

Investigation on the Industrial Drying Processes

T.Venkateshan¹, M. Easwaramoorthi²

¹PG Scholar, Department of Mechanical Engineering, Nandha Engineering College, Erode, Tamilnadu, India

²Professor, Department of Mechanical Engineering, Nandha Engineering College, Erode, Tamilnadu, India

Abstract: The non-renewable energy sources, their current consumption rates and their future availability have emerged as the areas of concentration which is mainly because of the growing needs and utilizations by the population. The current target of the government and researchers is to bring about an energy source that should be an alternative option for the depleting fuels. Further, the harmful effects of these fuels have to be considerably reduced so that they are eco-friendly in nature. The intended solution for these global energy crises could be the Hybrid Solar energy systems. In order to address these facts, an industrial survey has been conducted in the peripheral areas of Perundurai, Erode District of Tamil Nadu. A batch of nearly 30 industries has been investigated for the industrial survey to understand the real condition requirements of the drying processes and to analyse the scope for implementing the alternative solutions for drying processes in these industries by means of Hybrid solar energy systems.

Keywords: solar dryers, solar air heaters, hybrid solar energy systems, drying processes, paddy processing

I. Introduction

Drying process helps in removing moisture in the products. In case of effective storage purpose, the products have to be prevented from the activities of microorganism, and in case of easy transportation purpose, the bulk weight have to be reduced. Sometimes the heat energy from the Sun may be useful for drying the wet paddy in the rice mills. In olden days, thermal food drying had been practised for many years. The thermal food drying using the energy of the Sun is a very simple method. Open sun drying is a direct mode drying in which the products are directly exposed to the sun's radiation. Otherwise, in case of the indirect mode drying, the products are kept in a drying chamber and heated directly or indirectly. The open sun drying does not require great skill; the practice has become the most preferred method in villages. But the open sun drying holds many disadvantages one of which is the poor quality of the dried products.

The harnessed thermal energy from the Solar dryer could be utilized effectively and as a result the quality of the final products could be improved. The Solar dryers have quickened the drying processes by reducing the relative humidity and increasing the mobility rate of dry air. Further, the faster drying rate prevents the risk of spoilage of products. In order to study the feasibility of implementing the Solar dryers for domestic purpose drying processes, the following work had been initiated.

In India, almost 85 million tonnes of paddy have been processed per year for the huge population (Shweta et al. 2011). Further, in the context of global energy crisis, the possibilities of reducing the consumption of energy have been explored by all the countries. The Socioeconomic development of any country strongly depends on their energy sources and their utilization. Particularly in the case of farm products like paddy, it has become very important to conserve energy by its efficient utilization (Goyal et al. 2014).

1.1 Objectives:

In view of the above facts, a study on the commercial rice mills had been conducted to perform the cost-benefit analysis of different processing methods and propose the most effective one. The objectives of this work are

- a) To study the various types of rice processing technologies.
- b) To study the electrical energy utilization for the paddy drying process.
- c) To propose improvement for the processing by means of Solar dryers.

II. Materials and Methods

Erode is one of the major paddy growing areas in Tamil Nadu and has more number of rice mills. In this district, Perundurai taluk consists of numerous rice mills which are almost getting modernised leaving only a few.

The Conventional rice mills consist of units having steel hullers for paddy processing. This has been an age old and inefficient technology. Different activities in these mills like paddy cleaning, drying, grading, rice polishing, etc., are carried out manually.

The Modern rice mills consist of the units possessing rubber roll shellers for paddy processing. This has been a modern and efficient technology. The majority of the rice mills activities have been performed with machineries like aspirators, driers, polishers, graders, etc.

2.1 Site Selection:

In this study, a batch of nearly 30 commercial rice mills in the peripheries of Perundurai Taluk had been considered and visited for the survey purposes. These mills include both traditional and modern type rice mills.

2.2 Collection of Data:

Field surveys have been conducted during the period from November 2015 to February 2016 in the selected rice mills for collecting necessary information about their energy utilization and study the processing conditions. A simple questionnaire had been prepared for this data collection purpose. The data have been collected by direct interview with the mill managers, owners, supervisors, technical persons and workers working in the mills. The relevant information provided by them were recorded and verified to be sure that the details were reasonably correct.

In case of these surveyed mills, the parboiled rice has been processed as this becomes common practice in Tamil Nadu. The parboiled rice refers to the rice that has been processed after water heating treatment (boiling/ steaming) to the paddy. In this study a comparison between the modern rice mills and traditional rice mills could be done.

