Sizing and performance prediction of solar-powered pump-pipe systems using empirical solar radiation and pump characteristic data as applied in Zimbabwe

T. Hove* and E Mungofa
Department of Mechanical Engineering, University of Zimbabwe
P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe
Email: tawandahv2@yahoo.co.uk

Fax: +2634303280

Abstract

Solar powered systems have a natural synergy with most water pumping applications, since the demand for water rises at the same time when there is more solar radiation available for solar pumping output. In this paper a comprehensive method for sizing and performance prediction of a photovoltaic (PV) solar-powered pump-pipe system is proposed. The sizing and performance prediction methodology utilizes empirical data of the solar pump performance simultaneously with solar radiation and ambient temperature data, resulting in the prediction of the time-step response of solar pump-pipe system flow output to changing solar radiation level. Empirical functions of flow rate versus solar power are derived for different pumping main pipe diameters. The combination of pump, pipe diameter and PV array size which results in the least unit cost of pumping is selected as the optimal design of the solar pumping system. This kind of approach to solar pumping system design is recommended since it yields significantly different and more accurate sizing and performance prediction of the solar pumping system than the commonly used simple approach which does not account for the fact that total dynamic head varies as the solar irradiance (PV power) varies.

Key words

Solar pump-pipe design, variable total dynamic head, flow-power functions, unit cost of pumping