"DEVELOPMENT OF PARABOLIC DISC SOLAR THERMAL COLLECTORS FOR HOT WATER GENERATION"

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Abstract - The current project involves designing and fabricating a 4 foot diameter parabolic solar collector for experimental testing in order to create a commercial water heating system for residential usage. After three sets of studies, we've discovered an average temperature increase of 35 degrees centigrade above ambient while the receiver is focused open to the air and the incoming water flow rate is 600 ML per Minute. Second, at a mass flow rate of 600 ML per Minute with a receiver at focus covered with a black box, we found an average temperature of 45 degrees centigrade higher than ambient. Third, in a pump-provided system for 20L water, we noticed an average 46-degree centigrade rise in temperature over the course of an hour when the receiver was covered with a black box.

Existing water heating systems will be replaced by this new commercial model.

Key Words: **solar collectors, parabolic dish collector, solar water heating, non conventional energy, solar thermal energy, tilt angle**

1. INTRODUCTION

While other forms of energy are more expensive, we've relied on fossil fuels for the last century since they're both cheaper and more convenient; pollution hasn't been a serious issue until recently. The globe currently uses 85 million barrels of crude oil per day as a result of increased energy demand. By 2025, this is predicted to rise to 123 million barrels per day notwithstanding the well-documented harm that fossil fuel burning causes to the ecosystem.

As far as environmental destruction goes, this is it. Several solar energy studies are being carried out worldwide as a result of this. Among the benefits of using solar power is that it's clean, abundant, and won't pollute the environment like other forms of energy. The use of solar energy is beneficial to the environment. When using solar energy, you can use either thermal collectors or photovoltaic modules to create heat or power, depending on your needs. Thermal energy is generated by transferring heat from the sun to a moving fluid and employing a solar thermal energy collector to achieve this result.

1.1 ENERGY SCENARIO:

The strong desire and demand for energy sources is growing significantly. The proposed need for energy resources would be increased by 36% in 2035. There will be an increase in the fast-emerging need for fuel because of population growth, which is estimated to reach 25 percent in developing countries like India and China over the next two decades. Since the goal of improving living standards necessitates increasing energy demand, this will put further strain on energy supply. For instance, by 2035, energy demand is anticipated to rise by 75% in India alone.

1.2 REVIEW ON ENERGY DEMAND:

From 1900 to 2050, fossil fuel usage is shown against global population increase. The world's energy consumption is rising due to the increase in various procedures being used for various purposes. When a society expands, so does its consumption. Reforming their economies, developing countries now flourish and advance technologically.

The price of oil has dropped recently, and other fuels have followed suit in many parts of the world. As oil prices have dropped, developing countries such as India and Indonesia have moved forward with the suspension of fossil fuel subsidies.. Fuel supply is critical to the country's economic growth and national security goals. As a result of oil imports and pollution in developing countries like India, fuel has adverse economic effects in the form of budget deficits. Diesel use is at least 15% greater than the national average, despite the fact that importing them costs roughly 18,000 kroner.

It is estimated that today, the world may be consuming the energy 15 times higher when compared to the usages of energy in 1980. Possibly as abundant as numerous conservationists, the oil companies are willing to find substitutions to fossil fuels, since they comprehend that over the subsequent period they will see their source diminishing.

Nowadays, renewable energy sources of the world's supply, fossil fuels afford about 85% technically higher which have restrained the cost of renewable power sources, but expertise has also kept down the price using fossil fuels and some cases reduced their unsafe effects on the environment.

1.3 ENERGY CRISIS:

The crisis of fuel and energy sources is due to the excess consumption of it, without proper infrastructure facilities, disruption of choke point, troubles in oil refineries and port facilities that controls the supply of fuel. The growing demand for fuel arises extraordinarily during the cold season due to higher utilization of energy (Gillet al. (2012) and HanumanthaRaoet al. (2012)). A minor interruption in energy provisions is caused due to pipeline failures and other accidents. A crisis of energy sources might arise due to vital weather changes which results in infrastructure damage (Karthicket al. (2014) and Leninet al. (2013)).

1.4 SOLAR ENERGY.

Solar energy is a widely used, widely accessible, naturally occurring, environmentally friendly, and cost-free source of energy. Both visual and thermal manifestations can be found of it (IR).

1.4.1 SOLAR RADIATION.

The earth obtains energy from the sun through electromagnetic radiation. A large portion of the energy is absorbed by visible and infrared light, with the remaining being absorbed by ultraviolet light. FIGURE 1-1: Daily Sun Arc from North of Tropic of Cancer Figure 1-1: Daily Sun Arc (23 degrees N latitude). Sun is 81.5 degrees above the southern horizon on June 21, or nearly overhead at noon (solar time), but it is only 34.6 degrees above the horizon on December 21 at a typical site at 32° N latitude. Solar insolation is measured in Langleys (L) or Btu/ft2 (I). The Btu/ft value of a Langley is 3.688. The solar constant is equal to 429.2 Btu/ft/hr in 116.4 litres/hr, which is the amount of solar energy available outside the atmosphere. The earth's surface will absorb or reflect roughly 70% to 80% of this energy.

