DESIGN AND FABRICATION OF A SOLAR POPCORN MACHINE

BY

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CERTIFICATION

This is to certify that **OLUOKUN YUSUFF AKANBI** with Matric No: **ND/23/MET/FT/0019**, has carried out the project work, Title "Design and Fabrication of A Solar Popcorn Machine" presented in this report during the 2023/2024 academic session of the Department of Metallurgical Engineering, Kwara State Polytechnic, Ilorin.

8/8/25

DATE

MRS. IHOGBETIN F.F.
Project Supervisor

08/08/2025.

DATE

ENGR. ADEGBITE D.A.
Head Of Department

8/8/25

DATE

EXTERNAL EXAMINER

DEDICATION

I dedicate this project to Almighty Allah for guiding me through this successful endeavor. First and foremost, we would like to express my sincere appreciation to God, the Beginning and the End, who has showered me with His boundless mercy. He is the ultimate source of wisdom, knowledge, and understanding.

AKNOWLEDMENTS

I give all praise, honor, and gratitude to Almighty Allah for guiding me through this successful endeavor. First and foremost, we would like to express my sincere appreciation to God, the Beginning and the End, who has showered me with His boundless mercy. He is the ultimate source of wisdom, knowledge, and understanding.

I extend our heartfelt thanks to the Head of Department along with all the faculty members in the Department of Metallurgical Engineering for their invaluable support.

A special mention goes to my dedicated supervisor, Mrs. Ihogbetin F.F. whose careful guidance ensured that this project achieved a level of excellence.

To my parents Mr. and Mrs. Oluokun, siblings, and friends, I express my profound gratitude for your continuous support and encouragement throughout my academic journey. Thank you for your love and assistance; we hope to reunite in a higher place.

I would like to extend a sincere thank you to everyone involved to make this project work a success. May God continue to bless you all (Amen).

ABSTRACT

The project is the fabrication of solar power popcorn making machine. Which aim is for producing a solar popcorn machine and fabricate device that utilizes solar energy to popcorn, reducing reliance on conventional fuels and electricity. The materials used for the fabrication of solar power popcorn making machine are; solar collector, reflector, popping chamber, insulation, tracking mechanism and optional components. The solar power popcorn making machine is fabricated with good materials, so it can be used for a very long period of time.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Nigeria's economy has suffered a terrible setback over the year the common man finds it difficult to make for his livelihood, some people take pop-corn as one of their favorite food especially bachelors spinsters who can take pop-corn as super, breakfast and even lunch.

The University and Polytechnics graduate no longer find good employment thereby embarks on self-employment by constructing popcorn machine to meet their needs.

Popcorn is from a special type of maize unlike other types of corn which pops when heated. The popcorn preparation has long been in practice in Nigeria. It usually required a heating source (stove, fire wood as conventionally used), a frying pan with spoon as the stirrer. It was first discovered and used by the early Americans. Popcorn was introduced to the Western world by Christopher Columbus in the 15th century. The kind of popcorn most people pop in their microwave is the Zea mays. Zea mays everta has a certain amount of moisture content, a strong pericarp that does not allow moisture to escape very fast as other corn when heated. Consequently, a popcorn machine, which is generically used for the purpose of making popcorn for human consumption is essential. Most popcorn machines use gas, some use electricity, while some use the solar as sources of energy. The merits and demerits of these sources are observable in the production rate of the various machines, which in turn depends on the intensity of heat as well as the power source. The objective of the project, therefore, is to design and fabricate a solar popcorn machine that will enhance popcorn production using solar energy. In this work, Solar popcorn machine uses a simple solar thermal applications that convert solar radiation into heat that is used to pop up corn. Solar popcorn machine is now recognized as a reliable practice that saves substantial amounts of electricity or other conventional fuels, leads to peak load reduction and prevents emission of carbon dioxide.

1.2 PROBLEM STATEMENT

The two conventional method of making popcorn are using electricity or natural gas. The erratic nature of electricity and high cost of gas in developing country such as Nigeria has hindered the production of popcorn – which has made many people don't show much interest in popcorn making business. It was because of this challenges that has made technology to search for solution – by initiating solar energy in popping corn. Solar popcorn machine was invented to solve the problems of power supply and high cost of gas.

1.3 AIM AND OBJECTIVES OF THE STUDY

The main aim of this project is to fabricate a solar power popcorn making machine.

