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Abstract

Solar dryers convert solar energy from the sun to heat, are constructed with different materials, by using glass, mirror, metal, and aluminium to support the frame. Four experimental solar dryers were designed, built and evaluated, by using glass of 4mm thickness, metal, mirror of 2mm thickness. The solar dryers have cubical shape with the dimension of 0.50m length, 0.50m breadth and a height of 0.50m. Different type of solar dryers constructed for heat trapping ware, transparent glass dryer and transparent glass dryer with mirror base, black metallic dryer and black coated glass dryer. Each of the dryer has Vent hole through which the digital thermometer was inserted in other to record change in temperature every hour from 6:00AM to 6:00PM, for five days. The results of the work showed that, transparent glass dryer with mirror base, had the maximum average temperature which was recorded as 68.5^{o}c. The black coated glass dryer had the least records of average heat trapping of 54.0^{o}c. The order of their average heat trapping is transparent glass with mirror base, transparent glass, black metallic, and black coated glass dryers. From the result, transparent glass dryer with mirror base is useful for drying farm produce and other materials at fastest rate because of the maximum temperature trapped in the dryer.

Keywords: Temperature, Transparent Glass, Mirror Base, Glass Dryers, Black Metallic and Black Coated.

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Introduction

A solar dryer converts solar energy from the sun, to heat. Solar energy is created deep within the core of the Sun. It is here that the temperature (15,000,000ºc) and pressure (340 billion time Earth's air pressure at sea level) is so intense that nuclear reactions take place. (Solarviews, 2009). The sun has a mass of (kg) 1.989e+30, with an equatorial radius of 695,000(km), mean density of (gm./cm^3)1.410, with a rotational period 25 – 36 (days), escape velocity of 618.02 (km/sec), luminosity of about 3.827e33 (erg/sec), Magnitude of -26.8 (Vo), and has been in existence for about 4.5 billion years. The Sun's outer visible layer is called the photosphere and has approximately a black – body spectrum that indicates its temperature which is about 6,000ºc. (Wikipedia, 2010). Solar energy is produced at the core of the sun by nuclear fusion. This energy is them radiated to the convection zone, where mixing transfers the energy to the photosphere. The photosphere is the surface that emits solar radiation to space. As solar energy is incident on the surface of the dryer, some portion are reflected and scattered, while the other portion are absorbed and transmitted. The rate at which these processes takes place depends on the materials used and which characterizes the solar dryer. (www.eoearth.org/article/solar_ radiation)

Materials and Methods

Four experimental solar dryers were constructed using glass, and metal in cubical shape with the dimension of 0.50m length, 0.50m breadth and a height of 0.50m. The first solar dryer was made up of pure transparent glass of 4mm thickness. The second solar dryer was made up of transparent glass of 4mm thickness with the base been made up of mirror of 2mm thickness, The third solar dryer was made up of transparent glass of 4mm thickness painted black at the exterior to make the dryer a blackbody. The fourth solar dryer was made up of metal sheet painted black at the exterior to maximize heat absorption of the metallic material. One hole of 0.01m (diameter) was drilled on two opposite sides of each dryer for exchange of air and for insertion of the thermometer probe for obtaining temperature of the trapped heat. The metallic dryer was well weldered and the openings of the glasses were well filled with glass gum to avoid heat losses to the surroundings.

The four dryers ware placed on opened ground for maximum absorption of heat energy from the sun, probe of digital thermometer was inserted through one of the holes of each dryer to obtain temperature readings. The digital thermometer was used to measure the temperature of the core of each dryer from 6:00am, to 6:00pm, daily, on hourly basis for five days to determine increase in temperature between sunrise and sunset. The thermometer used has a range of -50ºC to 750ºc with a standard error of 1ºc.

