

A PROJECT REPORT ON  
SOLAR WATER HEATER  
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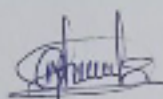
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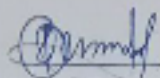
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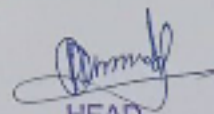
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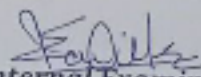


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## INTRODUCTION.

### Man and energy:

Energy is prime necessity of our day to day life. Man has need and used energy at an increase rate for his sustenance and we'll being ever since the came on the energy a few million years ago. Primitive derived this by eating plates or animals which be hunted. Subsequently he discovered fire and his energy needs increase as he started to make use of wood and other biomass to supply the energy needs Cook as well as for kipping himself warm. With the passage of time, man started to cultivate land and agriculture. He added the new dimension to the use of energy by domestication and training animal to work for him. With further demand for energy, man began to use the wind for sailing the ships and for driving windmills and the form of the falling water to turn water wheels. Till that time, it would not wrong to say that sun and indirectly and that man was using only renewable sources of energy.

Today, every country draw it's energy needs from a variety of sources. We can broadly categorise these sources are commercial and non commercial. The commercial source include the fossile fuel like coal oil and natural Gas, hydroelectric power and nuclear power, while the non commercial source include wood, animal water and agriculture waste

It is worth noting that while man's large scale of use of commercial energy has led to better quality of life it has also created many problems that combustion of fossil fuels has caused serious air pollution in many areas because of the localize release of large amount of harmful gases in the atmosphere.

It has also resulted in phenomenon of global warming which is now a matter of great concern. Similar, the release of large amountof wasted head from power plant has caused thermal pollution in Lake and river leading to the destroyer of many form , there is also concern over the possibility of radioactive being released into atmosphere in the event of an accident and over the long term problem of disposal of radioactive, as man embarks on the search for alternative sources of energy it is clear that he would do well to keep the environment in mind.

The energy sources such as solar energy, wind energy tidal and were energy, geothermal energy, hydroelectric power, fuel cells, biomass energy including agriculture waste, plate, fire stock waste etc. Are not depleting , almost popular free. We can them as a renewable energy sources.

### Origin of solar energy:

The sun is a large sphere of very hot gases, the head being generated by various kinds of fusion reaction. The principal characteristics of the sun are.

Mass (M) =  $199 \times 10^{30}$  Kg

Radius ( R ). =  $6.96 \times 10^8$  cm

Average temperature =  $5762 \times 500$ k

Inside the sum, there is continuous generation of head by thermonuclear reaction, which convert hydrogen atom to helium atoms. This energy is radiation from sun in all directions and our earth received a very small fraction of it.



The nature of sun is broadly divided into three region:

- Solar interior
- Photosphere
- Solar atmosphere

The solar interior contains main mass of sun and gases are at a very mass high pressure with temperature roughly equal to  $50 \times 10^6 \text{K}$ . All the gaseous matter is held in it due to gravitational force. The fusion reaction occurring in it are.

- The continuous conversion of hydrogen in the reaction the energy liberated is 26.7 mev.
- The other possible process is in which protone are converted into helium nuclei. In such a reaction consists.

The energy release in such carbon nitrogen cycle is also approximate of order 26Mev 02 about  $43 \times 10$ . It is estimated than a gram of sun contains about 30 billion years exhort it's supply

The energy related in this region is in the term of x ray and rays transfer out word by radius up to distance  $0.7 R$ , where temperature is about  $13 \times 10^4 \text{K}$  and density is of order  $0.07 \text{ gm/cm}^3$ . Outside this region, there is fluid in which energy is but to convection and is called as convective is  $6000^\circ \text{K}$ . The upper layer of this zone is the out sources of solar energy and light above the photographer. There is transparent layer of this verified gas having thickness of 104 km. It is called chromosphere due to radio he line is gases it appears red the temperature of it is  $4500^\circ \text{K}$ . Finally there is coma life whitish glowing layer that may be observed only during solar eclipse it contains highly ionized gases.

#### **Solar energy as in alternative sources of energy.**

Today front of everyone, there is very serious problem if energy. In spite of discovered of oil and gas off the west coast, the import of crude oil continue to increase and the price paid for it now dominant all other expenditure. This year the country will spend mote than RS.5000 crones for the import at oil this amount forms a major part of India import bill.

Itlf the present rate of consumption and population continue the world will be more crowded and more polluted than today. The world population is about 7 billions dungy the uses of conventional sources lot of carbon monoxide and carbon Dioxide gases are out. The convention exhausted by the source of energy have limited reserved and may be completed exhausted by the beginning of next century. The production of petrol will probably reach of consumption that 2020 will consume 80% of total reserves of petrol. The production of coal will be reaching its peak value around the years 2030. And afterwards it will decrease due to increase in production cost. That total reserves of coal are estimated to  $5 \times 10$  million years. With continue increase in the rate of consumption it is estimated reserve of would last of approximately the same period as petrol or crude oil. The wind energy sources has limited that wild of desired velocity does not occur continuous. Similarly in care of tides wave having constant and desired amount of every are very difficult to product.