1.4.2 COLLECTING SOLAR ENERGY. The "greenhouse effect" and dull, black surfaces' significant absorption of radiant radiation are the foundations for solar energy harvesting. That last part refers to the fact that while glass may transmit visible light, it does not allow the collection plate to lose heat that has longer wavelengths (infrared frequencies). Flat absorber plates are commonly covered with glass (or plastic) cover plates to minimise heat loss (see Figure 1-2). A fluid (water, air, or another) can pass over or through the heated absorber plate through tubes attached to the plate. The heated fluid can be used for a variety of purposes, including heating potable water, heating rooms, or powering an absorption or Rankine power cycle air conditioner.

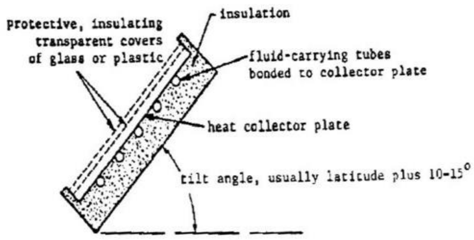


Fig 1.1 *:- Schematic cross-section of typical solar collector with heavy black insulation andtwo cover sheets*

1.5 ADVANTAGES AND DISADVANTAGES.

Using solar energy means you won't be affected by fuel price increases, and you'll also be saving money. In cold, overcast weather, when it's most needed, advantages include poor performance and the requirement for larger room heat exchangers and industrial unit heaters in traditional systems due to the lower temperature of the heating fluids. Disadvantages are that When fuel costs are high enough, a solar system will be more cost effective than a traditional power source. The collector will be used year-round in solar systems built for combined heating and cooling, making them more cost-effective.

1.6 SOLAR COLLECTOR AND THEIR TYPES.

With a solar collector you can harvest energy from the sun by absorbing solar radiation and converting it to heat or electricity. In order to get the most out of a solar collector, it's important to consider the material and coating. Solar collectors come in a variety of sizes to capture the most amount of light or to increase the power of the radiation once it reaches the receiver. The solar collectors listed below are popular options.

- **Flat-plate collectors:**

Simple radiation through a transparent layer and then being set on an absorber layer that absorbs the sun's heat energy is all it takes for a flat-plate collector to do its job well. Water, water with antifreeze ingredient, or air in the tubes can all be used to increase the temperature of the absorbed heat before it is used directly as thermal energy. To minimise conduction losses, the absorber plate's underside and the interior of the housing have been well-insulated. Large diameter header tubes link the liquid tubes at both ends. For this reason, the first-order transparent layer is utilised to prevent sunlight from leaking through. The transparent layer reduces absorber plate convection losses by preventing a stagnant air layer between the plate and the glass. Northern hemisphere collectors should face south, whereas southern hemisphere collectors should face north. It depends on the latitude of the area whether the ideal tilt angle of the collector is 10–15 degrees or not. Flat-plate collectors, as seen from the side, are depicted in the illustration below.

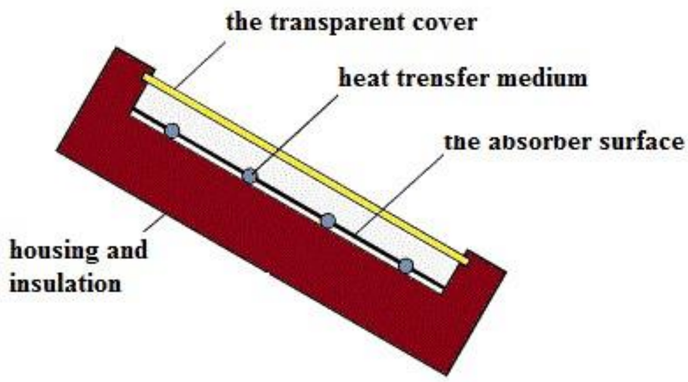


Fig 1.2 : An example of flat plate collector

Compound parabolic collectors

These light collectors are capable of absorbing nearly all of the light that is directed at their opening. These collectors can focus a huge amount of incident diffuse radiation without having to track the sun. Although some types of compound parabolic collector may track the sun light, these collectors are similar to flat-plate collectors in that they should be fixed at a specific angle called the acceptance angle based on their location. The minimum acceptance angle for this configuration of stationary CPC collectors is 47 degrees. The declination of the sun from the summer to the winter solstices is covered by this angle. In terms of constructing a compound parabolic, on the other hand, Figure below shows a schematic diagram of a set of collectors.

