Design and Construction Cylindrical Solar Water Heater

A report submitted to the Department of Mechanical, Sonargaon University of Bangladesh in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Mechanical Engineering.

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Abstract

In the present review paper, the existing solar water heating systems are studied with their applications. Nowadays, hot water is used for domestic, commercial and industrial purposes. Various resources i.e. coal, diesel, gas etc, are used to heat water and for steam production. Solar energy is the chief alternative to replace the conventional energy sources. The solar water heating system is the technology to harness the plenty amount of free available solar thermal energy. The solar thermal system is designed to meet the energy demands. The size of the systems depends on availability of solar radiation, temperature requirement of customer, geographical condition and arrangement of the solar system, etc.Time depends on the temperature rise based on the measurement of water. It will take us a while to heat water from solar in this project. However, if the system is kept longer, it will be able to heat up to 100°C.Therefore, it is necessary to design the solar water heating system as per above parameters. The available literature is reviewed to understand the construction, arrangement, applications and sizing of the solar thermal system.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The sun has been a powerful presence and forcethroughout the history of human existence on earth. Ithas beenregarded by many cultures as a god of oneform or another, and understood by most to be theultimate source of life on this planet. It has also beenintentionally exploited by many clever means over thecenturies, in order to better utilize this life-giving energy.[1] As far as renewable energy sources go, the sunrepresents the best and most stable we have. It isinfinite with respect to all practical timescales,immensely powerful, understood and predictable in itsoverall trends and patterns, and for the foreseeablefuture beyond anthropogenic effects. In short, theperfect energy source; but it is not without difficulties.Solar heater is a device which is used for heating thewater, for producing the steam for domestic andindustrial purposes by utilizing the solar energy.[2]

Modern systems designed for capturing the suns energyand transferring it to water, either for immediate use oras a storage medium, have been studied and put to usesince the 1970's, when they were first used for poolheating inCalifornia. Continued research andinnovation has resulted in products feasible in muchcolder and less sunny climates today (Bennet T, 2007).[3]With the energy crunch and sky rocketing prices, eyes are turning to the plant power house in the sky, the sun our national mission is also to harness the divine source of energy for well-being of mankind. Sunlight is mainly used in Thermal and photovoltaic forms water heating, but the real scope of using hot water system is in the domestic section.[4] Hence solar water applicable for use of the solar radiation falling on the, Flat plate Collector "is transformed into the heat energy, which is used to heat water in the range of 60**0**C to 75**0**C. This device makes direct use of sunlight available in abundance most part of India for most of the time.[5]

This system saves the costly consumption of electrical energy. Having not fear of wastage of resourceful energy. It provides uninterrupted hot water flow any day, any time without worrying for power cuts and electrical shocks. Thus inspire of many benefits the major problems for the existing solar water heating system is its initial cost is very high and also required some maintenance, so for these **"low cost solar water heating system with a heat storage"** is of great utility, which is the result of some rectification in the material used for making existing solar water heating system, and also to the design of existing solar water heaterswhich can heat the water up approx. 600C to 700C is of the capacity of nearly 400 liters with a heat storage system.[6]

1.2 HISTORY

The history of using the sun for energy goes way backto the Ancient Greeks and Romans as their buildingswere constructed such that the rays of the sun providedlight and heat for indoor spaces. The Greek philosopherSocrates wrote, "In houses that look toward the south,the sun penetrates the entrance in winter." Romansadvanced this art by covering the openings to southfacing building with glass, in order to retain the heat ofthe winter sun.

The history of utilizing solar energy in recent timesdates from 1861 when Mouchout developed a steamengine powered entirely by the sun and in 1883American inventor Charles Fritts described the firstsolar cells made of selenium wafers.The Arab oil embargo in 1973 confirmed the degree towhich the western economy depended upon there,being a cheap and reliable flow of oil. In the 1970s itwas thought that through massive investment in funding and research, solar photovoltaic costs coulddrastically reduced, such that eventually solar cellscould become competitive with fossil fuels.In the mid 50's Israeli engineer, Levi Yissar, suggestedthe use of solar energy for heating up domestic waterwith Israelis responding by the mass purchasing ofsolar water heaters. By 1983, 60% of the populationheated their water from the sun. When the price of oildropped in the mid-1980s, the Israeli governmentrequired its inhabitants to heat their water with the sun.Today, more than 90% of Israeli households own solarwater heaters.

By the 1990s, the reality was that the costs of solarenergy had dropped as predicted and the huge PVmarket growth in Germany and Japan from the 1990sto the present has boosted the solar industry.Furthermore, such large PV productions are creatingsteadily lowering costs. Meanwhile, the heating ofwater by solar energy is an increasingly cost-effectivemeans of lowering gas and electricity demand (KenButti, John Perlin, 1980).In the 19th century, people used a stove to heat waterby burning pieces of wood or coal. In cities, thewealthier heated their water with gas manufacturedfrom coal. In many areas, wood, coal or gas could notbe easily obtained and hence such fuels were oftenexpensive. To avoid these problems, a much easier andsafer way to heat water was created. This was achievedby placing outside a black painted metal tank full ofwater to absorb solar energy. The disadvantage wasthat even on clear hot days it usually took frommorning to early afternoon for the water to get hot. Asthe sun went down, the tank rapidly lost its heatbecause it had no insulation (Charles Smith, 1995).

1.3 CURRENT SOLAR ENERGY SYSTEMS

Solar technologies are commonly grouped into threemajor categories, generally differing in the ways theycollect, store and use energy.Passive solar systems involve direct utilization of thesun's radiation as light or possibly heat. Examplesinclude energy efficient windows, skylights,greenhouses, and hybrid lighting fixtures, which usefiber optic cable to transmit sunlight into interiorrooms. Next are solar thermal, which collect and usethe sun's energy as heat. They are different from directheating in their ability to store thermal energy for lateruse. Modern applications include domestic andindustrial water heating, air and space heating, radiantslab heating, and even the operation of heat pumps andsterling engines (Bennet T, 2007).The energy and the temperature level required to besupplied to carry out everyday tasks will vary.Generally, a domestic hot water supply at temperaturesin the range of 50 to 60 degree Celsius is considered tobe acceptable (SOPAC Technical Report, 1999).

1.4 Objective:

The objectives of this project are:

a) To study about Cylindrical Solar Water Heater.
b) To test the performance ofCylindrical Solar Water Heater

CHAPTER 2
LITERATURE REVIEW

Energy management activities, such as energy efficiency improvementsand the use of renewable energy systems, have recentlybeen introduced by Eskom, in order to mitigate a totalgrid shutdown. Energy efficiency improvements aim to decreasethe overall energy usage of a system, while energy managementschemes attempt to shift peak demand energy usage to off-peakperiods.Using Renewable energy as a source, rather than electricalenergy from the grid for heating water, lowers the strain on theelectricity supplier (Gets and Mhlanga, 2013).

