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FABRICATION OF ECONOMICAL SOLAR WATER HEATER

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Abstract: Since 1973 the word **energy** has been continuously in the news. There have been shortages of oil in many parts of the world and the price of this commodity has increased steeply. It is by now clear that the fossil fuel era of non-renewable resources is gradually coming to an end. Oil and natural gas will be depleted first followed eventually by coal. In India the energy problem is very serious. In spite of discoveries of oil and gas off the west coast, the import of crude oil continues to increase and the price paid for it now dominates all other expenditure .This year the country will spend more than rs5000 corers for the import of oil. One of the promising options is to make more extensive use of renewable sources of energy derived from the sun. Solar energy can be used both directly and indirectly. It can be used directly in a variety of thermal application like heating water or air drying, distillation and cooking the heated fluids can in turn be used for application like power generation or refrigeration a second way in which solar energy can be used directly is through the photovoltaic effect in which it is converted to electrical energy. Indirectly the sun causes winds to blow plants to grow, rain to fall and temperature differences to occur from the surface to the bottom of the oceans useful energy can be obtained for commercial and non-commercial purposes through all these renewable sources.

Keywords: Solar, water heater, energy, sustainability, development

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INTRODUCTION

Solar water heating has been around for many years because it is the easiest way to use the sun to save energy and money. One of the earliest documented cases of solar energy use involved pioneers moving west after the Civil War. They would place a cooking pot filled with cold water in the sun all day to have heated water in the evening. The first solar water heater that resembles the concept still in use today was a metal tank that was painted black and placed on the roof where it was tilted toward the sun. The concept worked, but it usually took all day for the water to heat, then, as soon as the sun went down, it cooled off quickly because the tank was not insulated. The first commercial solar water heater was introduced by Clarence Kemp in the 1890's in California. For a $25 investment, people could save about $9 a year in coal costs. It was a simple batch type solar water heater that combined storage and collector in one box. The first thermosyphon systems with the tank on the roof and the collector below were invented, patented, and marketed in California in the 1920's by William Bailey. One of the largest commercial systems in California was installed for a resort in Death Valley. Natural gas was discovered in Southern California and cheap natural gas, aggressively marketed by utility companies, ended the solar water heating market. Patents were sold to a Florida company, owned by HM Carruthers in 1923 and the solar hot water industry began in the coastal cities of central Florida and southern Florida. Today, more than 1.2 million buildings have solar water heating systems in the United States. Japan has nearly 1.5 million buildings with solar water heating. In Israel, 30 percent of the buildings use solar- heated water. Greece and Australia are also leading users of solar energy. There is still a lot of room for expansion in the solar energy industry. There are no geographical constraints. For colder climates, manufacturers have designed systems that protect components from freezing conditions.

2. Solar Energy

Every day, the sun radiates (sends out) an enormous amount of energy called solar energy. It radiates more energy in one second than the world has used since time began. This energy comes from within the sun itself. Like most stars, the sun is a big gas ball made up mostly of hydrogen and helium gas. The sun makes energy in its inner core in a process called nuclear fusion. Solar energy is a renewable resource. It is derived from the sun's rays. Solar energy is converted directly to electricity through solar photovoltaic panels. Solar rays, collected off reflective surfaces, heat an object in a process that creates solar thermal energy.

2.1. Solar Geometry

The sun is a sphere of diameter 1.39 109m and its average distance 1.495 1011m. We regard the sun as a blackbody, the effective blackbody temperature is Ts=5762K. The solar constant I0 is defined as solar radiation on an extraterrestrial surface normal to the solar rays. So we have:

$$\sigma T^4 s \prod D^*D\text{-}4I_o \prod l^*l$$

I0=1350 W/m2 Measurements by NASA indicated that the mean I0 is 1373 W/m2 .If all radiation from the sun is absorbed, and then is dissipated by the earth to sky dome by thermal radiation, the earth temperature can be calculated as follows:

$$\prod r^2 I_o - 4\prod r^2 \sigma T^4$$

$$T - \sqrt{I_o/4\sigma} - 279K - 6^o C$$

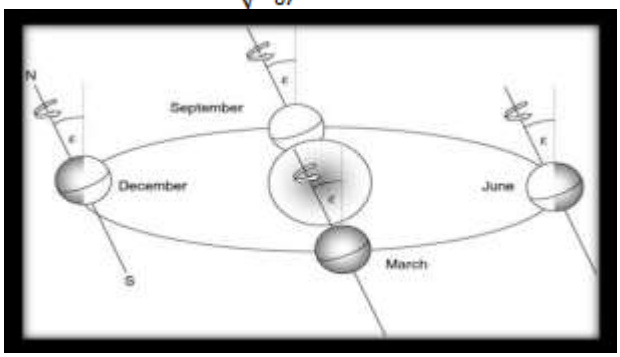


Fig. Solar Geometry

In fact only 70% of incident radiation is absorbed, other 30% is directly reflected to the sky again by the atmosphere of the earth. So we have:

$$T - \sqrt[4]{0.7I_o/4\sigma} - (-18)$$

2.2. Efficiency Parameters

2.2.1. Concentration Ratio : The term "concentration ratio" is used to describe the amount of light energy concentration achieved by a given collector. Two different definitions of concentration ratio are in general use. They are defined briefly here so that the terms may be used.

