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Construction of domestic solar fish dryer

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Abstract: *A solar fish dryer was design and constructed using a locally source materials. It was designed to determine the effect which is obvious during a beautiful sunset and solar rays with small angle of incidence are spread over a large surface with less energy per unit area. The efficiency of this fish dryer has been tested and was found to be effective in the sense that the temperature of the ice fish within the system raise to about 82^0c. The temperature attained was determined by a balance between the input of absorbed energy and the rate of the heat loss of the environment, and above all, is the effective use of drying fish. In view of the efforts at reducing emission and pollution to our environment, this research was carried out principally to design and construct a functional solar dryer from locally source materials. This dryer is capable of drying a piece of whole fish within some hours. All traces of moisture are been remove.*
Keywords: *Drying, Radiation, solar energy, solar fish dryer, Temperature,*

I. Introduction

Solar energy is the main energy source input into the earth systems. Our world today depends on energy. Energy is the ability to do work. Energy has always been the key to man goal to his dream of a better world. The availability of energy is of major importance to the economy of well being of any nation and social welfare of populace (Gulma, 1996). A country like Nigeria depends heavily on possible fuels to cover its energy needs. This present an increasing burden as well as over-dependence on the availability and exhaustible energy source. In it, we must look forward to atmospheric resources such as solar energy. The potential for utilizing solar energy to a large extent can be said to be unlimited as these energy sources are infinite and non-polluting to the environment. This is unlike other energy sources such as fire wood, coal, petroleum and natural gas which are limited and non-renewable (Goh-cheng Leon, et al, 1992). When wood burns to produce energy, it's an indirect utilization of solar energy.

Solar energy gave rise to the minerals deposit which is mined in the mining industry. Solar energy has been increasingly important all over the world because of the rapidly diminishing supply of fossil fuels.
The construction of this fish dryer is embarked upon to serve as the application of solar energy in assembling a drying, cooking and baking device that is beneficial to the society and the nation in the following ways.

i. To increase the market sales of fish and other food stuff.
ii. To increase the drying standard of indigenous people.
iii. To give opportunity for self employment to manufacture fish vendors and marketers.
iv. To reduce the risk cause to human sense organs especially eyes and lungs in relation to toxic gases when using firewood as a means of drying.
v. To maintain a suitable temperature to dry fish that is neither under-dried nor burnt.

II. Aim and Objectives of the Study

The aim is to produce a functional solar fish dryer and the following are the objectives of this work.

i. To provide a homemade drying device at an affordable price.
ii. To harness the relatively abundant energy resources from the sun for drying using the idea of green house effect.

III. Significance of the Study

The solar fish dryer is multi-purpose equipment which is of great importance to the economic growth of the country. It is not only constructed for household but also for mini-commercial use. It can be used for drying and preservation of fish, meat and food for household consumption and for commercial purpose. It dries fish without using conventional drying fuel such as kerosene, firewood, charcoal etc.
It has no smoke, soot or nauseating smell. It keeps the environment clean and conserves the precious resources of the country.

IV. Scope and Limitation

This study covered relatively the construction, importance and the effectiveness of the dryer. The concept of the solar dryer is wide and due to limitation in solar energy collection, the solar drying process is slow in comparison with dryers that use convectional fuels.

V. Advantages of Solar Fish Dryer

i. The drying is much faster than drying in the open space (i.e. because of the use of collector which concentrates the heat radiation).
ii. Protection of fish from dust, insects, flies, birds and animals.
iii. More spare time since less attention has to be given.
iv. Better quality and nutritious dry fish.
v. Can be easily turned towards the sun for effective drying.
vi. Very simple and low-cost technology.

VI. Review of Related Literature

Without careful drying technology, food is not fully dried resulting in growth of bacteria and fungi, thereby creating a potential health hazard. These days professional food dryers (fish and meat) need accurate temperature regulation and cost effective design while still be able to make use of the sun's fire energy (Lotus energy, 2007).

Using the solar dryer, 80-90% of the moisture content in the food is evaporated in 10-40hrs (depending on the moisture content of the food item and atmospheric temperature). The inner box absorbs sunlight effectively and converts it into heat, temperature of the food item in the dryer increases its moisture evaporating. While it takes more than 100hrs to dry food in the conventional open air method.

7.1 Forms of Heat Transfer

Conduction is the process that involves the flow of heat through a body from a place of higher temperature to another place of lower temperature, without any visible sign of movement. It occurs in solid substances which conduct heat rapidly is known as good conductor, others are called bad or poor conductors or insulators. Silver, copper, aluminium, iron and brass are good conductors**.**

Radiation is the transfer of heat via electromagnetic wave i.e. no material medium require to transfer energy from one place to another.

Convection occurs mainly in liquids and gases.

7.2 The Sun as a Source of Solar Radiation

The sun is a sphere of intensely hot gaseous matter with a diameter of 1.39×10^6km (860,000 miles), and is on the average of 1.5×10^3 km from the earth as seen from the earth. The sun rotates in its axis about every twenty four hours (24hrs). However it does not rotate as the solid body, the equator taking about 27 days for each rotation. Being a mass of incandescent gas (a gigantic nuclear furnace) when hydrogen is built into helium, its density is slightly less than 11/2 times that of water, the surface of the sun is at effective temperature of about 5726k.

