- constant rate drying period;
- decreasing speed drying time.

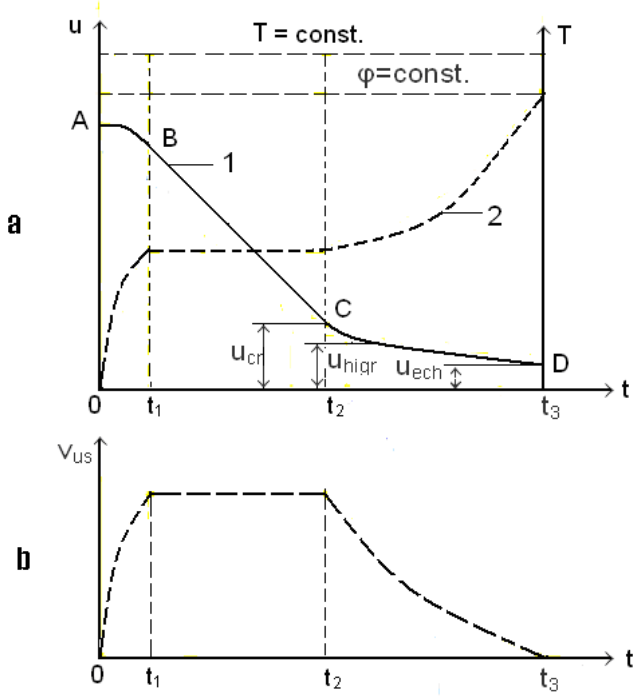


Fig. 4 - Variation of kinetic parameters defining the convective drying process: a - temperature and humidity chart: *1* – humidity curve; *2* – changes in product temperature. b - variation speed drying.

Grains to drying products are introduced into the chimney and flue weight and temperature parameters of the product and humidity are monitored continuously. Fruits and vegetables according to their structure and texture are cut into pieces to be distributed as evenly drying basket. Processes monitoring important parameters in the drying process are identical to those of the dry grain.

At the completion of the drying process monitored parameters (temperature wet weight) are transferred AUB numerical form or in the form of graphs on a PC.

CONCLUSIONS

1. Laboratory test rig is a complex installation, which can optimize workflow parameters, namely: drying temperature, drying time, drying speed etc.

2. Laboratory bench can be used for drying various agricultural products (vegetables, fruits, grains, malt etc.).

3. Registration experimental data can be transferred to external PC, including graphs of temperature and humidity evolution drying agent (input and output).

REFERENCES

1. Dieter B., Karl S., 2006 – *Heat and Mass transfer.* Ed. Springer, Germany, p. 154-160.

2. Incopera D., Bergman T. 2007 – *Fundamentals of Heat and Mass Transfer***.** Ed. John Wilwy and Sons Inc., Germany, p. 224.

3. Tenu Ioan, 2012 – *Utilaje in industria alimentară*. Note de curs.