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Research Article

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Analysis of moisture content of pulses pellets using fluidized bed dryer

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ABSTRACT

Fluidized is formed when solid particulate substance (usually present in a holding vessel) is placed under appropriate conditions to cause the solid/fluid mixture to behave as a fluid. This is usually possible by the introduction of pressurized fluid through the particulate medium. Fluidized bed dryer are primarily used in almost all chemical, pharmaceutical, food, dyestuff and other process industries to dry materials by fluidization with hot and/ or dehumidification air, which create a turbulence in the wet product (not totally liquid) while flowing through it. It is gives best result for powders, granules, agglomerates, and pellets with an average particle size between 50 and 5,000 microns. Very fine, light powders or highly elongated particles may require vibration for successful fluid bed drying. It is operated when moist material is feed onto a shaking perforated steel/glass bed through which the drying air flows. 'Fluidizes', the bed of material allowing intimate contact with each and every particle. On the introduction of air, shaking will occurs to the total length of the dryer bed. Moisture is removed by the flow of hot air throughout the bed having different type of grams. Air flow is controlled along the length of the dryer to maximize fluidization. After the grams moisture removed it will send to the cooling zone where hot air will be replaced by the cool ambient air, which will reduce the (desired) product temperature. The drying rate increases as increasing the velocity of the drying air, while decreases with increases solids holdup. This article deals with the study of initial and final moisture content, temperature and weight of grams or moisture content at different intervals, pressures and comparison between all the three pulses moisture content using fluidized bed dryer of split pea gram, Split Bengal gram, and Split Red gram pellets.

Key words: Fluidized bed dryer (FBD), split pea gram, Split Bengal gram, and Split Red gram

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INTRODUCTION

Fluid bed dryers are used extensively for drying of wet particulate and granular materials such as agricultural products, foods, chemicals, ceramics, minerals, and pharmaceuticals. Fluid bed systems give important advantages such as good material mixing, high rates of heat and mass transfer, low capital and maintenance costs, and ease of control and material transportation [1]. Based on moisture content of the products, drying kinetics from the text books refers constant rate period followed by falling rate period with the demarcation based on the critical moisture content. Drying of cereal grains, including rough rice, mostly occurs in the falling rate period and the moisture transfer during drying is controlled by internal moisture diffusion [2]. On the other hand, these materials have a very short duration constant rate period and a longer curvy linear falling rate period [3, 4]. The principle behind the drying process is to blow a hot gas upward through a bed of particulate material to be dried. The gas is distributed evenly through small orifices supporting the material at a rate sufficiently high to cause incipient fluidization of particles but not so high as to give the appearance of a vigorously bubbling bed. The fluidized bed drier can be operated continuous or batch wise.

The fluidized bed drier can be operated continuous or batch wise. The drying kinetics is important for the estimation of the performance of the drier. A complex transport phenomenon takes place during drying process including unsteady state heat and mass transfer which occurs simultaneously [5]**.** Heat necessary for evaporation is supplied to the particles and moisture vapor is removed from the material into the drying medium. Heat is transported by convection from the surrounding to the particle surfaces and then by conduction from there into the inside of particles. Moisture is transported in the opposite direction as a liquid or vapor on the surface evaporates and passes on to the surroundings by convection [6]**.** The heat and moisture transfer rates are related to drying air temperature and Reynolds number as a function of velocity of circulating air. Thus mass and energy balance mechanisms are involved in drying operations.

The developments of the regime of fluidization and subsequent design modifications have made fluidized bed drying a desirable choice among other driers. However the efficiency of the conventional drying system is usually low. It is therefore desirable to improve the efficiency of the drying process. Drying process has usually three typical drying rate periods [7] namely pre-warming period, constant rate and falling rate period. The different theories have been used to describe moisture evaporation in the different periods. The diffusion controls the drying process especially in the falling rate period [8]. Sender et. al. [9] reviews common air distributors used in fluidized bed drying of food particulates and also reviews special methods of fluidizing larger irregular food particulates. Depending on the size and shape of the materials, methods employed to achieve effective fluidization during fluid bed drying varies from use of simple hole distributors for small, light weight materials to special techniques for larger and/or moist materials [9].

This article deals with the drying of pulses, which are most important gram and having lost of protein and fiber. Now a day's consumption of pulses is increases as population increases. Lots of pulses destroyed due to moisture content. So, drying operation is the best way to protect the pulses from moisture.

EXPERIMENTAL SECTION

Material:
Fluidized bed dryer consist of a glass column, the conical portion, which is filled with fluidizing material. The material is supported on the screen mesh held between two flanges. Air from the compressor is heated in the heater box and passed through the column. Air rotameter is provided to measure the air flow rate. The flow rate can be adjusted by SS needle valve provided for air supply to the column. Sensors are given at different position to measure the temperature at different points.

Pulses of three different varieties (split pea gram, split bengal gram, and split red gram pulses) had been taken to know its drying rate, moisture content with respect to time and temperature. Initially take pulses of each sample and dipped it into water for 3 hrs. After 3 hrs keep that pulses into fluidized bed dryer for drying.