Higher rates are charged during peak energy consumption periods,while a standard rate applies for intermediate energy usageperiods and an off-peak rate for off-peak periods. Some renewableenergy water heating systems have their control optimized, inorder to shift usageto off-peak and standard periods and this maycut the energy costs in half (Kohler, 2014).Solar water heating systems are classified dependingon how the domestic water is heated or how the heattransfer fluid (water or antifreeze fluid) flows throughthe collector. Based onthis, there are basically twotypes of solar water heating systems, namely; Direct(open loop) and Indirect (closed loop) water heatingsystems which can either be passive or active (Roger Taylor, 2006).

Direct systems heat up water as it flows directly in thecollector whiles indirect systems heat up water througha heat exchanger employed between the collector andthe hot water storage tank. Active systems useelectrically driven pumps to circulate water or anotherheat absorbing fluid, and sometimes use electricallyoperated valves for freeze protection. Passive systemshave no electrical pumps. They rely upon convection tocirculate hot water through the collector and storagetank (Duffie J.A and Beckman W.A, 1991).

Water temperature increases as it passes through each heatingsegment, so that the final desired temperature is reached at thethird and final element. The microprocessor control board regulatesthe amount of energy needed to heat the water to thetemperature set by the user. Inlet cold water temperature, outlethot water temperature and the flow of the water is monitored andthe power is adjusted accordingly. Due to the absence of a storagetank, the heater requires less space, meaning that it may be placednear the hot water demand location.This, in turn, reduces heatlosses (Milward and Prijyanonda, 2005).

CHAPTER 3

THEORY & WORKING PRINCIPLE

3.1 Solar Water Heating

Solar water heating (SWH) is heating water by sunlight, using a solar thermal collector. A variety of configurations is available at varying cost to provide solutions in different climates and latitudes. SWHs are widely used for residential and some industrial applications.A sun-facing collector heats a working fluid that passes into a storage system for later use. SWH are active (pumped) and passive (convection-driven). They use water only, or both water and a working fluid. They are heated directly or via light-concentrating mirrors. They operate independently or as hybrids with electric or gas heaters. In large-scale installations, mirrors may concentrate sunlight into a smaller collector. As of 2017, global solar hot water (SHW) thermal capacity is 472 GW and the market is dominated by China, the United States and Turkey. Barbados, Austria, Cyprus, Israel and Greece are the leading countries by capacity per person.

Heat transfer

Direct

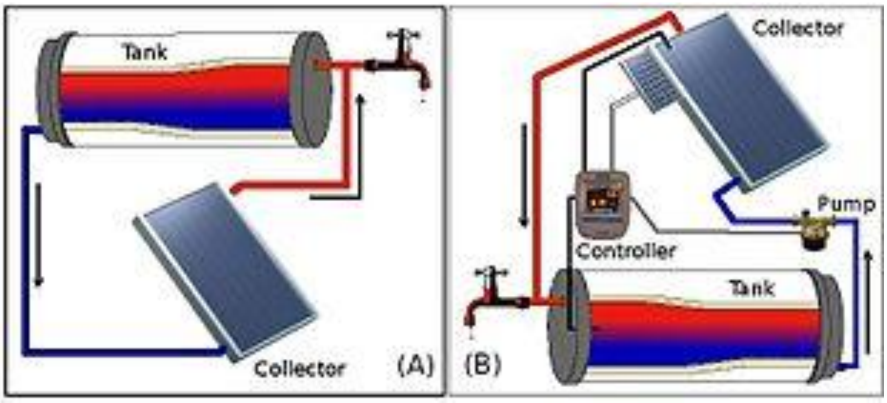

Figure 3.1: (A) Passive CHS system with tank above collector. (B) Active system with pump and controller driven by a photovoltaic panel.

Direct or open loop systems circulate potable water through the collectors. They are relatively cheap. Drawbacks include:

- They offer little or no overheat protection unless they have a heat export pump.
- They offer little or no freeze protection, unless the collectors are freeze-tolerant.
- Collectors accumulate scale in hard water areas, unless an ion-exchange softener is used.

The advent of freeze-tolerant designs expanded the market for SWH to colder climates. In freezing conditions, earlier models were damaged when the water turned to ice, rupturing one or more components.

Indirect

Indirect or closed loop systems use a heat exchanger to transfer heat from the "heat-transfer fluid" (HTF) fluid to the potable water. The most common HTF is an antifreeze/water mix that typically uses non-toxic propylene glycol. After heating in the panels, the HTF travels to the heat exchanger, where its heat is transferred to the potable water. Indirect systems offer freeze protection and typically overheat protection.

Propulsion

Passive

Passive systems rely on heat-driven convection or heat pipes to circulate the working fluid. Passive systems cost less and require low or no maintenance, but are less efficient. Overheating and freezing are major concerns.

Active

Active systems use one or more pumps to circulate water and/or heating fluid. This permits a much wider range of system configurations. Pumped systems are more expensive to purchase and to operate. However, they operate at higher efficiency and can be more easily controlled.

Active systems have controllers with features such as interaction with a backup electric or gas-driven water heater, calculation and logging of the energy saved, safety functions, remote access and informative displays.

Passive direct systems

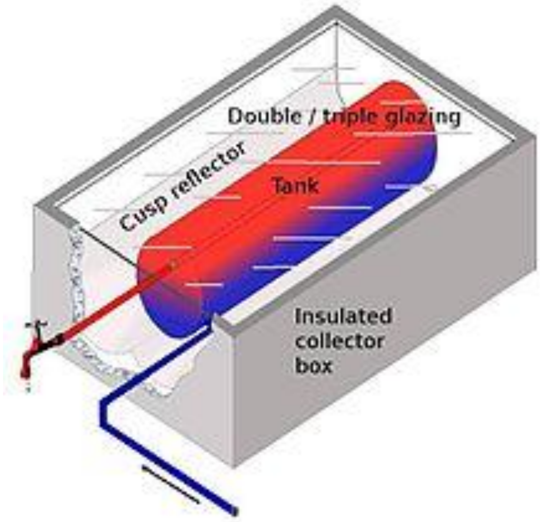

Figure 3.2: An integrated collector storage (ICS) system

An integrated collector storage (ICS or batch heater) system uses a tank that acts as both storage and collector. Batch heaters are thin rectilinear tanks with a glass side facing the sun at noon. They are simple and less costly than plate and tube collectors, but they may require bracing if installed on a roof (to support 400–700 lb (180–320 kg) lbs of water), suffer from significant heat loss at night since the side facing the sun is largely uninsulated and are only suitable in moderate climates.