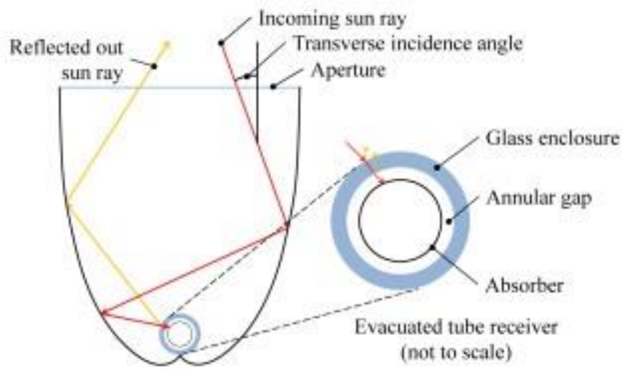


Fig 1.3: diagram of a compound parabolic collector

Evacuated tube collectors

Rather than using flat-plate collectors, which have moisture condensation on their surfaces in foggy or cold weather, evacuated heat pipe collectors were created as a workaround. In comparison to flat-plate collectors, the vacuum enclosure reduces convection and conduction losses, enabling these solar collectors to operate at greater temperatures. In vacuum-sealed tubes, heat pipes are used. Put in tube and it fills with black copper fin when sealed in copper pipe is put into tube. Each tube has a metal tip attached to the copper tube's seal at the other end (condenser). An evaporating-condensing fluid, such as methanol, fills one end of the heat pipe. Solatitive heating evaporates the liquid in this system. The vapour produced condenses and releases its stored latent energy at the heat sink zone. The condensed fluid is transferred to the solar collector, where the cycle is restarted. When tubes are arranged in this fashion in a heat exchanger, the metal tips upwards (manifold). A manifold filled with water or glycol receives heat from the tubes. Through an extra heat exchanger, heat is transmitted from the heated liquid into a process or from the heated liquid into the water in the solar storage tank.

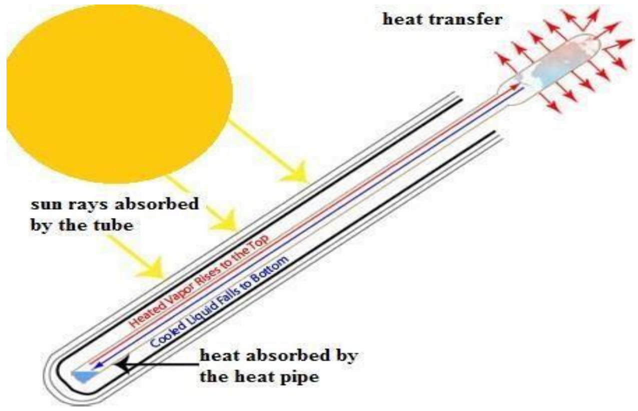


Fig 1.4 : An example of evacuated tube collector

Parabolic through collectors

A parabolic conduit can generate heat up to 400 C very effectively. An insulated black metal tube and a parabolic mirror help keep heat where it belongs. This tube extends beyond the focal point of the mirror. Pointing the mirror at the parabola causes a parallel beam to be reflected onto the receiving tube. It's enough to use standard long-collection modules that follow the sun on a single axis. The collector can be configured to follow the sun from north to south or east to west with a north–south orientation. Collectors facing south-north collect more energy throughout the year, although collectors facing west-east perform better just during the summer. This type of solar collector is seen in the following figure.

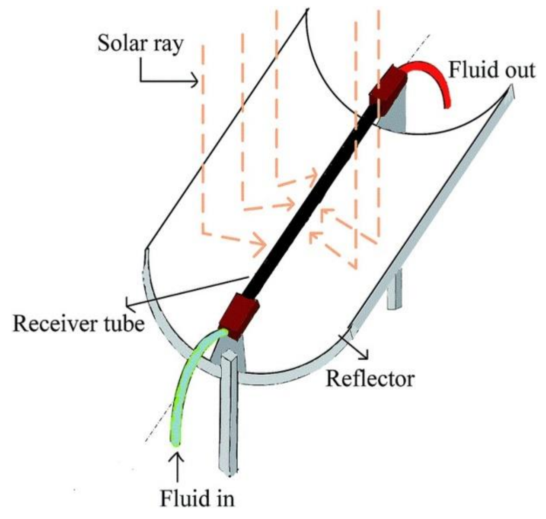


Fig 1.5 : Diagram of a parabolic trough collector

Linear Fresnel reflector

The most cost-effective characteristic of this lighting system is the use of flat or elastically curved reflectors instead of parabolic glass reflectors. Because it's so low to the ground, this design requires less support structurally. A secondary reflector surrounds the receiver tube of a linear Fresnel collector, which has many mirrors that focus light beams. There are numerous designs for this particular sort of collector. A single absorber tube is used in the typical design; however, updated models can accommodate up to two absorbers. The following image shows a Fresnel reflector in action.