III. Industrial Survey

In addition to the literature evidence, the real industrial conditions have been analyzed to focus in implementing the Solar hybrid drying systems. For this purpose, the Industrial survey regarding the energy utilization and type of processing had been carried out. The summary of the industrial survey has been provided in Table 1 and 2. In case of traditional rice mills, the electrical energy requirements for the drying process are very low as they adopt open sun drying. But in considering the modern rice mills, the blowers and dryers consume very huge electrical energy. A detailed study on the electrical and thermal energy use in selected rice mills was performed. Data on the horsepower of motors in the dryer units were also recorded. The analysis has been done considering the traditional and modern mills as separate categories. The following table lists the traditional rice mills considered for study.

[Refer Appendix – 1 for Table 1].

Table 1 explains the details considered in the traditional rice mills in which no electrical energy has been required for drying. The electrical usage mentioned in Table 1 refers to consumption for milling purposes. The Continuous Flow Dryer has been used in modern rice mills for large commercial facilities. The capacity of this dryer is approximately about 10tonne/hour. The system has positives like high capacity and automatic operations. The details corresponding to the modern rice mills are given in Table 2.

[Refer Appendix – 2 for Table - 2].

In case of Modern rice mills, the Plate fin heat exchangers are used for the drying purposes. This type of heat exchanger has been used in the dryer setup which is very essential for drying boiled paddy products before milling process.

The details provided in Table 2 explain the amount of energy consumed in the modern rice mill operations. The modern rice mills have been in need of more electrical energy for the drying purposes. The electrical usage mentioned in Table 2 refers to consumption for drying and milling purposes. The dryer setup used in modern rice mills is shown in Figure 1.



Figure 1: The Dryer Setup

The dryer setup shown in Figure 1 refers to the Plate fin Heat Exchanger for drying the paddy after crossing the stage of the blower. Further, the heat energy supplied to the dryers refers to the heat energy from the steam supplied from a boiler. This heat energy has been extracted by using Heat Exchanger.

IV. Energy Utilization

The energy utilized in the rice mills has been estimated considering the electrical and thermal energy neglecting the manual energy. The electrical energy consumed had been referred in terms of kilowatt hours. The thermal energy required for processing had been referred in terms of kilowatt hours or kilojoules. The energy consumed in Traditional rice mills had been shown in Figure 2.

4.1 Energy consumption in Traditional Rice Mills:

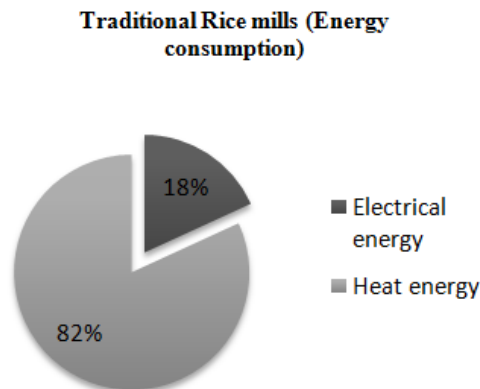


Figure 2: Energy Consumption Chart in Traditional Mills

Figure 2 explains the electrical and energy consumption in the traditional rice mills. There is no requirement of electrical energy for paddy drying in these mills. The electrical usage mentioned in Table 1 refers to consumption for milling purpose. Further, the heat energy supplied refers the energy from fuel combustion provided for steaming (boiling) the paddy. Since, the open sun drying has been followed here; the heat energy for drying the products is not required. The average electrical energy consumption for milling the rice is about 100 kWh/ tonne to 225 kWh/ tonne. The average heat energy supplied for boiling the paddy had been found to be in the range of 600 to 750 kWh/ tonne. The energy consumed in Modern Rice Mills had been shown in Figure 3.