A convection heat storage unit (CHS) system is similar to an ICS system, except the storage tank and collector are physically separated and transfer between the two is driven by convection. CHS systems typically use standard flat-plate type or evacuated tube collectors. The storage tank must be located above the collectors for convection to work properly. The main benefit of CHS systems over ICS systems is that heat loss is largely avoided since the storage tank can be fully insulated. Since the panels are located below the storage tank, heat loss does not cause convection, as the cold water stays at the lowest part of the system.

3.2 Methodology

- Creating an idea for Design and Construction of Cylindrical Solar Water Heater
- Collecting the all components/materials for construct the system.
- Finally, we made this system & checked it finally that working very well.

3.3 Block Diagram:

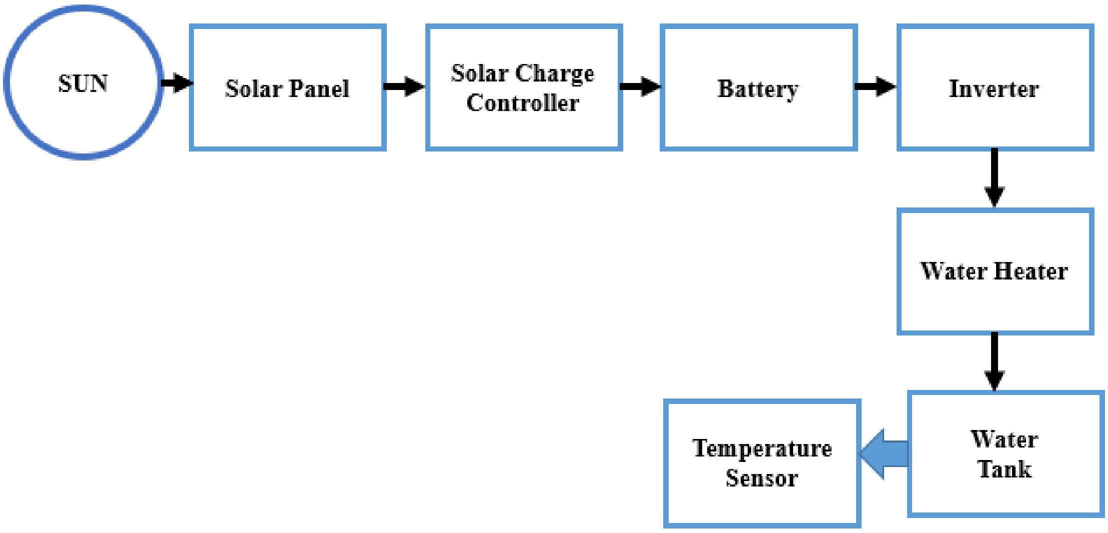

Figure 3.3: Block Diagram ofCylindrical Solar Water Heater.

3.4 Circuit Diagram

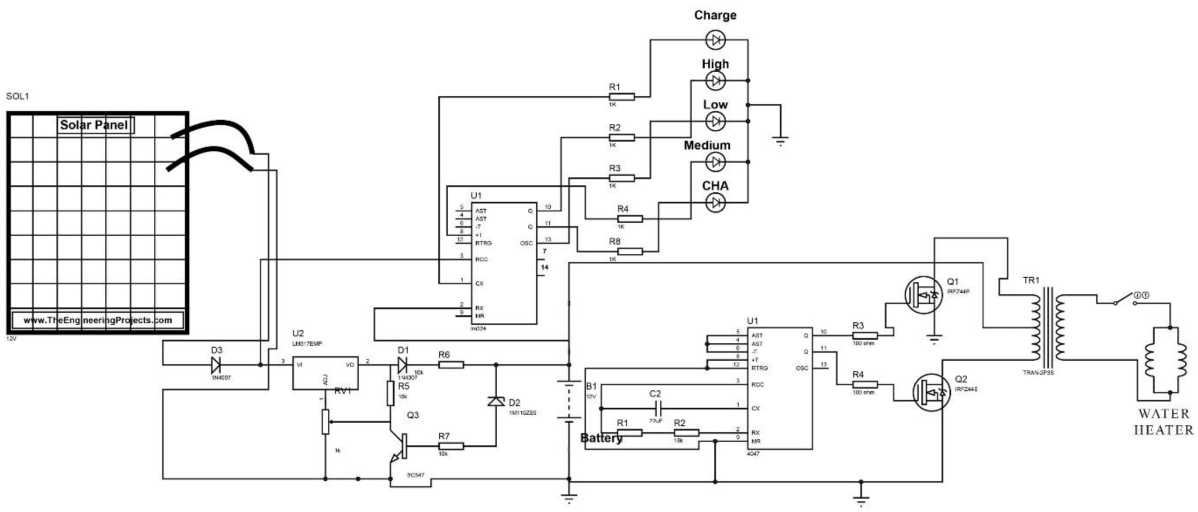

Figure 3.4: Schematic Diagram of Cylindrical Solar Water Heater

3.5 Working Principle

Our project is designed to cylindrical solar water heater purpose.Our main source of power in this system is solar, the energy generated by sunlight is the main driving force of our system. This energy is stored in the battery as a charge controller. We are using Solar Panel for main power sourcefor our project. We also use solar charge controller, Battery, Inverter, Water Heater, Temperature Sensor.

Solar panel absorbed the sunlight and store it in battery. This stored charge is converted DC to AC with the help of inverter circuit and supply in water heater system. This water heater heats the water. A temperature sensor with display sense the water temperature and show its display.

3.6 Complete Project Prototype Image :

Figure 3.5: Project Prototype Image .

3.7 Components List:

1. Solar Panel
2. Solar Charge Controller
3. Battery
4. Inverter
5. Water Heater
6. Temperature Sensor

3.8 Solar Panel

A solar panel is a set of solar photovoltaic modules that are electrically connected and mounted on a support structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of large photovoltaic systems for power generation and supply in commercial and residential applications. Each module is rated by DC output power under Standard Test Conditions (STC) and typically ranges from 100 to 320 watts.

The efficiency of the module determines the area of the given module with the same rated output - an 8% efficient 230-watt module will be twice the area of a 16% efficient 230-watt module. A single solar module can produce only a limited amount of energy; Most organizations have more than one module. A photovoltaic system usually consists of an array of panels or solar modules, an inverter and sometimes a battery and / or solar tracker and interconnection wires.

Figure 3.6: Solar Panel

Solar cell modules only generate electricity when the sun is shining. They do not store energy, so to ensure the flow of electricity when the sun is not burning, some of the energy produced needs to be stored. The most obvious solution is to use batteries, which chemically store electrical energy. Batteries are connected in series with a group of electrochemical cells (devices that convert chemical energy into electrical energy). The battery cells have two electrodes immersed in the electrolyte solution which creates an electric current when a circuit is formed between them. The current is the result of opposite chemical reactions between the electrode and the electrolyte in the cell. Rechargeable batteries are called secondary or rechargeable batteries. As the battery is charged, electrical energy is stored in the cells as chemical energy. During discharge, the stored chemical energy is removed from the battery and converted into electrical energy. Lead-acid batteries are the most common type of battery in East Africa.

