PERFORMANCE IMPROVEMENT OF SINGLE SLOPE SOLAR WATER DISTILLATION PLANT – A REVIEW

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ABSTRACT

Solar energy is a natural and renewable source of energy. The shortage of drinking water is gradually increasing day by day. As per govt. report in India, drinking water will exhaust in 2040.In this paper a parabolic concentrator with manual measurement system has been developed in association with single slope solar water distillation system for hot water generation in which concentrator is covered by are erective mirror film which work as reflector. Copper tubes of different diameter for absorption of solar radiation were taken keeping constant focal length of collector so that maximum heat transfer can be achieved.

Index Terms : Solar Still, Parabolic Trough, Pump

INTRODUCTION

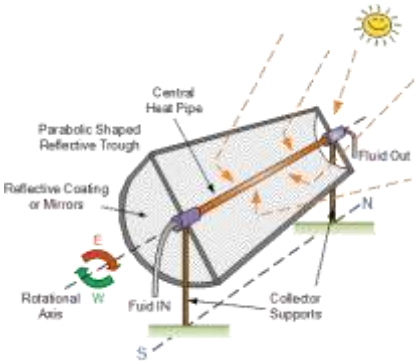
Solar energy is major source of energy for our earth. Solar energy is a high energy radiant energy source with great advantage over alternate energy sources. It provides 1000 times more power than we need. Solar energy can be used both directly and indirectly.it can be used variety of thermal application like heating water, distillationetc. We know world is facing an extreme problem of fresh drinking water and by 2015,40% of world's population will be living in regions without an adequate fresh water availability. In many areas, modern distillation techniques are not affordable due to financial and economic issues and many distillation techniques uses high amount of electricity and other costly equipments. Using solar thermal energy, we can use better efficient distillation techniques which are an environmentally free and friendly. Distillation is one of popular method to obtain fresh water .This process needs an energy input in form of heat or solar radiation. This radiation leads to increase in temperature of water and evaporation rates increases which leave behind all impurities. Hence these vapours get condensed as pure water. Solar distillers are more efficient to remove dissolved impurities in water such as salts, dust, and micro organismsetc. The impure water contains other dissolve heavy metals, iron, manganese, fluorides due to high drainage of untreated water discharge from factories and industries. The world's first conventional solar still was designed in Chile in 1883. Since then a various number of solar stills have been designed for fresh water distillation so far. Conventional solar stills are simple, cheap, eco friendly and highly efficient. The simple and most practicable solar still is single slope solar still. The distillation output of a solar still depends on various factors of water and glass cover temperatures, solar radiation to collector area, area of condensing cover and air flow rate.[1]

The basic principles of solar water distillation are simple, yet effective, as distillation replicates the way nature purifies water. The solar energy heats water to the point of evaporation. As the water evaporates, water vapour rises, condensing on the glass surface for collection. The process removes impurities such as salts and heavy metals, as well as destroys microbiological organisms. The end result is water cleaner than the purest rainwater. [4]

Fossil fuels (coal, oil & gas) will be the main fuels for energy. There is a fear they will get exhausted rapidly in next decade hence other system based on non-conventional and renewable sources are tried by many countries. In India energy problem is very serious. Inspite of discoveries of oil & gas the import of crude oil continues to increase & the price paid for it now dominates all other expenditure. One of best method to make use of renewable sources of energy derived from sun. solar energy can be used both directly and indirectly. [9]

IMPORTANT PARAMETER

1. Solar concentrator ratio: ratio of effective area of aperture to the surface area of absorber.
2. Aperture: it is surface opening of collector through which solar radiation passes.
3. Rim angle: the rim angle is defined as angle starts from edges of reflector at focus**.[8]**
4. Acceptance angle: it is defined as the maximum angle within light can be accepted by an element.



Parabolic Trough Solar Collector

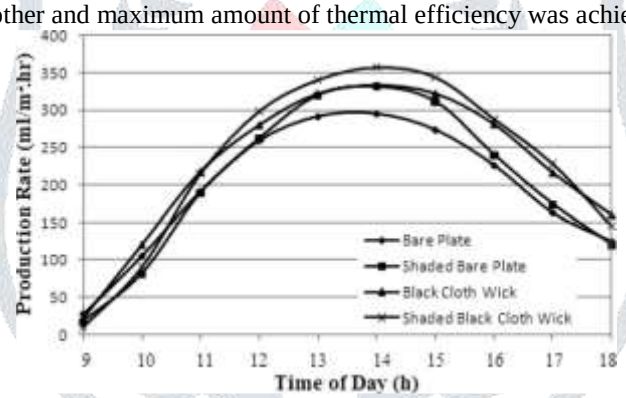
LITERATURE REVIEW

Anil kr. Tiwari and G.N. Tiwari[1] conducted a practical study of purification of contaminated water through solar energy in which they observed best Inclination of single slope passive solar still having glass cover for high distillation efficiency. The results were obtained by keeping three solar stills of different angle of inclination for one year time period.they found 15^0 inclinations for higher yield under uniform climatic conditions.

Anton A. Kiss [2] observed experimentally that distillation technology can be more productive and beneficial for fulfilment of demand of pure water requirement. he found some of the promising advance distillation techniques to be more efficient and effective such as membrane distillation which operates at low temperatures and used mostly in industrial process.