The solar energy does not have such limitations. Solar energy is a very inexhaustible sources of energy. The earth intercepted about  $1.8 \times 10^{17}$  million joules on energy per second



from the sun, which is many times the present need of global energy. Solar energy could supply all the present and future needs of the world. Non conventional sources are pollution free. Hence some means of ultimate the solar energy economically are found out that it will give the unending supply of energy on continue basis. So solar energy could be best alternative for present conventional sources energy. However there are some drawback for the solar energy also

- The solar energy is a very dilute source of energy even in the hottest region
- The solar energy incident per second on the square is less than 1000 joules.

Much more energy is needed for its technology application in order to collect sufficient amount of solar energy, large. Collecting surfaces are needed the cost of such large surface is quite high.

On the solar radiation flux hardly amount utilisation. Using large area of collection of solar radiation flux can increase this amount but these results of excessive cost.

The solar energy available at a given place is never constant, due to the motion of the earth the solar energy is not available for 24 hours a day and for all 365 days of years. There is daily variation in the availability due to local weather and atmosphere condition. Hence necessary to store the solar energy when it is available and use it during the period when it is not available. But system needs for storage the solar energy are very costly. Thus the real challenge in utilizing solar energy can still be regarded as the best alternative for conventional source.

### **Solar energy options:**

Solar energy is a very large in exhaustible sources of energy. The power from the sun intercepted by the earth is approximately  $1.8 \times 10^{19}$  MW. Which is many thousands of times large than the present consumption rate on the earth is all commercial energy sources. Thus in principle, solar energy could supply all the present and future energy needed of the world on a continuing basis. This makes it one of the most promising of the unconventional energy sources.

In addition to its size, solar energy has two other energy has two other factors in its favour. Firstly unlike fossil fuels and nuclear power, it is an environment clean source on energy secondly, it is free and available people live. Its abundance is large we receive solar energy approximately  $60 \times 10$  kWh/year. Out of this if we utilize only 5%, still it would be large than the estimate world energy demand of  $50 \times 10$  KM/ Year. It is either can be used directly or indirectly utilize. It is either can be used directly or indirectly ultimate. The cost of technology for its utilisation is lower compared with other sources.

### **Classification of method for solar energy Utilisation**

#### **Solar energy Utilisation**

#### **Direct method :**

- 1 Thermal
- 2 Photovoltaic

### Indirect Method :

- 1 water
- 2 powers
- 3 wind
- 4 wave Energy
- 5 ocean
- 6 temperature

This will minimize the heat losses. An additional storage system can be attached to it. For storage of hot water now a system is available from 100 to 200 liter capacities. The cost of this system is also reasonable. Hence it is popular.

Solar water heater is a good example to illustrate ones of the assets of the direct use of solar energy which has been mentioned so far. This is the possibility of matching the temperature achieved in the heating device with the temperature required for end use. As a result of this.

Matching , the thermodynamic efficiency based on consideration of available of energy can be shown to be highly in the case of solar water heating system than a water heating system wing natural gas or electricity. Solar water heater of the nature circulation type were used fairly widely in many countries from the beginning of the twentieth century till about 1940 until cheap old and natural gas became available now they are being installed again they are again they are in wind spread use in countries like Israel, Australia and Japan domestic solar water heating system has been steadily growing in the last decade, it is estimated that about 10000 system had been installed by the end of 1992 most of the system have capacities of 1000 to 2000 liter per day. And use or two flat plate collector having a face area of 2 M each. The installed cost is about RS. 110 per litre per day and the temperature of the hot water delivered from 50 to 70° C.

When large amount of hot water is required, a natural circulation system is not suitable large arrays of flat plate collector are used and force circulation is maintained with pump. The restriction that strong tank should be highly level is thus removed. A schematic diagram of a typical closed loop system is water from strong tank a pumped through a collector array, where hot water is withdrawn for use, cold make up water takes its place because of all ball float control down. The pump for maintaining the force circulation is opened by an on off controller which seems the difference between the temperature of the water at the exit of the collector and a switched on whenever this difference exceed a certain value and off when it fails below a certain value provide is also usually made for an auxiliary heaters located in the strong tank. Often it is a located on the hot water system of the type. Are well suited for factories, hospital l, hotels, offices etc. About 5000 units have been installed in India in the last decade. The total collector area of all solar water heater system current installed in the country is estimated to be about 200000 m typically theses system cost about RS 5000 per square meters of collector area used.

### Type of solar water heater



Solar water heater either active or passive. An active system uses an electric pump to circulate the heat transfer fluid a passive system has no pump. The amount of hot water a solar water heater produces depends on the type and size of the system, the amount of sun available at the site, proper installation, and the tilt angle and orientation of the collector.