7.2.1 Types of Radiation

There are three types of radiation namely:

1. Beam radiation.
2. Global radiation.
3. Diffuse radiation.

Beam Radiation: This is solar radiation that has not been scattered or diffused by atmosphere. The incident rays of the beam may be deduced from the difference between measurement of global and diffused radiation.

Global Radiation: This is the sum of the beam and diffused radiation and the term may be applied to the irradiance in weber per meter square (w/m^2) or to a time interaction of the irradiation in joule per meter square (j/m^2).

Diffuse Radiation: This is the radiation which has been scattered
by the atmosphere and cloud cover. Reflected radiation from building and the ground on incident surface is also diffused. Solar radiation on a horizontal surface must be measured with an uninterrupted field of review of the sky above.

VII. Solar Absorption

This is a process where the sun's radiation is collected by an absorber which then traps them in a required medium where they are utilized as source of energy.

VIII. Solar Collection

The earth is a solar collection, so are the other planet and asteroids in the star system. In fact, everything under the sun is solar collections.

Generally, there are two basic elements to any solar energy collections. The art that does the absorbing and the cover plate that does the capturing of the solar energy. Solar collection is devices that convert solar radiation into usable heat.

The warming effect of the sun is well known. When radiant energy strikes the surface of an object a proportion depending upon the angle of incidence and nature of the surface is reflected, some part is absorbed and other may be transmitted through object.

The temperature attained is determined by a balance between the input of absorbed energy and the rate of heat loss of the environment. The heat losses reduce the proportion of useful heat extractable from the system. Maximum temperature and maximum useful power output are therefore obtained when a highly absorbing, well insulated body is exposed to high intensity of solar radiation.

IX. Drying

Drying implies the partial removal of water from the material. Microorganism need to grow and the juice in fruit and vegetables and the blood in meat are sufficient for them. If we can dry those foods to remove the moisture the microorganism cannot grow and the food will not spoil. Fruit, vegetable, fish and meat can also be preserved by drying. The sun and dry season in Africa make drying an easy, cheap and effective method which has been used in many countries.

X. Methods of Drying

There are many different methods for drying each with their own advantages for particular application these include; Sun dryer, Air dryer, Grains dryer, Wind dryer, House hold oven, Commercial dryer (food dehydration), Smoking, Salting and Picking.

XI. Application of solar dryer.

Solar dryer can be utilized for various domestic purposes such as drying of fruits, vegetables, grains, spices, cash crops, fish and meat. They also find numerous applications in industries such as textile, wood, fruits, food processing, paper pharmaceutical and Agro-industries.

XII. Methodology

Construction: The based on specification and the fact that received radiation from the sun through the collectors was used to fabricate the project as it was designed according to specification. The dimension has been put together through different construction sequences, i.e. it was carried out to form the construction which involves measurement, cutting of parts, planning, assembling and painting.

XIII. Principle of Operation

The design and construction of the fish dryer was based on the fact that direct radiation is received from the sun through its collector (the mirror and the transparent glass). The outer casing made of wood was sectioned out with a saw manually into the required dimension and was shaped i.e. held together with nail of various sizes and wood glue in order for it to be firmly held together.

The wood was coated with black paint which served as the absorber for the system. The collector was made of plane mirror (for efficiency) and transparent glass was cut and shaped to the desired dimension that best suited the purposes. It was also built together with a new wooden frame which made it to serve two purposes of a collector and protective cones for the dryer.

The frame like collector was then clamped into the casing and held in place with

the aid of hinges while the mirror was clamped on top of the transparent wooden frame at an angle of 45^{o} and can be altered (International conference on solar cooking, 2000).

Collectors: There are varieties of solar collectors depending on the design and geometry. It is made up of a transparent glass which serves as the cover plate and a plate mirror for efficiency in the sun's radiation collection. The direct radiation is collected by both plate and the mirror and transmit the same to the absorber where it is been utilized.

Absorber: This is made up of wood. The surface is coated with a black paint of high absorbance. In this compartment, radiation is now used for drying food, most especially for drying fish and meat.

XIV. Test for Performance

When solar radiation falls on the collector, some of the radiation were reflected, some were absorbed while the remaining radiation is transmitted through the collector. The radiation is within the dryer, the transmitted radiation is then absorbed by the black-coated absorber.

Thereby the heat is thus trapped within, thereby causing the internal temperature of the dryer to be higher than that of the ambient (environmental) temperature.

The wave generated by the heat air cannot go back through the collector and the air is continuously heated like green house effect, which act like a heat trapped i.e. allow heat to enter but disallowed it to escape outside. This trapped hot air heat the absorbing medium (fish) in the dryer.

XV. Test of drying performance.

After the construction of the solar dryer, some fish were placed in the dryer and the temperature in the process of the drying was recorded at intervals. Tables below show the data (temperature) collected over two days

Table 1: Ambient temperature.