Specifications of Solar Panel

- Rated Peak Power: 11W
- Voltage at Maximum Power: 5.94V
- Current at Maximum Power: 1.85A
- Open Circuit Voltage: 7.23V

- Short Circuit Current: 1.97A

3.9 Solar Charger Controller

Here is a solar charger circuit that uses solar energy to charge lead acid or non-CD batteries.The circuit produces solar energy to charge a 6.5 4.5 rechargeable battery of 6 volts for various applications.The charger has voltage and current control and over voltage cut-off facility.

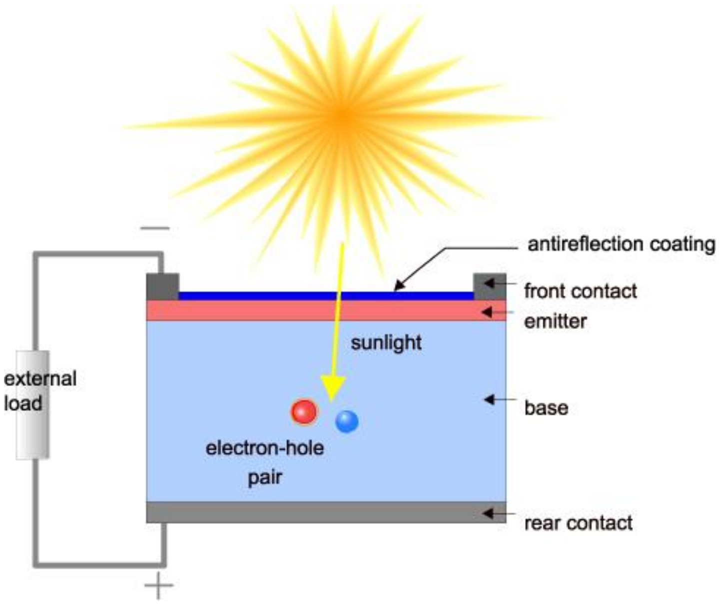

Figure 3.7 : Solar Panel Schema Diagram

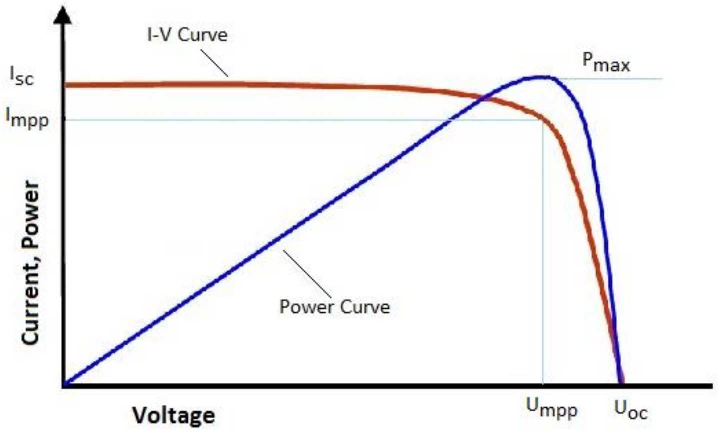

Figure 3.8: Solar Sell System Curve

The circuit uses a 12-volt solar panel and a variable voltage regulator IC LM317. A 12-volt DC is available from the panel to charge the battery. Output voltage and current can be controlled by adjusting its adjusting pin when the current is charged via D1 in voltage regulator IC LM317. Adjustments are placed between the pin and ground to supply an output voltage of 9 volts to the VRT battery.

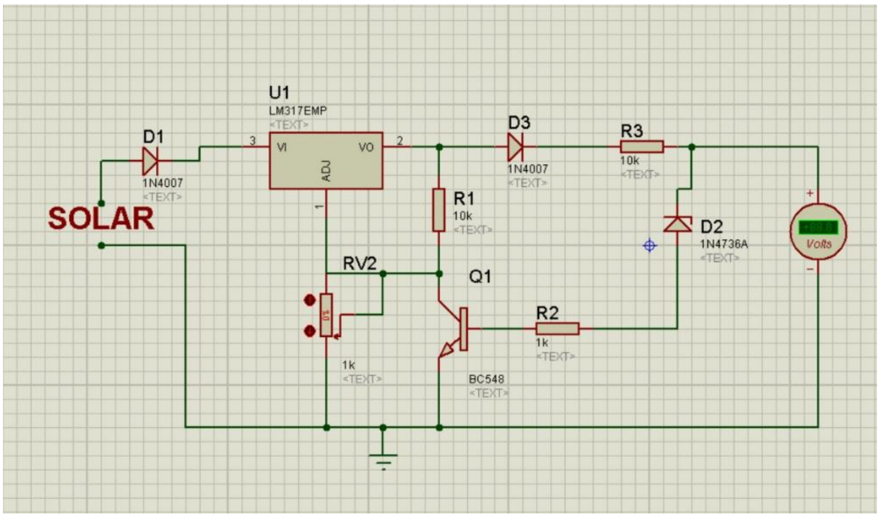

Figure 3.9: Solar Charger Controller Circuit

The resistor R3 limits the charging current and the diode D2 prevents the discharge of current from the battery. Transistor T1 and Zener diode ZD act as cutoff switches when the battery is full. Usually, the T1 stays off and the battery current is charged. When the terminal voltage of the battery rises above 6.8 volts, the base current is supplied to the Zener T1. It then turns on the output grounding of the LM317 to stop charging.

3.10 TRANSISTOR

Specifications:

- Bipolar Transistor, NPN, 45v, to-92
- Transistor Polarity: NPN
- Collector Emitter Voltage V(br)ceo: 45V
- Transition Frequency Type ft: 300MHz
- Power Dissipation Pd: 625mW
- DC Collector Current: 100mA

