NIR Enhancement of a LSU Dryer for Maize

Chanat Vipattnaporn[1], Suphan Yangyuen[1], Juckamas Laohavanich[1]

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Abstract

In the drying process of maize grains with mixed flow of plant drying, enterprises have faced problems at the outset of the drying process due to a long time required for drying high moisture grains. This research aims to develop the use of near-infrared radiation added to the mixed flow drying system, which will help increase the rate of heat exchange to reduce the grain's moisture faster. The experiment was divided into two parts 1) the principle of heating by near-infrared radiation and grains transporter and 2) the installation of the device and the testing of actual work in the factory. The zigzag pattern of the device was a developed track for the grains to turn and run through 3000 watts of near-infrared radiation power from 4 infrared lamps installed above the transport rail for longer operation time. And the installation of vibration motors could enhance a better flow in the case of high moisture maize. The zigzag tray could be installed parallel to the exit part that was connected to the bottom of bucket conveyor. The results of conducting experiments in two harvesting seasons on drying maize grains at initial moisture content of 30% wb, showed that the drying time was reduced to about 18 percent. The cost reduction in the drying cycle was about 934.54 baht per round and a breakeven point was 42 days

Keywords: maize, hot air, near infrared radiation, LSU dryer

Introduction

Maize is one of the crops important to both domestic production and export. Maize varieties are grown in countries with hot climates and are suitable for the climate in Thailand. Maize can be grown 2 times a year and can be harvested at 110 to 120 days of age[1]. In the rainy season from September to October high humidity endangers the quality of the seed corn. Rapid deterioration caused by a fungus produces aflatoxin. As a result, the quality does not meet the standard of corn production. Therefore, the post-harvest drying prior to storage is an important step in preventing the growth of fungus and microorganisms that destroy the grain quality. The proper moisture before storage is estimated at no more than 14.5 percent wet basis. In general, farmers get used to dry corn spread on the ground because it is convenient and economical but often problems are encountered during the rainy season. Drying by this method has been used instead of corn grain dryers to dry the seeds spread on the ground. The entrepreneur uses dried corn for animal feed. The mixed-flow dryers, or LSU dryer, experienced a time problem when drying corn grain with high moisture content in the first drying period. It was taking longer to dry. The cost of wasted energy increased. The researcher became interested in studying near infrared radiation with unique properties such as the ability to transfer heat directly to the material, inexpensive and could be applied with other drying techniques. This is a preliminary study.

Experimental set up

Near infrared radiation equipment was designed and built for installation with the LSU dryer. The main components include a conveyor zigzag tray to enhance the vibration

[1] *Faculty of Engineering, Mahasarakham University, Kham Riang, Kantharawichai, Maha Sarakham 44150, Thailand*

** Corresponding Author's E-mail: Chanat.vipat@yahoo.com, 0801700072*

motors ability to increase the heating period from the near infrared radiation. The near infrared radiation heating power of 3 kW from 4 lamps above the zigzag tray were set at a distance of 150 mm, which is suitable for the drying maize[1,2]. The equipment was installed between a dryer tank and bucket conveyor (Figure 1) to test the performance of the unit. This method was compared with the LSU drying system which was the original hot air drying system. The results of the study included measuring the moisture content, temperature and color value of maize grain temperature. The test was three replications of two harvesting seasons.

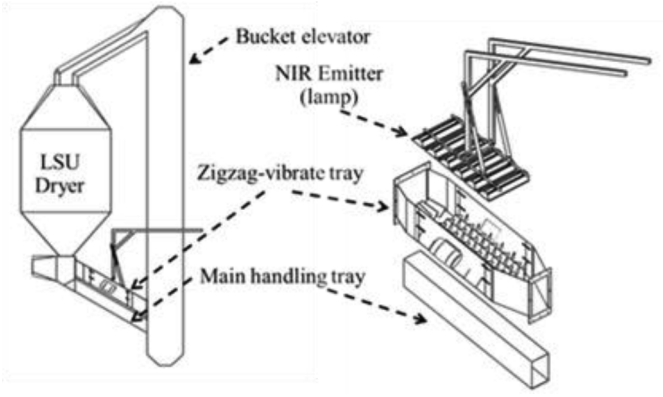

Figure 1 The installation of the near infrared radiation device with LSU dryer system

Results and Discussions

The results of near-infrared radiation equipped with LSU dryers were reported. This was a test comparison between the normal drying processes and drying with the enhancement of heat exchanging with near-infrared radiation. The results also indicated the moisture content, temperature and color values of the maize grains. The initial moisture content of corn was 30 percent wet basis. The changing moisture content of the corn grain drying system was enhanced by near-infrared radiation, and the drying period is likely to decline more than in the early part of the drying process (Figure 2). This is due to the heat exchange characteristic of infrared radiation which directly affects the maize grain.

