Design, construction and testing of a two axes tracking parabolic solar collector with economical consideration

Saif Khalfan AL-Jahwari

Abstract

Solar parabolic dish of 1 m diameter has been designed with the optimum rim angle of 45˚ for cavity receiver. The dish was designed for optical efficiency of 84%, concentrated solar energy of 424 W and concentration ratio of 21. The dish was simulated using ANSYS software to confirm safe structure for the dish. Both weight and wind loads were considered in the simulation. Auto-Cad software was used to simulate the geometry of the dish as well as the tracking mechanism. Finite Element Method was used for the stress analysis of both the dish and the tracking mechanism using four computer processors to achieve the numerical analysis. The tracking mechanism with the dish was simulated in ABAQUS software to confirm safe structure under dynamic loads. The safety factor is calculated and found to be 3.87. The dish was fabricated with new fabrication process and new tracking mechanism was constructed. New control circuit was designed and built using four Light Dependent Resistors (90˚ apart on the dish) as input components, NPN transistor as signal identifier and relays for inverting motors' rotation. The geometry and performance of the dish were tested through measuring the actual focal length which was found with 4 mm error (0.7%). The operation of the tracking system with the dish was tested and the results are satisfactory. Economical analysis was performed on the dish and it was estimated that solar heating is cheaper than electrical heating by 43 OMR per year (considering heating 200 liters of water daily from 28˚C to 42˚C).