- DC Current Gain hFE: 150
- Straight-lead housing

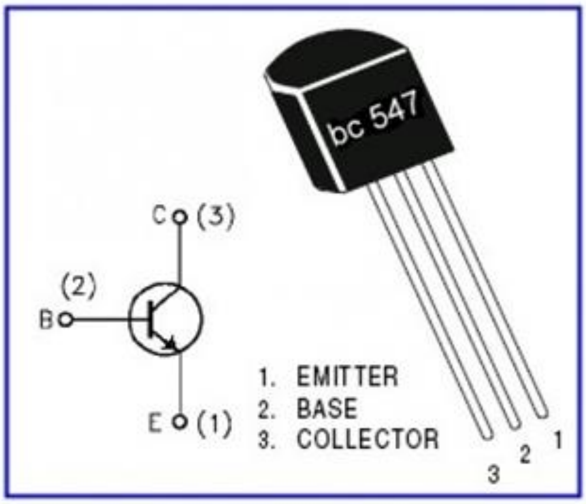

Figure 3.10: BC 547

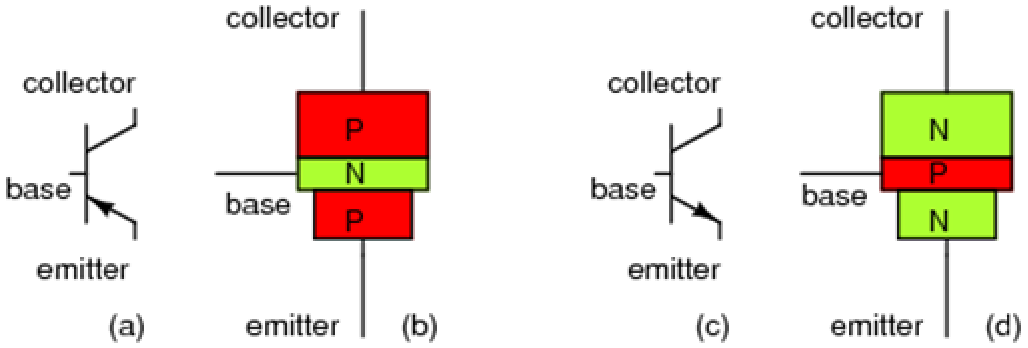

Figure 3.11: Transistor Symbols

My intent here is to focus as exclusively as possible on the practical function and application of bipolar transistors, rather than to explore the quantum world of semiconductor theory. Discussions of holes and electrons are better left to another chapter in my opinion. Here I want to explore how to use these components, not analyze their intimate internal details. I don't mean to downplay the importance of understanding semiconductor physics, but sometimes an intense focus on solid-state physics detracts from understanding these devices' functions on a component level. In taking this approach, however, I assume that the reader possesses a certain minimum knowledge of semiconductors: the difference between "P" and "N" doped semiconductors, the functional characteristics of a PN (diode) junction, and the meanings of the terms "reverse biased" and "forward biased." If these concepts are unclear to you, it is best to refer to earlier chapters in this book before proceeding with this one. A bipolar transistor consists of a three-layer "sandwich" of doped (extrinsic) semiconductor materials, either P-N-P in Fig below a(b) or N-P-N at (d). Each layer forming the transistor has a specific name, and each layer is provided with a wire contact for connection to a circuit. The schematic symbols are shown in Fig below (a) and (d).

BJT transistor: (a) PNP schematic symbol, (b) physical layout (c) NPN symbol, (d) layout.

The functional difference between a PNP transistor and an NPN transistor is the proper biasing (polarity) of the junctions when operating. For any given state of operation, the current directions and voltage polarities for each kind of transistor are exactly opposite each other. Bipolar transistors work as current-controlled current regulators. In other words, transistors restrict the amount of current passed according to a smaller, controlling current. The main current that is controlled goes from collector to emitter, or from emitter to collector, depending on the type of transistor it is (PNP or NPN, respectively). The small current that controls the main current goes from base to emitter, or from emitter to base, once again depending on the kind of transistor it is (PNP or NPN, respectively). According to the standards of semiconductor symbology, the arrow always points against the direction of electron flow. (Fig below)

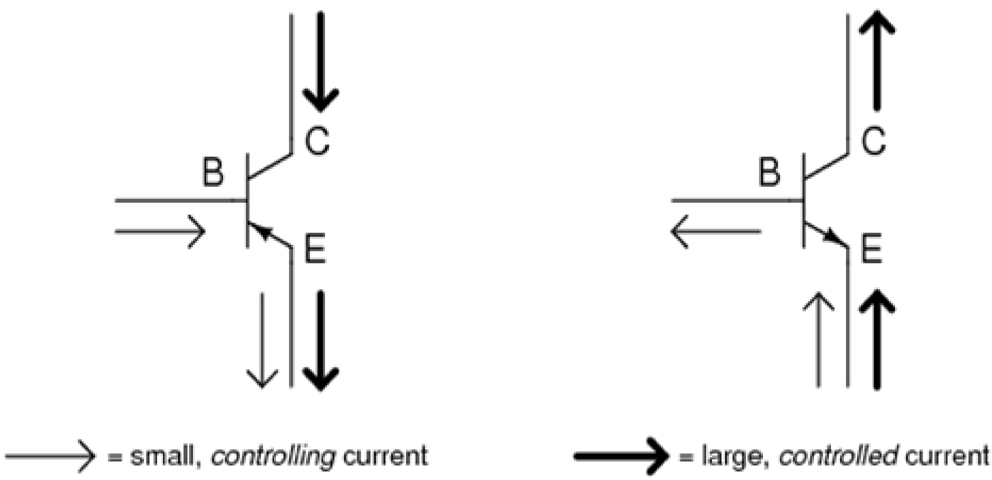

Figure 3.12: NPN & PNP Transistor Symbol

Small Base-Emitter current controls large Collector-Emitter current flowing against emitter arrow. Bipolar transistors are called bipolar because the main flow of electrons through them takes place in two types of semiconductor material: P and N, as the main current go from emitter to collector (or vice versa). In other words, two types of charge carriers—electrons and holes—comprise this main current through the transistor.

As you can see, the controlling current and the controlled current always mesh together through the emitter wire, and their electrons always flow against the direction of the transistor's arrow. This is the first and foremost rule in the use of transistors: all currents must be going in the proper directions for the device to work as a current regulator. The small, controlling current is usually referred to simply as the base current because it is the only current that goes through the base wire of the transistor. Conversely, the large, controlled current is referred to as the collector current because it is the only current that goes through the collector wire. The emitter current is the sum of the base and collector currents, in compliance with Kirchhoff's Current Law. No current through the base of the transistor, shuts it off like an open switch and prevents current through the collector. A base current, turns the transistor on like a closed switch and allows a proportional amount of current through the collector. Collector current is primarily limited by the base current, regardless of the amount of voltage available to push it.

3.11 12v Battery

A twelve-volt battery has six single cells in series producing a fully charged output voltage of 12.6 volts. A battery cell consists of two lead plates a positive plate covered with a paste of lead dioxide and a negative made of sponge lead, with an insulating material (separator) in between.

