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Research Paper

PARABOLIC SOLAR COLLECTOR

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Solar Energy is a renewable source of energy. Its uses do not contribute to emission of greenhouse gases and other pollutants to the environment. It is sustainable since it cannot be depleted in a time relevant to the human race. In this paper, the potential for a solar- thermal system for hot water generation has been studied. A parabolic trough concentrator is made of an aluminum sheet which is covered by a cloth on which rectangular mirror strips (1.20mx 0.05m) are pasted. Two different absorber tubes were taken and the efficiencies of the PTSC where compared without glass cover on the absorber tubes. They were designed with principal focus at 0.3m so that the receiver heat loss was minimized the microstructure and a low amount of defects.

Keywords: Cast aluminum alloys, Heat Treatment, Solution Treatment, Artificial Ageing, Tensile Properties, Plastic Deformation, Microstructure, Modeling

INTRODUCTION

Recent increase in energy demand and constraints in supply of energy becomes a priority for the different industry. Very few research attempts have been done to estimate the significance of energy required for the different process. In this experimental study alternative use of solar energy has been studied. Solar energy is a high-temperature, high-exergy radiant energy source, with tremendous advantages over other alternative energy sources. It is a reliable, domestic, robust renewable resource with large undeveloped potential, and it emits essentially none of the atmospheric emissions that are of growing concern. The design and fabrication of parabolic trough solar water heater for water heating was executed. The procedure employed includes the design, construction and testing stages. The equipment which is made up of the reflector surface, reflector support, absorber pipe and a stand was fabricated using locally sourced materials. This work presents a reproducible parabolic trough solar water heater as a suitable renewable technology for reducing water-heating costs and solar water heating systems with optical concentrating technologies as important entrants for providing needed bulk solar

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energy. Parabolic trough power plants are the only types of solar thermal power plant technology with existing commercial operating systems.

Parabolic- trough collectors are frequently employed for solar steam-generation because temperatures of about 300 can be obtained without any serious degradation in the collector's efficiency. The incident solar-radiation falling on the collector is utilized for pipe heating. Inside the pipe, the thermal fluid flows and its temperatureincreases due to the incoming radiation. A vacuum was created around the pipe and a thermal insolent was placed at its rear. The developed simulation program calculates the outlet fluid temperature and shows the efficiency of the proposed parabolic trough collector as a function of the outlet temperature, the pipe diameter, the intensity of the incoming solar radiation and the active diameter of the parabolic collector.

In spite of efforts to promote and develop renewable sources of energy and other new sources, fossil fuels (coal, oil & natural gas) continue to dominate the energy scene (Duffie John A, and William A Beckman, 2006). While the need for alternative sources of energy is recognized, no set of alternatives has emerged which can take over the role played by fossil fuel. 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. 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 applications like heating water of air, drying, distillation, and cooking.

THE SOLAR OPTION AND PARABOLIC THROUGH WATER HEATING

Solar energy is a very large, inexhaustible source of energy. The power from the sun intercepted by the earth is approximately 1.8* 10^11 mw, which is many thousands of times larger than present consumption rate on the earth of all commercial energy sources. Thus is principle solar energy could supply all the present and future energy needs of the world on continuing basis. This makes it one of the most promising of the unconventional energy sources. Solar energy has two other factors in the favor, Firstly unlike fossil fuels and nuclear power, it is environmentally clean source of energy, secondly, it is free and available in adequate quantities in almost all parts of the world parabolic trough solar water heating is a well-proven technology that directly substitutes renewable energy for conventional energy in water heating. Parabolic trough collectors can also drive absorption cooling systems or other equipment that runs off a thermal load. Facilities such as jails, hospitals, that consistently use large volumes of hot water are particularly good candidates. Use of parabolic trough systems helps federal facilities comply with executive order 12902's directive to reduce energy use by 30% by 2005 and advance other efforts to get the federal government to set a good example in energy use reduction, such as the 1997 million solar roofs initiative. The federal technology alert from the federal energy management program is one of a serieson new energy-efficiency and renewable energy technologies. It describes the technology of parabolic trough solar water-heating and absorption-cooling systems, the situations in which parabolic-trough systems are likely to be cost effective, and considerations in selecting and designing a system.

