A REVIEW OF UTILIZATION OF SOLAR ENERGY BY EMPLOYING PARABOLIC CONCENTRATORS FOR VARIOUS PURPOSES

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ABSTRACT
Solar energy is considered to be the most promising source of energy. Solar energy can be utilized for many thermal applications such as heating, deformation of metals, power generation, refrigeration and many more. This paper presents a review of literature on the developments in the area of harnessing solar energy for various applications, with a special focus on utilization of solar energy by employing parabolic concentrators for purposes of heating, cooking and use in water desalination systems. Since the present study has been carried out for design and fabrication of water desalination system for a rural household, work done in this area by researchers have been thoroughly reviewed with regards to approaches used and tools and techniques employed.


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1. INTRODUCTION
In the world the requirement of energy is continuously increases due to increase in population and development of new technologies. For fulfillment of the requirements research is running on the renewable energy. Solar collectors are also a method to generate heat energy by solar radiation. Heat from solar energy can be used for both domestic and industry purpose. In domestic, heat from sun can be used for heating, drying and cooking. Parabolic dish solar collectors have high concentration ration and efficiency. Energy demand increases with improvement in lifestyle of the people. And with growing population the cost of energy also increases. Thus the need of less expensive energy arises and researcher moves towards the renewable energy. In renewable energy, Solar is a major form of energy source. In present different types of research are going on for maximum utilization of solar energy. Most of the
existing systems have used flat plate collectors and parabolic trough concentrators for desalination.

2. SOLAR ENERGY AND ITS APPLICATIONS

Solar energy is considered to be the most promising source of energy. Solar energy can be utilized for many thermal applications such as heating, deformation of metals, power generation, refrigeration and many more. Now a day, sun power has provided the most efficient and most reliable solar products available in the market. Different industries and researchers are actively engaged in research in the area of solar energy.

Badran and Hamdam (1997) have described a process of utilization of solar energy for preheating fuel oil. In countries like Jordan, where fuel oil is used as a major source of energy, a large amount of fuel was used for heating it to the required temperature. They used solar energy as an alternative source to heat the fuel oil to a temperature of about 50°C. In this work, the performance of a conventional flat-plate collector filled with fuel oil was studied theoretically and experimentally. The performance was also compared with that of an identical collector filled with water. It was observed that the exit temperature from the fuel oil collector for the same incident solar radiations was higher than that at the exit of the solar collector. Efficiency was determined using heat balance equations. The deviations of experimental and theoretical observations were attributed to various factors like uncertainty regarding bond conductance, experimental error and manufacturing discrepancies of the collectors.

Lytvynenko and Schur (1999) have explained utilization of the concentrated solar energy for process of deformation of sheet metals. Importance of super plastic forming (SPF) was explained in this work, most important part that with the utilization of the concentrated solar energy, the operation can be made simpler and cheaper. Deformation experiments were performed for forming with a punch and negative forming. Several sheets made of aluminum alloys, brass and iron alloy were employed. The mirror dish concentrators with diameters of 1500 mm and of 5000 mm were used for heating the metals by solar energy. Solar tracking system was automatic. Results showed uniform deformations in almost all the experiments. Thus utilization of the concentrated solar energy for heating during forming of sheet metals was justified for the places which are located away from conventional power sources.

Karagiorgas et al. (2001) explored the potential for application of solar thermal systems in sectors such as food industry, agro-industries, textiles and chemical industry. In this paper, these systems were evaluated in economic terms in comparison with energy equivalent systems.

Kalogirou (2003) has explained the potential of solar industrial process heat applications. The range of temperature requirements of solar industrial process heat applications was determined. The characteristics of medium to medium-high temperature solar collectors were given. An overview of efficiency and cost of existing technologies was presented. Five collector types were studied varying from the simple stationary flat-plate to movable parabolic trough ones. Transient simulation program TRNSYS was developed for such systems. Based on TRNSYS simulations, an estimation of the system efficiency of solar heat plants operating in the Mediterranean climate were given for different collector technologies. The annual energy gains of using such systems were determined. The resulting energy costs obtained for solar heaters were estimated depending on the collector type applied. Dependency of the costs on international market trends and oil production rates was stressed. It was explained that costs will turn out to be more favorable when the solar collectors become cheaper and subsidization of fuel is removed. An optimization procedure was suggested in this paper to select the most appropriate system in each case.
Kalogirou (2004) conducted a survey of various types of solar thermal collectors and their applications and was presented in his work. Initially, an analysis of the environmental problems related to the use of conventional sources of energy was presented and the benefits offered by renewable energy systems were outlined. Various types of collectors like flat-plate, compound parabolic, evacuated tube, parabolic trough, Fresnel lens, parabolic dish and heliostat field collectors were explained. Optical, thermal and thermodynamic analysis of the collectors and a description of the methods used to evaluate their performance were described. Typical applications of various types of collectors were presented. These include solar water heating, space heating and cooling, heat pumps, refrigeration. Focus was also given on industrial process heat, which comprises air and water systems, steam generation systems, water desalination and 17 thermal power systems. Application of various devices such as the parabolic trough, power tower dish systems and solar furnaces were explained. The application areas described in this paper show that solar energy collectors can be used in a wide variety of systems and can provide significant environmental and financial benefits and should be used whenever possible.