Method:
Take about 200gms of split pea gram, split bengal gram, and split red gram pulses. Add known amount of water in it i.e. 250ml for 3 hrs after 3 hrs that pulses will become wet and its weight as well as moisture content will increases then load the conical portion of the dryer with that wet material from the top of the column. Close the lid. Start the blower and adjust the air flow rate at the desired level i.e. 70-90 LPM. Start the heater and adjust the varies to obtain the desired air temperature (i.e. 80 to 100 ^{o}C). Allow the air to pass through the bypass line till desired air temperature is reached. Allow the hot air at prefixed flow rate and temperature to pass through the dryer. The flow rate should be sufficient to fluidize the material. At regular intervals of time interval of time take out 50 gram of wet material and weigh it. Dry it completely and weigh it again and hence record the moisture present. Repeat the procedure 1-7 times to know its moisture content at different time intervals.

There are two procedures they are:

A. Theoretical Analysis
There are two ways of specifying the moisture content [10]. Moisture content in any sample is calculated as the percentage difference between the wet weight of the sample and the dry weight of the sample. If the percentage difference is calculated relative to the wet weight of the sample, it is called the wet basis moisture content and if it is calculated relative to the dry weight of the sample, it is called the dry basis moisture content. Thus wet-weight basis (M_w) and dry-weight basis (M_d) are calculated as the following.

$$M_d = w - d/ d \quad (1)$$

$$M_w = w - d/ w \quad (2)$$

where, w = total weight of product, kg & d = weight of dry product, kg Moisture content on dry basis has been used for all calculation purpose in this paper.

B. Equilibrium moisture
Drying generally occurs in three different periods, or phases, which can be clearly defined. In first phase, the sensible heat is transferred to the product & the contained moisture, which will increases the evaporation rate & removed the free moisture. Whereas on second phase or constant rate period, drying rate are high and higher inlet air temperatures than in subsequent drying stages can be used without detrimental effect to the product and relatively small increase in the product temperature during the second period. A common interesting occurrence is that the time scale of the constant rate period may determine and affect the rate of drying in the next phase.

The third phase, or falling rate period, is the phase during which moisture migrate from the inner interstices of each particle to the outer surface becomes the limiting factor that reduces the drying rate. Drying usually occurred in the falling rate period for all materials during this investigation. The variation of average moisture content of the sample as non-dimensional moisture ratio with time of drying [11] operation is expressed as:

$$MR= M-Me/ (Mo- Me) \quad (3)$$

RESULTS AND DISCISSION

Mass in dry basis (Md): As the time increases rate of dryness also increases because the moisture is evaporated when heat will provided and best result were found among three gram i.e. in split red gram, shown in figure 1.data or values are calculated by using equation 1.

Mass in wet basis (Mw): Similarly in case of wet basis, best result is found in case of split red gram. Data's are calibrated by equation 2 and shown in figure 2.

Effect on moisture ratio: As the temperature increases the rate of drying is also increases where as moisture content ratio is continuously decreases as the time increases. The best rate of drying among them in the case of pea gram was found, shown in figure 3.Moistur ratio are calculated by using equation 3.

Effect of moisture content to the initial moisture content: Ratio between moisture content to the initial moisture content increases as the time increases and more drying will occur in case of split pea gram on comparing with others, shown in figure 4.

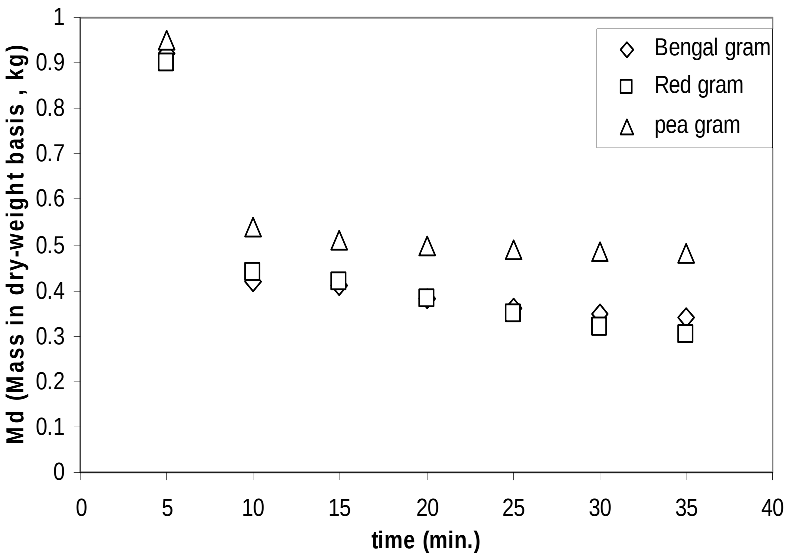

Figure 1. Graph between mass in dry weight basis, kg verses time in minutes between split Bengal gram, split red gram and split pea gram