The objectives of the study

- To get the dimension of the machine to produce.
- To cut the materials to meet the dimension.
- To weld the metal sheet together to form the shape required.
- To fix the solar panel and every other part of the machine.
- To test the machine.

1.4 JUSTIFICATION

The design of the improved and more cost effective solar popcorn making machine will encourage easier adoption of solar popcorn making technology due to the user benefits. The machine will cater for substantial household popcorn making energy needs hence reduce on carbon emissions in the atmosphere and high cost of gas. Implementation of the design will reduce on the time spent on moving from one place to another looking for gas. Certainly the project will enable cost savings compared to alternative electric or gas type.

1.5 PURPOSE OF THE PROJECT

A *solar* popcorn making machine is a device which uses the energy of direct sunlight to popcorn. The purpose of introducing solar popcorn making machine is to provide a cheap means of popping corn that does not involve using gas or electricity.

1.6 SIGNIFICANCE OF THE PROJECT

The advantages of building a solar popcorn making machine are:

Save Money – approximately 50% of your electricity bill and gas could be saved. Using solar popcorn making machine could drastically reduce the size of installed gas cylinder.

An investment – solar popcorn making machine will add value to your property.

Environmental Friendly – solar energy is clean energy. No pollution.

Self-sufficiency – with a solar popcorn making machine you are protected from the ever-increasing cost and erratic.

CHAPTER TWO

LITERATURE REVIEW

2.1 POPPING HISTORY

People originally popped popcorn by holding a basket over an open flame. This method was less than desirable as it often resulted in uneven cooking and burned popcorn. In the 1880s, Charles Cretors adapted a peanut warming machine to better cook popcorn and the modern day popcorn maker was born.

Since then, the design has become increasingly smaller. No longer needed a vendor cart, anyone can cook popcorn in the comfort of their own home with one of many popcorn makers on the market today (*PBS Food, 2016)*.

2.2 REVIEW OF POPPING METHODS

Part of the "design" of popcorn is the method used to pop it. The dry method consists of putting the unpopped grain in a basket or wire cage, agitating it over a heat source like the campfire or coal stove, allowing the corn to pop, and seasoning it with butter and salt. In the wet-pop method, corn is placed in a container with a solid bottom. Oil is added (either before the corn or poured on top), and the oil helps to distribute the heat and cause more even and complete popping. Commercial popping machines use the wet-pop method, and coconut oil is used for its aroma and lightness. Microwave popcorn also uses the wet-pop method, although the moisture is present in a solidified form of oil, flavoring, and salt that melts when the microwaving process begins (*PBS Food*, *2016)*.

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2.4 HISTORICAL REVIEW OF CORN

Corn may have begun its long evolution as a kind of grass. In the Americas, corn varieties, including popcorn, were cultivated by the Aztecs and Mayans in Central America and Mexico and by the Incas in South America. The Aztecs decorated their Gods of Rain and Maize with strings of popcorn . North American Indians also strung the popped kernels on grass strings and used them for decorations and personal adornment. Archaeologists have found popped corn in dwelling caves in New Mexico, and the corn is estimated to be 5,600 years old. Scientists' best guesses for the age of popcorn and the place where it originated are 8,000 years and in Mexico. Curiously, popcorn was also common in parts of India, China, and Sumatra before the discovery of the Americas, but the paths and methods of its migration are unknown, as is the reason for its existence in these areas but not others. Part of the answer may be the hardiness of this type of corn over others or the change in climate conditions around the world over thousands of years (*PBS Food*, *2016)*.

Popcorn officially crossed into Western culture at the first Thanksgiving celebration. Popular legend has it that Quadequina, brother of the Indian chief Massosoit, brought a deerskin bag full of popped corn to that harvest celebration. The Indians' methods for popping corn varied from tribe to tribe. They probably discovered how to pop popcorn by accident because the hard kernel doesn't give any hint of the potential treat inside. The earliest poppers of corn may have thrown it into the fire and eaten the kernels when they popped and flew out of the flames. Our only historical evidence of early but more sophisticated popping methods is from the Incas whose ruins contain specially shaped clay pots with kernels of popped corn still inside them. The Incas apparently heated sand and placed it in these pots, then placed the corn on the sand. The pot was covered, and heat from the sand popped the kernels. The heavier sand stayed at the bottom of the pot, and the popped kernels rose above it where they could be reached (*history.com*).