4.2 Energy consumption in Modern Rice Mills:

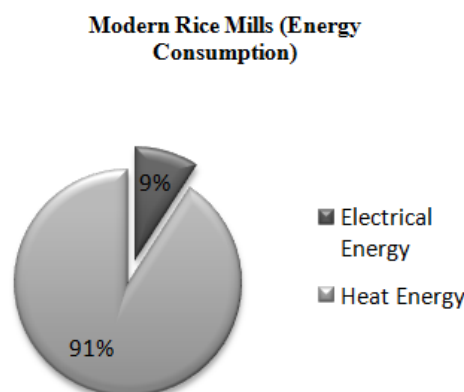


Figure 3: Energy consumption chart in Modern Rice Mills

The chart given in Figure 3 explains the amount of energy consumed in the modern rice mill operations. The modern rice mills have been in need of more electrical energy for the drying purposes. The electrical usage mentioned in the case of these mills refers to consumption for drying and milling purposes. Further, the heat energy supplied refers the energy from fuel combustion provided for steaming (boiling) and drying the paddy. The heat energy has been supplied for drying the products in these mills by means of blowers. The average electrical energy consumption for drying and milling the paddy is about 100 kWh/ tonne to 250 kWh/ tonne. The average heat energy supplied for boiling and drying the paddy had been found to be in the range of 1100 kWh/ tonne to 1360 kWh/ tonne.

V. Conclusions and Future Works

The efficient energy utilization in the rice mills is a great challenging task to the researchers. The modern rice industries consume a large amount of energy in comparison with the traditional rice mills. This is evident in the chart shown in Figure 4.

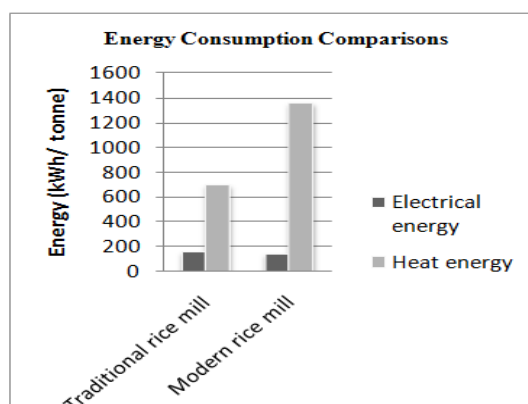


Figure 4: Energy consumption comparisons between Traditional and Modern Rice Mills

The chart in Figure 4 explains that the amount of heat energy required in Traditional mills is almost half of the energy required in the case of modern mills. Thus, by means of energy conservation in the rice industry, the consumption of fuels and electricity could be reduced. This survey will help in proposing the alternate energy source (Solar energy) for requirement of heat energy which is to assist in boiling and drying.

The following conclusions could be arrived with this survey.

- It is observed that a temperature rise of about 60 to 70°C could be achieved by Solar dryers.
- Additional thermal energy required for processing could be achieved by Fuel combustion process.
- The Solar and Fuel combustion system could be used as a Hybrid energy system.
- Almost 40 to 45% energy consumptions in the modern rice mills could be compensated by this system.

Thus, by the applications of Energy substitute technologies and better planning, the industrial energy crisis could be easily solved. The modern rice mills, which consume more thermal energy, could not be compared with the traditional rice mills in terms of their capacity. Furthermore, in the study area, the modern rice mills are found to be dominating among other types of mills. Since a major share of paddy had been found to be processed by modern rice mills, there is a lot of scope in the implementation of the Hybrid Solar Energy systems in these rice mills.

The following works could be considered in addition to the current work in the future.

- The feasibility of implementing the Solar dryer systems in other drying processes like coconut drying, turmeric curing fields could be surveyed.
- The research work to bring about the Solar water heater into operations in the Rice mills could be considered.
- The experimental analysis has to be carried out to understand the efficiency and performance of the systems.
- The Phase change materials could be considered in the system to bring about the Uniformity of the temperature in the Solar dryer system.

Acknowledgements

Author is heartily thankful to Dr. M. Easwaramoorthi, Dean and Professor, Department of Mechanical Engineering, Nandha Engineering College (Autonomous), Erode District, Tamil Nadu for his continuous advice, guidance and encouragement for preparing this manuscript.

References

- [1] M. K. Shweta, S. B. Mahajanashetti and N. M. Kerur. 2011. "Economics of paddy processing: a comparative analysis of conventional and modern rice mills." *Karnataka Journal of Agricultural Science* 24(3): 331–335. <http://web.inflibnet.ac.in/ojs/index.php/KJAS/article/download/730/677>.
- [2] S. K. Goyal, S. V. Jogdand and A. K. Agrawal. 2014. "Energy use pattern in rice milling industries - a critical appraisal." *Journal of Food Science and Technology* 51 (11): 2907 – 2916. doi:10.1007/s13197-012-0747-3.
- [3] www.woodenergy.ie
- [4] http://www.worldenergy.org/publications/survey_of_energy_resources_2007/625.asp
- [5] <http://www.knowledgebank.irri.org/rkb/index.php/rice-milling/commercial-rice-milling-systems/husking>

