International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 7, September - 2012

Drying rate analysis of different size paddy processed under various drying conditions in L.S.U dryer

Shekhar F.Lilhare
Research Scholor,
GHRCE, Nagpur

Dr. N.G.Bawane
Principal
S.B.Jain Institute of Tech & Research

Abstract

In this paper the experimental simulation of a Louisiana state university (LSU) paddy dryer system has been presented. The continuous flow mixing type LSU grain dryer , consists of rectangular drying chamber (4.10 m ×2.35 m × 5 m), air blower powered by 40 hp squirrel cage induction motor, heat exchanger with duct , adjustable grain discharging system with hopper bottom, 32 ton installed capacity for paddy was considered for experimentation. The drying time for different size paddy in different ambient conditions have been measured. From obtained data drying rates are calculated. The graphs for drying time in minute verses moisture contents in dry basis (db), for thick and medium size paddy, drying rate (R) verses moisture contents, for thick and medium size paddy are plotted.

***Key Words:* Paddy, Thin layer drying, LSU dryer, Moisture content, Drying rate.**

1. Introduction

Parboiling of the paddy improves the milling characteristics and enhances the rice yield, without affecting chemical composition and nutritional value. The method of drying is most important process for maximizing the milling quality of the rice (Bhattacharya and Indudhara Swamy 1967).Several methods are being used for paddy drying. For parboiled paddy Louisiana state university dryer (LSU), and fluidised bed dryers are preferred by millers in India. The main reason of selection of this dryer is because of local whether condition and high amount of moisture contents of the paddy to be removed (55 to 13%). The moisture content of the raw paddy is normally less than 33% (db), and attends the high level of the moisture after parboiling .This high moisture removal of paddy need delicate drying operation. This phenomenon is very complicated and may cause the irreversible change in the physical and chemical properties of the food materials. Rice kernel is sensitive to the thermal treatment and moisture stress during drying process. Moisture removal of the agriculture product is depending on the drying temperature, relative humidity of the air, velocity of the drying air and variety of the food grain Proper drying of paddy achieves the sufficient mechanical strength for milling with minimum breakages of kernels. Whole rice and whiteness are most important qualities of the rice which gives more commercial value than the broken and partial yellow. Thin layer drying is the one of the important process for removal of high moisture from the porous media by evaporation. In this process heated air is passed through the thin layer of the paddy to remove the water content to reach the equilibrium moisture content (EMC).The EMC is useful to determine whether paddy will gain or lose moisture under a given set of temperature and relative humidity conditions. The EMC is dependent upon the temperature and relative humidity of the environment and variety of the paddy and thus it is directly related to drying and storage .

Cuto stated the various isolated and combined parameters involved in grain drying. Under hot and humid climates, it is recommended to dry the paddy with low air flow rate (near ambient air) to minimize the energy consumption and moisture gradient in the grain bed for obtaining the high head yield in milling. Somchart soponronnarit, Sutherland and Ghaly stated that the head rice yield will decrease significantly if in the first stage high moisture paddy is dried rapidly below 18-19% moisture contents. The drying requirement of the agricultural product varies from product to product. The moisture to be removed from particular product is determined by the initial moisture contents of the product and safe storage moisture content of dried product. For heated air drying operations where the drying temperature and relative humidity can be controlled, each product has its specified drying condition and drying rate for best quality. Fast rate of drying to remove the excessive moisture leads to stress cracks, but prevent the rice from yellowing. Rice is subjected to lower milling yield if it is dried so quickly. Rice quality can be maintained by drying in several 20 -30 minute long passes through a dryer. In between the passes, rice should be stored in the temporary holding bins; this is called tempering and allows moisture to equalize within kernels. (Rice quality workshop, high tempering rice drying). According to E.Barati, J.A Esfahani effect of initial temperature of grain on the energy consumption is small. Aversa M., Curcio S. et.al., have studied theoretically the model using finite element method for determination of the influence of operating variables like air flow velocity, relative humidity, and air temperature on the performance of drying process.