Over 700 types of popcorn were being grown in the Americas by the time Columbus discovered these continents. French explorers in 1612 saw the Iroquois people popping corn in clay pots; and the Winnebago Indians who lived near the Great Lakes simply drove sticks into the cobs and held the cobs near the fire. Popcorn soup was a favorite method of using the grain among the Iroquois, and the Indians of Central America even made popcorn beer. Early explorers observed ornamental necklaces, bouquets, and headdresses made of popcorn.

In early America, popcorn became a ritual part of many festivities including quilting bees and barn raisings. In cabins and homesteads, corn could be popped in the fire-place, seasoned with grease or butter, and shared by the family. Popped kernels were used as teeth in Halloween pumpkins and strung in long ropes to festoon Christmas trees. Popcorn was the accompaniment to banjo playing, singing, and the telling of ghost stories and folktales. In the 1700s, the first puffed cereal was created by pouring milk and sugar over popped corn; this breakfast dish was popular from Boston south to the Carolinas.

Popcorn was grown in family gardens or farms or bought from neighbors who grew more than they needed until about 1890 when it started to become recognized as a legitimate cash crop. The first automatic popcorn popper was a steam-powered machine invented by Charlie Cretors in 1885; before Cretors' invention, street vendors popped corn in wire baskets over open fires. By about 1890, the glass-sided popcorn machine with its gasoline burner became a popular feature of the circus, carnival, sideshow, local fair, and small town streets where popcorn vendors would sell bags of popcorn as dusk fell. The packaging of popcorn for use at home began in about 1914.

In 1893, Fred and Louis Rueckheim used the Chicago World's Fair to kick off their blend of popcorn, peanuts, and molasses. These German brothers made their name in America by manufacturing Cracker Jack, as this mixture came to be called, in a small kitchen and then at the World's Fair. In order to claim a prize, the consumer could mail in a coupon found in every box of Cracker Jack. After the Fair and until World War II, prizes were actually packed in the boxes, although this practice stopped during the War because the prizes were made in Japan. After the War, a bonus prize returned to every box (Onwuka, 2005).

When moving pictures became the rage and movie houses opened across the country, the street vendors of popcorn would rent space outside the theaters and sell bags of popcorn to movie ticket buyers. In 1925, Charles T. Manley perfected his electric popcorn machine, and popcorn vendors moved inside the theater where the trapped sounds and smells of popping corn often made more money than the feature film. During the Great Depression in the 1930s, vendors sold popcorn in five-cent bags, and popcorn became one of few affordable luxuries. Meanwhile, back in the theater, the paper bucket replaced the bag as the container for popcorn because the rustling bags made too much noise. During World War II, popcorn was taken overseas as a treat for American servicemen and was adopted by other countries. In 1945, Percy Spencer applied microwave energy to popcorn and found that it popped; his discovery led to experiments with other foods and development of the microwave oven. Television brought popcorn into the home in the 1950s, when electric popcorn poppers and pre-packed corn for popping were developed and marketed. The 1970s and 1980s witnessed a boom in electric poppers, hot-air poppers, and microwave popcorn as the videotape industry brought movies and the desire for all the customs associated with movie-going into the home (*history.com)*.

2.5 PRINCIPAL OF SOLAR POPCORN MACHINES.

Solar popcorn machines operate by harnessing solar energy to achieve the high temperatures (180-200°c or 350-400°F) required to pop corn kernels (zea Mays everta). According to studies on solar cooking, such as those documented on Appropedia (2023), the primary mechanism involves concentrating solar radiation using reflective surfaces, typically parabolic or box-type collectors, to focus heat onto a popping chamber.

My projectcircuits (2022) explains that parabolic dish collectors are preferred due to their ability to achieve high thermal efficiencies (50-60%) by concentrating sunlight to a focal point, where temperatures can reach up to 550°F. This is critical for popping corn, as kernels require rapid heating to vaporize internal moisture, causing the starch to expand.