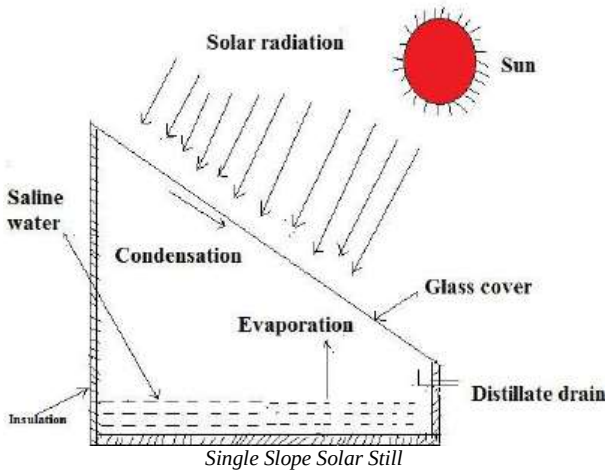
Bhagwan Prasad and G.N. Tiwari[3] experimentally observed thermal as well as numerical analysis of concentrator integrated solar still such as water and glass temperature, daily yield, thermal efficiency. They found better glass cover inclination for maximum yield at 75^0 resulting that increase in glass cover inclination leads to increase in release of thermal energy from glass cover.

Emrah Denis [4] conducted a comparative experiment to formulate problem of inclined solar water distillation system for maximum thermal energy absorption. He proceeded with four different variants such as bare plate, shaded bare plate, black cloth wick and shaded black cloth wick. After performing with all four variants, he concluded that shaded black cloth wick solar distillation system was better than other and maximum amount of thermal efficiency was achieved.



Pankaj Srivastava and Abhay Agarwal[5] have designed a high acting solar operated distilled water plant. They derived results on basis of monthly and yearly productivity of performance of system with comparison with conventional type solar plant. They concluded that production cost of their highly acting plant was Rs.5.7 whereas for conventional was 7.9 and market rate is Rs.20. Hence their high acting plant was more efficient and cost effective.

Med uGu and Ndatuwong[6] performed an experiment by designing a solar distillation plant in Nigeria to analysed heat and mass transfer mechanisms. They did theoretical analysis of performance of plant and found that with rate of increase of solar radiation, instantaneous efficiency also increases as well as increase in feed water temperature.



Single Slope Solar Still

Ruby et al[7] did an experimental study by deigning a parabolic solar trough collector to obtain high amount of steam by thermal temperature. Using solar radiation at parabolic trough, they observed that high temperature water was processed into approx. 300 pounds per ssq. Inch of steam. That processed steam could be use for domestic as well as industrial purpose.

Saurav Gupta et al[8] have performed an experiment by using single slope solar water distillation system using parabolic tough concentrator. They used aluminium as absorber in concentrator and analysed thermal absorption at different focal length and different copper tube diameter. After completing process, they resulted that maximum temperature was obtained at 240 mm focal length and on 19 mm diameter copper tube .

Vijayaraghvan et.al. - have performed a test to justify performance of a spectrally selective liquid under concentrated light. The design was included with a Fresnel lens based concentrator which focuses solar radiation on to a glass absorber. Thermal performance of collector was measured using copper sulphate solution as heat collector fluid. Finally it was found that solution flow rate through absorber and optical concentration as measured have an insignificant impact on thermal efficiency. [10]

Sagade et.al. – conducted an experiment on parabolic trough made of fiber glass reinforced plastic with its aperture area coated by aluminium foil with reflectivity of 0.86. The line focussing parabolic trough with mild steel receiver has been tested with and without glass cover. As per Indian condition, low cost FRP parabolic trough system proves to be beneficial for industrial heating and for domestic heating. [11]

Mohd. Rizwan, Mohd. Abdul Raheem Junaidi et.al.[12] have designed a solar parabolic collector for water distillation to evaluate maximum distilled water output with low maintenance. They used highly polished Aluminium sheet as a reflector and a copper tube as an absorber. After completing process, maximum temperature obtained was 106^0C at 1 pm.

Kanika Mathur et.al[13] have designed and fabricated a solar distillation water system to obtain maximum pure water output with help of an external mirror reflector attached to solar still. After performing experiment at three different water level, they concluded that volumetric efficiency of system is 23.33% for an input of 15 liters of water per day.

M. Gowtham et.al.[14] have designed and experimented a water desalination process by concentrating solar energy through a parabolic trough concentrator with paraffin wax as latent heat storage material adding with different scrap material for heat storage like sponges, pebbles and mild steel billets. After carrying out experiment with various heat storage material, the concluded that heat storage capacity was maximum of 54.08% with paraffin wax and mild steel scraps.

Mehta et.al.[15] have fabricated and designed a solar water distillation model which convert impure water into pure water by solar energy. They resulted the amount of pure water from evaporation of impure water and calculated that 1.5 ltr. of fresh water was produced from 14 ltr. of impure water during six hr. of time period and efficiency of model was around 64.37%.

PROBLEM FORMULATION

After study and analysis of above research papers, I observed that Anil kumar Tiwari and G.N Tiwari have very well done comparative study of high solar radiation on glass cover resulting that inclination angle was 30 degree at maximum solar energy absorption level. Beside this, Ruby et al performed an experiment to obtain highly processed steam by solar parabolic concentrator. In research paper of Surav gupta, they have used aluminium foil as absorber and it could be better by using thermal refractive film. So from all studies, mostly parameters were based on collectors. Parabolic trough solar collector with mirror silver solar reflective film can be strongly be used for better enhancement of thermal efficiency with other parameters which can be considered necessary for experiment going to be conducted.

CONCLUSION

Effectiveness and efficiency of parabolic trough solar collector is directly proportional to solar radiation and receiver diameter. It is found that performance of parabolic trough can be optimised by changing focal length of collector as well as diameter of absorbing tube.

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