Quick Details

- Brand Name: DOUBLE TECH(rechargeable 12v dc battery pack)
- Model Number: DBG12-200(12V 200AH)
- Nominal Capacity: 200AH
- Place of Origin: Fujian, China
- Weight: 57kgs

- Certification: ISO9001,CE,MSDS
- rechargeable 12v dc battery pack: 1PCS/CTN(according to the actual situation)
- Production Capacity: rechargeable 12v dc battery pack:50000PCS/Month
- Lifetime: 8-12years
- OEM/ODM: 8 years experience
- Total Workers: 300
- QC Stuffs: 12
- Technical Engineers: 5
- Battery Production Lines: 5
- Factory space: 6000m2
- Maintenance Type: Free
- Voltage: 12V
- Size: 522*240*220/225mm
- Sealed Type: Sealed
- Usage: AGM,UPS

Figure 3.13: 12V Batter

3.12 500w Inverter Circuit

Feature:

- High converting efficiency.
- Under voltage shutdown-protection.
- Overload-protection, overheat-protection.
- Low battery alarm, low / high battery shut down.
- Automatic thermal shut down.
- Safely shuts down if under over temperature or overload condition.
- Advanced chip technology, high conversion efficiency.
- Dual Intelligent cooling fan system, CPU microprocessor to realize multiple-protection.
- Protect the electrical and automotive circuits in use.
- Can be operated with your car cigarette socket or direct connected with wires clips.
- Adapting Aluminum Alloy case, antioxidant, sturdy and durable.
- Positive and negative pole terminal
- Working Indicator Lamp
- Universal Socket, suit for various household electrical appliances, etc.
- Inverter Manual Switch

Specification:

- Output Wave Form: corrected sine wave
- Inputvoltage:DC12V
- OutputVoltage:AC220V
- Peak-power: 500W
- Continuous output power: 450W
- Conversion efficiency: Greater than 90%
- Frequency:50Hz
- Under-voltage shutdown: 10.5VDC
- Low-voltage alarm: 10.5VDC
- Overload-shutdown: Yes

- Short-circuit shutdown: Yes
- Net-weight: 0.60Kg
- Gross-weight: 0.95Kg
- Dimensions:16.3X5.4X5.5CM

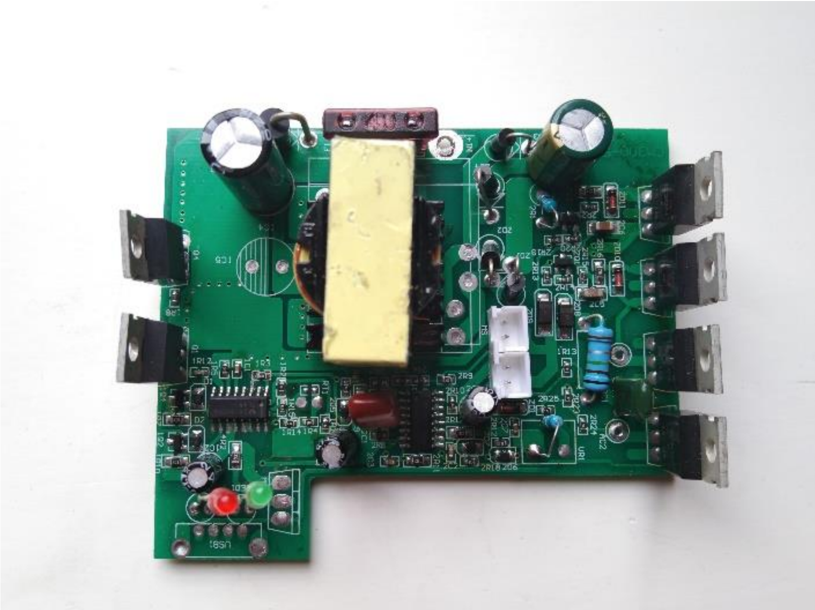

Figure 3.14: 500w inverter circuit

3.13Temperature Sensor with display

A thermometer is a device that measures temperature or a temperature gradient (the degree of hotness or coldness of an object). A thermometer has two important elements: (1) a temperature sensor (e.g. the bulb of a mercury-in-glass thermometer or the pyrometric sensor in an infrared thermometer) in which some change occurs with a change in temperature; and (2) some means of converting this change into a numerical value (e.g. the visible scale that is marked on a mercury-in-glass thermometer or the digital readout on an infrared model). Thermometers are widely used in technology and industry to monitor processes, in meteorology, in medicine, and in scientific research.

Some of the principles of the thermometer were known to Greek philosophers of two thousand years ago. As Henry Carrington Bolton (1900) noted, the thermometer's "development from a crude toy to an instrument of precision occupied more than a century, and its early history is encumbered with erroneous statements that have been reiterated with such dogmatism that they have received the false stamp of authority." The Italian physician SartorioSartorio (*Sanctorius*, 1561-1636) is commonly credited with the invention of the first thermometer, but its standardization was completed through the 17th and 18th centuries. In the first decades of the 18th century in the Dutch Republic, Daniel Gabriel Fahrenheit made two revolutionary breakthroughs in the history of thermometry. He invented the mercury-in-glass thermometer (first widely used, accurate, practical thermometer) and Fahrenheit scale (first standardized temperature scale to be widely used).

PRODUCT DESCRIPTION:

- Product Type: THERMOMETER
- Digital Thermometer Hygrometer
- Temperature Range: -50°c - 70°c
- Measuring Humidity Range: 10% RH - 99% RH
- Humidity Accuracy: 5%
- Humidity Display Resolution: 1% RH
- Temperature Accuracy: 1°C
- Operating Voltage: 1.5v, 2 x LR44 Batteries(Include)
- Sampling Period: 10S

Figure 3.15: Temperature Senor with Display

3.14 Water heater

Water heating is a heat transfer process that uses an energy source to heat water above its initial temperature.Appliances that provide a continual supply of hot water are called water heaters, hot water heaters, hot water tanks, boilers, heat exchangers, geysers (Southern Africa only), or calorifiers.

Principle:

Different heating brands have different arrangements of their heating principle but the concept, usually, remains the same. In other words, most water heaters work simply by converting the electrical energy into heat through the heating element to raise the temperature of the water to a particular degree.

Figure 3.16: Water Heater

3.15 Resistor

Resistors are electronic components that have a fixed, never-changing electrical resistance. Resistor resistance limits the flow of electrons through a circuit. These are passive elements, which means they only receive energy (and cannot produce it). Resistors are usually connected to circuits where they complement active components such as op-amps, microcontrollers and other integrated circuits. Resistors are commonly used to limit current, divide voltages, and draw I / O lines. The electrical resistance of a resistor is measured in ohms.

The symbol for ohm is the Greek capital-omega: the (slightly spherical) definition of Ω Ω 1) is the resistance between two points where 1 volt (1V) of applied potential energy will push the current 1 ampere (1A). As SI units go, large or small ohm values can be matched with a prefix like kilo-, mega- or giga- to make it easier to read the larger values. It is very common to see resistors in the Kiloham (KA) and Megoham (MA) ranges (less common to see Millioham (MA) resistors). For example, a 4,700Ω resistor is equivalent to a 4.7kΩ resistor, and a 5,600,000Ω resistor can be written as 5,600kΩ or (usually) 5.6MΩ. All resistors have two terminals, with a connection at each end of the resistor.

