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AUTOMATIC ROTATING PARABOLIC TROUGH WATER HEATER

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ABSTRACT;

The Sun Tracking Solar Water Heater is a novel system designed to maximize the efficiency of solar water heating. It achieves this by dynamically adjusting the position of solar collectors to track the sun's movement throughout the day. Traditional solar water heaters often rely on fixed solar panels, which can lead to suboptimal energy capture, especially during mornings, evenings, and seasonal changes. The proposed system addresses this limitation by integrating solar tracking technology. This technology continuously monitors the sun's position and adjusts the orientation of the collectors accordingly. By maintaining an optimal angle relative to the sun's rays, the collectors maximize solar energy absorption, significantly increasing the system's overall efficiency.

Key components of the system include a tracking mechanism with sensors, actuators, a control system, solar collectors, and a heat exchanger. The system offers several advantages over fixed solar water heaters. Firstly, it ensures increased energy efficiency through continuous sun tracking, leading to higher heating efficiencies and reduced energy consumption. Secondly, the system enhances performance by adjusting collector positions, improving operation under various weather conditions, seasons, and geographical locations. Overall, the Sun Tracking Solar Water Heater presents a promising solution for maximizing solar energy utilization in water heating applications. Its innovative design and advanced tracking technology have the potential to revolutionize the efficiency and effectiveness of solar water heating systems, making them more accessible and viable for a wide range of residential, commercial, and industrial applications.

INTRODUCTION

Introduction to Sun Tracking Solar Water Heater:

The Sun Tracking Solar Water Heater represents an innovative approach to harnessing solar energy for water heating applications. By integrating sun tracking technology with a traditional solar water heater system, this solution aims to maximize energy capture from the sun throughout the day, enhancing efficiency and performance.

1. Solar Energy Harvesting: Solar water heaters utilize solar collectors to absorb sunlight and convert it into heat energy, which is then transferred to water for heating. Traditional solar water heaters are typically fixed in position, which limits their ability to capture sunlight optimally throughout the day.

2. Sun Tracking Technology: The Sun Tracking Solar Water Heater incorporates sun tracking technology to automatically adjust the orientation of the solar collectors in real-time, ensuring they are continuously aligned with the sun's position. This dynamic tracking capability traditional solar water heater system, this solution aims to maximize energy capture from the sun throughout the day, enhancing efficiency and performance enables the system to capture maximum sunlight intensity and angle, significantly increasing energy capture and conversion efficiency.

3. Improved Performance: By dynamically tracking the sun's movement across the sky, the solar water heater can maintain an optimal angle of incidence with the sun's rays, maximizing solar irradiance and heat absorption. This leads to improved performance and higher water heating temperatures compared to fixed-position solar water heaters.

4. Energy Efficiency: The integration of sun tracking technology enhances the overall energy efficiency of the solar water heater system by minimizing energy losses and maximizing energy utilization. This results in reduced energy consumption and lower operating costs over the system's lifecycle.

5. Environmental Benefits: Sun tracking solar water heaters utilize clean and renewable solar energy, reducing reliance on fossil fuels and lowering greenhouse gas emissions associated with conventional heating methods. This eco-friendly approach contributes to environmental sustainability and helps combat climate change.

6. Adaptability: The Sun Tracking Solar Water Heater can be designed to accommodate various system configurations, including flat-plate collectors, evacuated tube collectors, or hybrid collector designs. It is suitable for residential, commercial, and industrial applications, offering versatility and scalability to meet diverse user needs.

LITERATURE REVIEW

When conducting a literature survey on sun-tracking solar water heaters, it's essential to explore a range of sources, including books, research papers, journals, and conference proceedings. Here are some recommended books and authors that can provide valuable insights into this topic:

1.“**Solar Engineering of Thermal Processes**" by John A. Duffie and William A. Beckman - This comprehensive book covers various aspects of solar energy utilization, including solar collectors, thermal storage, and system design. It provides a solid foundation in solar thermal engineering principles, which are applicable to sun-tracking solar water heaters.

2."**Solar Energy: Principles of Thermal Collection and Storage**" by S.P. Sukhatme - This book offers a detailed overview of solar energy technologies, including solar water heating systems. It covers topics such as solar radiation, flat-plate collectors, concentrator systems, and thermal storage, which are relevant to sun-tracking solar water heaters.