THE SOLAR OPTION AND SOLAR COLLECTOR

solar energy is a very large, inexhaustible of energy, the power from the sun intercepted by the earth Is approximately 1.8* 10^11 mw, which is many thousands of times larger than present consumption rate on the earth of a commercial energy source. Solar radiation energy to internal energy of transport medium. Solar collector is a device which absorbs the transport medium. Solar collector is a device which absorbs the incoming solar radiation, converts it into heat, and transfer this heat to a fluid (usually air, water) flowing through the collector.

PARABOLIC TROUGH COLLECTORS ENERGY SAVING MECHANISM

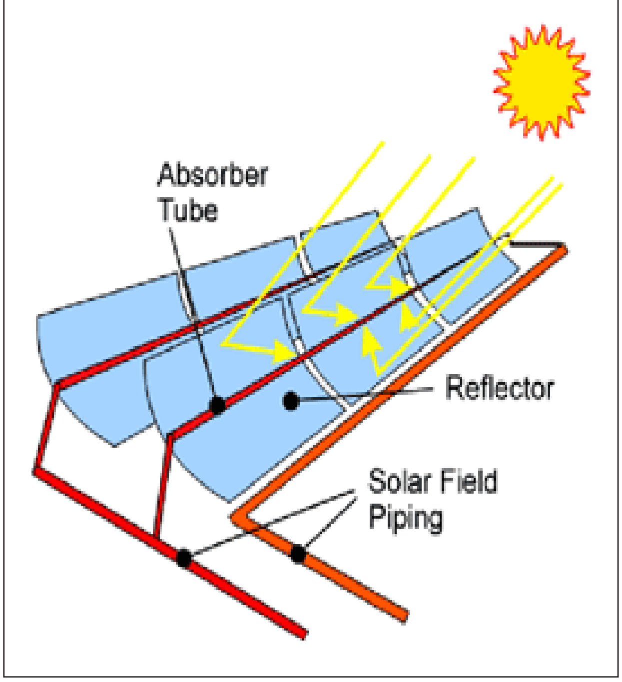
In order to deliver high temperature with good efficiency a high performance solar collector is required. Systems with light structures and low cost technology for process heat application up to 400 8c could be obtained with parabolic through collectors.

Parabolic-trough collectors are typically used in active, indirect water heating systems. Such systems use pumps to circulate an antifreeze solution between the collectors and the storage tank, where a heat exchanger transfers heat from the circulating fluid to water in the thermal storage tank.

DESCRIPTION OF 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.

Figure 1: Parabolic Trough Concentrator



METHODOLOGY

For this research, a different integrated approach are used, different theory are integrated by experimental study.

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 of the absorber.

DESIGN ANALYSIS

The initial plan for a solar concentrator was to use semi-spherical surface covered with many small sections of mirror to form a segmented, spherical concentrator. Referring to the optics section of a University Physics textbook it was found that the focal point of a spherical mirror would be located at a distance of half of the radius of the spherical section, directly above the vertex of the sphere. Quite some time was spent on trying to find a way to orient the small mirror sections at the proper angles about the inner surface of the sphere. The initial thought was to take the derivative of a circular equation to find the proper incline at different points along the sphere's inner surface. These inclines would then be rotated about the origin. This was a difficult problem considering the limited resources. A different approach was taken. After conducting more research on solar energy and solar collection, the decision was made to attempt to build a parabolic trough solar concentrator. In a parabola all of the incoming rays from a light source (in this case the sun) are reflected back to the focal point of the parabola. If the said parabola is extended along an axis (becoming a trough) the solar rays are concentrated along a line through the focal point of the trough. The focal point of a parabola is located at 1/4a , if the equation of the parabola is y = ax2The instantaneous efficiency of a PTC ( ) can be calculated from an energy balance on the receiver tube. The instantaneous efficiency is defined as the rate at which useful energy is delivered to the working fluid per unit aperture area divided by the beam solar flux (at the collector aperture plane.