When a schematic is modeled, a resistor will appear as one of these two symbols:

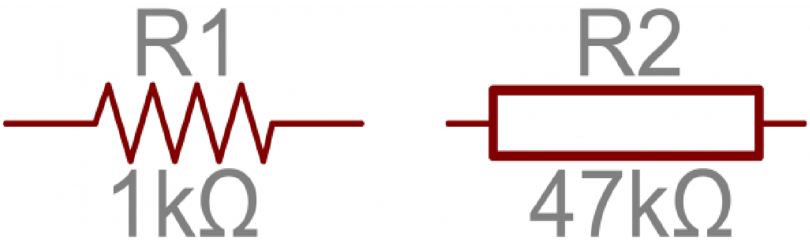

Figure 3.17: Two common resistor schematic symbols

3.16 Project Cost Estimate

Sl. No.	Particulars	Specification	Qty.	Unit Price (Taka)	Total Price (Taka)
01	Solar Panel	6Watt	1	700	700
02	Inverter	500Watt	1	850	850
03	Charge Controller		1	420	420
04	Battery	12V	1	1380	1380
05	Heater		1	220	220
06	Box		1	250	250
07	Digital Temperature Sensor		1	320	320
08	Others				1100
Total					5240/=

Table: Project Cost Estimate

CHAPTER 4

DATA COLLECTION &DISCUSSION

4.1 Data Collection

(December Month Data Reading)

Date	Time	Temperature ($T_i - T_f$)
01-12-21	12:00 pm – 01:00 pm	23.4℃ − 27.6℃
02-12-21	12:00 pm – 01:00 pm	23.4℃ − 27.7℃
03-12-21	12:00 pm – 01:00 pm	23.3℃ − 27.2℃
04-12-21	12:00 pm – 01:00 pm	23.3℃ − 27.3℃
05-12-21	12:00 pm – 01:00 pm	23.4℃ − 27.5℃
06-12-21	12:00 pm – 01:00 pm	23.3℃ − 27.4℃
07-12-21	12:00 pm – 01:00 pm	23.3℃ − 27.4℃
08-12-21	12:00 pm – 01:00 pm	23.3℃ − 27.3℃
09-12-21	12:00 pm – 01:00 pm	23.4℃ − 27.6℃
10-12-21	12:00 pm – 01:00 pm	23.5℃ − 27.6℃
11-12-21	12:00 pm – 01:00 pm	23.5℃ − 27.6℃
12-12-21	12:00 pm – 01:00 pm	23.5℃ − 27.6℃
13-12-21	12:00 pm – 01:00 pm	23.4℃ − 27.3℃
14-12-21	12:00 pm – 01:00 pm	23.3℃ − 27.1℃
15-12-21	12:00 pm – 01:00 pm	23.3℃ − 27.0℃
16-12-21	12:00 pm – 01:00 pm	23.2℃ − 27.0℃
17-12-21	12:00 pm – 01:00 pm	23.3℃ − 26.8℃
18-12-21	12:00 pm – 01:00 pm	23.4℃ − 26.8℃
19-12-21	12:00 pm – 01:00 pm	23.4℃ − 26.7℃
20-12-21	12:00 pm – 01:00 pm	23.3℃ − 26.8℃
21-12-21	12:00 pm – 01:00 pm	23.3℃ − 26.5℃
22-12-21	12:00 pm – 01:00 pm	23.3℃ − 26.4℃
23-12-21	12:00 pm – 01:00 pm	23.4℃ − 26.3℃
24-12-21	12:00 pm – 01:00 pm	23.3℃ − 26.1℃

25-12-21	12:00 pm – 01:00 pm	23.3℃ − 26.0℃
26-12-21	12:00 pm – 01:00 pm	23.2℃ − 25.8℃
27-12-21	12:00 pm – 01:00 pm	23.2℃ − 25.6℃
28-12-21	12:00 pm – 01:00 pm	23.42 − 25.4℃
29-12-21	12:00 pm – 01:00 pm	23.1℃ − 25.2℃
30-12-21	12:00 pm – 01:00 pm	23.2℃ − 25.0℃
31-12-21	12:00 pm – 01:00 pm	23.2℃ − 25.8℃