Solar water heaters are also characterized by open loop also called direct or closed loop also call indirectly an open loop system circulate household water through the collector. A Closed loop system uses a heat transfer fluid to collect heat and a heat exchanger to transfer the heat to household water.

#### **ACTIVE SYSTEM:**

Active systems use electric pump, valves and controllers to circulate water or other heat transfer fluid through the collector. They are usually easier to retrofit than passive systems because their storage tank does not need to be installed above or closed to end collector. But because they use electricity they will not function in the power outage. Active systems range in price from 2000 to 4000 installed.

#### **Open loop active system:**

Cost but is not applicable if your water is hard or acidic because scale and corrosion quickly disable the system. These open loop systems are popular in non-freezing climates such as Hawaii they should never be installed in climate that experience freezing temperatures for a sustainable period. You can install them in mild but not freezing climate, but you must consider freeze protection.

Recirculation systems are a specific type of open loop system that provides freeze protection they use the system pump to the circuit warm water from storage tanks through collector and export piping when temperature approaches freezing. Consider recirculation system only where mild freeze occurs once or twice a year at most. Actualize the freeze protection more frequently the freeze protection more frequently wastes electricity and stored heat.

Of course, when the power is out the pump will not work and the system will freeze. To guard this freeze valve can be installed to provide additional protection in the event the pump doesn't operate. In freeze weather recirculation system only where mild freeze occurs once or twice a year at most activating the freeze protection more frequently wastes electricity and stored heat.

#### **Closed loop Active system :**

These systems pump heat transfer fluid through collector heat exchanger transfer that heat from the fluid to the household heat from the fluid to the household water storage in the tank.

Double walled heat exchanger prevents contamination of household water. Some codes required double walls when the heat transfer fluid is anything other than household water.



Closed loop glycol system are popular in areas subject to extended freezing temperatures because they offer good freeze protection. However, glycol must be checked each year and changed every 3 to 10 year. Depending on glycol. Quality and system temperature.

Drain back system use water as the heat transfer fluid in the collector loop a pump circulate the water through the collector loop. A pump circulates the water drain by gravity to the storage tank and heat exchanger there are no valve to fail. When the pump are off, the collector are empty, which assured freeze protection are also allows the system to turn off if the water in the storage tank became too hot.

#### **Pumps in active system:**

The pump in solar water heating have low power requirements and some companies now includes direct current pump powered by small solar electric panes convert sunlight into dc electricity such systems cost nothing to operate and conditions to function during power outage

#### **Passive system:**

Passive system household water or hot transfer Fluid through a system without pumps passive system has to electric components to break. This makes them generally more reliable, easier to maintain and possibly longer lasting then active system. Passive system can be less expensive than active system. But they can be also be less efficient installed costs for passive system range from about 1000 to 3000 depending on whether it is a simple batch heater or a sophisticated thermo siphon system.

#### **Batch heater:**

Batch Heater also know as or integral collector storage system are simple passive system consisting of one or more storage tanks place in an insulated box that has a glazed side facing the sun batch heater are inexpensive an have few components in other words, maintenance and fewer failure . A batch Heater is mounted on the ground or on the rood some beach. Heater use selective surface absorb sun well but inhabit radioactive loss.

In climate where freezing occuring, batch Heater must either be protected from freezing or drained for the winter. In well designed system, the most valuable components for freezing are the pipes if located in insulated area that lead to the solar water heater if theses pipes are well insulated the warmth from the tanks will prevent freezing certain system clear state the temperature level than can install heat tape .

Insulated exposure pipes, or both remember, heat tape required electricity . So the combination of freezing weather and a power outage can lead to burst pipes. If you live in an area where freezing is infrequently, you can use plastic mind, through that some of these pipes can't withstand unlimited freeze. Cycle before they crack.

#### **Thermo siphoned system:**

A thermo siphon system relies on warm rising a phenomenon know as natural convection, to circulation water through the collector and to the tank . In this type of installed , the tank must be above the collector. As water in the collector heats, it becomes lighter and rises naturally into the tank above. Meanwhile, cooler water in the tank flow down pipes to the bottom of the collector, causing circulation through the system the storage tank is attached

to the top of the collector so that Thermo siphoning can occur. These systems are reliable and relatively inexpensive but require careful planning in new construction because the water tanks are heavy. They can be freeze proofed by exposing the loop to a heat exchanger in an exposed loop to heat the household water.

#### **Drain down system :**

In cold climate, this system prevents water from freezing in the collector by using electric valves that automatically drain the water from the collector when the temperature drops to freezing. "Drain back system" a variation of this approach, automatically drains to collector when the circulation pump stops.

#### **Swimming pool system:**

In solar heated swimming pools, the pool's filter pump water through a solar and the pool itself stores the hot water.

#### **Sizing Of System:**

Just as you have to choose a 30,40,50 gallon. Conventional water heater, you need to determine the right size solar water heater to install. Sizing a solar water heater involves determining the total collector area and the storage volume required to provide 100% of your household hot water during the summer. Solar equipment experts use worksheets or special computer programs to assist you in determining how large a system you need. Solar storage tanks are usually 50-,80-,or12- gallon. A small system is sufficient for 1 to 3 people, a medium system is adequate for 3 or a person household and a large system is appropriate for 4 to 6 people.