Results and Discussion

From the results obtained, the transparent glass with base mirror solar dryer (A) was found to always have the highest temperature followed by the transparent glass solar dryer, and the black metallic solar dryer, then the black coated glass solar dryer which have the least temperature which is more than the ambient temperature. From the overall performances of the solar dryers, the transparent glass with base mirror solar dryer (A) was always found to have the highest rate of temperature, followed by the transparent glass solar dryer (B), the black metallic solar dryer (C) and the black coated glass solar dryer (D) have the least rate of temperature. The black coated glass solar dryer's (D) rate of temperature is higher than the open air rate of temperature which showed that the dryer is active and better than the open air drying.

It was observed that temperature was at maximum at 2:00 pm on 16/03/2012, at 3:00 pm on 17/03/2012, at 2:00 pm on 18/03/2012, at 3:00 pm on 19/03/2012, at 4:00 pm on 20/03/2012, variation in time with temperature depended on atmospheric condition of the day. Temperature is increasing gradually from 6:00am to maximum temperature at 2:00 pm or 3:00 pm or 4:00 pm, and reducing at any of the aforementioned hours to the minimum at 6:00 pm, because it depended on whether condition of the day. It was also observed from the graph that, the temperature of the dryer was increasing and decreasing according to the intensity of the sun on the each dryer.

Conclusion and Recommendations

From the earlier discussion, it was shown that the temperatures in the solar dryers are relatively higher than that of the open air (ambient temperature). In this work it was found that transparent glass with base mirror dryer always had the maximum temperature records on each day of experimental period. The black coated glass dryer always had the least records of heat trapped through the period. The order of their mean heat trapped is 68.5126ºC for transparent glass with base mirror dryer, 65.2225ºC for transparent glass dryer, 57.5031ºC for black metallic dryer and 53.9779ºC for black coated glass dryer, respectively. It is obvious from the data that the temperature of the dryer changes as the intensity of the sun changes, this characteristic cause fluctuation in the data analysed as shown in the graph. Therefore as solar energy is incident on the surface of the dryer, some portion are reflected and scattered, while the other portion are absorbed and transmitted. The rate at which these processes takes place depends on the materials used, which characterizes the solar dryer. (www.eoearth.org/article/solar_ radiation). It is recommended that, the transparent glass with base mirror dryer is the best, and fastest of four constructed dryers for drying agricultural produce and foods for storage as direct solar radiations would not seriously affect the flavour, texture, colour and nutritional contents of the food. (Kendell P. and Allen L. 1998). It has been proven medically that, foods been preserved chemically are not too good for health as they all have side effects like cancer. Nutritionally, dried food is ranked by the United States Food and Drug Agency better than canned food. Kerr (1999)

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Tables

Table 1: Change in temperature (^{o}c) with time on 16/03/12

TIME (s)	A (^{O}C)	B (^{O}C)	C (^{O}C)	D (^{O}C)
06:00(AM)	4.1048	4.1048	4.1048	4.1048
07:00(AM)	4.1048	4.1048	4.1048	4.1048
08:00(AM)	13.4950	12.7037	12.0941	11.4893
09:00(AM)	16.8741	15.0164	15.7032	12.2375
10:00(AM)	40.163	38.7747	36.8173	34.1248
11:00(AM)	59.3073	56.1586	47.0561	37.9658
12:00(PM)	66.698	62.4762	56.1026	51.0164
01:00(PM)	68.9252	63.7348	54.7229	52.4718
02:00(PM)	73.1894	67.1418	62.6137	58.3163
03:00(PM)	72.518	65.1742	60.4582	59.0953
04:00(PM)	60.9361	60.7358	58.9367	58.2659
05:00(PM)	50.6664	50.1047	49.8160	49.3729
06:00(PM)	32.9048	32.6309	32.4792	32.0001