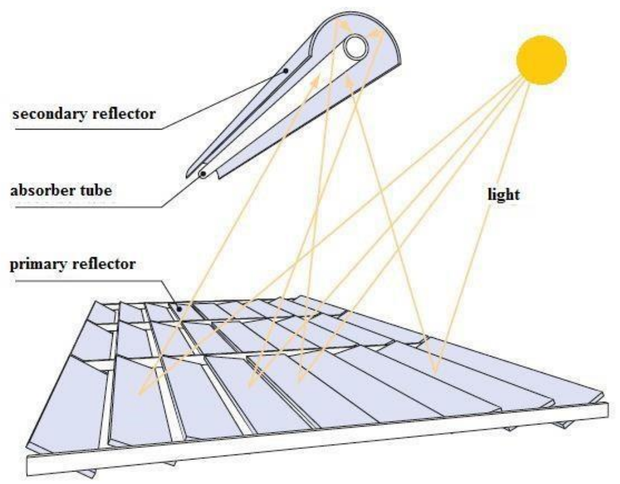


Fig 16 : Diagram of a linear Fresnel collector.

Parabolic dish reflector

The parabolic dish reflector, which is a dispersed receiver system, keeps track of both the sun's axes throughout the day and concentrates the light emitted into a single point. The dish construction must follow the sun's course in order to reflect the beam onto the thermal receiver. Flowing fluids use thermal energy to transform incident sun radiation into heat. An engine-generator or a central power conversion system can convert thermal energy directly into electricity.

These are the most efficient collector systems available, and they can tolerate temperatures of up to 1500 degrees Celsius without losing performance. The high absorption and conversion efficiency of thermal energy absorption and power conversion systems is generally assessed as a concentration ratio and benefits both systems substantially (the averaged radiant flux over the dish area divided by the insulation impinge on the receiver aperture). A dish collector is depicted in the figure below.

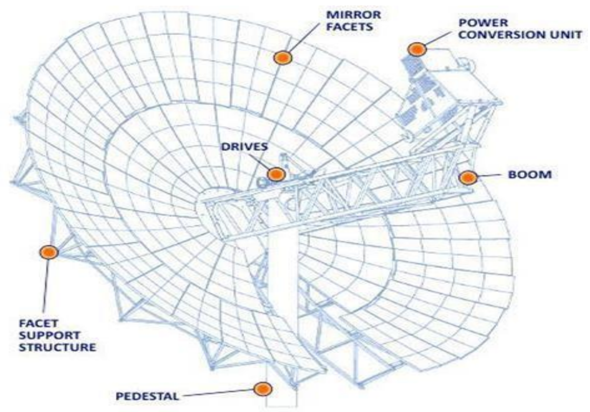


Fig 1.7: A parabolic dish reflector

Heliostat field collector

Heliostats are tracking mirrors with a small concavity that are used to locate a tower with a receiver perched on it. Large amounts of solar energy would be concentrated in a receiver's cavity and transmitted to a steam-generator to produce high-pressure steam. Because of this, heat energy is captured and stored for use at night, when it may be converted to electricity. This collector's concentration ratios range from 300 to 1500. Thermal storage systems are sometimes used in these plants, which occupy a space of 50 to 150 m2. Hybrid power plants, utilising both solar and fossil fuels in the thermal storage system, can be created in some instances.

The average received solar flux ranges from 200 to 1000 kW/m2. Because of the high flux, it can operate at temperatures as high as 1500 C. Rankine and Brayton cycles are the most commonly employed cycles in a heliostat plant, with the latter being used at greater temperatures. The schematic perspective of a heliostat field collector is shown in the figure below.

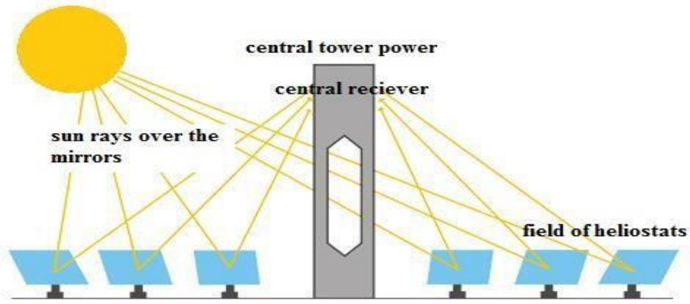


Fig 1.8 *Diagram of a heliostat power plant known as tower power*

1.7 DOMESTIC HOT WATER AND ITS NEED:

Everywhere in the country, demand for hot bath water varies enormously. When it's cold outside, a medium-sized family needs 85 litres of hot water each day to accomplish things like wash dishes, soak grains, and cook. Hot water is typically utilised around 68 degrees centigrade, according to research. Greentech Knowledge Solutions (P) Ltd New Delhi conducted a survey to find out how often people use hot water. According to these statistics, households used hot water for an average of six months out of the year. Climat change and human behaviour have an impact on hot water usage, according to the results of a main survey (which is influenced by culture and traditional practices). According to the results of the survey, there is a large demand for hot bathing water outside of cold and mild climate regions (>8 months of the year). Maharashtra, Kerala and Tamil Nadu households report using hot water for more than eight months of the year, despite the warm temperature. The use of hot water is common in a wide range of businesses, from dairy processing to soap manufacture to chemical manufacturing to hotels.