A rule of thumb for size collector, allow about 20 square feet of collector area for each of the first two family members if you live in the sun belt. Allow 12 to 14 additional square feet per person if you live in the northern United States.

A ratio of at least 1.5 gallons of storage capacity to 1 square foot of collector area prevents the system from overheating when the demand for hot water is low, in very warm, sunny climate, experts suggest that the ratio should be at least 2 gallons of storage to 1 square foot of collector area. Example a family of four in a northern climate would need between 64 and 68 square feet of collector area. And a 96 to 192 gallon storage tank because you might not be able to be sure to meet your hot water needs.

#### **EXPERIMENTATION :**

The basic parts that make up a conventional liquid flat plate Collector are

- The absorption plate
- The tubes fixed to the absorption plate through which the liquid to be heated flows
- The transparent covers and
- The insulated container

The main advantage of the flat collector is that it utilizes both the beam and diffused components of the solar radiation in addition, because of its simple stationary design it requires little maintenance its principle advantage is that because of the absence it



that because of the absence of optical concentration, the Area from which heat is lost is large. As a result, the collection efficiency is generally low.

The liquid heated is generally water. However sometimes mixture of water and ethylene glycol are used if ambient temperature below  $0^{\circ}\text{C}$  are like sheet ranging in thickness from a metal sheet ranging in thickness from 0.2 to 1 mm while the tubes, which are also of metal, range in diameter from 1 to 1.5 cm they of the absorber plate with the pitch ranging from 5 to 12 cm. In some design the buyers are bounded to the metal most commonly used both for the absorber plate and the tubes, is copper. However, in India, because of the shortage of copper, other absorber plate tube combination has been successfully developed. These include aluminium sheet fixed to copper or galvanized sheet tubes with a pressure bond. Mild steel or galvanized steel sheets with galvanized steel tubes and stainless steel sheets with built in channel the water in and out of collector and distribution it to the tube, are made of the same metals as the tubes and are of slightly larger diameter.

Plan or toughened glass of 4 or 5 mm thickness is the most favoured material for the transparent covers. The usual practice is to have one or two covers with spacing ranging from 1.5 to 3 mm

When solar radiation pass through two glass cover and strike on absorber plate then heat is produced. The part of it is transpired to liquid flowing through tube and thus temperature of outgoing liquid increase during this process the following heat losses occur.

- Loss due to convection and re emitted radiation passing to surrounding through covers. This loss is minimize by using two glass at top
- The loss due to conduction and is minimize by using the Thermal insulation on backside plate and at edges.
- The bottom and side are usually insulated by mineral wood, rock wool or glass wool with a covering of aluminium foil and has a thickness ranging from 2.5 to 8 cm. The suitable angle the collector box may be made of aluminium steel sheet, 02 fibre glass.

The face area of most commercially available collector is around plate, the tubes as well as the covers have increase. This is particularly true for application involving lower temperature up to  $60$  or  $70^{\circ}\text{C}$ . Initially plastic were not used because they degraded on exposure to sunlight. They degraded on exposure to sunlight they also have low Thermal conductivity and high coefficient of expansion as compared to metals. However recent advances in polymer technology have resulted in the development of suitable plastic material which can with stand long exposure to sunlight plastic have the advantage of being light in weight and easy to manufacture. They also cost less and requires less energy input for their manufactured than metal like copper and aluminium. However it has to be remembered that they generally originated from fossil fuel as the volume of production of flat plate Collector increase the above consideration of energy input and raw material original will become increasingly important.

The present rate of production of liquid flat plate Collector in the world, as well as in India, is low however, it is increasing rapidly about 200000m have been installed in India



in the 1980 The typical cost of a good quality collector is about RS 3500 per square meters are usually about times the above cost since they include the cost of erection piping and accessories.

### **Procedure:**

To prepare a flat plate collector have collector the all materials which requires for making flat plate Collector? I brought plywood of 2x1 sq.ft. Size of plywood also I have collected a metallic pipe of length 9 feet and diameter 1.2 cm. Which are cut into 5 pieces two another pipes are fitted whose length is 18 cm each.

In a olden plywood 5 pieces of pipes are fitted whose distance from each other is 6.5 cm at the upper side of the box, I have drilled a small hole for the purpose of connecting out let pipe and at lower end but in opposite side, I have also drilled a another small hole for inlet of cold Water in the collector

The pipe fitted to the lower side of flat plate collector takes cold water in and pipe fitting to upper side let's hot water out.

The white drawing paper is mounted over the pipe inside the box with the help of Fevicol the painting the whole box with black paint from a transparent glass is attached over the box. From which the solar radiation pass through and sink on absorption plate than heat is produced.

### **Effects of various parameters on performance**

The parameters affects the efficiency of collector which discussed are the selective of the absorber surface, the number of glass, the tilt of the collector, the fluid inlet temperature the incidence solar flux and dust settlement on the top glass cover.