Appendix – 1:

Table 1: Details collected in industrial survey (Traditional mills):

Company Name	Plant Capacity Boiler Type (Capacity tonne)	Total Plant Capacity (hp)	Electricity Usage		Heat Energy (kWh/ tonne)
			(kWh/ month)	(kWh/ tonne)	
Palaniandavar Rice Mill, Nasayanur	4 Steam(1.0)	80	2150	67.18	750.00
P.S.R Rice Mill, Chengapalli	4 Steam(1.0)	20	4000	125.00	687.50
P.R.P Modern Rice Mill, Chengapalli	3 Steam(1.0)	20	3500	145.83	625.00
Kittusamy Rice Mill, Chengapalli	3 Steam(1.0)	30	5000	208.50	833.30
Lakshmi Rice Mill, Vellore	3 Steam(1.5)	50	5500	225.00	583.30

Appendix – 2:

Table 2: Details collected in industrial survey (Modern Rice mills):

S.No	Company Name	Plant Capacity (tonne)	Boiler Type (Capacity tonne)	Total Plant (hp)	Dryer (hp)	Electricity Usage		Heat Energy (kWh/ tonne)
						kWh/ month	kWh/ tonne	
1	K.S.V Modern Rice Mill, Perundurai	12	Steam(2.0)	125	16	14000	145.83	1250.00
2	Thirupathi Modern Rice Mill, Seenapuram	40	Steam(3.5)	300	30	30000	93.75	1340.00
3	Saraswathi Rice Mill, Perundurai	13	Steam(2.0)	120	17	14500	139.37	1346.10
4	Palaniyammal Rice Mill, Gobi	16.5	Steam(3.0)	200	40	21500	162.87	1287.80
5	S.S.M Modern Rice Mill, Kanchikovil	16	Steam(2.5)	150	18	7150	55.87	1171.80
6	S.V.S Modern Rice Mill, Kanchikovil	40	Steam(4.0)	149	24	23000	71.87	1218.70
7	Palanimurugan Rice Mill, Gobi	12	Steam(2.0)	100	20	11500	119.78	1250.00
8	Arun Karthick Hi-Tech Modern Rice Mill, Thingalur	18	Steam(3.0)	150	15	17150	119.09	1388.8
9	Sri Arumugam Rice Mill, Modachur	12	Steam(1.5)	120	20	13570	141.35	1458.3
10	Sengodappan Rice Mill, Modachur	16.5	Steam(1.5)	145	15	12000	90.90	1212.1
11	Kanthapa Modern Rice Mill, Thingalur	15	Steam(3.0)	165	15	21400	178.47	1333.30
12	Sri Murugan Rice Mill, Kanchikovil	24	Steam(2.5)	147	23	28570	148.80	1416.60
13	Brinthavan Modern Rice Mill, Gobi	14	Steam(4.0)	140	17	17000	151.78	1339.20
14	Periyasamy Rice Mill, Gobi	14	Steam(2.0)	135	20	12850	114.73	1517.80
S.No	Company Name	Plant Capacity (tonne)	Boiler Type (Capacity tonne)	Total Plant (hp)	Dryer (hp)	Electricity Usage		Heat Energy (kWh/ tonne)
						kWh/ month	kWh/ tonne	
15	Kathiravan Rice Mill, Modachur	13	Steam(2.0)	150	15	21400	205.70	1538.40
16	Dhanalakshmi Rice Mill, Gobi	13.5	Steam(1.5)	112	14	10500	97.21	1296.20
17	Vigneshwara Rice Mill, Chengapalli	2.2	Steam(1.0)	60	10	4285	243.60	1704.50
18	Sri Shiva Shakthi Rice Mill, Chengapalli	4.8	Steam(1.5)	60	12	8200	213.54	1302.00
19	M.M.K Modern Rice Mill, Nasayanur	13	Steam(2.0)	125	17	15700	150.95	1250.00
20	Govithammal Rice Mill, Gobi	15	Steam(2.0)	120	16	13500	112.50	1333.30
21	Sri Shakthi Rice Mill, Karukampalli	21	Steam(2.5)	135	20	18750	111.62	1428.50
22	Sri Vengadeswara Rice Mill, Kavinthapadi	38	Steam(3.5)	280	35	28000	125.00	1513.10