3."**Solar Thermal Engineering: Heating Systems for Buildings and Domestic Hot Water**" by John W. Lund and Tony E. Unruh - This book focuses on solar thermal applications for heating buildings and providing domestic hot water. It discusses different types of solar collectors, system design considerations, and performance optimization

4."**Solar Energy: Technologies and Project Delivery for Buildings**" by Andy Walker - This book provides practical guidance on integrating solar energy systems into buildings, including solar water heating systems. It covers design principles, installation techniques, and project management considerations for solar energy projects.

1. HARDWARE SPECIFICATIONS

a. 3 BALL CASTER WHEEL

b. WIRE 1MM

c. 1.5 IRON STRIP

d. 24x4 inch plank

e. 24x24 MDF BOARD

f. ASMO MOTOR

g. 10 RPM DC GEAR MOTOR

h. GEAR 24 TEETH

i. 2 IRON DISK 6 INCH

j. 0.75 SQUARE PIPE

k. DPDT SWITCH

l. ARDUINO UNO

m. RELAY DUAL CHANNEL

n. 2 LDR SENSOR

o. RESISTOR 10K

p. 5V REGULATOR BY USING 7805 MOSFET

q. 2 FILTER CAPACITOR 10 micro farad



CASTER WHEEL WIRE 1 MM 24X24 MDF BOARD



6 INCH IRON DISK GEAR 24 TEETH DPDT SWITCH


ARDUINO UNO RELAY DUAL CHANNEL

WIRE 1MM

A wire with a diameter of 1mm (millimeter) is a thin, flexible, cylindrical strand typically made of metal or a conductive material. Here's a descriptive overview:

- The wire may be composed of various materials, including copper, aluminum, steel, or alloys.
- Copper wire is commonly used for electrical and electronic applications due to its excellent conductivity and corrosion resistance.

Diameter:

- The wire has a diameter of 1mm, which is equivalent to 0.0394 inches or approximately 18 AWG (American Wire Gauge) standard.
- This diameter classifies the wire as relatively thin, suitable for low to medium current applications.

24X24 MDF BOARD

A 24x24 MDF (Medium-Density Fiberboard) board refers to a panel of MDF material that measures 24 inches in both length and width. Here's a descriptive overview of a 24x24 MDF board:

MDF is an engineered wood product made by breaking down hardwood or softwood residuals into wood fibers, combining them with wax and a resin binder, and forming panels by applying high temperature and pressure. The resulting board is dense, flat, and smooth, with no visible wood grain.

The MDF board measures 24 inches by 24 inches, making it a square-shaped panel. The thickness of the board can vary based on the specific application and requirements but is not specified in this dimension.

GEAR 24 TEETH

A gear with 24 teeth is a mechanical component designed to transmit motion and power between two rotating shafts. Here's a descriptive overview:

2. **Number of Teeth:**

- The gear has 24 evenly spaced teeth around its circumference.
- The number of teeth determines the gear ratio and affects the speed, torque, and direction of motion in gear systems.

3. **Pitch Diameter:**

- The pitch diameter of the gear is a theoretical diameter at which the gear engages with another gear in a meshing system.

6 INCH IRON DISK

A 6-inch iron disk refers to a circular disc made of iron material with a diameter of 6 inches. Here's a descriptive overview:

1. Material Composition: The disk is typically made of iron or a ferrous alloy. Iron disks are commonly composed of cast iron or wrought iron, known for their strength, durability, and resistance to deformation.

2. Diameter: The disk has a diameter of 6 inches, which is approximately 152.4 millimeters. This dimension defines the size of the disk and is crucial for determining its compatibility with other components or equipment.

3. Thickness: The thickness of the iron disk can vary depending on the specific application and requirements. It may range from a fraction of an inch to several inches, depending on factors such as load-bearing capacity and structural integrity.

DPDT SWITCH

A 6-pin DPDT (Double Pole Double Throw) switch is a type of electrical switch that

provides two separate circuits, each with two positions. Here's a breakdown of its characteristics:

1. Number of Pins: The switch has a total of six pins, with two pins for each pole (commonly labeled as pole A and pole B) and two additional pins for the common connections (often labeled as COM).