#### **Selective surface:**

Absorber plate surface which exhibit the characteristics of a high value of absorptivity for income solar radiation and low value of emissivity for out going re radiation are called selective surface such surface are desirable because they maximum the emission of the radiation loss. Obviously they would yield higher collector efficiency than are obtained when the absorption and emissivity are equal.

For absorber surface the selective ratio  $\alpha/\epsilon$  must be very high. The some examples of selective surface are nickel black layer black Chrome copper oxide on copper

#### **Number of cover plate:**

For getting the maximum efficiency one or two cover plate are suitable. For the situation studies the efficiency goes through a maximum value of 43.3 per. For the case of two covers.

As the number of cover increase the value of both transitive absorption products for beam radiation falling on the collector and transmission absorption products for diffused radiation falling on the collector thus the flux s absorber in the absorber plate decreased. The addition of more cover also cause the value of top loss coefficient  $U_T$ , and hence the

heat loss, to decrease. However, the amount of decrease is not the same in both cases. For this reason, the efficiency goes through a maximum. This kind of result is obtained with all collectors, a maximum efficiency being usually obtained on one or two covers.

#### **Types of solar energy collector:**

- **Flat plate Collector**

The most common type for solar hot water is the flat plate collector. It is a rectangular box filled with a transparent cover, installed on a building roof. Small tubes run through the box and carry fluid. Either water or other fluid, such as an antifreeze solution. The tubes attach to a black absorber plate as heat builds up in the collector, it heats the fluid in the tubes. The hot water or liquid goes to a storage tank. If the fluid is not hot by passing it through a tube inside the storage tank full of hot fluid.

- **Evacuated tube collector**

This collector consists of rows of parallel transparent glass tubes, each containing an absorber and covered with a selective coating. Sunlight enters the tubes. Strikes the absorber and heats the liquid flowing through the absorber. These collectors are manufactured with a vacuum between the tubes, which helps them achieve extremely high temperatures so they are appropriate for commercial and industrial uses.

- **Concentration collector:**

Parabolic trough shaped reflectors concentrate sunlight on to an absorber or receiver to provide hot water and steam, usually for industrial and commercial applications.

- **Transpired solar collector :**

A transpired collector is a south-facing outside wall covered by a dark sheet metal collector. The collector heats outside air, which is then sucked into the building ventilation system through perforations in the collector. They have been used for preheating ventilation air and crop drying. They are inexpensive to make and commercial, have achieved efficiency of more than 70 percent.

- **Batch or breadbox heaters :**

This system is referred to as a batch heater and a bread box. It consists of an approximate 40 gallon insulated tank, lined with glass on the inside and painted black on the outside. Plumbing from the house supplies the box with cold water through an inlet that extends down to the bottom of the tank. From the bottom of the tank the box itself acts like a collector, absorbing and trapping the sun's heat and heating the water. An outlet supplies the house with water from the top of the tank.

#### **Directions of collector Tilt:**

We already know that the collector is so fitted that it can get the maximum amount of solar energy. The direction of collector tilt is towards the sun.



obviously toward the equator, that is true south in the northern-hemisphere that is India it has also been established that for maximum radiation to be collected.

The collector tilt from thus horizontal should be equal to the latitude of the place 19 degree that is in winter season. In summer and year round, the collector tilts should be and  $0.9^\circ$  respectively on a clear day, a square meters of collector area can heat 50-70 liter of water up to  $60^\circ$ - $70^\circ\text{C}$ .

### *Thermal efficiency and cost analysis of solar of solar water heater in Rwanda*

#### Abstract

Solar water heater is a technology of capturing the energy from the sun's radiation for the purpose of raising the temperature of water from supply temperature to be desired higher of thermal efficiency of solar water heaters and their associated costs, especially different customer want to replace their existing convention water heating energy by solar water heating system. In this present paper, a deep investigation has been accomplished to determine thermal efficiency and cost analysis of solar water heater made in Rwanda. During manufactured of solar water heater the collector was the main part to emphasize on the high efficiency of the system was achieved by replacing galvanized iron sheet by aluminium sheet slotted and black painted as an absorber plate. The ambient temperature and average solar radiation of the three sites where solar water heaters are installed were investigated. The used material, specifications and sizing were discussing in this paper.

#### **Keyword**

Thermal, efficiency, solar , energy, cost analysis , water heater

#### **Introduction**

##### Background

Solar water heater system is a technology of capturing the energy from the sun's radiation for the purpose of raising the temperature of air or water to be used for domestic commercial or industrial purpose by using solar water collector and concentration. Solar water heater system is a renewable energy technology that is free for use with high potential and is available all over the world. Solar water heating system are mostly used in a wider scale because they provide an environment favourable heat for various areas such as household water heating, swimming pools heating and other area where hot water is needed. This system collects the energy but from the sun to use it for heating air or water.