2.2.2. Optical Concentration Ratio (CRo): The averaged irradiance (radiant flux) (Ir) integrated over the receiver area (Ar), divided by the insolation incident on the collector aperture

$$CR_o = \frac{1/A_r \int I_r \, dA_r}{I_a}$$

2.2.3. Geometric Concentration Ratio (CRg). The area of the collector aperture Aa divided by the surface area of the receiver Ar

$$CRg = A_a / A_r$$

3. What Influences the Amount of Solar Radiation?

•Atmosphere

•Angle of Incidence

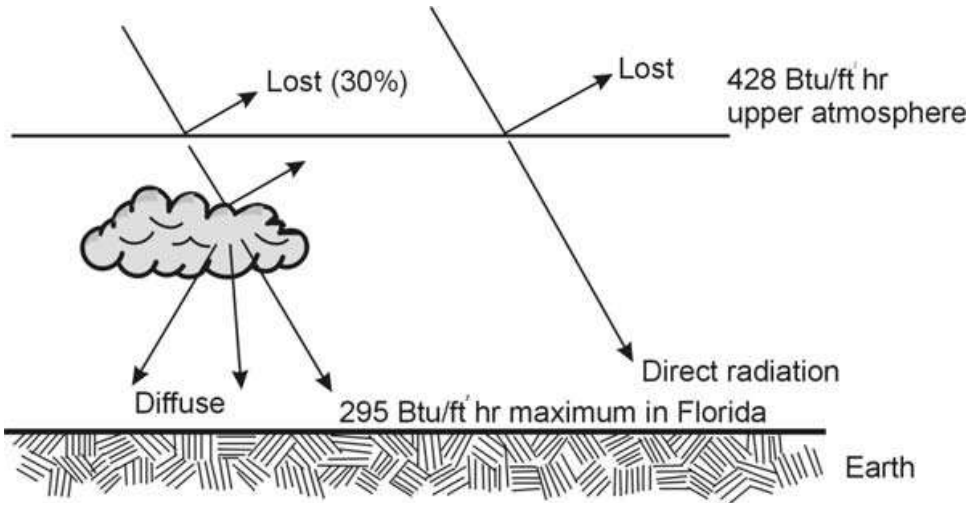
•Geography

•Latitude and Season

•Air Pollution and Natural Haze

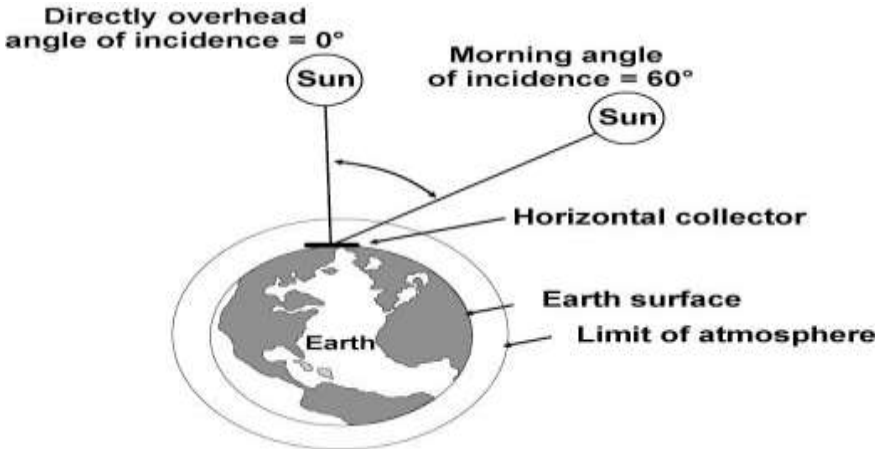
3.1.Atmosphere

The atmosphere absorbs certain wavelengths of light more than others. The exact spectral distribution of light reaching the earth's surface depends on how much atmosphere the light passes through, as well as the humidity of the atmosphere. In the morning and evening, the sun is low in the sky and light waves pass through more atmosphere than at noon. The winter sunlight also passes through more atmosphere versus summer. In addition, different latitudes on the earth have different average “thicknesses” of atmosphere that sunlight must penetrate. The figure below illustrates the atmospheric effects on solar energy reaching the earth. Clouds, smoke and dust reflect some solar insolation back up into the atmosphere, allowing less solar energy to fall on a terrestrial object. These conditions also diffuse or scatter the amount of solar energy that does pass through.