COMPILATION OF THERMAL TRANSFER FACTORS FOR SOLAR PLATE COLLECTORS

The properties mentioned are compiled in Table.

Table 1: Compilation of Factors to Take into Account When Calculating Conduction and Convection

Property	Glass	Copper	Aluminium
Young's modulus (GPa)	69	118	70
Poisson's ratio (-)	0.23	0.30	0.30

MECHANICAL PROPERTIES

As can be seen in Table 2, the model in Marc also needed the mechanical properties for the parts.

These are the some mechanical properties and thermal transfer factor for its complicance which estimate its analytical description.

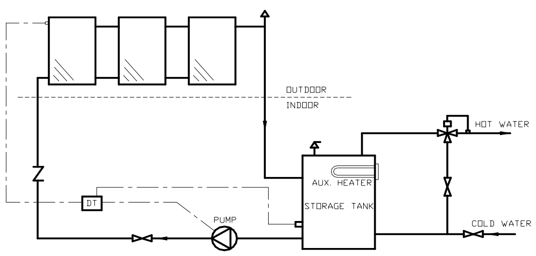
Table 2: Properties of Materials in Solar Collector

Property	Lowering thermal transfer by	N.B.
Conductivity	Decrease	material property
Nusselt Number	Decrease	
Rayleigh number	Decrease	
Prandtl number	Decrease	
Grash of number	Decrease	material property
Density	Decrease	material property
Plate spacing	Increase (conduction) Decrease (convection)	
Viscosity	Increase	material property

WATER CIRCULATION AND WATER HEATING SYSTEMS DIRECT CIRCULATION SYSTEMS (ACTIVE)

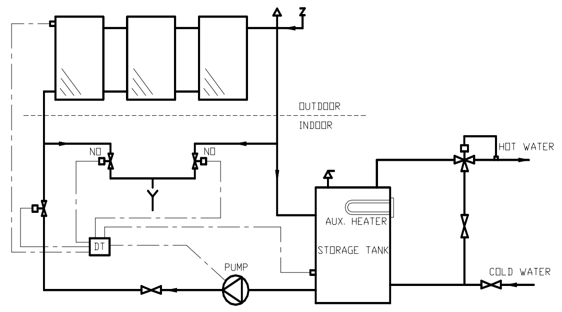
- In direct circulation systems a pump is used to circulate potable water from storage to the collectors when there is enough available solar energy to increase its temperature and then return the heated water to the storage tank until it is needed.
- As a pump circulates the water, the collectors can be mounted either above or below the storage tank.

Figure 2: Direct Circulation System



DRAIN DOWN

Figure 3: Drain-Down System



DIRECT OR FORCED CIRCULATION TYPE DOMESTIC SWH

- In this system only the solar panels are visible on the roof.
- The hot water storage tank is located indoors in a plant room.
- The system is completed with piping, pump and a differential thermostat.
- This type of system is more appealing mainly due to architectural and aesthetic reasons but also more expensive.

FORCE CIRCULATION SYSTEM-1

Figure 4: Forced Circulation System-1

FORCE CIRCULATION SYSTEM-2

Figure 5: Force Circulation System-2

THERMO SYPHON SYSTEMS (PASSIVE)

- Thermosyphon systems heat potable water or heat transfer fluid and use natural convection to transport it from the collector to storage.
- The water in the collector expands becoming less dense as the sun heats it and rises through the collector into the top of the storage tank.
- There it is replaced by the cooler water that has sunk to the bottom of the tank, from which it flows down the collector.
- The circulation continuous as long as there is sunshine.
- Since the driving force is only a small density difference larger than normal pipe sizes must be used to minimise pipe friction.
- Connecting lines must be well insulated to prevent heat losses and sloped to prevent formation of air pockets which would stop circulation.