There are two types of solar collector evacuated tube and flat plate solar collector and evacuated tube solar collector have been proven to have lower heat loss coefficient, high performance and reliability. In recent years, many groups of research focus on theoretical and experimental research for improving and measuring heat transfer losses in Evacuated tube and flat collector using different approach and method. Some literature points out a high effectiveness and environment friendliness of solar water heater while other still questions on the initial cost and maintenance cost of solar water heater installed in chosen municipality in South Africa, the shortage and longest payback period have calculated, he



found that the average payback period of 8 year exceeds the warranty period of solar water heater in South Africa which is 3 year.

Solar energy is an alternative to replace convention water heating energy for different applications and is available sources of energy to be forced on an the future due to increased demand of energy with rising cost of fossil fuels.

Analysis of different literature and quotation from different manufacturers of solar water heater shows that the cost of solar water heaters became cheaper in last year at present, the price range from 800\$ to 10000\$ depending on the type and capacity from 2010 the Tumba college of technology started a project of solar energy heaters manufactured, efficiency, unit research and development. The first solar water heater fabricated, efficiency, smartness and cost effectiveness. At present, many solar water heater of different capacity are sold to different customer but no research havebeen conducted in order to know and comfort their efficiency and the associated payback period. The aim of this paper is to present the method used to increase the efficiency of solar water heater during its manufactured.

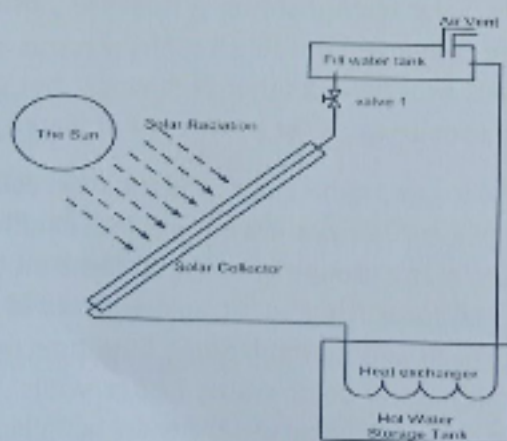
During onsite experience for installed solar water heater in three areas, measurements shows that a solar water heater with a surface of 2.77 m is able to heat 200 L of water heated from 17°C to 68°C in average. This is due to high efficiency of collector achieved during its construction and high solar radiation in the country which is around 5 k wh/ day. Solar water heater are used in Rwanda mainly for providing hot water in household, hotels, hospital and school and the installed units are still at lower level according to the country vision

## 1. Solar water heating experimental apparatus

### Main part of solar water heater

- Solar collector –  
Solar collector receives and transfer the solar radiation energy into thermal energy in the working fluid usually water.
- System of working fluid channel or pipe-

This is the connection between collector and storage tank.



## 2 main part of solar water heater.

### Literature review

As a green and renewable energy, solar energy become important to develop and there is a good and promising progress in the field of solar energy particular in solar thermal. This is because of its simple structure and it's low to zero running cost in general. Many Design and improvements on existing designs have been done by different research to increase the efficiency of solar water heaters. Design of solar water heater in glass evacuated tube with high heat collection rate by high throughput screening method based on machine learning become more important and promising method to increase that heat collection rate

Another study on design of solar water heater using HTS method was conducted by Li al. And this method was proved to provide first and precise prediction method for performance of solar water heater. Computational fluid dynamics was used to conduct a numerical study and to predict water temperature at the outlet of collector. Numerical analysis and some software have been used to study and design the Thermal efficiency solar water heater using U type evacuated tube solar collector and the results showed that this solar collector should provide 40.5% of the total consumed energy in the year. Research on solar water heater using concentration solar collector evidence that the maximum temperature of 69.5% $^{\circ}\text{C}$  should be obtained and efficiency up to 51% is possible at present, different designs of building integrated photo thermal have been developed and used and used in China to meet people requirements in production and living

All solar system which utilize the solar energy depend upon the efficiency of solar collector. Some of the collector are flat plate, component parabolic, evacuated tube parabolic through. The solar collector are used for domestic, commercial and industrial purpose. They are used in various kinds of heating and cooking purpose, such as solar water heating which comprises thermosiphon. Integrated collector storage, direct and indirect system, air system, space heating, cooling and services hot water. Industrial process heat comprises air, water system and steam generator system.

The size of solar water heating system depending on availability of solar radiation, temperature needed by customer, geographic location and arrangements of solar system. Therefore, its design should focus on the above parameters especially on solar system.

The storage unit utilize a small cylinder made in aluminium with paraffin wax inside as heat storage medium. He found that the system is a commercial viable option for solar heating energy storage. Series connection of more than one thermosiphon solar water heater should increase the efficiency of solar water heater up to 55% and series.