2.6. DESIGN AND FABRICATION APPROACHES

Solar collector designs:

The parabolic dish is the most common collector in solar popcorn machines due to its high concentration ratio. Adejumo and oluwo(2019) describe a solar popcorn machine fabricated with a 1.2 meter aluminum parabolic dish coated with reflective Mylar film, achieving temperatures of 180-220°c under optimal sunlight (800-1000 W/m2). The dish's focal point is positioned to hold a food-grade aluminum pot, which serves as the popping chamber. Appropedia (2023) highlights a similar design using a repurposed satellite dish, reduced materials.

Popping chamber and heat transfer:

The popping chamber is typically a lightweight, food-grade aluminum or stainless steel pot placed at the focal point of the collector. My projectcircuits (2022) emphasize the importance of a perforated lid to allow steam escape while retaining popped corn, ensuring safety and efficiency. Some designs incorporate a stirring mechanism-either manual or motorized - to prevent kernel burning and ensure even heating. Adejumo and oluwo (2019) report that manual stirring is cost-effective but labor-intensive, while a small DC motor (powered by a10-20W solar panel) improve automation.

Sun-Tracking systems:

To maintain optimal solar energy capture, many designs incorporate Sun-Tracking systems. Uniprojects(2023) details a motorized tracking system using a linear actuator controlled by an Arduino microcontroller and light sensors. This system adjusts the parabolic dish's angle to follow the sun, ensuring consistent heat delivery. However, Adejumo and oluwo (2019) note that manual tracting, using a protractor and locking bolts, is a viable low-cost alternative, especially for small-scale or educational projects. Manual system reduce costs but require user intervention every 15-30 minutes.

2.7 HEAT TRANSFER (PRINCIPLE OF HEAT TRANSFERRE

There are three classed of heat transfer.

1. Conduction
2. Convention
3. Radiation

1. **CONDUCTION:** This is the transfer of heat from one molecules or matter remaining in a fixed position relation to each other. Conduction of heat through any body in unsteady if the temperature at any point in the body

varies with tune and steady of the temperature at every point in the body remains constant.

$$\frac{KA\ (t1 - t2)}{L}$$

Where Q = rate of heat transfer

K = Thermal Conductivity of the body

A = Cross sectional area of the body taken normal to the direction of heat flux.

L = Thickness of the body.

2. **CONVENTION:** This is the transfer of heat from part of a fluid to another by mixing of warned cooler particles of the fluid. When convention is caused by thermal action only on the molecules it is called **Natural Convention**.

3. **RADIATION:** This involves the transfer of heat from one body to another as a result of bodies emission are absorption of radiant energy to a greater or lesser degree the effect on thus matter being the same as it were heated. Radiant energy travels through space as a velocity of light. It does not require the presence of matter for its transmission. The rate of radiation

and absorption depends on the nature of the surface while a bright surface is poor absorber (Sobukola, 2013).

LAW OF RADIATION:

The total energy radiated by a body is proportional to the fourth power of it’s absolute temperature.

1. **Fourth Power Law:**

   Q = 56 .7 x 10 –12 EA (T14 – T24)

   Where Q = Quality of heat.

   E = Emissivity

   A = Surface area

   T1 and T2 = Absolute Temperature.

2. **LAWBAT’S LAW:** This states that the energy radiated in any direction at any angle with the surface is the normal radiation multiplied by the cosine of the angle between the direction and the normal to the surface.

3. **THE INVERSE SQUARE LAW:** It states that the intensity of radiation on a surface is universal proportional to the square of the distance of the surface from the source of radiation.

CHAPTER THREE

3.0 MATERIALS USED

S/NO	ITEM	MATERIAL	NO. OF
1	ABSORBER	ALUMINIUM	1
2	SCREW LOCK	STEEL	2
3	PARABOLIC DISH	ALUMINIUM	1
4	RING CONNECTOR	STEEL	1
5	SWING ROD	STAINLESS STEEL	1
6	BOLT LOCK	STEEL	3
7	CLAMP	BRASS	1
8	SUPERJACK		1
9	HANDLE	STEEL	1
10	SHORT-BAR SUPPORT	STEEL	2
11	BOLT	STEEL	16
12	NUT	STEEL	16
13	WHEEL BRACKET	STEEL	4
14	WHEEL AXLE	STEEL	4
15	WHEEL	RUBBER	4
16	NUT	STEEL	8
17	BOLT	STEEL	8
18	BASE SUPPORT	STEEL	1
19	LONG-BAR SUPPORT	STEEL	2
20	TRUNK	STEEL	1

3.1 METHODOLOGY

Measurement:

- Parabolic dish: approximately 1-2 meters in diameter
- Aluminum pot: around 20-30cm in diameter and 10-15 cm in height
- Insulation materials: depends on the size of the machine

Assembly instructions:

1. Assemble the frame using wood or metal.
2. Attach the parabolic dish to the frame, ensuring it's securely fixed.
3. Place the aluminum pot at the focal point of the parabolic dish.
4. Add insulation materials around the pot to minimize heat loss.
5. Cover the parabolic dish with reflective materials to enhance solar radiation collection.

