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Construction of A Parabolic Dish Collector For Domestic Purpose Water Desalination Using Solar Energy

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Abstract: With the decline of non-renewable energy sources, i.e. fossil fuels, renewable energy sources such as tidal, geothermal, solar, wind, etc., will play a vital role in our energy needs. In the future, the efficient use of solar energy will be of primary importance to replace the conventional energy source. The present study details the utilization of solar energy for desalination of water for domestic purpose. It involves the construction, testing & analysis of parabolic dish collector /reflector for small scale domestic purpose. Ground water is heated from solar radiation directly into the receiver and the generated steam is collected & condensed. The parabolic dish can deliver temperature ranging from 473K to 773K. Direct steam generation results in high thermal efficiency. Overall cost is low & it is not harmful for the environment. The experiment was carried out for one module of reflector diameter of 1.2 meters. Also, the concentration ratio is 20 and the focal length is 0.36m. This Solar based distillation system is optimum to remove minerals & hardness found in ground water and make it suitable for drinking.

Keywords: Solar Energy, Desalination, Dish Collector, Flash Chamber, Absorber

Introduction: The use of solar energy in India is of great importance as it lies in a temperature-climate region of the world where sunlight is abundantly available throughout the year for most of the country. The fundamental research in solar energy is being carried out in universities and various educational research institutions. Applications of solar energy are : Heating and cooling of residential buildings, Water heating, Drying of agriculture and animal products, Distillation, In engines for water pumping, Food refrigeration etc.

Fresh water is a life-supporting requirement as well as the secret to matching prosperity. Fresh water supplies are increasingly becoming inadequate to meet the needs of growing populations, both for domestic and agricultural uses as well as for industries that are continuously expanding rapidly. The problem of getting water in arid and semi arid areas and at some of the coastal areas is acute. Saline or brackish is defined as any water with less dissolved salts than in sea water.

In village, it is very common for the people to travel long distance to get portable water for drinking purpose. Solar energy which is available in abundance and at the site can be used for converting the ground water available which is saline into desalinated water.

Desalination means conversion of saline water into suitable so that human can consume it.. But this separation needs energy. Solar energy is radiation thermal energy so it can be used for water distillation.

Salty or brackish water distillation solves the diverse and innumerable water problems to some extent. A number of existing desalination plants use fossil fuels as source of energy. While few techniques are employed, such as multi-effect evaporation, multi-stage flash evaporation, and thin film distillation, the process is energy-intensive and high cost. Hence, application of solar

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powered or solar augmented distils, can replace need for a large proportion of oil or other desalination plants.

W.R.Mccluney et al explain the basic principles of solar distillation of water and its economics over bottled drinking water purchased in the store. Also researcher discussed about details of purity of water by solar distillation method. After experimentation researcher found that purity of water is increased by slow distillation rather by rapid. Also Solar distillation of tap water or brackish ground water can be a pleasant and energy efficient option. [1]

The design of solar energy systems both thermal and photo voltaic types is illustrated by another author Bagget. He also discussed about the Solar Resource and the ability of various types of solar collectors to capture it effectively. Along with this design tools are developed which integrate performance of isolated solar collectors considering Economic and Environmental effects. [2]

Solar dish concentrators provide high temperature and high efficiency. And solar thermal energy at a cost comparable to that of residential TV satellite dish antennas. Evaluating this relationship yields an economical analysis and return on investment for solar energy collectors using mature manufacturing references. Researcher estimated cost of thermal output per kilowatt and found that annual efficiency could be better or worst depending on the site, dish opening temperatures and maintenance. Also solar steam is possible. [3]

The special cost of the product is evaluated for different climate conditions, plant capabilities, cost of solar collector and costs of a conventional energy supply. Researcher tried to explain the working of a direct solar distillation system and solar multi-effect distillation plant and multistage flash distillation plant. The economical benefit of solar direct steam generation from brine is pointed out as having better thermo dynamic efficiency. [4]

2 Solar energy based for domestic purpose water desalination: The solar desalination plants have proven to be reliable, simple, scalable, sustainable and affordable way to produce drinking water from almost any water where it is needed locally. The ground water is pumped to the overhead tank and it is then allowed to pass through the absorber coil under a controlled flow rate. The solar collector is used to focus the energy of the sun to the absorber coil.

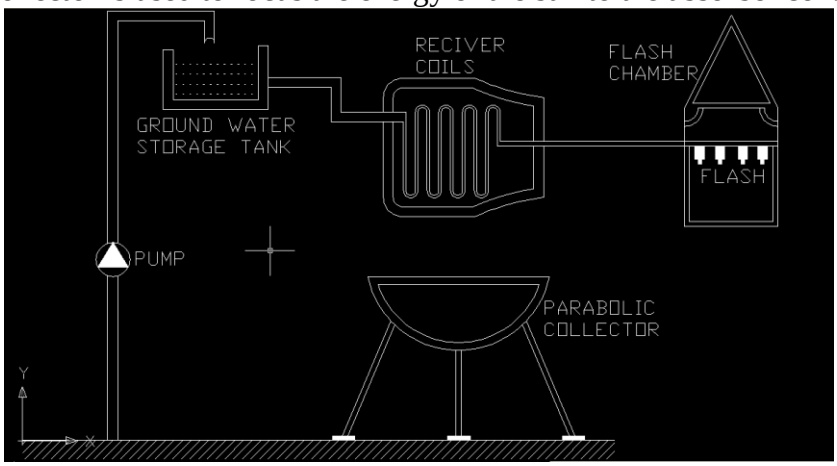

Figure 1: Domestic Purpose Water Desalination Method

The focused incident rays thus heats the absorber pipe and water gets heated up due to this. This will change heated water into steam. The steam is then made to pass through the pipe which is then collected into the flash chamber. The flash chamber made of mild steel with a pyramidal

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shape top made up of glass. The steam thus moves up and gets condensed. Water is then collected from the top of the flash chamber which can be used for drinking.