### Materials and methods

#### Data collection



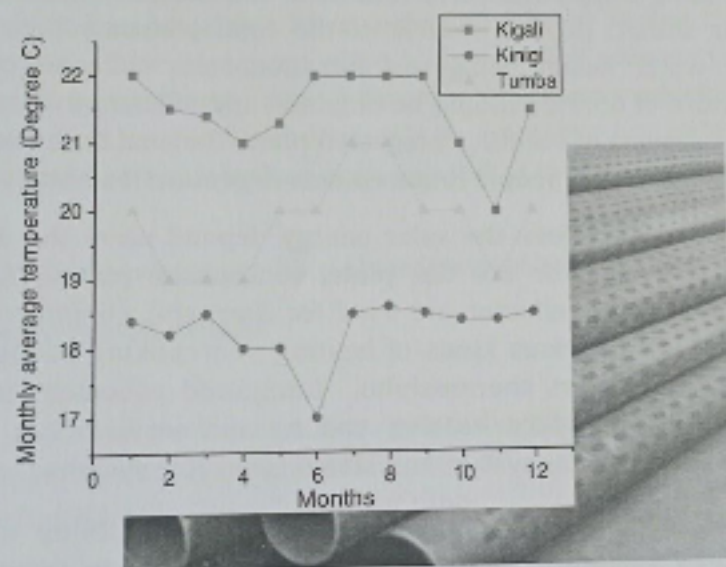
To collect data, the three solar water heater were manufactured and installed in three different areas. All measurements was performed in the same condition and in the same season, using portable instructions. Tested solar water heater were made and installed by Tumba college of technology. During manufactured of these solar water heater, the collector was a main part to emphasize , Increase the heat collection rate on absorption plate, a galvanized iron was replaced by aluminium sheet because of its high Thermal conductivity. Aluminium sheet of 960mm× 1300×0.6mm was used for absorber plate. The equal speed slots were designed and performance on aluminium sheet to accommodate more than a half of a perimeter of pipe

### Slots creation on aluminium plats

Temperature distribution in degree Celsius in three areas.

Solar water heater

Observation Table. Date 21/05/2021





Sr. No	Time	Intensity	Inlet Tem.	Outlet Tem.	Glass. Tem	Water Collection D ml	Time Sec	Rate of Glow
1	10	380	28	55	29	1440	6	240
2	11	460	30	58	30	1470	6	245
3	12	470	31	64	32	1560	6	260
4	1	550	32	67	35	1570	6	261
5	2	650	33	72	37	1680	6	280

22/05/2021

Sr. No	Time	Intensity	Inlet Tem.	Outlet Tem.	Glass Tem.	Water Collection D ml	Time Sec	Rate Of flow
1	10	380	24	55	29	1450	6	241
2	11	560	26	61	30	1560	6	260
3	12	670	27	65	32	1580	6	263
4	1	740	28	70	35	1670	6	278
5	2	730	30	72	37	1710	6	285

Sr. No	Time	Intensity	Inlet Tem.	Outlet Tem.	Glass Tem.	Water Collection	Time	Rate of flow
1	10	380	28	58	30	1360	6	226
2	11	390	29	59	32	1480	6	246
3	12	420	30	62	33	1510	6	251
4	1	415	30	66	32	1560	6	260
5	2	280	31	59	31	1670	6	278

23/05/2021

## BENEFIT AND APPLICATION

### Discussion:

A solar water heater is a long term investment that will save your money and energy for many years. Like other renewable energy systems. Solar water heaters minimize the environment effects of enjoyed a comfortable, modern life style, additional, they provide insurance against energy prices increase, help reduce our dependence on foreign oil and are in everyone future.

I have planned to make a working model of solar water heater, I am college students from rural background, due to this I doesn't get money to install working model solar water heater, so I have mode a model of flat plate collector. Flat plate collector is the heart of solar water heater.

In India some states office subsidies on domastic as well as commercial solar water heating system installation. Government of India offers 100%

Indian on renewable energy Development agency, new Delhi, extends loan on soft terms through designated intermediate for financial of installation of solar thermal devices. For more information about loans visit the website.

### Benefit :

There are many benefit to owing a solar water heater and number one is economics solar water heater economic compare quite favourable with those of electric water heater, while the economic area quite so attractive when compared with those of gas water heater heating water with the sun also means long. Term benefits, such as being cushioned from future, shortage and price increase and environment benefit

### 1 Economic Benefits :

Many homebuilders choose electric water heater because they are easy to install and relatives inexpensive to purchase. However, research shows that on a average household with an electric water spend about 25% of its home energy coast on heating water.

It make economic sense to think behold the initial purchase price and consider lifetime energy coast or how much you will spend on energy to use the application over its lifetime. It found that solar water heater offered the larges potential saving compared to electric heating, with solar beater heater owner solar water heater owner saving as much 50% to 85% annual on their utility bills over the cost of electric water heating.

However, at the current low price of natural gas, solar water heater cannot complete with natural gas water heater in most part of a country expect in net house construction although you will still save energy coasts with a solar water heater because you wants by buying natural gas, its won be economical.

Paybacks very widely, but you can expect a simple payback of 3 to 8 year on a well designed and properly installed solar water heater of time required to recover your investment through reduce or avoid energy cost.

