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Development of mobile dryer for freshly harvested paddy

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Abstract

Presently, due to an increase in usage of large scale mechanical threshers and combine harvesters, moisture content of freshly harvested paddy is being high as much as 18-24%. The mechanical threshers or combine harvesters with elevated capacity enable for both harvesting and threshing at once. Thus the paddy harvested all over persists with high moisture content that affects adversely in unit operations of paddy processing such as cleaning, storing, and milling. The research was conducted to overcome this problem by developing a mobile paddy dryer that can be used at field level for freshly harvested paddy. A mobile dryer, one ton capacity, was developed and tested for drying freshly harvested paddy. The performance of the mobile dryer was evaluated in terms of overall thermal efficiency, heat utilization factor, coefficient of performance, total heat efficiency and head rice yields. The overall thermal efficiency of this dryer was 46.83%. The average heating efficiencies namely heat utilization factor and total heat efficiency were 0.82 and 0.72 respectively. The coefficient of performance of the developed dryer was 0.18. The head rice yields of freshly harvested paddy after drying at 60 ºC air temperature was of 73.78%. The overall drying performance of the dryer was found to be good.

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Keywords: drying; movable paddy dryer; freshly harvested paddy;

1. Introduction

Excess moisture in harvested paddy if not removed quickly has an adverse effect on grain losses and milling quality of rice. Excess grain moisture can alter final characteristics of the rice.

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Short- and medium-grain varieties are generally harvested at 20 to 24 % moisture content and long-grain varieties at 18 to 21 % moisture content and this moisture levels have to be brought down to 14% or less by drying before subsequent storage and processing as quickly as possible[1]. Using combine harvesters leads to harvest paddy with high moisture content because both harvesting and threshing actions have to be done simultaneously without field drying. Farmers do not have facility to dry paddy before storing due mainly to unavailability of drying yards and dryers at farm level. At bad weather conditions, drying mats used for sun drying are rendered useless. Storing paddy with high moisture content leads to spoilage of the paddy. Microbes found on the freshly harvested paddy grow under these conditions and produce a wide variety of volatile compounds that impact the flavor/aroma of the milled rice obtained after milling of the paddy[2]. This paddy may also give higher broken rice percentage.

Hence, the Institute of Post Harvest Technology initiated this research project on development of a portable dryer for freshly harvested paddy. This study aims to develop a dryer having capacity 1 MT per batch to dry freshly harvested paddy at the field itself just after harvesting, in order to remove excess moisture of the paddy and to test the performance of the dryer with freshly harvested paddy at air flow rate of 6 m^3/min and temperature 60 ºC that is emphasized by Chakraverty and More[3] in 1983. It is expected that this developed dryer will enhance the quality of freshly harvested paddy by reducing the moisture content up to the allowable limit for safe storage thus enabling farmers to keep their paddy for longer periods. According to the Standardization of Sri Lanka, allowable limit of moisture content for storage is 14%.

2. Methodology

The dryer designed at the Institute of Post Harvest Technology, Sri Lanka consists of the following components: drying chamber, bucket elevator, suction blower, fan, kerosene burner, screw conveyer and movable gate (loading hopper) shown in figure 1. Freshly harvested paddy is fed to the screw conveyor through movable gates at both sides of the dryer. The screw conveyer at bottom of the drying chamber moves paddy to bucket elevator at front side of the dryer. The bucket elevator feeds paddy to spreader at top of the drying chamber and it is allowed to pass through the drying chamber using the gravitational force and collected by the screw conveyor. The paddy comes in contact with a cross flow of hot air and is mixed while flowing down through the drying chamber. The paddy is re-circulated until its moisture content is brought to the desired level. Suction blower removes moist air and dust from drying chamber. Bag prepared using cloth is fixed to suction blower and this bag releases cleaned air to environment while keeping dust particle in the bag.

A kerosene oil burner (Model: SL-3L, Korea) is used as an air heater in this dryer. Temperature of drying air could be controlled in this kerosene oil burner. The drying air temperature is kept at 60 ºC. Bucket elevator and screw conveyor were operated using electric motor of capacity 200 W. To determine the performance of the mobile dryer, three drying tests were conducted with mobile dryer for freshly harvested paddy at a temperature of 60 ºC. A minimum air flow rate of 6 m^3/ min was maintained for all experiments[3].