ARDUINO UNO

Microcontroller: The Arduino Uno is powered by the ATmega328P microcontroller, which has 32KB of flash memory for storing code, 2KB of SRAM for variables, and 1KB of EEPROM for non-volatile storage

1. Digital I/O Pins: It features 14 digital input/output (I/O) pins, of which 6 can be used as PWM (Pulse Width Modulation) outputs. These pins can be used to interface with various sensors, actuators, and other electronic components.

2. Analog Inputs: The Uno has 6 analog input pins, marked A0 through A5, which can be used to read analog signals from sensors such as temperature sensors, light sensors, and potentiometers.

RELAY DUAL CHANNEL

1. Functionality: A dual-channel relay module allows you to control two independent electrical circuits using a single module. Each channel has its own relay, which can be independently activated or deactivated.

2. Relay Type: The relays used in a dual-channel relay module are typically electromagnetic relays. These relays consist of a coil and one or more sets of contacts that open or close when the coil is energized or de-energized.

3. Control Interface: Dual-channel relay modules are commonly designed to be controlled by a microcontroller, such as an Arduino or Raspberry Pi. They often feature opto-isolated inputs, which provide electrical isolation between the control circuitry and the relay circuitry for added safety and protection.

DESIGN AND PROCESS FLOW

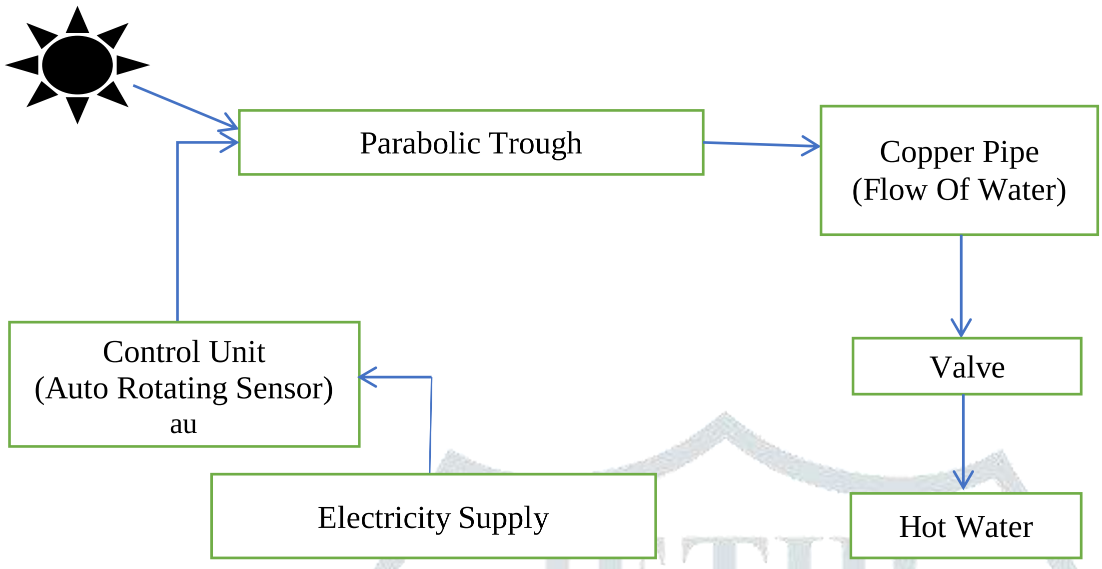

Fig: PROCESS FLOW

PARABOLIC TROUGH CONCENTRATOR: A parabolic trough concentrator consists of a reflecting surface mounted on a reflector support structure having the profile of a parabola. A receiver assembly comprising a circular absorber tube with suitable selective coating and enclosed in a concentric glass envelope is centered along the reflector focal line. Maintain focusing of solar radiation on the receiver assembly. The incident energy is absorbed by a working fluid circulating through the absorber tube.

DESIGN PARAMETERS : The design parameter of a parabolic trough collector can be classified as geometric and functional. The geometric parameters of a PTC are its aperture width and length, rim angle, focal length, diameter of the receiver diameter of the glass envelope and the concentration ratio. The functional parameters of a PTC are optical efficiency, instantaneous and all day thermal efficiency and receiver thermal losses. These parameters are largely influenced by the absorptive.