After the payback period you accurate the savings over the life of system, which ranges form 15 to 40 year, depending on the system and how well it is maintained



You can determine the simple payback of a solar water heater by first determine the net cost of system net cost includes the total installed cost less any as incentive or utility , after you calculate the net cost of the system, calculate the annual fuel savings and divide the net investment by this number of determine the simple payback

### 2 long term benefit:

Solar water heater offer long term benefit that go beyond simple economic in addition to having a free hot water after the system has paid for itself in reducing utility bills, you and your family will be cushioned from future fuel shortage and price increase. You will also be doing your part to reduce this country depending on foreign oil. The national remediless association report that adding a solar water heater to an existing home raises the resale value of the home by the entire cost of the system. You may be able to recoup your entire investment when you sell your home.

### 3 Environment benefit:

Solar water heater do not pollute. By investing in one, you will be avoided carbon dioxide, nitrogen oxides, sulfur dioxide nitrogen oxide the other air pollution and waste create when your utility generate power or you burn fuel to heat your household water, when a solar water heater replace electric water heater, the electronic displaced over 20 year represent more than 50 tons of avoiding carbon dioxide emissions along.

Carbon dioxide traps heat in the upper atmosphere thus contribute to the ' Greenhouse Effects '.

### 4 A Bright Future:

A solar water heater is a long term investment that will save your money and energy for many years. Like other renewable energy systems, solar water heaters minimize the environmental effect of enjoying a comfortable, modern lifestyle. In addition, they provide insurance against energy price increase, help reduce our dependence on foreign oil and are investment in everyone's future.

## **Applications**

### 1 business applications:

Solar water heating system.

Best known applications of solar energy.

Domestic solar water heating is quite popular and is preferred over electric water heating by many homeowners

However in business applications conventional heating system based on electric oil wood still rule the roost inspire of massive subsidies in the past not many industries.

Opted for solar water heating system. Only recently with the temperature increases in cost of electricity and conventional fuels are industrialists turning to solar energy as a means to meet their hot water needs.

### 2 Breweries:

Bottle washing waste prepared boiler feed Applications. Bulk drinks manufactured units.

Fermentation of mixture, boiler feed Applications.

### 3 Dairies:

Ghee production,

Cleaning and sterilizing. Pasteurisation

### 4 Distilleries:

Bottle washing, boiler feed Applications

### 5 Edible oil and refining:

Boiler feed Applications.

### 6 Electroplating Galvanizing Units:

Heating of plating baths, cleaning degreasing application.

### 7 paint shops:

Cleaning, degreasing applications.

### Pulp and paper industries:

Boiler feed Applications, soaking of pulp.

### Solar process heat.

Theses system consists of several thousand sq. ft. Of ground mounted collection, pump, heat exchanger, control and one or more large storage tank. Typically they provide hot water and hot water space heating for large institutions such as school, office building, prisons and military bases.

### Active solar cooking.

As water evaporation it cools the air. Evaporative cooling system usually appreciate for hot dry climate can be powered with solar technology. In humid climate, desiccant evaporation cooling system uses the same evaporation concepts to cool air, but they also includes a desiccant wheel to dry the income air. Waste heat from the building, natural gas, or solar technology can be used to regenerate desiccant wheel, evaporation cooling is a free and energy efficiency way to cool commercial building. In absorption solar cooling. An absorption device uses a heat source, such as natural gas or large solar collector, to evaporate refrigerator.

### Result, Discussion and Conclusion.

The system is tested in several times in a day. As the solar rays always make strike it. The solar radiation losses or the reflection of the energy collector surface Neill be decreased also and the efficiency be maximum the collector is covered by transparent smooth glass with has a higher solar radiation transmission. However the radiation emitted by the glass with increase it temperature.



All these issues help to get higher solar heat on the collector surface. These heat it absorber by the water when flows steadily over the collector surface. The maximum temperature recorded at around 01.00 pm. The steady variation of a temperature during the morning time from 10.30 to 11.30 am in fact around 2.00 pm when there is high solar intensity of around maximum temperature of the outlet water of the collector is achieved a 90°C. It is observed that the collector with the reflector always products a higher temperatures that of a collector without the reflector.

To analysis the effect of flow rate, the experimental were conducted at different flow rates and the variation of outlet temperature at different flow rates is observed. It is also seen that the outlet temperature decrease with increase the volume flow rate of water. However, the flat plate collector is oriented is such a way that it received both direct and diffuse radiation during the daytime a. In fact , the including angles affect strongly on the heat transfer rate of flow plate solar collector and also noted the maximum collector efficiency angle 45° from the horizontal surface.

The water flow due to gravity from the reservation the volume flow rate of water is measured the mass flow rate of water is calculated. The collector inlet and outlet water temperature were measuredly a digital thermometer with a precision of 0.1 ° c. The collector surface area is 4m, the solar intensity is 945 w/ m, the transmitter of glass is 0.85 and assume that the incidence radiation on the collector surface is around 70% . The total absorber of glass is 0.9. The collector efficiency is calculated