If the yield of the product quality in terms of the head rice yield and whiteness is to be preserved, inlet air should not be of more than 120^{0}C (Somkiat Prachayawarakorn et. al.) for superficial air velocity of 3.2 m/s, and bed depth of 0.1m.Looking in to the references it is summarised that the drying rate is depends on (1) Drying air temperature. (2) Air flow rate. (3) Relative humidity. (4) Exposure time. (5) Types and variety of grain. (6) Initial moisture contents (7) Grain bed depth

First four factors are playing more important role in drying process. Battarcharya et.al. have studied the effect of the temperature on drying process and shown that higher temperature is drying the parboiled paddy faster as compared to lower temperature. Simmonds et. al. have done the study for wheat drying rate between 21^{0}C to 77^{0}C and shown that the drying rate is depend on the temperature variation.

To study the effect of drying temperature, tempering time, and initial moisture level German et. al. conducted the experiments and found that these parameters are effecting the head rice yield and Browning Index (BI) of the rice .Based on the surface response technology, a polynomial model was obtained to predict over the wide range of effect on the drying conditions for quality variable. He further concluded that temperature has the negative influence on the head rice yield while tempering time effects positively. Similar effect of the temperature on the head rice yield was reported by Bhattacharya and Indudhara Swamy . A decrease of head yield was observed for long tempering period at 80^{0}C or above. This fact shows that the limit for both the drying and tempering periods.

The method of drying is most important process for maximizing the milling quality of the rice Bhattacharya and Indudhara Swamy.

2. Material and Method

Boiler

VEE SON'S Energy system private limited Tricharapally model FFF4 rated working pressure 150 kg /cm^2 , 2 Ton /hour capacity, is supplying the steam to heat exchanger through 75 mm diameter insulated steel pipe at a pressure of 125 kg /cm^2 .The temperature at input point to the heat exchanger is 120^{0}C .

Blower and Heat exchanger

Blower fan diameter 0 .95 m, powered by 40 hp, 1440 rpm GEC make squirrel cage induction motor .Belt and pulley system is being used for blower speed reduction. The blower is running at 900 rpm constant speed and blowing the air at the rate of 3000 m^3 /minute. The blown air allowed to pass across Usha make heat exchanger housing 90 tubes with fins, each tube is 100 cm long and 3 cm diameter. These tubes are arranged in 3 rows (30 tubes in each row)equally spaced .

Paddy samples

The heat penetration is depends on the thickness of the paddy. The local varieties of paddy samples are classified in three major categories i.e. thick, medium and thin as per thickness. Since the thin paddy's Parboiled rice is not in demand by the consumer that's why it is not processed in parboiling plant in and around vidharbha region , only thick and medium varieties are being processed.

L.S.U. Dryer

The continuous flow mixing type L.S.U. grain dryer consists of a rectangular drying chamber fitted with holding bins, air blower with duct, and grain discharging system with a hopper bottom is taken in to consideration for the study purpose .The rectangular bin is made up of 2 mm thick iron plates with the dimensions 4.10 m ×2.35 m × 5 m. The installed capacity of the dryer is 32 Ton of the paddy. One side of the dryer (opposite to the duct) is having 90 vents (10c.m. ×10c.m.) to release the air after passing through bulk paddy.

Method

The parboiled paddy with initial moisture content of 33 %(wb) is fed to the dryer chamber .The forced air at normal temperature is passed through the drying chamber to evaporate the water content (if any) for about half an hour . The steam supplied by boiler is passed through heat exchanger and forced air is flown across the heat exchanger to get heated .The hot air is supplied to the dryer through duct at 80^0C (constant). The temperature of the hot air is maintained by changing the opening of steam outlet valve manually. The heated air is blown through drying chamber continuously, to evaporate the moisture content of the paddy. Since the moisture removal is the very slow process, the recirculation of paddy is done for maintaining the uniform moisture content in the bulk paddy. The moisture content measured in the interval of every half an hour in the initial stage and after every 15 minutes in the latter stages .This process is continued till the paddy attends the desired moisture level (13-13.5 %).