3.2. Angle of Incidence

The sun's electromagnetic energy travels in a straight line. The angle at which these rays fall on an object is called the angle of incidence. A flat surface receives more solar energy when the angle of incidence is closer to zero (i.e. perpendicular) and THEREFOAE receives significantly less in early morning and late evening. Because the angle of incidence is so large in the morning and evening on earth, about six hours of —usable‖ solar energy is available daily. This is called the —solar window".



3.3.Absorptance vs. Reflectance

Certain materials absorb more insolation than others. More absorptive materials are generally dark with a matte finish, while more-reflective materials are generally lighter colored with a smooth or shiny finish. The materials used to absorb the sun's energy are selected for their ability to absorb a high percentage of energy and to reflect a minimum amount of energy. The

solar collector's absorber and absorber coating efficiency are determined by the rate of absorption versus the rate of reflectance. This in turn, affects the absorber and absorber coating's ability to retain heat and minimize emissivity and reradiation. High absorptivity and low reflectivity improves the potential for collecting solar energy.

3.4.Seasonal Variations

The dome of the sky and the sun's path at various times of the year are shown in Figure 1

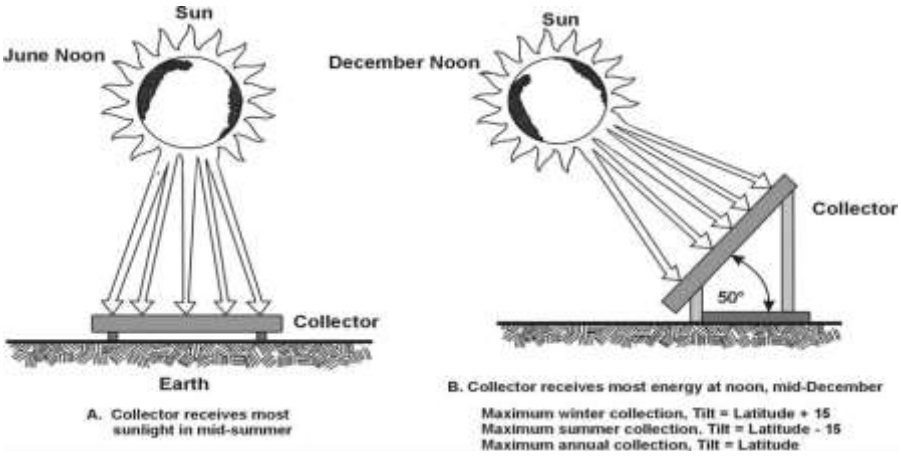


Figure1: A And B. Collected Energy Varies with

Time of Year And Tilt

For many solar applications, we want maximum annual energy harvest. For others, maximum winter energy (or summer energy) collection is important. To orient the flat-plate collector properly, the application must be considered, since different angles will be "best" for each different application.

4. Procedure To Design Economical Solar Water Heater

4.1. Requirements:

1. Insulated PVC pipes 2. Galvanized Iron Sheet 3.60-Plastic Bottles 4. 2-Storage Tanks 5. 22-TCouplings 6. M-seal 7. 2-Control Valve

4.2. Properties Of Galvanized Iron:

Galvanized iron and steel have good corrosion resistance to Concrete, mortar, lead, tin, zinc and aluminum. Galvanized iron and steel have poor corrosion resistance to Plasters and cements

(especially Portland cements) containing chlorides and sulfates, acidic rainwater run- off from roofs with wood shingles (redwood, cedar, oak, and sweet chestnut), moss, or lichen, condensation on the underside of zinc plates and ponded water on the exterior surfaces of the zinc features Galvanic (Electrochemical) Corrosion.

4.3. Properties of Plastic bottles :

The plastic bottles are generally of polypropylene and act as insulator. It helps in concentrating the solar energy on pipes. It prevents the heat loss. It cab bear a temperature about 60c

4.4. Mechanical properties of PVC:

PVC has high hardness and mechanical properties. The mechanical properties enhance with the molecular weight increasing, but decrease with the temperature increasing. The mechanical properties of rigid PVC (uPVC) is very good, the elastic modulus can reach to 1500-3,000 MPa. The soft PVC (Flexible PVC) elastic is 1.5-15 MPa. However, elongation at break is up to 200% - 450%. PVC friction is ordinary, the static friction factor is 0.4-0.5, the dynamic friction factor is 0.23.