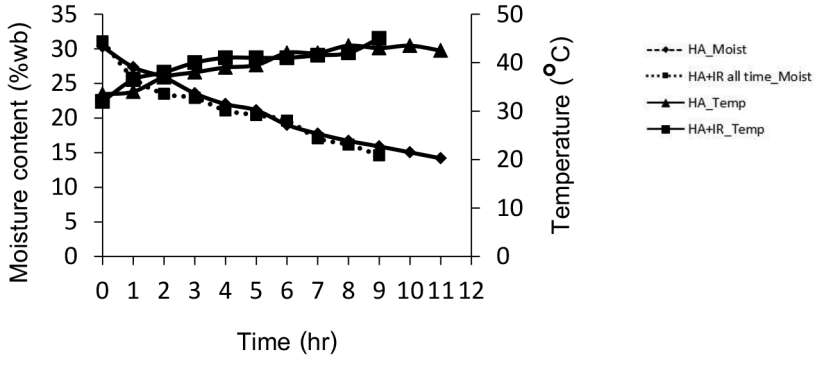

Figure 2 Moisture and temperature changing of the maize grain by near-infrared radiation all the drying time

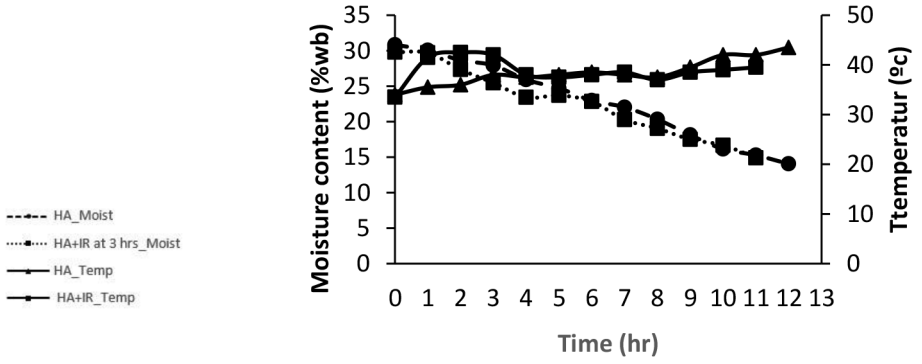

Figure 3 Moisture and temperature changing of the maize grain by near-infrared radiation for 3 hours

The study found that a heat exchanger with near-infrared radiation could shorten the drying time. The long decline could be compared with the cost of energy from the burning of corn. The comparison shows the cost of system operation and the enhancement of the heat exchanging with near-infrared radiation (Table 1).

Table 1 Cost of operation compared to enhancement of heat exchanging with near-infrared

Drying System	Cost(Baht/Cycle)		Sum(Baht)
	Electric charge	Cob cost	
Regular System	1,326.36	5,000	6,326.36
Enhanced NIR System	1,391.82	4,000	5,391.82
Variation	-65.46	+1,000	+934.54

The color values of maize grain after drying was compared by different drying methods. There was no significantly difference at 95% (Table 2).

Table 2 The average color values of maize grain of three drying conditions

Experimental conditions	Color Values		
	L*	a*	b*
After drying with HA + NIR (all time)	58.85±2.00[a]	17.90±1.80[b]	35.28±3.10[c]
After drying with HA+NIR (at 3 hrs)	59.57±2.52[a]	18.2±1.38[b]	37.28±0.17[c]
After drying with regular system HA	58.32±0.83[a]	18.13±0.90[b]	36.24±0.92[c]

Note - HA : Hot Air, NIR : Near Infrared Radiation

Conclusion

Application of near-infrared radiation for pre-heating maize was developed. The prototype set was installed with the LSU dryer at Tah Yong Limited Partnership. Then, The results of conducting experiments in two harvesting seasons on drying maize grains at initial moisture content of 30%wb, showed that the drying time was reduced to about 18 percent. The cost reduction in the drying cycle was about 934.54 baht per round and a breakeven point was 42 days

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