SOLAR POWERED IRRIGATION MANAGEMENT USING NEUTRON SCATTERING TECHNIQUE

By

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B. Sc. Agric. Sc. (Agric. Mechanization), Ain Shams University, 1987

M. Sc. Agric. Sc. (Agric. Mechanization), Ain Shams University, 2000

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ABSTRACT

Ahmed Mahmoud Abdelmoneim Hegazi: Solar Powered Irrigation Management Using Neutron Scattering Technique. Unpublished Ph.D. Thesis, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2010.

This study was conducted to modify a locally assembled solar-powered irrigation system. A direct-coupled photovoltaic pumping system has been assembled and installed in the Egyptian desert in Inshas (إنشاص) at the Nuclear Research Center (31^{O} 21' E, 30^{O} 17' N). 800 Watt DC motor with brushes was modified to match unsteady PV generator current output. The DC motor was supplied with PV generator current, which was divided between 9 and 4 modules. Pump-set output was tested at different insolation levels and a relationship was carried out from observed data. Hourly solar insolation averages for ten years period were obtained from a program named "Meteo-Norm" software in order to predict and calculate the average daily pumping system water delivery in cubic meters. Preliminary experiment was conducted to acquire a relationship between PVP system outputs and solar-radiation intensity values; which differ from time to time during the day and through different seasons. Solar radiation, power consumption (as Voltage and Current), motor RPM and pump flow varied, while head was kept constant at 4 meter.

The system showed trustworthy response to the PV generator output power demonstrated in DC motor RPM and consequently water delive

Based on the obtained results of this study, conclusions are:

1. Parameters affecting the performance of solar generator under desertic conditions were ambient temperature and contaminants. Focusing on the controllable parameter; dust contaminants; experiments were made to find out the best cleaning period which has limited decrease of the PV output. Results showed that output power was 22% lower for the panel

with no cleaning for 20days. Recommendation is made to do cleaning schedule every three days.

2. Maximizing photovoltaic system efficiency is achieved in order to minimize the initial costs, in other words; more power generated from the PV system unit. These can be obtained by tracking the sun rays through the daytime. Solar tracker was designed (metal frame, detecting sensors and DC motor with gear-box) and used for this purpose. 28% more power output was gained.

3. Matching system components with DC motor obtained from local markets to meet PV generator performance. Performance curves of both PV generator and DC motor was plotted.

4. Setting up a pumping system matches the PV output. pump efficiency was calculated (30%) at 1100 rpm.

5. Hourly pump discharge and reference evapotranspiration (ET_O) were estimated using 10 years meteorological data averages "Meteo-Norm Software", years (1995-2005). Analysis showed that the strongest correlation was between the solar radiation and ETo, while solar radiation with other parameters affecting ETo such as temperature, RH% were not that strong. Correlations between both hourly solar radiation and air temperature were positive and highly significant. Calculations were made to determine area to be cultivated using the pumping system under study, to meet ET_o. Results ranged from more than 4 feddan at winter time to 2.3 feddan in summer season.

6. Determination of actual evapotranspiration (ET_o) using neutron moisture meter for the evaluation of estimated (ET_o). Actual evapotranspiration (ET_a) values were calculated within the wet area around emitter (location of plant) in five sites (S1, S2, S3, S4 and S5). Average ETa values for three replicates for the five sites in developing stage of squash plant were calculated.

Key Words: Solar energy, tracker, photovoltaic, solar powered irrigation, Nuetron moisture meter.

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LIST OF ABBREVIATIONS

AC	Alternative Current
ARD	Active Rooting Depth
Cu. SMD	Cumulative Soil-Moisture Depletion
DC	Direct Current
DCM	DC Motor
DSS	Decision Support Systems
EEPROM	Erasable Electronic Programmable Read Only Memory
ET_a	Actual Evapotranspiration
ET_C	Crop Evapotranspiration
ET_O	Reference Evapotranspiration
ET_p	Potential Evapotranspiration
IM	Induction Motor
I-V	Current- Voltage Curve
K_c	Crop Coefficient
kVA	1000 Volt-Ambs
kW	1000 Watt
kWp	Kw Peak
N.M.	Neutron Moisture Meter
PLA	Programmable Logic Array
PMSM	Permanent Magnet Synchronous Motor
PV	Photovoltaic
PVG	PV Generator
PVPS	Photovoltaic Pumping System
PVT	Photovoltaic Thermal Technology
RSM	Reluctance Stepper Motor
SOC	Standard Operation Test
STC	Standard Condition Test
SWS	Soil Water Storage
VSD	Variable-Speed Drive
WUE	Water Use Efficiency