MAKERERE UNIVERSITY

COLLEGE OF NATURAL SCIENCES
SCHOOL OF PHYSICAL SCIENCES
DEPARTMENT OF PHYSICS

CONSTRUCTION AND DESIGNING A SIMPLE SOLAR BOX COOKER

BY

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF PHYSICS IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE WITH EDUCATION OF MAKERERE UNIVERSITY

SUPERVISOR

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Abstract

Solar cooking is the one of the most economical methods of decreasing deforestation. Cooking is the important aspect in life. Without cooking , people in this world cannot survive. The main purpose of this study is to construct and design a solar box cooker that can be used at their homes to solve a problem of cooking in developing world and how solar power can help. This evaluation of the project is based on the needs of the user such as reducing pollution, deforestation need and the preserve natural resources, costs incurred. The basic components includes; insulated box. The ndings show that this cooker can be used during sunny conditions not cloudy condition.

Declaration

I,NGABIRANO Gilbert do hereby declare that this report contains true record of all the activities and work that i was involved in during the project research in the department of physics Makerere University. This report has not been presented to any institution for an academic award.

Signed.....

Date...12/01/2022...

NGABIRANO Gilbert.

Supervisor Declaration

I hereby declare that i have checked this project report and my opinion this project is satisfactory in terms of scope and quality for award of a Degree in Bachelor of Science with Education (Physical)

Signed..... Date...12/1/2022

Supervisor : DR Denis OKELLO

Dedication

This report is dedicated to my beloved, earthly gifts guardians especially my elder brothers. These have been my standing pillars in my carrier especially my project research. They have made it come possible through Encouragement, moral support, nancial assistance Every step i took they stood with me am so moved and grateful to their unending support they have always availed to me.

Ancknowledgement

I would like to rst of all take this golden opportunity to give thanks to my almighty God who has given me Grace and love to begin and complete my research project successfully. My sincere acknowledgement goes to my beloved , esteemed supervisor Dr. Denis OKELLO Of Makerere University Physics department for the unending extra aid, support guidance that he constantly ensured is available to me right from the beginning of the project study through the entire process and has been there for me to see the project to completion. Thank you very much dear Doctor i will live to remember you even when am out in the eld of physics. Your directions have been my turning points and they have made me to mature in eld of research, am humbled Doctor. I wish to extend my sincere gratitude and acknowledgement to the golden and valuable support, guidance and training i received from our beloved internal supervisor Dr. Annet Eva ZAWEDDE MUKIIBI. She made sure i made research and collected data from authentic sources, she availed me with technical guidance in particular using latex presentation templates, project template. Madam thank you very much am what i am because of your extra aid in physics. I cannot get tired of acknowledging the golden contribution of my dear parents in supporting me in all aspects. Not forgetting my beloved elder Brother Mr.BYAMUKAMA Alkengello. Thank you very much my second brother BYABASHAIJA Ben. And Finally to all my friends both course mates and non course mates like NAREEBA Esau,NIWAGABA Ambrose and NABAASA Anthony for the workdone during this project.

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Chapter 1

Introduction

Solar cooker is de ned as cooker that uses direct sunlight as the energy for cooking and heating food.It has di erent categories such as ;parabolic re ector, solar panel cooker and solar box cooker which is commonly used in most African countries and worldwide. Solar box cooking has already been practiced within a variety of cultures. The potentially dramatic bene t of this resource in terms of world hunger, health, and deforestation has yet to be realized. solar box cookers are commonly used because materials to be used a in construction are readily available for example; insulated box, box knife or scissors, aluminum cardboard foil , clear tape , glass wrap, black sheet of paper, ruler,cooking pot and thermometer are sold within our countries.solar box cooker can often accommodate multiple pots and usually take one and threehours to cook various food in case i tested it using eggs and typically at temperature range from 25^0C 800C where temperature stopped rising and an egg was ready to eat: The experment started at 10 : 00AM 01 : 00PM direct sunlight where the sides and bottom are insulated to retain cooking heat:

The solar box cooker consists aluminum foil which is used to allow minimal conduction of heat from the inner and outer side of a box,glasswrap which acts as a greenhouse roof, allowing (direct and re ected) sunlight to pass into the box, while also

retaining heat ,a sheet of black paper which act as a heat sink that absorbs direct and re ected sunlight to warm it, which will heat food(an egg) inside cooking pot placed on top of it.[8]

In Uganda today and other countries, there is an increase in the levels of economic growth and development. This increase comes with an increase in schools, hostels, industries and others that clears our natural resources to set up them. Most of these face a problem of cooking so this solar box cooker comes in handy to help in cooking of food using solar power. This saves the extra costs that users incur in buying fuel, re wood and other biomass fuels.It also helps to preserve our natural resources without requiring the use of wood and other biomass fuels to cook.