Heat is generated by a variety of things, including: Water can be heated using a variety of methods, the most common of which are liquid fuel, wood burning, or electric geysers. When deciding on a mode, keep in mind the costs of both operation and maintenance. Furthermore, the ecosystem is harmed by the produced flue gases.

As previously said, solar water heating can be an important approach to promote free energy systems while also operating at a low cost per unit of used energy. The study found that installing a solar water heater pays for itself in fuel savings within a year, even if the upfront cost is higher.

1.8 OBJECTIVE OF STUDY.

In present work a parabolic solar dish collector of 4 feet diameter is developed which is able to track sun radiations by facing to its directions to meet hot water requirement of households. This collector is able to warm water to a faster rate and for grater quantity. With this reflector we shall be able to warm water in larger quantity and make it available throughout the day.

2 LITERATURE REVIEW

1. As a demonstration prototype, **J.Macedo-Valencia etal** described the stages of design, modelling and assessment of a parabolic trough collector (PTC) for heating water. The parabolic aperture of 0.5 m wide by 0.95 m long was taken into account during the design process. Computer-aided design and manufacturing were used in the creation of the design. To determine the thermal performance of the parabolic trough collector, the results of the evaluation showed that at a flow rate of 0.200 L/min and a solar radiation of 783 W/m2, the maximum output temperature was 47.3 °C.

2. SWH technologies developed **by Chandrasekhar and Kandpal** could assist a large number of homes, according to their methodology. The methodology establishes a relationship between the seasonal and diurnal variations in ambient temperature at a place and the need of hot water for bathing. This has been used to estimate the expected capacity utilization of SWH for different locations in the country. The income levels of the households directly affect their capacity to purchase SWH. Using the income distribution of households in the country, the capital cost of typical SWH, and the rate of interest on the loans provided to the users to purchase SWH, the potential number of households who can use SWH have been estimated. In one of the examples presented in the paper, it is estimated that 45 million households in India can use SWH. This translates into a potential of 90 million m2 of SWH in the residential sector.

3. To estimate the potential for **SWH, Pillai and Banerjee** developed a model that takes into account adoption variables at the end-use level (microlevel factors) as well as market-wide effects (macro-level factors). The methodology can be used to estimate the potential for the individual sectors and also for the target area as a whole. In the paper, the methodology is illustrated for a synthetic area at Pune with an area of 2 sq. km and population of 10,000. The end use sectors considered are residential, hospitals, nursing homes and hotels. The estimated technical potential and market potential are 1700 m2 and 350 m2 of collector area, respectively.

4. In a detailed design and complete numerical study of a hybrid geothermal-PCM flat plate solar collector, **Anan Ashrabi Anannob, Mahadi Hasan Masud**, and colleagues, this is in effect a self-sustaining renewable energy food drying system. The applicability of the hybrid geothermal-solar dryer for developing countries with a significant underground geothermal temperature gradient was investigated. They performed numerical analysis

promises high efficiency and effectiveness of near-zero hybrid energy technology. They proposed conceptual design assessed using the related mathematical model to assess the functional parameters of the hybrid geothermal PCM flat plate solar collector dryer. Numerical simulation showed that the efficiency of hybrid geothermal PA-FPSC is 20.5% higher than conventional flat plate solar collector when the mass flow rate is at 0.02 kg/s. Therefore, successful integration of this technology to the existing food processing industries of the developing countries could be a step towards the prevention of irreversible climate change achieving SDG 12 (sustainable development goals).

5. **Aishwarya Sharma, Namish Mehta and Nilesh Diwakar** They presented research work to study the feasibility, stability and commercial analysis of storing solar energy and using fins for reducing the PV Panel temperature as much as possible to increase the power generation and efficiency. PV cells convert a certain wavelength of the incoming irradiation that contributes to the direct conversion of light into electricity, while the rest is dissipated as heat. Only 15-20% of incident solar energy is converted into electricity. The remaining part of the solar energy is converted into heat, which causes heating of the solar cell in PV panels. The surface of the PV panels can be heated up to 40 °C above ambient temperature. Increasing the temperature of the solar cell causes drop of the electrical efficiency of a photovoltaic panel, Conversation efficiency of PV panel decreased by 0.4% to 0.65% for every increased degree of PV cells temperature.

