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DESIGN, MANUFACTURING AND PERFORMANCE EVALUATION OF PARABOLIC DISH CONCENTRATOR USING HELICAL COPPER RECEIVER

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Abstract:
Solar steam generation has garnered considerable interest due to its low cost and wide range of applications in areas such as sterilization and cooking. However, the efficiency of solar evaporation remains low, highlighting the need to investigate the limitations of current low-efficiency systems and to develop new strategies for improving solar evaporation efficiency. This study examined the performance of a helical copper coil receiver (HCCR) using a parabolic dish concentrator (PDC) with dual tracking and freshwater as the working fluid. A simple, low-cost model of a PDC system for low-grade thermal processes was designed using AutoCAD software, and manufactured with an aperture area of 12.5 ft^2 (1.16 m^2), a focal length of 1.67 ft. (0.51m), and a rim angle of 61.8°. PDC parameters, including focal length, size, shape, depth, and diameter were analysed using Parabola Calculator Software 2.0. Experiments were conducted on sunny days in August, September, and October in Rahim Yar Khan (RYK), Pakistan. The findings showed that the maximum temperature of 221°C (429.7°F) and intensity 931W/m^2 (295 BTU/h.ft^2) were achieved in August. Energy calculations, hourly heat rates, steam generation, and efficiencies were determined with respect to solar time. Additionally, the optical efficiency (η_{opt}) was found to be 82%, and the instantaneous efficiency (η_{ins}) was calculated as 77.3 % strongly indicating the system's capability to convert solar thermal energy into heat for steam generation. The results also showed that the system's performance is highly dependent on the collector's shape, the optical characteristics of the materials used, and fabrication-related deficiencies.

Keywords:
Parabolic Dish Concentrator (PDC), Helical Copper Coil Receiver (HCCR), Collector, Solar Radiation, Solar Energy

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