3. Observations

The observations of LSU Dryer for 32 ton capacity of paddy installed at BALAJI rice mill Gankhaira distt. Gondia (Maharashtra) is recorded for thick and medium size paddy in different weather conditions. In all 50 drying performances of both size of paddy were recorded. The three observed data for extreme weather conditions for each size of paddy are chosen to analyze drying duration, and drying rate.

Medium size paddy:-

- Average ambient temperature T=28.5^0C, average relative humidity H=89%, drying time =540 minute.
- Average ambient temperature T=20.90^0C, average relative humidity H=69%, drying time =480 minute.
- Average ambient temperature T=42.5^0C, average relative humidity H=38%, drying time =465 minute.

Thick size paddy:-

- Average ambient temperature T=28 ^{0}C, average relative humidity H=89%, drying time =570 minute.
- Average ambient temperature T=23^0C, average relative humidity H=89%, Drying time =525 minute.
- Average ambient temperature T=42.5^0C, average relative humidity H=39%, drying time =480 minute.

The recorded data for drying time verses moisture contents for medium and thick paddy are shown in figure 1&2, and the calculated values of the drying rate (R) for the same samples are presented in figure 3&4.

4. Results and Conclusions

(1) It is seen that there is considerable difference in the drying time as shown in the Fig.1 & Fig.2. The drying time is varying with paddy quality and ambient condition. The drying duration is more when relative humidity is more and less ambient temperature for medium as well as thick paddy. The moisture content of the paddy decreases with increase in drying duration, but the rate of reduction in moisture contents becomes slower as the drying time progressing. The same results were obtained by G.N. Tiwari et. al. and E. Barati ,J. A.Esfahani in their study.

(2) Fig .3 & Fig .4 indicating that the drying rate increasing in the initial stage whereas moisture contents is decreasing , and it is almost constant in the middle portion of the graph while in the later stage drying rate decreasing. This is an indication of slower drying rate at lower moisture level. It is also observed that drying rate varies with ambient conditions and moisture contents. The same characteristics are quoted by A.Chakraborty and D. S. De. It is also observed that drying rate in summer season is decreasing fastest,

followed by drying rate in winter and the drying rate in the rainy season is decreasing with slowest rate.

(3) In Fig .3 & Fig .4 curves for summer season (black) is indicating that the reduction in drying rate is faster than rainy and winter season for moisture content lower than 0.275(27.5%wb),while in the rainy and winter season reduction in drying rate is almost constant for lower than 0.35(35%wb) of moisture contents.