6. **Soroush Dabiri and Mohammad Fazel Rahimi** have researched solar thermal collectors, concentrating solar plants (CSP), solar cookers, and photovoltaic (PV) panels. In this regard which is mainly about solar collectors the aim is to introduce different types of solar collector systems such as solar heliostats collectors, A heliostat collector with a molten salt cavity receiver would be used as a specimen to study the energy and exergy of the solar parabolic plant and solar dishes. Final methods for improving plant performance will include calculating the cycle's energy and exergy loss and making adjustments accordingly.

7. I.Zeghib I'm An A.Chaker, A A house-wide solar water heating system is simulated in this article. The results of daily simulations for a solar system in Constantine (Algeria) that delivers hot water for heating (collector surface of 2 m2 and storage tank of 200 litres). Solar flat collector, water storage tank, auxiliary energy supply, and radiators make up the system. We examine the impact of the thermosiphon-flow rate and, as a result, the tank stratification degree on water heating system performance in greater detail. There's a lot of interest in this study because of the modelling approach and the analysis of how many nodes were employed on the extra energy.

8. **Fernández-Garca**, E. This article discusses the parabolic-trough collectors that have been built and sold throughout the last century, as well as the prototypes that are currently being developed. It also includes a survey of systems that could use this type of concentrated solar system to supply thermal energy up to 400°C, most notably steam power cycles for electricity generation.

9. 9. J.Macedo-Valenciaa J.Ramírez-Ávilaa The design, modelling, and assessment stages of a demonstration prototype parabolic trough collector (PTC) for heating water are presented in this work. The parabolic aperture of 0.5 m wide by 0.95 m long was taken into account during the design process. Computer-aided design and manufacturing were used in the creation of the design. A flow rate of 0.200 L/min and a solar radiation of 783 W/m2 yielded a maximum outlet temperature of 47.3°C for the parabolic trough collector during the testing process.

10. Most solar thermal energy is used for domestic hot water heaters and space heating up to a temperature of 60 degrees Celsius, according to a study by Kalogirou and Soteris. Solar energy can be used to a large extent in industrial process heat. A limited, isolated energy infrastructure makes Cyprus completely reliant on foreign imports to meet its energy needs. The island's abundance of solar radiation, combined with a strong technological foundation, made solar energy exploitation possible. The amount of heaters currently in use equals one heater for every 3.7 island residents, which is a global first. To far, no solar-powered industrial process heat system has been put into service despite this stellar track record. The key issue here is the substantial outlay necessary to implement such a system, as well as the ambiguity around its benefits. Researchers in Cyprus have examined whether or not parabolic trough collectors can be used to generate industrial heat. TRNSYS and the TMY for Nicosia, Cyprus, assess the system from a thermal and economic standpoint to demonstrate the scope of the anticipated benefits. For the first three quarters of each hour between 8:00–16:00 h, five days a week, the load is hot water delivered at 85°C at a flow rate of 2000 kg/h. All of the components work together to create the entire system, including the hot water storage tank and the parabolic trough collectors. A 300 m2 collector area, a 54 kg/m2 h collector flow rate, and a 25 m3 storage tank are all optimal for the current application. The system saves around

C£6200 (€10800) over the course of its life cycle by covering 50% of the system's annual load. This sum shows the money saved by not paying for fuel and instead using the system instead. To be clear, these savings are based on current fuel prices, not those that will be in force until 2003. As a result, the best system saves 208 tonnes of CO2 emissions while delivering 896 GJ per year. The performance of the system was examined as a result of numerous design adjustments. The E–W tracking system (collection axis aligned in N–S direction) outperformed the N–S tracking system. The needed load temperature has an impact on the system's performance because higher temperatures necessitate more auxiliary energy. Other differences in the load utilisation pattern have been studied and reported here. Larger loads (such as a two-shift operation or a 24-hour work pattern) necessitated a larger collector area, which resulted in higher first-year fuel savings and longer system lifecycle benefits. As a result, greater energy-consuming businesses can benefit from using solar industrial process heat.

3.0 CONSTRUCTION OF MODEL

The construction is done in following two parts (as shown in figure)

