

Performance Evaluation Of A Grain (Maize) Solar Dryer

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Abstract: Drying under direct sunlight is one of the oldest techniques used by mankind to preserve Agriculture based food and non-food products. This paper focused on the use of solar dryer to reduce the moisture content of Agriculture produce such as maize. The experiment performed showed the moisture content of maize reduced from 20% to 13%. It was also observed that the temperature increased with time. The assumed maximum temperature of the collector plate in the experiment was 100%.

Index Terms: Solar radiation, Temperature, Moisture, Time, Drying

1 INTRODUCTION

Preservation of fruits, vegetables, and food are essential for keeping them for a long time without further deterioration in the quality of the product [1]. Several process technologies have been employed on an industrial scale to preserve food products; the major ones are canning, freezing, and dehydration [2]. Among these, drying is especially suited for developing countries with poorly established low-temperature and thermal processing facilities [3]. It offers a highly effective and practical means of preservation to reduce post harvest losses and offset the shortages in supply. Drying is a simple process of moisture removal from a product in order to reach the desired moisture content and is an energy intensive operation. Solar energy is fast becoming a welcome alternative source and hazard free heat source; especially in the tropics [4]. It has a further advantage of availability and positive health implications [5]. This work is centered on the performance evaluation of a solar dryer, natural convection type with a one-glass cover absorber plate for the preservation of crops (maize), designed for the rural farmers. The dryer consists of a flat plate collector made of corrugated iron sheet measuring (900mm x 350mm) coated with dull black paint and a glass cover measuring (900mm x 360mm) was used as top cover. The drying chamber measuring (250 x 520 x 560) fabricated with wood and partitioned into four sections. The absorber is made up of wood, corrugated iron.

2 MATERIALS AND METHODS

2.1 Collection of grain

The maize used for this experiment was collected from Ugwuoke's farm in Iheakpu-Awka, Igbo Eze South Local Government Area of Enugu State, Nigeria.

2.2 Instrument used

The instruments used for this experiment include the following: A stopwatch (2) Three thermometers (3) Stone Gravel painted black

2.3 Parameter measured

Inlet temperature to collector, T_{ci}
 Outlet temperature from collector, T_{co} .
 Outlet temperature from drying, T_{do}
 Ambient temperature, $T_a = 30^\circ\text{C}$
 over plate temperature, T_c
 Absorber plate temperature, T_p
 Absorber plate temperature with stone... (T_{psc}) collector
 Time of smoke reaching collector outlet, t_c
 Absorber stone temperature in the drying chamber, T_s
 Total time for smoke to travel from collector inlet to chimney exist, t_t
 Time for smoke to travel from inlet to drying chamber to chimney outlet, t_o
 Assumed maximum temperature of absorber plate, $T_p = 100^\circ\text{C}$ [6]

2.4 Methods

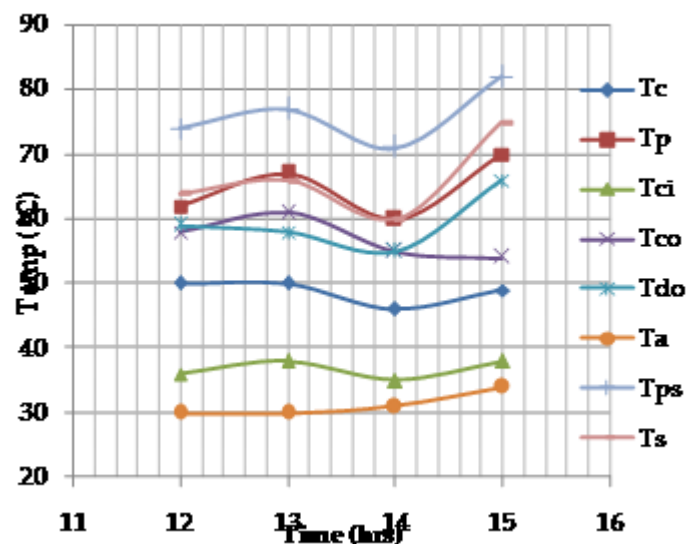
One thermometer was placed permanently at the control gate, which was opened fully throughout the test. The thermometer could be read from the transparent glass cover plate. It recorded T_{co} . The other thermometers were used to the other temperature readings at their appropriate points. Smoke was used to measure the velocity of heated air flow both in the collector and the drying chamber. The time t_d was recorded by subtracting t_c from t_t as $(t_t - t_c)$. Where;
 t_t = Time the smoke entered the collector and
 t_c = Time the smoke left the dryer

