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Narjes Malekjani, Seid Mahdi Jafari, Habibollah Mirzaee, Mohammad Hashem Rahmati

Abstract

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Keywords:

fluidized bed dryer; dehumidifier; relative humidity; temperature

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Design and Application of a Novel Dehumidifying System for a Fluidized Bed Dryer for the Drying of Canola Seeds

Narjes Malekjani[#], Seid Mahdi Jafari[#], Habibollah Mirzaee[#], Mohammad Hashem Rahmati*

[#] *Department of Food science and Technology, Gorgan university of Agricultural science & natural resources*
Basij square, Gorgan, Iran
Tel.:+989111357452, E-mail: Narges.malekjani@gmail.com

*Department of agricultural machinery engineering, Gorgan university of Agricultural science & natural resources
Basij square, Gorgan, Iran
Tel.:+989122580214, E-mail: hmrahmati@yahoo.com

Abstract⎯ **A novel fluidized bed dryer equipped with a dehumidifying system was designed and constructed. The dehumidifying system was based on refrigeration cycle and composed of an evaporator, a compressor, a condenser an expansion valve and a damper. The drying experiments were carried out in three temperature (35, 45 and 55°C) and three relative humidity (30, 50 and 70%) levels. The results showed that the relative humidity of drying air has a significant effect on drying rate. The drying rates decreased as relative humidity increased at a constant temperature, and increased as temperature increased at a constant relative humidity so dehumidifying can accelerate drying and decrease drying times.**

Keywords— **Fluidized bed dryer, Dehumidifier, Relative humidity, Temperature.**

I. INTRODUCTION

Drying is one of the most common preservation methods to prolong the shelf life of agricultural and bio origin products [1]. The drying process may influence the product properties and quality which may shrink, break or undergo rheological, physical and biochemical changes. The important parameters responsible for such changes are drying conditions, type of drying techniques and residence drying time. Among drying conditions, drying air relative humidity is an important parameter to consider that is always neglected. Humidity is more difficult to measure and control accurately compared to other parameters like temperature and air velocity [2].

Most drying experiments are conducted at an ambient humidity [6]. The advantage of conducting experiments using the same humidity as the ambient air is simplicity of the experimental set-up. It usually consists of a hygrometer for ambient humidity measurement and a heater to warm drying air to a desired temperature. However its reproducibility can be poor as the humidity of the drying air is determined by the ambient conditions, which change often. It is therefore difficult sometimes to compare the drying results.

Previously, especially for measuring the desorption isotherms for various foods, the majority of the experiments were carried out at relatively low temperatures or non controlled humidity [7]. To simulate single droplet drying kinetics accurate desorption isotherms over a wide range of relative humidities as well as those at elevated temperatures are required. The information in the temperature range of 50-90ºC and relativity humidities of up to 100% is incomplete.

There are a number of methods to produce air with known humidity [5]. In this research a novel technique is used to control the relative humidity of drying air. This technique is based on the refrigeration cycle. The use of this system enables control over the moisture content and the temperature of the process air. In this system the relative humidity of the air can be conditioned at low and high relative humidities. Using low air relative humidities in humid places (sometimes with relative humidity up to 100%) can accelerate the drying process and reduce the drying time. Also drying can be conducted at lower temperature because low relative humidity

air has a greater potential for drying and therefore it has a little impact on drying induced stresses. So it is suitable for heat sensitive products [8].