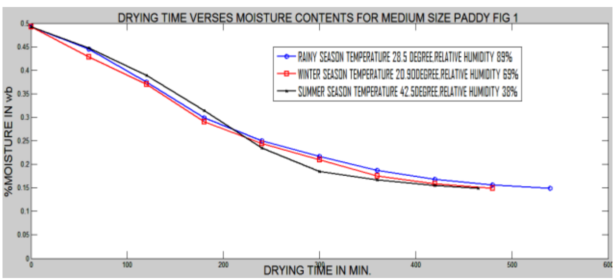

Fig .1Dring Rate v/s Moisture Content for medium sized paddy

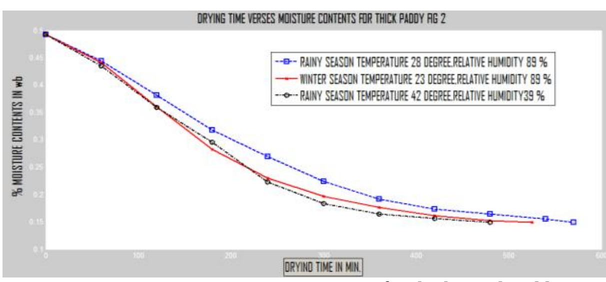

Fig .2 Dring Rate v/s Moisture Content for thick sized paddy

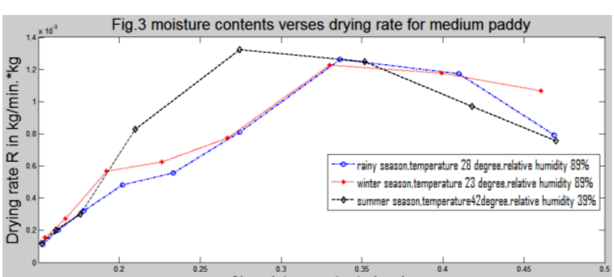

Fig .3 Avg. moisture content v/s drying rate(R) for medium paddy

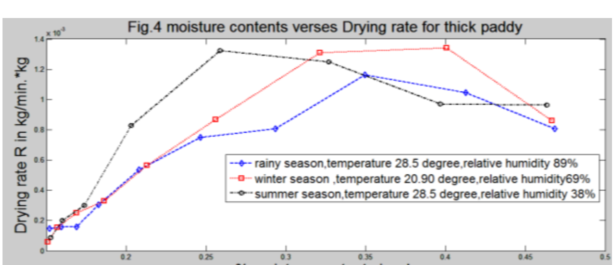

Fig.4 Avg. moisture content v/s drying rate(R) for thick paddy

Acknowledgment

Our sincere thanks to Mr Krishnakant B. Khandelwal for the facility provided in his own Rice processing plant to carry out research work and Agriculture science centre Hiwara, Affiliated to Dr. Panjabrao Deshmukh Agricultural University Akola, Maharashtra (India) to assist in weather data collection.

5. References

[1] A.Chakraborty , D S De: "Post harvest technology " Oxford and IBH publication 2008,PP-98.
[2] Chang –ho lee, Do sup Chung: Principles of grain drying and Aeration.
[3] Couto.S.M.,2002 . Modelling grain drying as discharge of an RC electrical circuit
[4] E Barati ,J A Esfahani: Mathematical modelling of convective drying :Lumped temperature and distributed moisture in slab: Energy36(2011),2294-2301.
[5] G.N.Tiwari,A.K.Singh and P.S.Bhatia "Experimental simulation of a grain drying system" ,Energy convers. Mgmt Vol. 35, No .5 pp. 453 -458, 1994.
[6] C.Igathinathane,P K Chattopadhyay (2002) Development of an Accelerated Tempering process for drying Parboilled paddy Boimass engineering (2002)83(1),97-105.
[7] Somchart Soponronnarit Fluidised bed grain drying: School of Energy and Materials King mongkut's University of Technology Thonburi Bangkok 10140 Thailand.
[8] Petcharet Jaiboon , Somkiat Prachayawarakorn ,Sakamon devahastin,Somchart Soponronnarit Effect of fluidised bed drying temperature and tempering time on quality of waxy rice Journal of food Engineering 95(2009) 517-524.
[9] C.Igathinathane,P K Chattopadhyay (2002) Development of an Accelerated Tempering process for drying Parboilled paddy Boimass engineering (2002)83(1),97-105.
[10] Somchart Soponronnarit Fluidised bed grain drying: School of Energy and Materials King mongkut's University of Technology Thonburi Bangkok 10140 Thailand.
[11] Bhattacharya K R .,and Indudhara Swamy, Y M .,(1967) Condition sof drying parboiled paddy for optimum milling quality cereal chemistry, 44.
[12] Yedollahinia A. R., M.Omid and S. Rafiee: 2008. Design and fabrication of experimental dryer fpr studying agriculture products. International journal of agriculture and biology,10:61-65.
[13]S.F.Lilhare and N.G.Bowane Classification of paddy varieties using image processing National Conference on Innovative Paradigms in Engineering & Technology (NCIPET-2012) Proceedings published by International Journal of Computer Applications® (IJCA).