4.5. Procedure to make solar water heater:

PVC pipes each of 4feet in length and 1 inch in diameter are connected using couplings. All the PVC pipes and couplings are paint using black oil paint so that it can absorb maximum incident energy. In each 4 Feet PVC pipe , 5 Bottles are inserted and sealed using adhesives.

Hot water storage tank is insulated with insulator (Thermocol).GI sheet of cross sectional area 4 * 3.25Feet and thickness of 4.9 mm. The volume of panel is 10.5 liter.

4.6. Storage Tank Specifications:

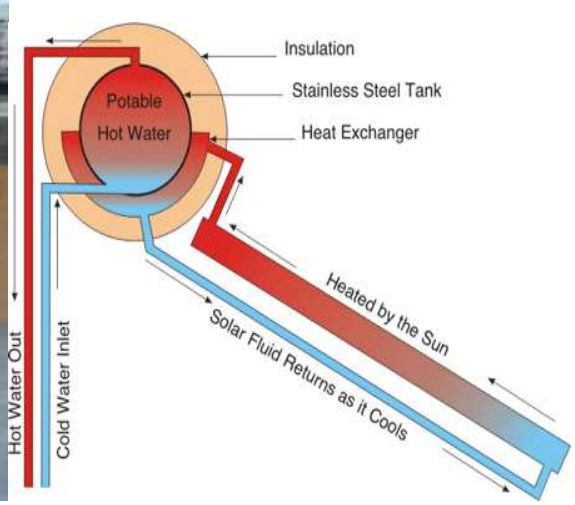
The storage tanks of capacity 100 liters each are coated with black paint.

Channels Grid	Collector Material	Storage	Insulating material
PVC Pipes	G.I. Sheet	Thermocol Tank	Plastic bottles

The storage tank is made of plastic material and insulated by thermocol. The storage capacity is of 100 liters and it can give the hot water up to 4 to 5 hours and can be use whenever necessary. Thermocol is good insulator. It is cheap.

4.7. Actual Image and Flow Chart

Image: Solar Water Heater



Flow Chart

5.1. Environmental Benefits

Solar water heaters do not pollute.

Solar water heaters help to avoid carbon dioxide, nitrogen oxides, sulphur dioxide, and the other air pollution and wastes created when the local utility generates power or fuel is burned to heat domestic water.

When a solar water heater replaces an electric water heater, the electricity displaced over 20 years represents more than 50 tons of avoided carbon dioxide emissions alone.

5.2. Economic Benefits

Many home builders choose electric water heaters because they are easy to install and relatively inexpensive to purchase. However, research shows that an average household with an electric water heater spends about 25% of its home energy costs on heating water.

In addition to having free hot water after the system has paid for itself in reduced utility bills, owners could be cushioned from future fuel shortages and price increases.

5.3. Advantages

Solar Energy is Sustainable and reliable energy source.

Solar water heaters help to avoid carbon dioxide, nitrogen oxides, sulfur dioxide.

Solar water heaters offer long-term benefits that go beyond simple economics. Reduces the electric bills by 80% and saves energy.

Cheap and easy to construct and easy to install.

This source of energy is completely renewable, therefore, there is no fear of losing it, unlike coal and other fossil fuel.

5.4. Disadvantages

The solar water heater unable to give the hot water during night.

It gives relatively low efficiency in cloudy atmosphere.

Space required is more.

The time and temperature required to warm the water is depends on the intensity of light radiation

Solar water heaters can assist in reducing this country's dependence on foreign oil.

6.1. Cost Estimation

Material	Costs
PVC Bottles	120
PVC Pipes	960
Storage tank (S.S.)	1000
GI Collector	1000
Coupling	200
T- Joint	200
Stand	500
Control Valve	100
M- Seal	50
Black Paint	50
Total Cost	4180

6.2. Cost of Heaters Available in market

Sources	Installation Cost (Rs)	Maintenance Cost Per Year (Rs)
Electric Heater	8000	2200
Gas Heater	6000	3000
Solar Water Heater	15000-Subsidy	200
Our Solar Water Heater	4180	100

7. CONCLUSION

Now a day's the use of non-renewable energy sources is enormous and are rapidly depleting day by day. Today, the world is totally based on renewable energy sources as they are assumed to be abundant. Considering the environmental effects and cost we have designed a solar water heater. Which is an efficient, ecofriendly and cheap heater compare to the other solar and non-solar water heaters available in the market. It is easy to make and easy to install and easy to use with very short period of time. Also it does not require any special equipment and maintenance. It is based on simple phenomenon of solar radiation. It is mainly designed for domestic purpose where it is not possible to buy expensive market solar water heater.

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