MIRROR MATERIALS : In solar energy applications, back silvered glass plates, various commercially available reflector materials, having evaporated silver coating, is the best reflector, since its reflectivity is high at all acceptance angles. The composite glass mirror having reflectivity of the order of 92% in the solar spectrum has been used in several industrial.

THERMAL ANALYSIS : concentrating solar power (CSP) technologies now constitute feasible commercial options for large scale power plants as well as for smaller electricity and heat generating devices. The principle of CSP (also referred to as solar thermal power), on the other hand, is the use of heat generated by direct solar radiation concentrated onto a small area with the purpose of producing electricity. There are currently four basic commercially available CSP technologies. From the available CSP technologies, parabolic trough is the most widespread today, with around 29 plants in operation and around 1220 of installed power in the world, corresponding to 96.3% of the total operational concentrating solar power as the beginning of 2011.

TRACKING SYSTEM OF SOLAR CONCENTRATOR TROUGH : The manual tracking system of solar concentrator trough in which we track the concentrator from E to W direction by 10 in every 30 minutes interval it depends upon situtaions on the sun moment by sun

EXPERIMENT ANALYSIS:

1.Temperature (°C) change without automatic rotating parabolic trough.

Flow rate (L/min)	**Solar insolation (W/m^2)**	**Temperature (°C)**
5	800	18
5	900	19
5	1000	21
10	800	23
10	900	25
10	1000	25
15	800	26
15	900	28
15	1000	31

2. Temperature (°C) change with automatic rotating parabolic trough.

Flow rate (L/min)	**Solar insolation (W/m^2)**	**Temperature (°C)**
5	800	20
5	900	22
5	1000	24
10	800	25
10	900	27
10	1000	29
15	800	30
15	900	32
15	1000	34

We have observed fluctuations in temperature during our analysis, both with and without the implementation of an automatic rotating parabolic trough. This highlights the crucial role that the automatic rotating sensor plays in enhancing the machine's efficiency. By continuously adjusting the position of the parabolic trough to optimize sunlight absorption throughout the day, the sensor ensures maximum utilization of solar energy, leading to improved performance and overall efficiency of the system.

The automatic rotating sensor significantly enhances the functionality of the parabolic trough system by dynamically tracking the movement of the sun. This feature allows the trough to maintain its optimal orientation towards the sun, thereby maximizing the amount of solar radiation captured at any given time. As a result, the system can consistently generate higher temperatures and achieve greater thermal efficiency compared to static systems. Additionally, the real-time adjustments made by the sensor help mitigate the impact of environmental variables such as cloud cover or changes in sunlight intensity, ensuring reliable performance under varying conditions. Overall, the inclusion of the automatic rotating sensor is pivotal in unlocking the full potential of the parabolic trough technology, enabling it to deliver more consistent and efficient energy output.

3. Solar insolation refers to the amount of solar radiation received per unit area at a given location on earth's surface. It is typically measured in watts per square meter(W/m^2). Solar insolation accounts for factors such as time of day, season, latitude and weather conditions, all of which affect the intensity of sunlight reaching a particular area.

4. Solar insolation can be calculated using various methods, but one common approach is to use data from weather stations or solar radiation database.

5. **Gravity Feed Systems**: For simpler setups, you can rely on gravity to control the flow rate. Adjusting the height of the water source relative to the collector can influence the flow rate.

CONCLUSION

The conclusion regarding the auto-rotating parabolic trough water heater is as follows:

Implemented at a lower cost : This means that the auto-rotating parabolic trough water heater can be put into operation without requiring a significant financial investment. This is beneficial as it makes the technology more accessible and feasible for implementation, especially in areas with limited resources.

Useful for solving several problems: This indicates that the technology addresses multiple issues or challenges. For example, it could help in providing hot water for domestic or industrial use, reducing reliance on traditional energy sources, or even contributing to environmental conservation efforts.

Environmentally friendly: This highlights that the technology has a minimal negative impact on the environment. It may use renewable energy sources or have low emissions, helping to reduce pollution and combat climate change.

Offers numerous future opportunities: This indicates that there are many potential applications or advancements that can stem from the technology. It suggests that the auto-rotating parabolic trough water heater has the potential for further development, innovation, and integration into various sectors or industries, paving the way for future advancements and improvements. analytics, hold promise for further improving the efficiency and reliability of sun-tracking solar panel systems. Additionally, research into cost-effective tracking solutions and scalability for large-scale deployments will drive wider adoption of this technology.