Table 2: Change in temperature (^{o}c) with time on 17/03/12

TIME (s)	A (^{O}C)	B (^{O}C)	C (^{O}C)	D (^{O}C)
06:00(AM)	3.7815	3.7815	3.7815	3.7815
07:00(AM)	3.7815	3.7815	3.7815	3.7815
08:00(AM)	12.6392	9.9356	9.2184	6.8873
09:00(AM)	31.2944	28.4892	24.1841	18.261
10:00(AM)	38.6204	36.5205	27.1492	26.4810
11:00(AM)	49.2447	48.5189	36.4891	29.9578
12:00(PM)	56.7041	53.5832	35.836	26.9858
01:00(PM)	57.3586	55.1638	38.3810	30.8426
02:00(PM)	63.0524	62.6184	51.7390	45.0141
03:00(PM)	66.3589	63.7997	54.9468	47.2084
04:00(PM)	64.3268	61.4136	55.0131	54.2105
05:00(PM)	50.1583	48.1204	44.6105	40.0316
06:00(PM)	34.7248	33.9957	31.6452	29.9034

Table 3: Change in temperature (^{o}C) with time on 18/0312

TIME (s)	A (^{O}C)	B (^{O}C)	C (^{O}C)	D (^{O}C)
06:00(AM)	3.9470	3.9470	3.9470	3.9470
07:00(AM)	3.9470	3.9470	3.9470	3.9470
08:00(AM)	7.2753	6.9534	6.4753	5.8476
09:00(AM)	18.4633	18.0635	17.5285	14.3624
10:00(AM)	28.5725	24.5735	24.1633	18.2638
11:00(AM)	43.7957	41.6537	33.9461	22.6385
12:00(PM)	48.4527	45.2744	42.3513	27.3963
01:00(PM)	44.7399	42.8539	38.9653	25.6946
02:00(PM)	61.0963	58.1096	42.9362	39.0753
03:00(PM)	59.4274	56.3487	40.5148	37.0664
04:00(PM)	68.1443	64.0348	48.0421	44.0634
05:00(PM)	57.3375	55.7421	40.0143	36.8154
06:00(PM)	39.4673	38.6819	36.5624	34.9064

Table 4: Change in temperature (^{o}C) with time on 19/0312

TIME (s)	A (^{O}C)	B (^{O}C)	C (^{O}C)	D (^{O}C)
06:00(AM)	4.9452	4.9452	4.9452	4.9452
07:00(AM)	4.9452	4.9452	4.9452	4.9452
08:00(AM)	12.7832	11.8490	10.5832	10.1408
09:00(AM)	32.8462	11.8645	24.2865	28.5749
10:00(AM)	40.6349	29.1032	26.3696	25.4495
11:00(AM)	51.0635	38.4222	38.7955	32.4589
12:00(PM)	56.7319	49.6289	36.4587	30.7452
01:00(PM)	57.9087	54.3953	37.9946	35.8493
02:00(PM)	64.8923	56.0267	51.6738	45.2687
03:00(PM)	66.5318	62.7590	55.4824	48.7451
04:00(PM)	63.3275	63.8936	56.0317	46.7809
05:00(PM)	52.4087	50.3852	49.3385	44.7137
06:00(PM)	29.9461	24.7256	22.8428	19.5584

Table 5: Change in temperature (^{o}c) with time on 20/0312

TIME (s)	A (^{O}C)	B (^{O}C)	C (^{O}C)	D (^{O}C)
06:00(AM)	4.7457	4.7457	4.7457	4.7457
07:00(AM)	4.7457	4.7457	4.7457	4.7457
08:00(AM)	18.2538	15.9363	14.7147	14.0147
09:00(AM)	39.4634	34.7382	30.4183	27.1047
10:00(AM)	44.7145	41.3378	38.8145	32.8631
11:00(AM)	56.8157	54.0146	47.4666	42.5374
12:00(PM)	59.4213	56.5483	53.8914	50.2663
01:00(PM)	54.2792	51.8935	45.3339	40.0042
02:00(PM)	62.4775	60.0158	57.3827	54.3795
03:00(PM)	66.7589	65.2168	63.8522	61.2269
04:00(PM)	68.3385	67.2422	65.8148	63.7748
05:00(PM)	49.1853	46.8327	43.4756	41.8463
06:00(PM)	34.9436	33.7148	31.3362	30.6418