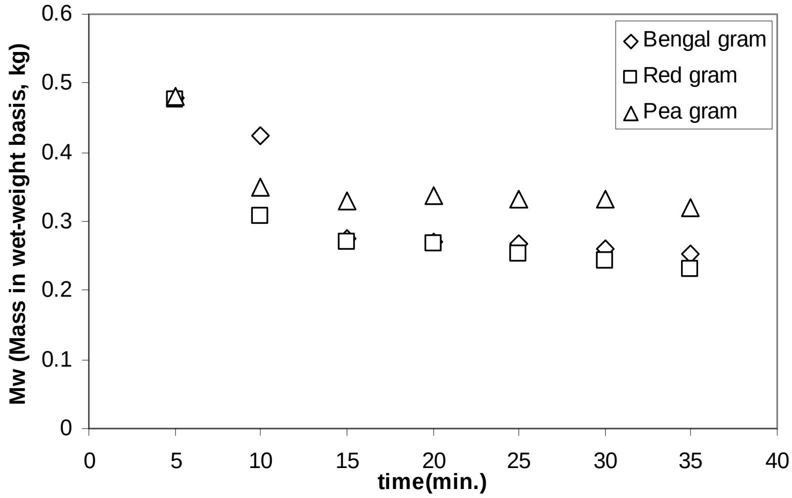

Figure 2. Graph between mass in wet weight basis, kg verses time in minutes between split Bengal gram, split red gram and split pea gram

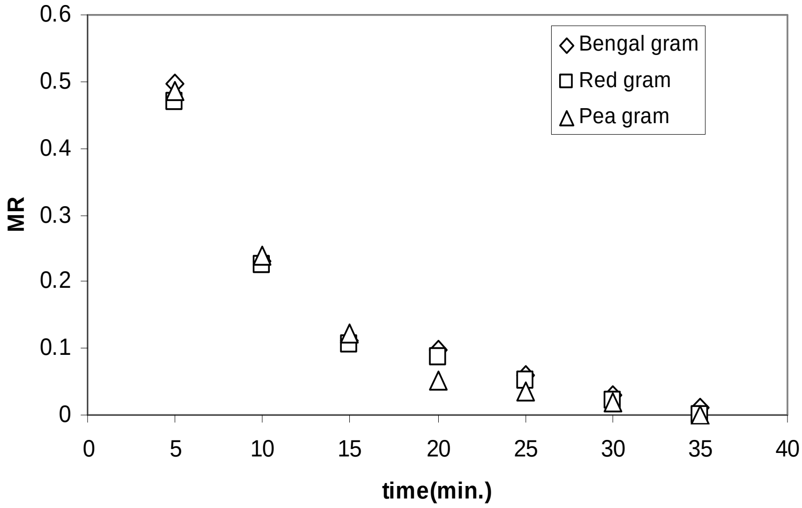

Figure 3. Graph between moisture ratio verses time in minutes between split Bengal gram, split red gram and split pea gram

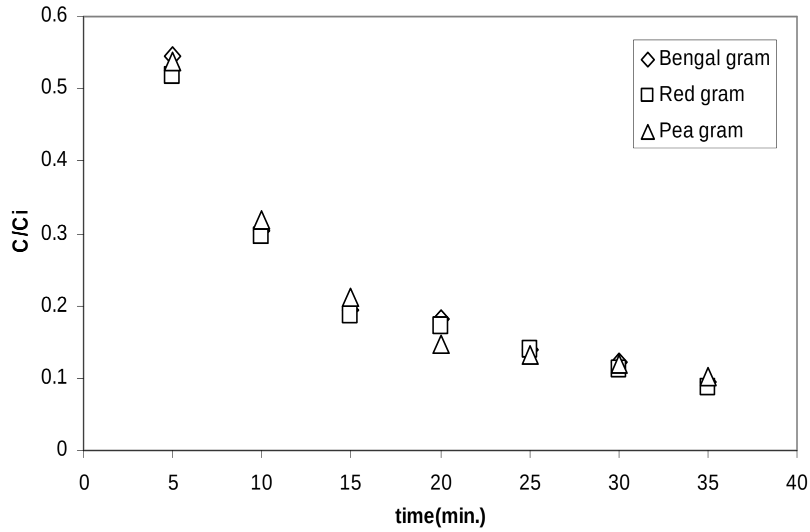

Figure 4. Graph between moisture content to the initial moisture content verses time in minutes between split Bengal gram, split red gram and split pea gram

CONCLUSION

The drying characteristics of materials (pulses granules) have been assessed in the fluidized bed dryer with respect to the various operating variables and distributor plates. The drying rate is found to increase significantly with increase in temperature and flow rate of the heating medium as the time increases. Best result were found in case for moisture ratio and initial to the final moisture content is split pea gram and split red gram is found in case of mass in dry basis and wet basis. The results can be improved by using more time intervals. The results or drying rate can be decreases when the equipment becomes over loaded.

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NOMENCLATURE
Mw: Mass in wet-weight basis, kg
Md: Mass in dry-weight basis, kg
w: Total weight , kg
d: Dry weight, kg
M: Moisture Content, % wet basis
Mo: Initial Moisture Content, % wet basis
Me: Equilibrium Moisture Content, % wet basis
MR: Moisture ratio, non-dimensional
T: drying time, min
C: moisture content (dry basis), at time t, minute.
Ci: initial moisture content (dry basis)

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