In this paper design of a dryer equipped with a novel system for controlling the relative humidity is described. The drying experiments are conducted at various temperatures and relative humidities. Then the drying curves are plotted and compared at various conditions.
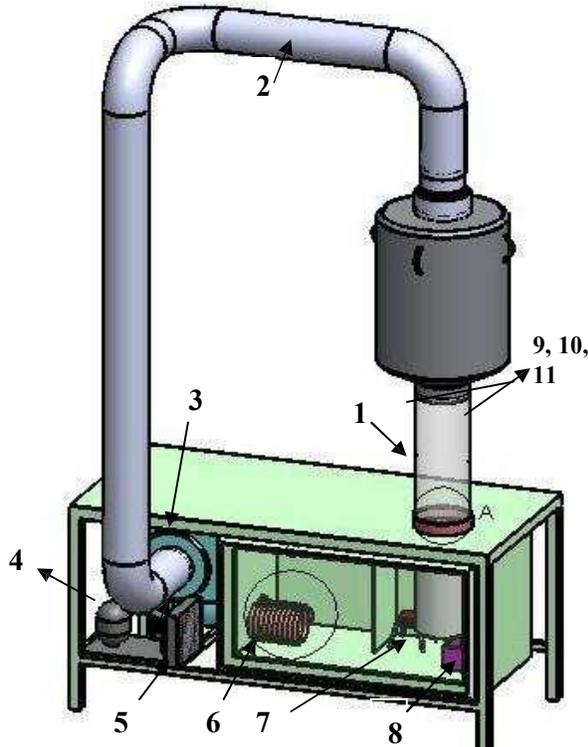

Fig. 1 Schematic of dryer apparatus; 1.The drying chamber, 2.Conecting pipes 3. Blower, 4. Compressor 5. Condenser, 6. Evaporator, 7. Heater, 8. Damper 9. Humidity sensor 10. Velocity sensor 11. Thermocouple
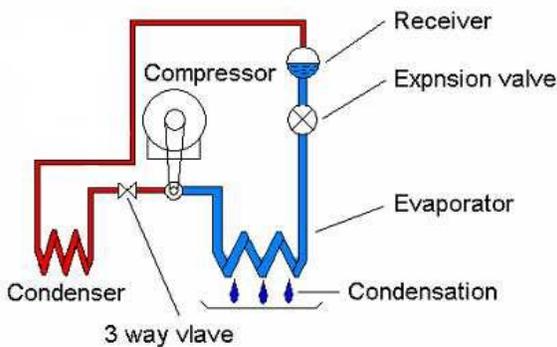

Fig. 2 Schematic of the components of dehumidifying system

II. MATERIAL AND METHODS

A. Description of the experimental set-up

The fluidized bed drying chamber receives wet solids and discharges dried products. Processed air is dehumidified by the evaporator and then is heated to a higher temperature by the heater. The air is then arrives into the fluidized bed chamber from the bottom. Moisture is transferred from the solids into the air when two phases are in contact. The schematic of dryer apparatus is shown in Fig1.

The components of dehumidifying system are shown in fig 2. This system consists of an evaporator, a compressor, a condenser and an expansion valve and a damper. The working fluid (refrigerant) at low pressure is vaporized in the evaporator by receiving heat from the surroundings. This causes temperature of the air at the surrounding to decrease. If the temperature of air is below the dewpoint, condensation occurs; the air is cooled and dehumidified. Thus evaporator acts as a condenser or dehumidifier for the air.

The working fluid then goes to compressor, where the enthalpy of the working fluid raises and discharges it as superheated vapour at high pressure. The superheated vapour then goes to the condenser; where heat is removed from the working fluid and transferred to the process air around the condenser. As a result, the temperature of the air increases. Finally, the working fluid is throttled using an expansion valve to the low pressure line and enters the evaporator to complete the cycle.

To control the humidity level at a specified point, a damper was installed in the drying apparatus. When the humidity of the air reaches the determined level, the sensor switches the damper on, and produces vapour. So the relative humidity of drying air increases up to the desired level. Then the humidifier would be switched off.

B. The drying experiments

Raw canola seed was used for drying trials, the reason for choosing this seed was the sensitivity of this seed to drying condition [9]. The seeds were cleaned and any dust, sand and external material were removed. The oven drying technique was used to measure the initial moisture content of the particles according to AOAC method 934.06 [3]. Sample weighing dishes were pre-washed, dried and kept in a desiccator with silica gel for two days prior to experimentation. Duplicated samples of 5-10 g in mass weighed by an electronic balance (sartorius, + 0.001g) were put into tared weighing dishes from the desiccator, and placed inside the oven. Moisture content was determined by measuring the loss in weight of finely chopped samples held at 105 °C for more than 24 hours. Samples were transferred from the oven to the desiccator in order to cool. When cooled, samples were weighed as quickly as possible to an accuracy of 0.1 mg.