1.1 Problem Statement

Cooking is important to the world. There is an increased pollution, deforestation and degradation which increases poverty and hunger in our home countries and other areas as natural resources been exhausted due to deforestation, so there is a need to nd out problems which come with cooking in developing world and how solar power can help.

1.2 Aim and Objectives

To construct and design the solar box cooker.

Speci c objectives.

To determine the performance solar box cooker.

To design and test a solar box cooker.

1.3 Signi cance

Cost-e ectiveness. A solar box cooker requires no such re-curring payments.This is because sunlight is free and unlim-ited and hence cooking on a solar box cooker is e ectively free.you just need to make an initial investment of installing a solar box cooker ,and that's all.

Environment friendly.natural gas is non renewable energy source ,and if you reside in a hot area,a conventional cooker makes your house hotter while cooking .A solar box cooker produces no emission of gases like carbon dioxide,maintaining abetter quality indoors.Besides,sunlight is unlimited and a renewable energy source.The environmental impact is thus minimum when you are using a solar box cooker.

Nutritious,tasty and hygienic cooking .Solar box cooker make cooking more nutritious,hygienic and tasty.it elimi-nates the possibility of burning food when you are cooking .the latest solar c box cooker can even direct the sun rays in more precise manner,thus o ering abetter e ciency.

Power cuts is not an issue .Induction ovens and microwaves requires electricity to run , and power cuts are major chal-lenge.However, as solar cooker use sunlight to cook food ,you do not have to worry about power cuts.

1.3.1 Limitations

useful only cooking in daytime.The biggest disadvantage is that solar box cooker is dependent on sunlight for cooking .as a result ,you cannot cook using a solar cooker at night .Besides,rain,low sunlight penetration, cloudy weather etc, also impediment to cooking on a solar box cooker.

Eye damage .One needs to be careful while using a solar box cooker, as accidental re ection of sunlight into your eye can damage your eye sight.

less e cient. solar box cooker take a lot more to cook than conventional stoves .Hence ,if you are in hurry to cook your food, you will have to use a normal stove .Besides, solar cooker costlier than gas stoves .You will also need to nd a suitable place a solar cooker,where the sunlight reception is maximum.You might also be required to change the position of the re ector.

1.4 Justi cation

In Uganda today and other countries, there is an increase in the levels of economic growth and development. This increase comes with an increase in schools, hostels, industries and others that clears our natural resources to set up them. Most of these face a problem of cooking so this solar box cooker comes in handy to help in cooking of food using solar power. This saves the extra costs that users incur in buying fuel, re wood and other biomass fuels.It also helps to preserve our natural resources without requiring the use of wood and other biomass fuels to cook.

Chapter 2

Literature Review

Solar cooker is a device that uses the sun's energy to cook food . Solar cookers can eliminate the problems that come with utilizing rewood, charcoal, kerosene, and electricity. Unlike rewood, charcoal, and kerosene, solar cookers do not emit harmful gases that can cause air pollution and global warming . Fire accidents will not be a problem in cooking with solar cookers. No trees have to be cut for rewood, which in turn helps to prevent soil erosion. Unlike kerosene, since they use only the sun's energy, they are not expensive. Unlike electricity, they can cover all parts of rural areas without spending a big budget. Box, parabolic, and panel cookers are the three main types of solar cookers .

Solar cookers use solar radiation either by re ecting the radiation to concentrate on a cooking pot or by retaining the radiation to trap the heat . A solar box cooker is one of the main solar cookers, which can cook food and boil water at a high temperature within a short period (2-3) hours. According to Mbodji and Hajji [47], box solar cookers can be designed and manufactured for thermal applications.