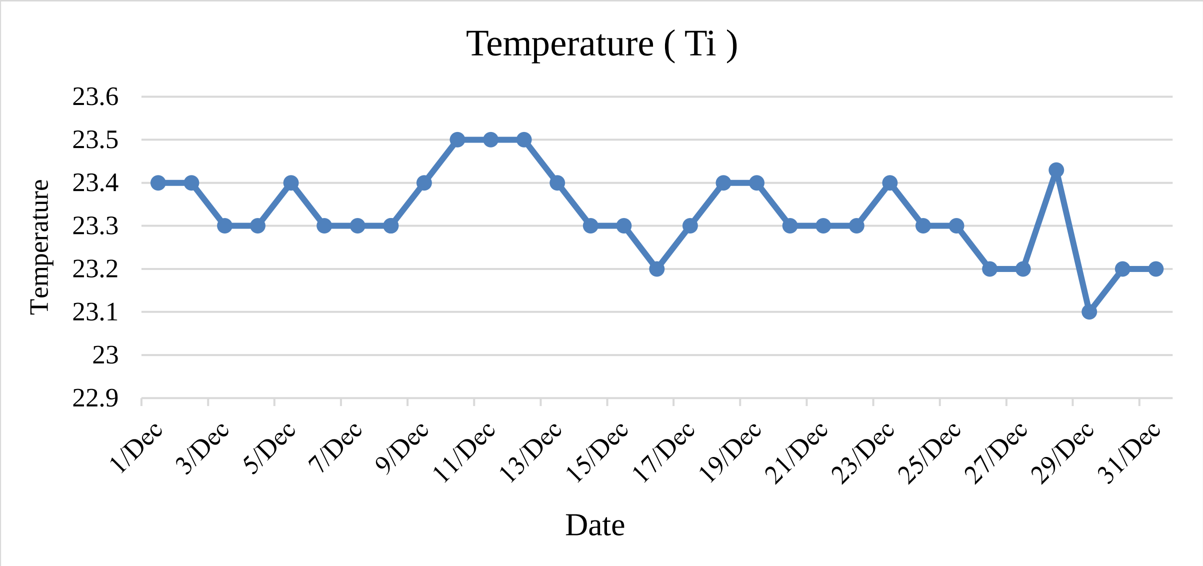

Figure 4.1: Starting Temperature of the Water Graph

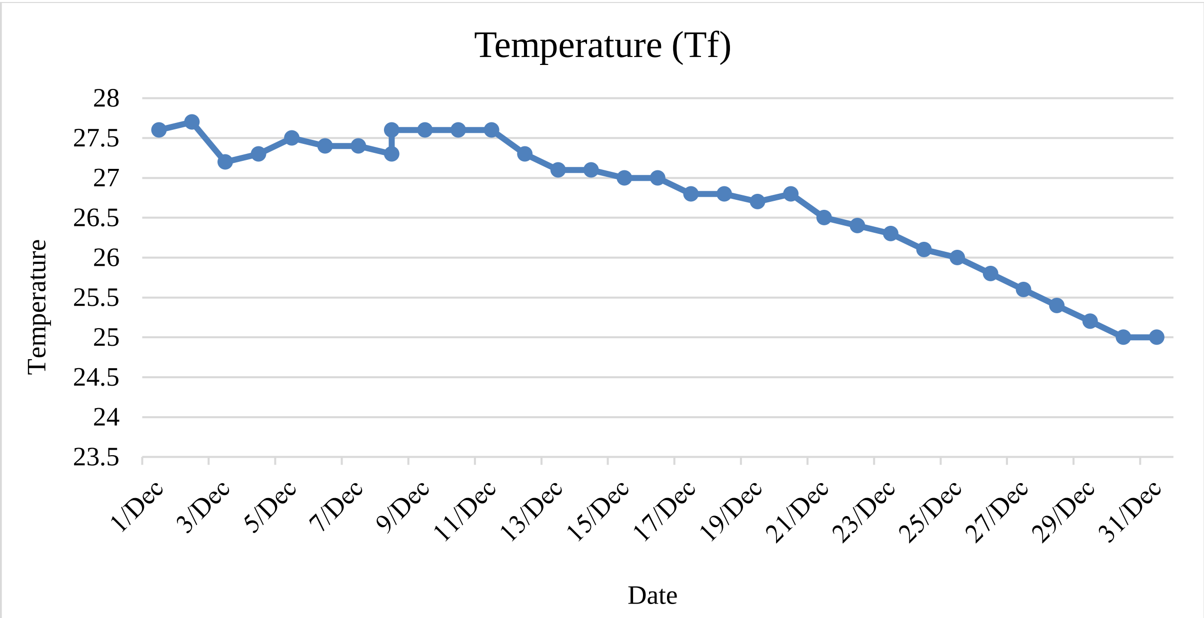

Figure 4.2: Last Temperature of Water Graph

Calculation:

We Know,

$Q = ms\Delta\theta$

$= 5 \times 4200\ (t_f - t_i)$

$= 5 \times 4200 \times 3.43$

$= 89180$

Here,

$m = 5\ liter$

$s = 4200$

$\Delta\theta = (t_f - t_i)$

$p = 6w$

$= 6 \times .75\ \ j/s$

$= 4.5\ \ j/s$

t_f	t_i	Δt	Q	$Q/_{3600}$
27.6	23.4	3.43	89180	$= \frac{89180}{3600}$
27.7	23.4			$= 24.77$
27.2	23.3			
27.3	23.3			
27.5	23.4			
27.4	23.3			
27.4	23.3			
27.3	23.3			
27.6	23.3			
27.6	23.4			
27.6	23.5			
27.6	23.5			
27.3	23.5			
27.1	23.4			
27.1	23.3			
27	23.3			

27	23.2			
26.8	23.3			
26.8	23.4			
26.7	23.4			
26.8	23.3			
26.5	23.3			
26.4	23.3			
26.3	23.4			
26.1	23.3			
26	23.3			
25.8	23.2			
25.6	23.2			
25.4	23.43			
25.2	23.1			
25	23.2			
25	23.2			

$$\therefore\ \eta = \frac{24.77}{3600}$$

$$= 5.50\ j/s$$

4.2Discussion

Solar water heating (SWH) is one of the most effectivetechnologies to convertsolar energy into thermalenergy and is considered to be a developed andcommercialized technology. However, there existopportunities to further improve the systemperformance to increase its reliability and efficiency. Time depends on the temperature rise based on the measurement of water. It will take us a while to heat water from solar in this project. However, if the system is kept longer, it will be able to heat up to 100°C. Aconcise review primarily on the design features andrelated technical advancements of the solar water heating(SWH) systems interms of both energy efficiency and cost effectivenesshas been presented. Several solar water heating designshave been introduced in the market and are morecommonly utilized in the tropical regions of developingcountries. Recent developments in heat pipe basedsolar collector technology exhibit a promising design toutilize solar energy as a reliable heating source forwater heating applications in solar adverse regions.Heat pipe based solar water heating is influenced bymany factors including the nature of the refrigerant,due to the environmental concerns.And this system work efficiency rate is 5.50 J/S.When we made this project then we face some of problem. We did not run it smoothly. After hard work and team work, we did it.

4.3 Advantage

- You are using free energy. Solar energy is free and abundant (even in cloudy weather).
- They are efficient. Approximately 80% of the radiation is turned into heat energy.
- Domestic and commercial properties are entitled to claim the renewable heat incentive.
- Reduce energy waste.
- No Oil consumption.
- Less skill technicians are sufficient to operate.
- Simple construction
- Ease of operation.

4.4 Application

The project has a major application in the

1) Domestic: Flats, Apartments, Car Wash,
2) Commercial: Hotels, Hospitals, Hostels and Dormitories, Restaurants,
3) Industrial: Process Industries, Preheating boiler feed water, Breweries & Wineries, Agriculture

4.5 Limitation

It is a demo project so we found some limitation. In future we will work for reduce this kind of limitation. These limitations are –

- Solar thermal panels can only heat water. Solar PV panels, however, generate electricity and some of this electricity can also be used to heat water. So, there is more flexibility with solar PV.
- Annual maintenance is recommended. This is because there are a few parts to the system like the pump and antifreeze which need to be checked to ensure that they are performing optimally.
- Usually, a new hot water cylinder will need to be installed so space is required to house this.

CHAPTER 5

Conclusion

5.1 Conclusion:

The main objective of this project was to develop a cylindrical solar water heater system. There are numerous practical applications where sensible temperature is required. Such as water heating, industrial process heating, power generation, steam generation, pumping of ground water etc. The performance of the system can be improved by installing a transparent cover over the collector to prevent from dust collecting on the surface of the collector. This project was successfully implemented. We consider this project as a journey where we acquired knowledge and also gained some insights into the subject which we have shared in this report.

5.2 Future Scope

The model can be improved by making some changes in the program and components. Some suggestions are given below-

There is a great scope of this project as it is of very low cost and the materials required for the project are cheaply available in the market. The model system is only for testing and analysis of project. If the performance is positive, then large system can be designed and manufactured which will be connected to a tank and continuous supply of hot water will be there. In the present population is increasing due to that requirement of heating water is more. Hence the cost of solar water heater is increasing day by day. So low-income family cannot pay high cost for solar water heater. So, in the future maximum CPC type solar water heater will be used.

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