After determining the initial moisture content, sufficient amount of water was added to the seeds to increase the moisture content to a desired level and then the seeds were kept in zipped polyethylene bags in 5 °C refrigerator and remained in room temperature 1 hour before drying experiments were carried out. The amount of added water was calculated by [4] :

$$Ww(\%d.b) \quad \frac{W_i(M_d \quad M_i)}{(100 \quad M_i)} \qquad (1)$$

During the drying experiments, the temperature of dryer was first raised to the set temperature and the steady conditions maintained for at least 2 hours before inserting the samples. The drying experiments were carried out in three temperature levels (35, 45 and 55° C) and three relative humidity levels (30, 50 and 70%). The mass of sample was measured using a digital balance, measuring to an accuracy of 0.001 g, immediately before inserting it into the dryer. Thereafter the mass was periodically taken in 10 minute intervals for 3 hours for each test by briefly removing the sample from the dryer. The velocity of the air during drying was set at 1 m/s and the sample was dried until the moisture content was 8% (db) or lower.

C. Analysis of experimental data

The analysis of variance (ANOVA) was used to evaluate differences. For all the analysis, the Statistical Analysis System software (SAS, 1985) was used.

The moisture content at any time in drying experiment was calculated by [4]:

$$M_t \quad \frac{Wi \quad Wf}{W_i} \quad 100 \qquad (2)$$

The drying curves (moisture content vs. time was plotted and drying time in different relative humidities were compared.

III. RESULTS AND DISCUSSIONS

Figure 3 shows time-course changes in the moisture content of canola seed under RHs of 30, 50 and 70% at 35, 45 and 55 °C. As expected, there is an acceleration of the drying process due to the increase of the temperature of the drying air from 35 to 55 °C. This is very obvious during the first periods of drying. The effect of air temperature is considered very important, which makes the drying temperature as the most important factor affecting drying rate.

The effect of air humidity on the acceleration of the drying process is considered, in general, as lower than that of air temperature. As expected, there is an acceleration of the drying process due to the decrease of drying air humidity from 70% to 30%.

As it is shown in table 1 the best condition for drying canola seeds in this experiment was 55 °C and 30% RH, that drying time decreased to 32 minutes. The longest drying time was occurred in 35 °C and 70% RH, That was 150 minutes. It is obvious that changing the drying condition from 35 °C and 70% RH to 55 °C and 30% RH decreases drying time about 118 minutes.

IV. CONCLUSIONS

An experimental fluidized bed dryer equipped with a dehumidifier system was constructed. The drying experiments were carried out in three temperature and air relative humidity levels. It was obvious that although the effect of drying

temperature is important, but the relative humidity of the air has also a significant role on drying rate.

Finally it can be found that the drying rates decreased as RH increased at a constant temperature, and increased as temperature increased at a constant RH.
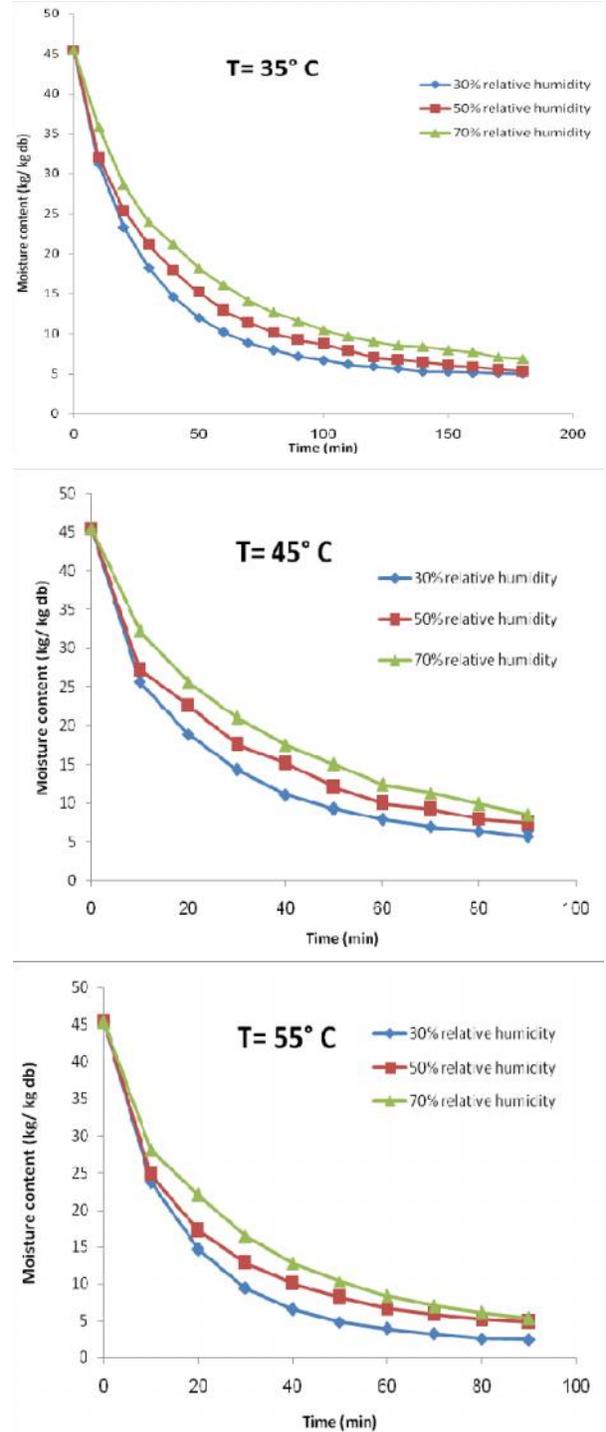

