Name: Hadole Mahesh Vinayak **Roll No.:** 15AG92R03

Title: Modelling and Optimization of Directly Coupled Solar Photovoltaic Pump Operated Micro Irrigation System

Abstract

A directly coupled solar photovoltaic-powered micro irrigation system is one of the most appropriate renewable energy applications for crop production. The operation of directly coupled systems is simple, and photovoltaic energy should be used at the same time it is generated for effective utilization. Therefore, the real-time matching of photovoltaic energy generation with micro irrigation operation is essential. An integrated performance simulation model and design optimization model are required to operate a micro irrigation system with reliability. This research study presents the development of an integrated dynamic simulation model and a design optimization model for a directly coupled solar photovoltaic pump-operated drip irrigation system.

The fundamental mathematical expressions of the subsystem components are used to develop a simulation model in a MATLAB/SIMULINK environment. The hourly solar irradiance, temperature, and groundwater level monitored for the study area are inputs to the model. The model simulates solar photovoltaic power, pump discharge, pressure head, and emitter discharge. The simulation accuracy of the developed model is evaluated using statistical test parameters and compared with experimentally measured field data. The developed model is applied to a case study on the Okra crop to evaluate the model's efficacy. The design optimization model of the solar PV pump and drip irrigation system was developed to minimize system cost. The fulfillment of water demand, development of minimum operating pressure head for drip irrigation system, head loss due to friction in pipe, and standard minimum and maximum sizes of the system components are the significant constraints considered for the optimization. The solar PV pump is optimally designed to irrigate Broccoli and Okra in the winter and summer seasons, respectively.

The drip irrigation system is optimally designed for the Broccoli crop based on the simulated performance of an optimally designed solar PV pump for winter. The model produced an optimal design with a reduction in the solar photovoltaic system cost of 7.8 % to 11.7 % and drip irrigation system cost of 6.9 % to 12 % as compared to the conventional system for 0.5 ha to 2 ha area. The developed model and approach presented in this research are helpful for the optimal design, and scheduling of real-time system operation based on simulation. The developed models can be tested for surface water resources and climatic and crop conditions of other regions. The simulation model can be improved for more precision using field-oriented control and the looped drip irrigation network.

Keywords: Micro irrigation, Photovoltaic, Pump, Simulation, Optimization