TYPICAL THERMOSYPHON SOLAR WATER HEATER

Figure 6: Thermosyphon Solar Water Heater

INDIRECT WATER HEATING SYSTEMS (ACTIVE)

- Indirect water heating systems circulate a heat transfer fluid through the closed collector loop to a heat exchanger, where its heat is transferred to the potable water.
- The most commonly used heat transfer fluids are water/ethylene glycol solutions, although other heat transfer fluids such as silicone oils and refrigerants can also be used.
- The heat exchanger can be located inside the storage tank, around the storage tank (tank mantle) or can be external.
- It should be noted that the collector loop is closed and therefore an expansion tank and a pressure relief valve are required.

DRAIN-BACK SYSTEM

Figure 7: Indirect Water Heating System

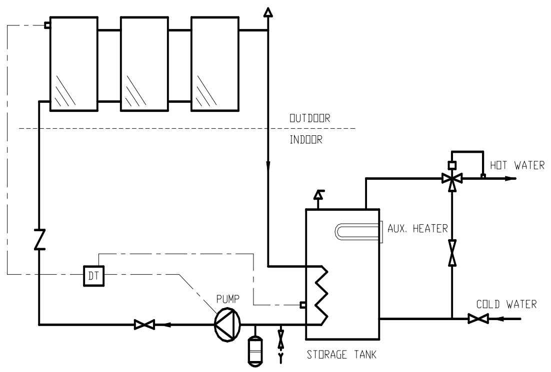
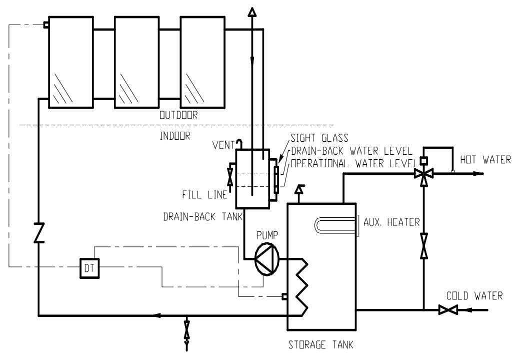
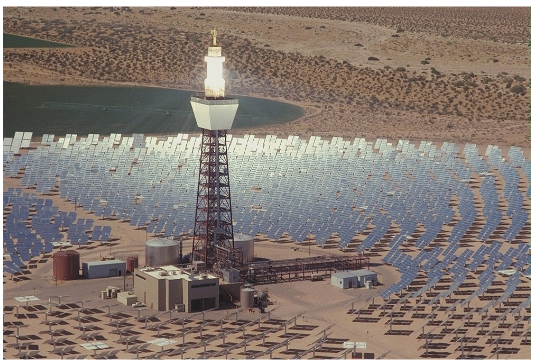


Figure 8: Drain-Back System



CENTRAL RECEIVER SYSTEM

Figure 9: Central Receiver System



WHERE TO APPLY

the technology is best applied at:

1. Hospitals
2. Other large health care facilities such as large clinics
3. Military
4. Food preparation
5. Laundries

WANT TO AVOID

If purchasing a system or seeking an project one should be aware of certain considerations. No one of these situations would a project, but be sure to inform staff about:

1. Areas with unusually high dust or dirt loads in air
2. Facilities possible closure or Reduction on hot-water or air Conditioning.

LIMITATIONS

1. Concentration systems collect little diffuse radiation depending on the concentrationratio.
2. Some form of tracking system is required so as to enable the collector Tofollowthesun.
3. Non uniform flux on the absorber whereas flux in flat plate collector Uniform.
4. High initial cost.

CONCLUSION

Dramatic technology break through to make parabolic-trough solar water heating economically attractive in areas with less sun or for facilities the have low cost conventional energy available are unlikely, incremental improvements in mirror and absorber coasting , however, are quite likely, and will make parabolic through increasingly efficient for the situations where the already are attractive. Any major cost reductions would come from economies of scale associated with substantially, or an increase in conventional energy prices. Climate change gas emission reduction the outlook is quite good the technology is more limited geographically to areas of high solar resources and to larger facilities than are other solar water heating technologies, but the economics are better.

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