3.0 RESULTS AND DISCUSSIONS

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Table 1: Temperature as obtained on 15th Jan. 2015

Time of day	T _C (°C)	T _P (°C)	T _{Ci} (°C)	T _{CO} (°C)	T _{do} (°C)	T _a (°C)	T _c (s)	T _t (s)	T _d (s)	T _{PS} (°C)	T _s (°C)
12:00pm	50	62	36	58	59	30	-	-	-	74	64
1:00pm	50	67	38	61	58	30	4	20	16	77	66
2:00pm	46	60	35	55	55	31	-	-	-	71	60
3:00pm	49	70	38	64	66	34	5	23	18	82	75

**Figure 1: Graph of Temperature(°C) verses Time (hrs).**

From the graph above, it indicates that the temperature of samples increases with increase in time (i.e. the later time implies the Sun is hotter than the earlier times). Therefore, the grains dry faster when the temperature increases in a sunny day.

Table 2: Temperature as obtained on 16th Jan. 2015

Time of Day	T _C (°C)	T _P (°C)	T _{Ci} (°C)	T _{CO} (°C)	T _{do} (°C)	T _a (°C)	t _c (s)	T _t (s)	T _d (s)	T _s (°C)	T _{ps} (°C)
10:00am	40	49	35	52	50	30	-	-	-	50	58
11:00am	42	52	34	54	54	32	4	24	20	55	61
12:00pm	49	61	38	58	60	30	-	-	-	64	72
1:00pm	50	66	38	60	63	31	5	27	22	66	74
2:00pm	46	60	36	56	55	33	-	-	-	61	70
3:00pm	48	72	38	62	62	34	4	22	18	72	81

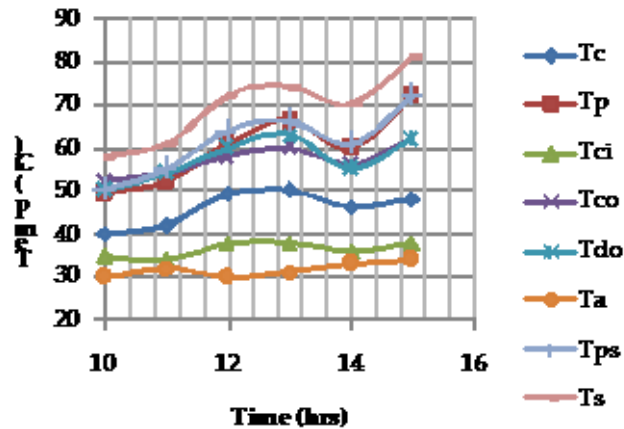


Figure 2: Graph of Temperature (°C) Verse Time (hrs)

Also, from fig 2 above, it indicates that the temperature of samples increases with increase in time (i.e. the later time implies the Sun is hotter than the earlier times). Therefore, the grains dry faster when the temperature increases in a sunny day.

4.0 CONCLUSION

The result obtained after test showed that the dryer achieved good drying result for the products (millet) in the drying chamber. The stone (painted black) placed in the drying chamber which is capable of absorbing enough heat during the day (sunny) which could be released to the drying products during inclement weather. Using the dryer, it was possible to dry the millet. The millet which initially had a water content of 20% was reduced to 13% after drying for 3 hours on 16th of January 2015.

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