Figures

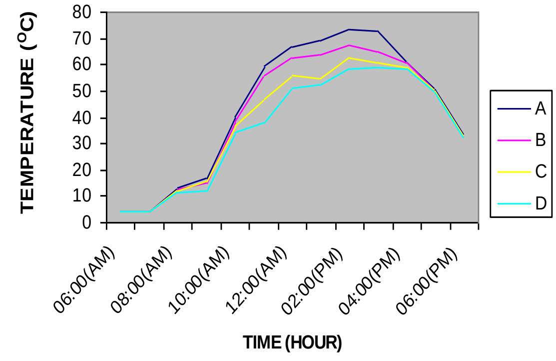

Fig.1: Graph of change in temperature against time on 16/03/12

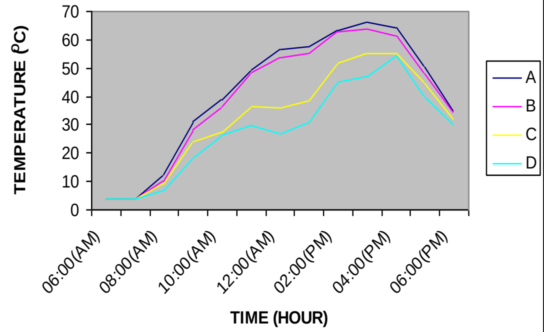

Fig.2: Graph of change in temperature against time on 17/03/12

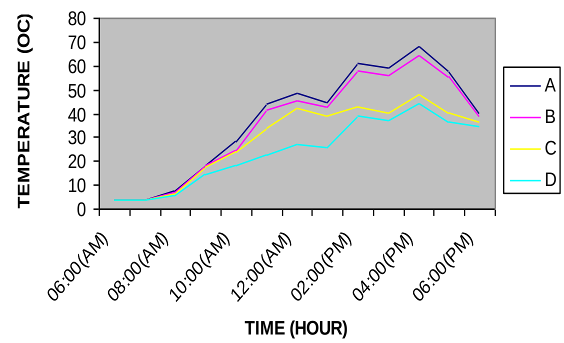

Fig. 3: Graph of change in temperature aganist time on 18/13/12

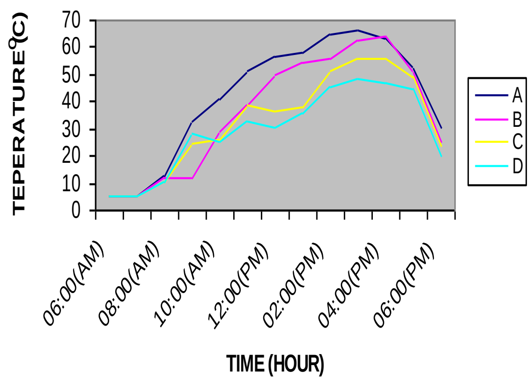

Fig. 4: Gaph of change in temperature aganist time on 19/13/12

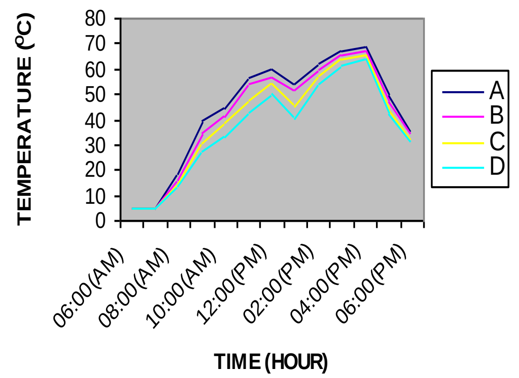

Fig.5: Graph of change in temperature against time on 20/03/12