3 Construction:

3.1 Parabolic Dish: Number of panels and required area of absorber is calculated and radius was found to be 600 mm and cross-sectional area of 1.47m^2. the depth of the dish was taken as 26 cm. Focus for the dish is calculated and found to be 36 cm from the depth. The frame of the parabolic dish was then made as per the required dimensions and the sheet metal was cut into 8 segments. These segments were then settled and welded onto the frame. A required tracking system was then incorporated with the dish to give the east west movement..

3.2 Absorber: Absorber dimensions were calculated taking the ratio of the aperture area to the concentration ratio. The required value was found and the base diameter of the coil was then set with the calculated value. Keeping inlet and outlet straight, the coil was formed in the middle. With the help of a conical die cooper tube was bent.

3.3 Flash Chamber: Flash chamber is a tank used for collection of desalinated water. The construction of the tank is simple having a pyramidal top used for condensing of the steam generated and also used to give the pure desalinated water.
The parabolic dish collector thus made for the solar desalination of domestic purpose water is shown in fig 2 below:

Fig 2: Parabolic Dish Collector

3.4 Components used: Various components used for the construction of parabolic dish collector are shown in table 1 below:

Table 1: Components used for the construction

Component	Material	Dimensions
Parabolic Dish	G.I. Sheet	120 cm X 120 cm
Reflector Sheet	Polished Aluminium	15 Mtrs.

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Ground Water Tank	--	20 Ltrs.
Cone	Glass	
Supporting Stand	Mild Steel	Height – 40 cm Length – 80 cm
Infra Red Thermometer	--	Upto 530 ^{0}
Pipes	Plastic	Length – 6 m Diameter – 8 mm
Absorber Tube	Copper	Length – 8 m Diameter – 8 mm

4 Performance Analysis: An investigation using different instrumentation had been carried out to access the performance of the collector. Infra-red thermometer was used to measure the temperature of water at inlet, outlet and the absorber temperature. The readings were tabulated and shown in table 2 below:

Table 2: Readings

Local Time	**10:00**	**11:00**	**12:00**	**13:00**	**14:00**	**15:00**	**16:00**
Ambient temperature (^{0}C)	33	34	35	35	36	35	34
Solar Insolation (W/m^2)	723.78	827.18	960.12	901.12	856.72	653.21	451.23
Beam radiation (W/m^2)	550	650	700	680	650	450	300
Inlet Water Temperature (^{0}C)	33	33	33	33	33	33	33
Outlet Water Temperature (^{0}C)	40	58	73	82	78	71	63
Reciever Surface Temperature (^{0}C)	73	92	106	123	114	96	88

5 Conclusion: Readings taken at various times of a day are shown in the form of a graph as fig 3 below:

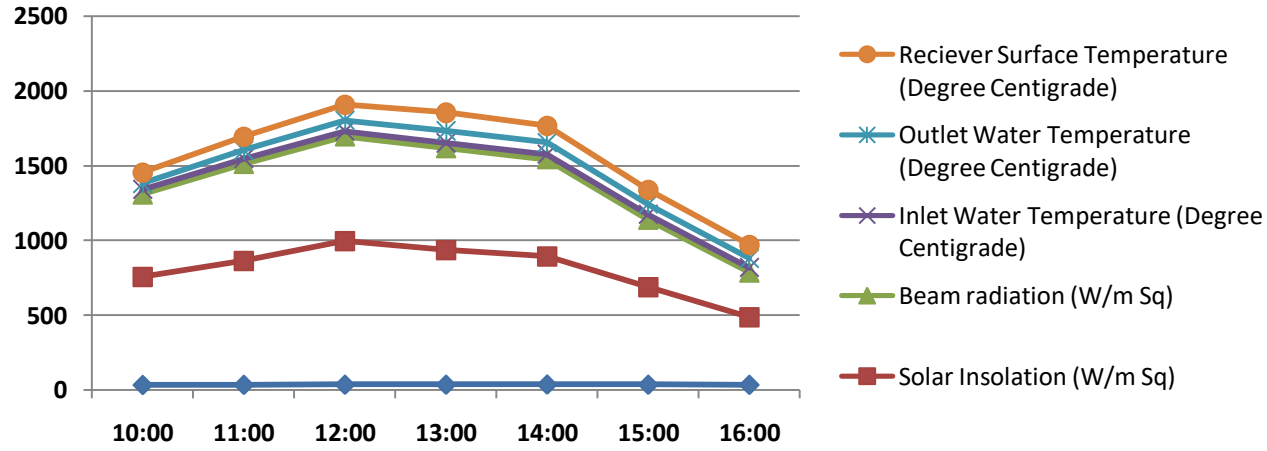

Fig 3: Graph representing various reading

The above graph shows the variation of receiver, inlet water and ambient temperature at different time period in a day. The temperature of the water leaving the collector was found to increase as

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the intensity of solar radiation was more at high solar insolation rates. The ambient and inlet water temperature was observed to increase slightly with increase in solar insolation.

1. Desalination appears to be one of the best options to palliate the problem of water scarcity.
2. As high solar irradiance levels characterized arid areas, the energy demand for the desalination process can be supplied by a solar thermal system
3. Direct steam generation from parabolic dish exhibit potential for improving solar desalination.
4. The replacing of oil based technology by DSG presents many advantages from point of view of thermodynamics, environmental hazards, land use, use of material, etc.
5. Heat exchangers are not necessary to generate stem.
6. The area occupied by the solar system is a worrying factor and it can be optimized by improving the collection efficiency.
7. The optical efficiency is improved by keeping the reflector clean and polished.

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