The performance of the mobile dryer was evaluated in terms of overall thermal efficiency; heat utilization factor, coefficient of performance, total heat efficiency and the head rice yields.

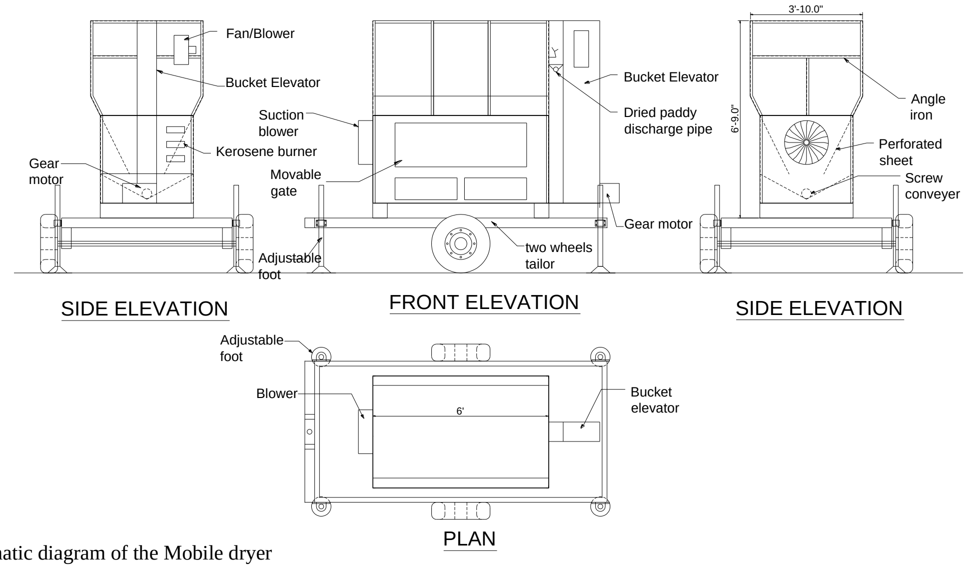

Fig. 1. Schematic diagram of the Mobile dryer

3. Results and Discussion

Efficient drying from any mobile dryer would result superior quality product within a desirable time. The overall thermal efficiency gives an idea about the amount of heat utilized against amount of heat available. The overall thermal efficiency of this dryer is 46.83%. The heat utilization factor of a dryer shows the amount of heat utilized during drying. If the paddy absorbs all heat of drying air, the heat utilization factor should approach to unity. The average heat utilization factor of this dryer was found to be 0.82 which indicates high heat utilization efficiency. The drying air temperature throughout the drying period was maintained constant with the use of temperature controllers by regulating the heat supplied to the drying air. The amount of heat utilized decreased since exhaust air temperature was increased with the progress of drying time.

The coefficient of performance normally started with a small value and gradually increased. The small value of coefficient of performance at the beginning of drying was due to the fact that the exhaust air temperature became almost equal to the ambient air temperature. The average value of coefficient of performance for the mobile dryer was about 0.18 which revealed high efficiency of the dryer. The total heat efficiency decreased with the progress of drying time. By definition, total heat efficiency is always smaller than heat utilization factor at any time. The average value of total heat efficiency for the present dryer was found to be 0.72, indicating higher efficiency.

As regards the milling quality of dried paddy, head rice yields obtained from continuous drying of freshly harvested paddy was 73.78% that is complied with the SLS for raw rice in between grade I and grade II standard. This result shows that the milling quality of freshly harvested paddy dried in the mobile dryer is quite satisfactory.

The average total drying time for drying of freshly harvested paddy was 165 minutes. The approximate drying cost is 1.70 rupees per kilogram of paddy. On the basis of overall thermal efficiency; heat utilization factor; coefficient of performance; total heat efficiency; head rice yield, it is concluded that the performance of the mobile dryer developed at Institute of Post Harvest Technology is found to be good. Hence, this dryer could be used to dry freshly harvested paddy on hiring base.

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