In a solar box cooker, the re ecting material illustrated by gure 2.1, which is shaped in good way that receives the sun radiation and re ects it to the bottom of the cooking pot thus causes the

heating e ect which will be used to cook di erent foods forexample eggs in this case.
A solar box cooker also consists of an insulated box with a transparent glass cover .The bottom of the box is wrapped with a black sheet paper in order to maximize the sunlight absorption as in gure 2.2. A cooking pot is then placed inside the box.[1]Each component on solar box cooker has a signif icant inf luence on cookingpower:

However, optimization of the parameters is vital for obtaining a maximum e ciency of power. Rays of light are coming to the earth at an angle. The aluminum foil shown in gure 2.1 re ects the ray and bounces it directly into the opening of the box.[8] Onceit has gonethrough the glass wrap; it heats up the air that will trapped inside: The black sheet of paper absorbs the heat at the bottom of the box and the newspapers prevents heat f rom escaping; allowing the temperature in the box to rise:[2]

A solar box cooks because the interior of the box is heated by the energy of the sun. Sunlight, both direct and re ected, enters the solar box through the glass. It turns to heat energy when it is absorbed by a black paper as shown in gure2.2 and cooking pot.[3]and[4]; 7: This heat emitted by theinf rared radiation causes the temperature inside of the solar box cooker rise until the heat loss of the cooker is equal to the solar heat gain: Temperatures suf f icient f or cooking f ood (eggs) and purif ying water will be achieved as shown in f igure2:3:
The average isolation data during experimentwhich started f rom 10 : 00 01 : 00PM were determined as f ollows;
solar power of 12:47W=m^2;pyrameter at 0^{0}C as 2237:1K W=m^2 at 269:038hours with direct radiation as288:37W=m^2 and Global temperature at0^{0}C as7050:4W=m^2; 2334:75K W=m^{2}at15^{0}C and 2309:28K W=m^2 at 22:5^{0}C:
Below are some f igures of components involved in experiment:

Figure 2.1: shows aluminium foil used

Figure 2.2: shows a black piece of paper

Figure 2.3: shows cooking pot with cooked eggs inside

Chapter 3

Materials and Methods

3.1 Materials

Introduction
This chapter presents the materials that i used in carrying this

project and methods that shows the procedures followed during and carrying an experiment.
Materials include;

Insulated box.

Box knife or scissors.

Aluminum cardboard foil .

Clear tape and glass wrap.

Black sheet of paper.

Cooking pot and thermometer.

3.1.1 Methods

Under this ,there some procedures involved while carrying an experiment.

On the top ap of the solar box use the marker to draw a square with one inch edges.
I used a craft knife shown by gure 3.2 to cut the ap in the lip of solar box.Cut along three sides and fourth ap is left.
Fold the the fourth ap with aluminium foil using glue shown in gure 3.3 gently with shiny surface facing up so that the rays from the sun will be re ected o .This re ects solar radiation in the box.
Line the inside of the cardboard ap with aluminum foil shown in gure3.5. Fold the edges of the foil over the ap to help hold the foil in place and glue the foil onto the ap. Keep the foil as smooth as possible. Cover the opening made by the ap (in the lid) with a layer of glass wrap.
Attach the glass wrap to the opening's edges using glue. By making sure there are no holes in the glass wrap and that all of its edges are completely attached to the lid.
Glue or tape a sheet of black paper to the bottom of the box, centered there. And this acts as solar box heat sink and cooking pot is placed inside the box on top of black paper.
Lastly, use a ruler of 30cm to prop the solar lid up, at about a 90-degree angle from the rest of the box.
Leave the solar box cooker outside on a hot day as shown in gure 3.6 (non-windy days).Initial temperature were recorded 25^0 inside and 30^o outside at 10 : 00AM using thermometer shown in f igure3:1
Temperature were read f or every 15minutes until an egg is ready to eat:
Results are tabulated and a graph of temperature against time taken were plotted:

Figure 3.1: shows thermometer

Figure 3.2: shows knife box

Figure 3.3: shows glue

Figure 3.4: shows solar box with glasswrap

Figure 3.5: shows cardboard folded with aluminium foil

Figure 3.6: shows diagramatic illustration

Chapter 4

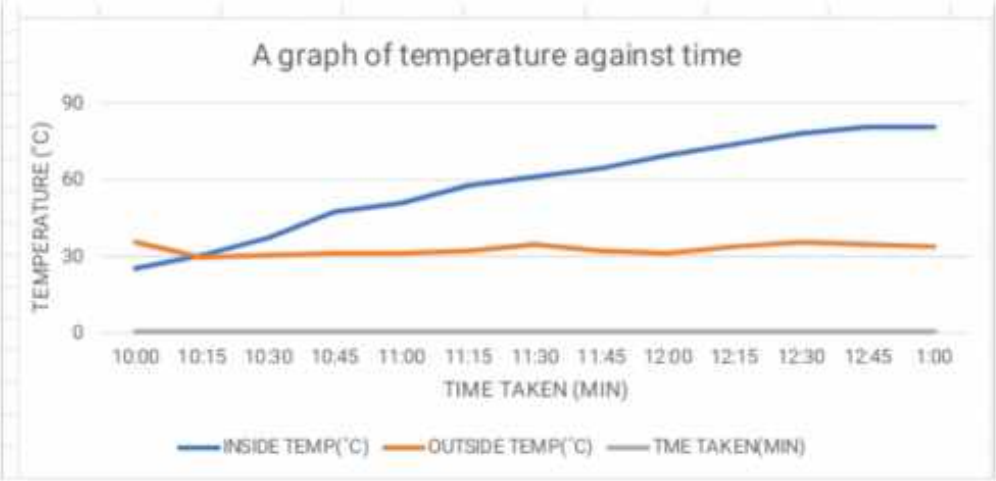
Results and Discussion

In this chapter ,it shows results that were obtained during testing and performance of solar boxer cooker and discussion to the results and objectives as well.

4.1 Results

This table 1; shows the variations of temperature with time taken during experiment.

INSIDE TEMP(˚C))	OUTSIDE TEMP (˚C)	TIME TAKEN (MIN)
25	35	10:00
30	29	10:15
37	30	10:30
40	31	10:45
50	31	11:00
57	32	11:15
61	34	11:30
64	32	11:45
69	31	12:00
73	33	12:15
78	35	12:30
80	34	12:45
80	33	1:00



4.2 DIscussion

The variations of the temperature have been tested in this study. The results obtained by cooking two eggs until it is ready to eat in the box of solar cookers.

1. Energy of radiation intensity .In determining the heat loss that occurs in the box solar cookers, can be done by measuring temperature both inside of box and surround of the box cooker. The increasing temperature depends on the radiation intensity. The maximum radiation is 288.37 W/m2 at 12:45 PM .Both inside and outside temperatures have its maximum temperature 30^0C at 10 : 15am:The surrounding temperature increases and decreases as inside temperature increases rapidly with time:

4.2.1 Objective 1?

The variations of temperature in solar box cooker is dueto ;
Concentrating sunlight. Flap fold with aluminium foil acts as re ector to re ect the sunlight so that it is concentrated and the energy is stronger.
Converting light into heat .At bottom of the cooker is blackened which absorbs and retain heat which is important for keeping

cooking hot.
Trapping heat. Isolating the air inside the box cooker from the air outside makes an important di erence.A glass cover creates a green house e ect within the box to make sure that heat is allowed inside but cannot escape it .
Through all the above views shows the performance of solar box cooker hence objective 1 is veri ed.

4.2.2 Objective 2?

After trapping heat is then emitted by the infrared radiation causes the temperature inside of the solar box cooker to rise until the heat loss of the cooker is equal to the solar heat gain. Temperatures su cient for cooking an and purifying water will be achieved hence solar box cooker is tested.

Chapter 5

Conclusions and Recommendation

5.1 Conclusion

A solar cooker with area has been designed and manufactured.
The test starts with initial 25^0C and 35^0C both inside and outside temperatures respectively:
The main purpose of this study is cooking of food (eggs) were are broken then put into cookingpot cook them using asolar box cooker:
The results show that the duration of eggs to cook up 80^0C with 2hours and 45minutes were temperature become stable up 3hours:
The maximum solar box temperature is 80^0C at 12 : 45pm:
The main conclusion can drawn here is that solar box cooker can be used to cook food (eggs):

5.2 Recommendations

During cooking eggs temperature raises up 80^0C and it become constant for next 15minutes:
I recommend that further work should be carried out on cooking other meals using solar box cooker to see whether temperature increase beyond 80^0C:
The rate of vapor formation and the effect of vapor on the glazing

surface that could affect the transmittance of the glazing that gives the better results are not answered in this research:

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