Arulkumaran and Chirstraj (2012) performed experimental analysis of solar parabolic dish concentrating system which was used for steam generation. The evaporation part setup included a solar parabolic dish system and absorber. A galvanized steel pipe was used to carry water from a tank to the coiled absorber tube made up of copper and located in the focal point. The performance of the concentrator was studied experimentally with the water circulated as heat transfer fluid. Highly reflective aluminium foil sheet was used for fabrication. The experimental setup was placed in open, where tests were carried out. Heat transfer analysis was carried out to obtain its efficiency. The designed system eliminates tracking the sun in the east west direction and optimal tracking of the sun in the north-south to obtain maximum solar energy. The experimental results were taken on summer and cloud free days. The maximum temperature achieved was 2150°C with solar steam conversion efficiency of 60-70%.

2.1. Developments in Analysis, Design and Fabrication of Parabolic Concentrators

Parabolic concentrators play an important role for focusing solar energy on to a heating area. Various types of concentrators are used for heating applications. Utilization of solar energy largely depends upon the construction and the tracking mechanism of the concentrator. Analysis on different types of concentrators have been made as per the desired application and few of them are disused below.

Rubio et al. (2007) in their paper presented a control application that performs solar tracking for concentrator with high accuracy without the necessity of recalibration. Performance of a solar concentrator can decrease due to errors in alignments and tracking. This paper explained the need and presented a control strategy for two axes trackers executed using microprocessor. In summary, there were three main aspects concerned with this control strategy, a new sun tracking strategy for low cost position with two degrees of freedom, a simulator that allows to evaluate how the tracking strategy is working and a mechanical structure that acts as a solar tracker. Simulation and experimental results were compared between a classical open loop tracking strategy and the proposed hybrid one. Simulation and experimental results have shown that new strategy gives more benefits than classical open loop strategy.

Dascomb (2009) in his thesis explained the concept of low-cost concentrating solar collectors for steam generation. The work presented the use of concentrating solar power to provide electricity, refrigeration and water purification in one unit. An economic parabolic
A dish concentrating system was built at the Sustainable Energy Science and Engineering Center at Florida State University. The aim of the project was to provide 6.67 kW of thermal energy using a conventional micro steam turbine. The concentrator was coated with a highly reflective polymer film. Sodium nitrate was filled in the cavity type receiver which acts as a heat storage and transfer medium. Thermal losses were determined for each component and the losses from the absorber were also calculated. Other losses were considered due to mirror reflectivity, mirror wear, absorptive, imperfect insulation and receiver conduction to the support arm. The gross thermal conversion efficiency of the system was calculated and found to be 39%.

Chong and Wong (2009) derived a general formula for on-axis sun-tracking system using coordinate transformation method. Two most commonly used configurations in two-axis suntracking system were azimuth-elevation and polar tracking system which have their own application domains. Azimuth-elevation system was based on ordinary optical mirror mount while tilt-roll polar tracking system drives the collector to follow the sun-rising and sun-set. The change of the tilting angle of the collector due to the yearly change of sun path was also discussed in the work. Accuracy of both systems was based on alignment of the concentrator. But, the general sun-tracking formula in the paper was derived using matrix method. It not only provided a general mathematical solution, but more significantly, it improved the sun-tracking accuracy by tackling the misalignment of solar collector during installation.

Ying Yeha et al. (2011) in his paper proposed a novel concentration solar collector and developed the focal point tracking system for it. Instead of rotating a heavy concentrating lens, the proposed system moves the photo transducer. It was observed that the design required no exposed moving parts that were difficult to maintain and consumed less power to move the light weight solar transducer. The design was also found suitable for vertical applications like building walls. This paper explained the procedure to calculate the trajectory and then built an experimental setup to verify the concept. The experimental results proved that the proposed focal tracking system consumes less power and achieves solar energy conversion efficiency as comparable to the conventional systems.

Garcia et al. (2012) developed an efficient parabolic dish engine based on Rankine cycle. They carried out a case study to evaluate the technical viability of a parabolic dish concentrator to convert solar energy into electric power. This was done by means of a high performance Rankine cycle operating with ethane, ammonia or water. Thermal efficiency and net developed work were compared. Parabolic Dish Concentrator was used to convert the solar energy to mechanical energy and then to electrical power. System used a mirror array to reflect and concentrate incoming solar radiation at a receiver using dual axis tracking. Among all concentrated solar energy technologies, parabolic dish based systems have demonstrated the highest efficiency, approaching 30%. The receiver was designed to absorb the concentrated solar radiation and to transfer as much energy as possible to a high transfer fluid. Results obtained show that Rankine efficiency was greater than that of the Stirling cycle under the same operating temperatures with Stirling engine conversion efficiencies of around 30% to 40%. Thermal losses were determined for each component. The losses from the absorber were also calculated. Other losses were considered due to mirror reflectivity, mirror wear, imperfect insulation and receiver conduction to the support arm. The gross thermal conversion efficiency of the system was calculated and found to be 39%.

Mohammed (2012) designed and developed a parabolic dish solar water heater for domestic hot water application. The concentrator acted as a water heater and was used to provide 40 liters of hot water a day for a family of four. To improve the efficiency of the system, an automatic electronic control circuit was designed and developed for automatic
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tracking. Experimental test showed that the thermal efficiency of the system was in the range of 50%. The diameter can be decided as per the requirements.

CONCLUSION

From the above literatures, most of the existing systems have used flat plate collectors and parabolic trough concentrators for desalination. Complex mechanisms have been used for solar tracking. Finite element analysis is used to determine temperature stress and temperature distribution but costly instruments like infrared cameras are used. As can be seen solar energy systems can be used for a wide range of applications and provide significant benefits, therefore, they should be used whenever possible.

REFERENCES

[1] Badran and Hamdam, Utilization of Solar Energy For Heating Fuel Oil