CHAPTER FOUR

4.0 DIAGRAM OF A SOLAR POWER POPCORN MAKING MACHINE

The solar popcorn machine is painted with yellow colour and well design.

CHAPTER FIVE

5.1 Summary

This project focused on the design and fabrication of a solar-powered popcorn machine aimed at providing an eco-friendly, cost-effective, and portable solution for popcorn production, especially in rural or off-grid areas. The machine utilizes solar energy to generate the necessary heat for popping corn, eliminating the need for conventional fuel sources such as electricity, charcoal, or gas.

The design incorporated key components such as a solar collector (reflector or panel), a heating chamber, an insulated popping container, and in some models, a battery or energy storage unit. Locally available materials were selected to reduce cost and improve accessibility.

During testing, the machine proved capable of efficiently popping corn under sufficient sunlight conditions. The system offers several benefits, including zero carbon emissions, low operational cost, and suitability for outdoor and remote use. However, limitations include dependency on weather conditions and relatively slow operation compared to electric models.

In conclusion, the solar popcorn machine demonstrates a sustainable alternative for small-scale snack production and can be further improved through advanced insulation, automatic controls, and hybrid energy systems. It presents significant potential for entrepreneurship and local economic empowerment in developing regions.

5.2 CONCLUSION

The design and fabrication of a solar popcorn machine represent a promising application of solar thermal technology, offering an eco-friendly alternative to conventional popcorn machine. Existing designs leverage parabolic collectors, food-grade popping Chambers, and optional Sun-tracking systems to achieve efficient popping with thermal efficiencies of 50-60%. While challenges like weather dependency and open-source designs enhances accessibility. Future advancements in thermal storage, automation, and scalability could further expand the adoption of solar popcorn machines, particularly in regions with abundant sunlight and limited access to electricity.

5.3 RECOMMENDATIONS

1. Improved Solar Power Storage, It is recommended that future designs incorporate high-capacity lithium-ion batteries or solar power banks to store excess energy. This ensures the machine operates efficiently even during cloudy weather or at night.
2. Use of Advanced Thermal Insulation, Integrating better heat insulation materials (such as ceramic wool or fiberglass insulation) in the popping

chamber will help retain heat and improve energy efficiency, resulting in faster popping time and reduced energy loss.

3. Temperature and Timer Control System, Future models should include automatic temperature regulators and timing systems. These will: Prevent overheating, Allow uniform popping, Enhance safety, Enable energy conservation, Hybrid System Integration
4. A hybrid energy option combining solar and electrical sources is recommended. This allows the user to switch to grid or generator power when solar energy is insufficient, ensuring continuous operation.
5. Use of Lightweight and Durable Materials, For better portability and reduced manufacturing costs, use materials such as aluminum, stainless steel, or reinforced polymer composites for structural components.
6. User-Friendly Design; The design should be modified to include: Simple interface or control panel, Easy-to-clean compartments, Transparent popping chamber covers for visibility, This enhances user experience and encourages wider adoption.
7. Incorporation of Safety Features; Install safety mechanisms like:

Automatic shut-off when overheating occurs

Insulated outer surfaces to prevent burns

Overload protection for electrical circuits

8. Economic and Commercial Feasibility

It is recommended to conduct a cost-benefit analysis for mass production and commercial distribution, especially in rural or off-grid areas, where solar-powered machines can be a sustainable source of income.

9. Further Research

Encourage research into:

More efficient solar thermal collectors

Integration with Internet of Things (IoT) for remote

monitoring Modular designs for ease of repair and upgrade

10. Field Testing and Community Training

It is also recommended that prototype models be tested under real-world conditions (e.g., outdoor markets, schools, rural areas), and training programs be offered to teach locals how to operate and maintain the system.

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