Fig. 3 Time-course changes in the moisture content of canola seed at the RH of 30% (~), 50% (&)and 70% under conditions of 35, 45 and 55 °C.

TABLE I
DRYING TIME IN DIFFERENT EXPERIMENTAL CONDITIONS

Temperature (°C)	Drying Time (min)		
	Relative Humidity (%)		
	30	50	70
35	75	105	150
45	55	80	110
55	32	49	60

NOMENCLATURE

M	moisture content	kg H_2o/kg dry matter
W	weigh	kg

Subscripts
d   desired
f   final
i   initial
w   water

REFERENCES

[1] A. Mulet, "Effect of air flow rate on carrot drying", Drying Technology, vol. 5, pp 25-258, 1987.

[2] A. Rossello ," Simple mathematical model to predict the drying rates of potatoes", Agric Food Chemical, vol. 40, pp. 2374-2378 .1992.

[3] AOAC Official method of analysis, Association of Official Analytical Chemists (No. 934.06). Arlington, VA, 1990.

[4] G.J. LoCurto, V. Zakirov, R.A. Bucklin, D.M. Hanes, A.A. Teixeira, O.R. Walton, X. Zhang, and L. Vu-Quoc" Soybean friction properties", Annual International Meeting, ASAE., Paper No. 97-4108, 1997.

[5] H.W. Cheng, G.V. Jefferys and C.J. Mumford,"A receding interface model for the drying of slurry droplets", AIChE Journal, vol.32(8), pp. 1334–1346,1986.

[6] K.J. Chua, S.K. Chou, M.N.A. Hawlader, J.C. Ho and A.S. Mujumdar, "On the study of time-varying temperature drying – effect on drying kinetics and product quality", drying Technology – An International Journal, vol. 20(8), pp. 1579-1610, 2002.

[7] M.S. Nargal and B. Oraikul, "Effect of some physical and chemical pretreatment on improvement of drying characteristics of hash-brown potatoes", Food Science Technology, vol. 33, pp. 436-439 1996.

[8] S. E. Papadakis and C. J. King, " Air temperature and humidity profiles in spray drying", Industrial and Engineering Chemistry Research, vol. 27, pp. 2116–2123, 1988.

[9] W.E. Muir and R.N. Sinha, " Theoretical rates of flow of air at near ambient conditions required to dry rapeseed", Canadian Agricultural Engineering,vol. 28, pp. 45-49,1985.

[10] Mujumdar, A.S. (2001). Drying Technology in agricul- ture and food science. Science Publishers, Inc, Enfield, USA.313 p.

[11] Swensabai, P. and Prasertsan, S. (2003).Effects of component Arrangement and Ambient and Drying conditions on the performance of Heat Pump Dryers. Drying Technology.21 (1): 103-127