AMBIENT TEMPERATURE READING OVER TWO DAYS

S/N	Time	Tempt. of day 1(^{0}C)	Tempt. of day 2(^{0}C)	Average
1.	11.00-11.30	29.0	32.0	30.5
2.	11.00-12.00	30.0	34.0	32.0
3.	12.00-12.30	32.0	36.0	34.0
4.	12.30-01.00	33.0	35.0	34.0
5.	01.00-01.30	35.0	35.0	35.0
6.	01.30-02.00	35.0	35.0	35.0
7.	02.00-02.30	38.0	34.0	36.0
8.	02.30-03.00	39.0	33.0	36.0

Table 2: Absorber Temperature Reading Over Two Days

S/N	Time	Tempt of day 1(^{0}C)	tempt of day 2(^{0}C)	Average
1.	11.00-11.30	60.0	70.0	65.0
2.	11.00-12.00	65.0	77.0	71.0
3.	12.00-12.30	66.0	82.0	74.0
4.	12.30-01.00	68.0	83.0	74.2
5.	01.00-01.30	73.0	78.0	75.5
6.	01.30-02.00	75.0	76.0	75.5
7.	02.00-02.30	80.0	68.0	74.0
8.	02.30-03.00	82.0	60.0	71.0

Table 3: mean absorber temperatures.

ABSORBER TEMPERATURE READING FOR OVER TWO DAYS

S/N	Time	Mean daily ambient tempt.(^{0}c)	Mean daily absorber.(^{0}c)
1.	11.00-11.30	30.5	65.0
2.	11.00-12.00	32.0	71.0
3.	12.00-12.30	34.0	74.0
4.	12.30-01.00	34.0	74.2
5.	01.00-01.30	35.0	75.5
6.	01.30-02.00	35.0	75.5
7.	02.00-02.30	36.0	74.0
8.	02.30-03.00	37.0	71.0

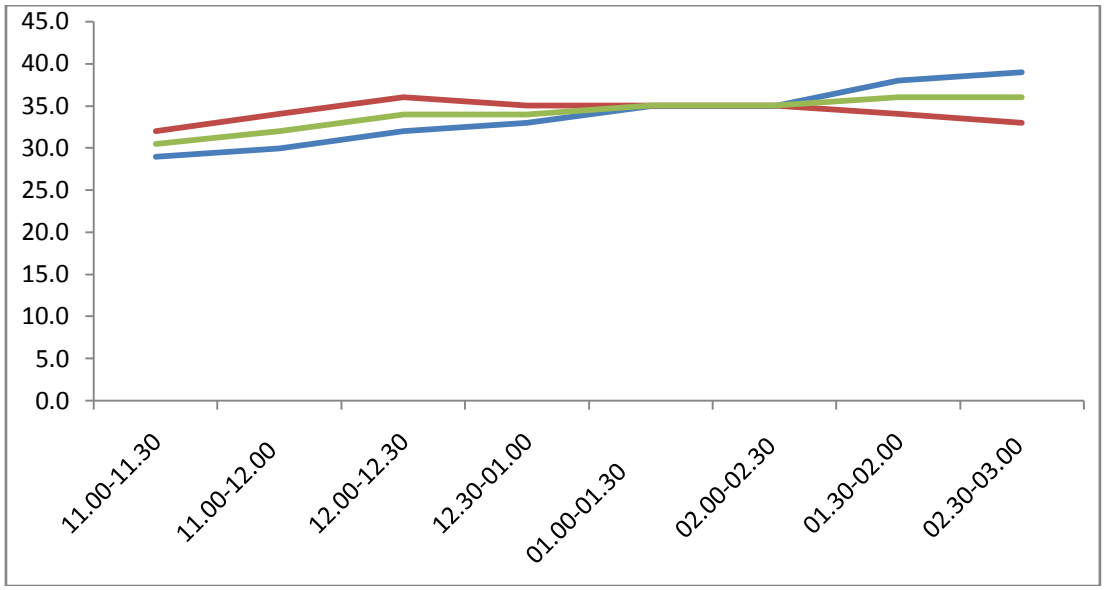

Fig 1.0 Graph of ambient temperature, absorber temperature for two days and the average for two days.

XVI. Efficiency of the dryer.

The efficiency of this dryer has been tested and was found to be effective in the sense that the temperature of the ice fish within the system raise to about 82^0c. Table 2 shows the variation in absorbed temperature while table 3 shows the comparison between absorbed and ambient temperature (see the table above).

XVII. Conclusion

Solar fish dryers function effectively via the use of solar energy. The solar fish dryer has no smoke; soot or nauseating smell; it keeps the environment clean and conserved the precious resources of the country. The effect is obvious during a beautiful sunset when solar rays with a small angel of the incidence spread over a large surface with less energy per unit area. Lastly the temperature attained is determined by a balance between the input of absorbed energy and the rate of the heat loss of the environment; and above all, is the effective use in drying fish.

In conclusion, collection and trapping of solar radiation was achieved for drying purposes. The results show that from the rising of the sun, temperature increases as the earth rotate about its axis and as the evening approaches (between the hour of 2.00 pm and 4.00 pm) the temperature falls.

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