3.1 The reflector: to collect the radiations, to amplify them and project at the focal point.

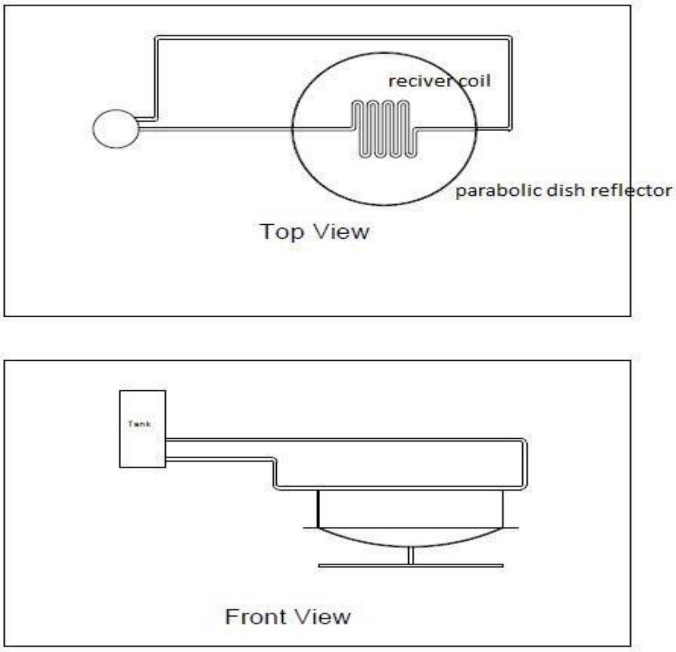


Figure 3.1 – line diagram of setup

3.1.1 To create the concave component of the collecting dish, a sheet of 18-gauge steel is hammered and die-cut by hand. The dish has a diameter of 1200 MM and a height of 150 MM when viewed from above. Adhesive-bonded 100*100 MM square mirrors are mounted on the concave surface.

3.1.1 25*3 mm MS strips are banded into similar circular arc shape also a circular ring is made of same diameter, MS strip sections are riveted and joined at the convex part since all members of the setup are to be connected, to provide necessary movement and rigidity.

3.1.2 Two members of 30 MM round MS pipe are welded in a shaft mounted on two bearings so as to provide free rotational motion as required for changing the angle of the dish.

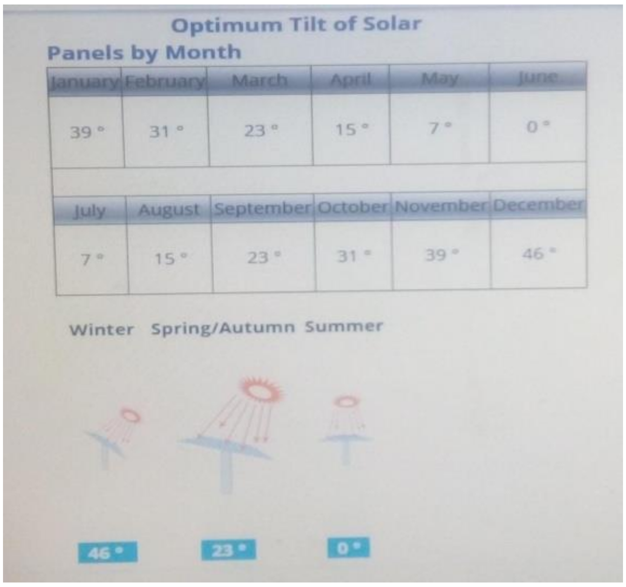
3.1.3 At one end of the dish, a movable joint is welded which provides angular moment to a 600 MM long pipe. In this pipe holes at calculated lengths are done. The angle needed shall be adjusted and fixed every month according to the tilt angle calculator bellow (shakti pumps dewas)

https://www.shaktipumps.com/solar-calculator.php"

The best angle for your solar panels changes throughout the year, based on the seasons and where you live, and this tool tells you how the sun's height changes month by month. Even more exact angling would necessitate monitoring the movement of the sun minute-by-minute throughout the day. An automatic mechanical sun tracker can do this, but it's not very cost-effective.

It is during solar noon, when the sun is at its highest angle, that this calculator provides the most accurate readings of the day's position. Sun irradiation is highest at solar noon, thus you can create the greatest power.

As an illustration, in the northern hemisphere, solar noon occurs when the sun is directly south of the horizon. Photovoltaic panels work best when facing south at an optimal angle, therefore face them south at this time for best results.


Optimum Tilt of Solar Panels by Month

January	February	March	April	May	June
39 °	31 °	23 °	15 °	7 °	0 °

July	August	September	October	November	December
7 °	15 °	23 °	31 °	39 °	46 °

3.2 The receiver: to receive the amplified radiations and utilize the temperature generated for heating. The receiver coil is placed at the focus of the dish ie 690 MM form the center.

3.2.1 A spiral in 30*30 mm square area, made of copper is used as shown bellow. Copper tube used is of 12MM diameter, breezed well with fittings so that water may flow with no leakage. for event I experiment as shown bellow

3.2.2 A wooden box of 480*480*300 MM covered with 4 MM tampered glass, painted black is also made to place at focus for event II experiment as shown bellow

4.0 **EXPERIMENTATION AND OBSERVATION**

The experimentation shall be done in three set of events.

Note: - All temperature readings are taken in degree Celsius.

Event I: - Receiver at focus open in air at mass flow rate 600 ML per Minute as shown in figure bellow.

The observations made of this experiment event on date 08.03.2021 and 22.03.2021 are shown in table below.