ADVANTAGES

Sun tracking solar panels offer several advantages compared to fixed solar panels:

- **Increased Energy Production:** Sun tracking systems adjust the orientation of solar panels throughout the day to directly face the sun, maximizing solar irradiance. This optimized positioning leads to higher energy output compared to fixed panels, especially during mornings, evenings, and seasons with low sun angles.
- **Seasonal Adaptability:** Sun tracking systems can adjust the tilt and orientation of solar panels to accommodate seasonal variations in the sun's path. This flexibility allows them to maintain optimal performance throughout the year, maximizing energy production even during winter months when the sun's angle is lower.
- **Optimized Power Output:** By dynamically adjusting the panel's orientation, sun tracking systems can maintain a near-ideal angle of incidence, which maximizes the power output per unit area of solar panels. This optimization results in higher energy production per installed kilowatt-peak (kWp) capacity compared to fixed installations.
- **Reduced Installation Footprint:** Sun tracking systems typically require fewer solar panels to achieve the same energy output as fixed installations due to their higher efficiency. As a result, they can help reduce the overall land or rooftop space required for solar power generation, making them suitable for constrained or space-limited environments.

- **Financial Returns:** While sun tracking systems generally involve higher upfront costs and maintenance compared to fixed installations, their increased energy production can result in faster payback periods and higher financial returns over the system's lifetime, especially in locations with high solar irradiance.

DISADVANTAGES

While sun-tracking solar panels offer several advantages, they also come with some disadvantages. Here are some common drawbacks of sun-tracking solar panels:

- **Maintenance Requirements:** Sun-tracking systems require regular maintenance to ensure proper operation. The moving parts, such as motors and gears, may wear out over time and require lubrication or replacement. Additionally, the sensors and tracking mechanisms may need calibration to maintain accurate alignment with the sun.

- **Energy Consumption:** Sun-tracking systems consume energy to power the motors and tracking mechanisms, which can offset some of the energy gains from increased sunlight exposure. This energy consumption reduces the overall efficiency of the solar panel system.

- **Reliability:** Sun-tracking systems are more prone to mechanical failures and malfunctions compared to fixed solar panel installations. Any malfunction in the tracking mechanism can reduce the performance of the solar panels and may require manual intervention to reset or repair.

APPLICATIONS

Sun-tracking solar panels, also known as solar trackers, are devices designed to orient solar panels or solar arrays to follow the sun's path across the sky. This dynamic positioning optimizes the absorption of sunlight and enhances the efficiency of solar energy generation. Here are some common applications of sun-tracking solar panels:

- **Utility-Scale Solar Power Plants:** Large-scale solar power plants often employ sun-tracking systems to maximize energy output. By continuously adjusting the orientation of solar panels to face the sun, these systems can significantly increase electricity generation, improving the overall efficiency and profitability of the solar plant.

- **Commercial and Industrial Installations:** Many commercial and industrial facilities utilize sun-tracking solar panels to offset energy costs and reduce dependence on traditional grid electricity. These installations can range from rooftop solar arrays on warehouses and factories to ground-mounted systems at commercial properties.

- **Residential Solar Installations:** While less common due to cost considerations, some homeowners choose to install sun-tracking systems for their residential solar panels. These systems typically require more space and investment but can offer higher energy yields, especially in locations with variable sun exposure throughout the day.

- **Agricultural and Aquacultural Operations:** Sun-tracking solar panels can be integrated into agricultural and aquacultural operations to provide power for irrigation systems, water pumps, lighting, and other equipment. By harnessing solar energy efficiently, these systems can help reduce operational costs and environmental impact.

- **Research and Development:** Sun-tracking solar panels are also used in research and development projects to study solar energy harvesting and optimize system performance. Researchers may investigate new tracking algorithms, control systems, materials, and designs to improve efficiency and reliability.

- **Education and Demonstration:** Sun-tracking solar panels serve as educational tools in schools, universities, and science centers to teach students and the public about solar energy technology, renewable energy concepts, and sustainability. These systems provide hands-on learning opportunities and demonstrate the practical applications of solar tracking technology.

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