S.NO.	TIME	AMBIENT TEMPRATURE	TEMPERATURE OF RECEIVER	INLET WATER TEMPERAT	OUTLET WATER TEMPERATUR
1	10:00am-10:30am	28	78	22	30
2	10:30am-11:00am	28	85	22	39
3	11:00am-11:30am	31	105	22	45
4	11:30am-12:00pm	32	112	22	53
5	12:00pm-12:30pm	35	119	22	61
6	12:30pm-1:00pm	34	126	22	66
7	1:00pm-1:30pm	35	135	22	67

Table 4.1 Event I Observation date 08.03.2021

S.NO.	TIME	AMBIENT TEMP.	TEMPERATURE RECEIVER	INLET WATER TEMPERATUR	OUTLET WATER TEMP.
1	10:00am-10:30am	30	77	22	34
2	10:30am-11:00am	32	86	22	36
3	11:00am-11:30am	32.5	98	22	39
4	11:30am-12:00pm	34	110	22	45
5	12:00pm-12:30pm	37	118	22	58
6	12:30pm-1:00pm	39	135	22	65
7	1:00pm-1:30pm	39	137	22	74

Table 4.2 Event I Observation date 22.03.2021

Event II When the receiver coil is covered with a black box as mentioned in chapter 3 shown bellow.

The observations made of this experiment event on date 09.03.2021 and 23.03.2021 are shown in table below.

S.NO.	TIME	AMBIENT TEMPRATURE	TEMPERATURE OF RECEIVER	INLET WATER TEMPERATURE	OUTLET WATER TEMPERATURE
1	10:00am-10:30am	27	75	22	32
2	10:30am-11:00am	28	82	22	34
3	11:00am-11:30am	32	98	22	41
4	11:30am-12:00pm	32	107	22	55
5	12:00pm-12:30pm	34	130	22	59
6	12:30pm-1:00pm	36	138	22	67
7	1:00pm-1:30pm	37	142	22	73

Table 4.3 Event II Observation date 09.03.2021

S.NO.	TIME	AMBIENT TEMPRATURE	TEMPERATURE OF RECEIVER	INLET WATER TEMPERATURE	OUTLET WATER TEMPERATURE
1	10:00am-10:30am	27	75	22	33
2	10:30am-11:00am	28.5	81	22	38
3	11:00am-11:30am	31	88	22	42
4	11:30am-12:00pm	31	95	22	53
5	12:00pm-12:30pm	34	112	22	66
6	12:30pm-1:00pm	34	129	22	73
7	1:00pm-1:30pm	36	148	22	85

Table 4.4 Event II Observation date 23.03.2021

Event III When the receiver coil is covered with a black box and continuous water is circulated to and from the coil by a pump as shown in figure bellow.

The observations made of this experiment event on date 27.03.2021 and 28.03.2021 are shown in table below.

S.NO	TIME	AMBIENT TEMPRATURE	TEMPERATURE OF RECEIVER	INLET WATER TEMPRATUR	OUT LET WATER TEMPRATUR	TEMPERATUR E DIFFERENCE
1	10:00am	30	34	22	24	2
2	10:10am	30	40	24	30	6
3	10:15am	31	56	30	39	9
4	10:20am	32	58	39	43	4
5	10:25am	32.5	63	43	45	2
6	10:30pm	33	69	45	52	7
7	11:00am	33.4	73	52	60	8

Table 4.5 Event II Observation date 27.03.2021

S.NO	TIME	AMBIENT TEMPRATURE	TEMPERATURE OF RECEIVER	INLET WATER TEMPRATUR	OUT LET WATER TEMPRATUR	TEMPERATURE DIFFERENCE
1	10:00am	28	33	22	26	4
2	10:10am	28	38	26	31	5
3	10:15am	29	47	31	38	7
4	10:20am	31	52	38	43	5
5	10:25am	31.6	56	43	47	4
6	10:30pm	32.1	67	47	51	4
7	11:00am	33	74	51	57	6

Table 4.6 Event II Observation date 28.03.2021

5. CONCLUSIONS

The experimentation in this work shows that the performance of parabolic solar collectors. Parabolic solar collector of 4 feet diameter is designed and fabricated for experimental testing so as to make a commercial water heating system for house hold purpose.

The experiments are done are in three set of events, first when the receiver is at focus open in air and inlet water is at mass flow rate 600 ML per Minute we have found 35 degree centigrade on an average above ambient temperature. Second when receiver at focus covered with black box at mass flow rate 600 ML per Minute we have found 45 degree centigrade on an average above ambient temperature. Third when receiver at focus covered with black box in a pump provided system for 20L water we have found average 46 degree centigrade rise in temperature in a duration of an hour.

Analysis shows that design of solar water heating system should be done based on demand of solar water and non-useful roof area allowable for the installation of solar collectors. Economic analysis indicates that solar water heating system is much attractive compared to electric and gas heaters so this model can be viewed as a new commercial model to replace existing water heating systems.

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