International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-8,November 2015
ISSN: 2395-3470
www.ijseas.com

# Experimental Performance of Solar Water Helical Screw Pump for Irrigation and Drinking Water

**Mr. Sangram S. Methe[1], Mr. C. H. Bhosale [2], Mr. N.N Shinde [3], Mr. M.M. Wagh [4]**

[1]*Research Student, Department of Technology, Shivaji University, Kolhapur, Maharashtra, India*
[2] *Professor, Department of Physics, Shivaji University, Kolhapur, Maharashtra, India*
[3]*Professor, Department of Technology, Shivaji University, Kolhapur, Maharashtra, India*
[4] *Professor, Department of Technology, Shivaji University, Kolhapur, Maharashtra, India*

## Abstract

Today there are various solar pumps in operations at different cities of India but the problem with them is that all of them are centrifugal pumps of high capacity and the cost is also high. Many of these pumps operate at high speed means at high current and voltage drawn from the panel which in turn increases the size of the panel. Secondly very few Indian manufacturers is manufacturing Helical pump running on solar energy. A small sized farm owner with limited resources is totally dependent on either diesel or high size pumps.

The solar water pumping systems are the need of present time all over world duet the energy crisis, the use of these systems is limited. The major limitation is the cost of SPV systems while other reasons include the mismatch of parameters of SPV and pumping systems. Although the life span of SPV systems is 20-25 years, the variable output limits its use to small pumping systems only.

The progressive cavity pump used for water pumping is shown to be well adapted to solar power because of its flexibility thus Improving overall performance of solar water pumping system. The hydraulic efficiency was calculated with respect to head and found to be increased 23%.

**Key Words:** Solar water, helical screw pump, solar water supply system, solar water pumping, energy saving in electrical.

## 1. INTRODUCTION

The agricultural consumption is less but it is necessary to supply electricity in peak load time also because the production of agricultural products (food) is a necessary thing for a human being. The farmers are placed everywhere in the world at each point on earth. The electricity available or not, the vegetation is there. To grow the product where the grid energy doesn't reach in the hands the PV system plays an important role. Another important reason of using PV based pumping systems is: conventional electricity not supplied for sufficient time (6-8 hour supplied to farmers in Maharashtra India), the cost of conventional energy, government subsidy in solar pumping systems and it is difficult to extend the electric grid to every location where it is needed for every farmer. Most cost effective solution is the photovoltaic system based water pumping station and it can be used in water pumping for the low or high head.

The present solar pumping market is dominated by the so-called 'first generation' PV system in terms of water delivery capability at pumping systems, i.e. centrifugal pumps, usually driven by variable frequency AC motor with proven long term reliability and hydraulic efficiency. The so-called 'second generation' PV pumping systems refer to positive displacement pumps, progressing cavity generally characterized by the low PV input power requirement (between 100 Wp and 400 Wp), low capital cost evaluation and daily operation of the pump, both and high hydraulic efficiencies of even 70%.Because of a long tradition of using centrifugal pumps for groundwater pumping in India, for the adoption of solar-powered progressive cavity pumps there is a need for work to be done on to analyze the potential of small Helical pump (progressive cavity) pumping system in terms of water delivery capability at a low power cost.

### 1.1 Agriculture economy inputs:

Agriculture is the backbone of Indian economy. India's geographical condition is unique for agriculture because it provides many favorable conditions. There are plain areas, fertile soil, long growing season and wide variation in climatic condition etc. Apart from unique geographical conditions, India has been consistently making innovative efforts by using science and technology to increase production.

### 1.2 Salient features of Indian agriculture

(a) Subsistence Agriculture: As the most parts of India have subsistence agriculture. This type of agriculture has been practiced in India for several hundreds of years and still prevails in a larger part of India in spite of the large scale change in agricultural practices after independence.
(b) Pressure of population on Agriculture: Despite increase in urbanization and industrialization, about 70% of population is still directly or indirectly dependent on agriculture.
(c) Mechanization of farming: Green Revolution took place in India in the late sixties and early seventies. After more than forty years of Green Revolution and revolution in agricultural machinery and equipments, complete mechanization is still a distant dream.

International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-8,November 2015
ISSN: 2395-3470
www.ijseas.com

(d) Dependence upon monsoon: Since independence, there has been a rapid expansion of irrigation infrastructure. Despite the large scale expansion, only about one third of total cropped area is irrigated today. As a consequence, two third of cropped areas is still dependent upon monsoon. As you know, monsoon in India is uncertain and unreliable. This has become even more unreliable due to change in climate.
(e) Variety of crops: Can you guess why India has a variety of crops, India has diversity of topography, climate and soil.
(f) Predominance of food crops: Indian agriculture has to feed a large population, production of food crops is the first priority of the farmers almost everywhere in the country
(g) Seasonal patterns: India has three distinct agricultural/cropping seasons.

### 1.3 Solar Energy based water pumping system for small scale Irrigation

Solar technologies useful in agriculture are water lifting and pumping with solar photovoltaic systems. Small scale irrigation is one of the most potential applications of solar power. The main advantage is that solar radiation is intense when the need for irrigation is high. A benefit of using solar energy to power agricultural water pump systems is that increased water requirements for livestock and irrigation tend to coincide with the seasonal increase of incoming solar energy. Solar-powered pumping systems are making headway in becoming leading and appropriate technology for small-scale water systems in developing countries.

## 2.0 The research criteria

### 2.1 Study solar energy technologies with applications in solar pumping

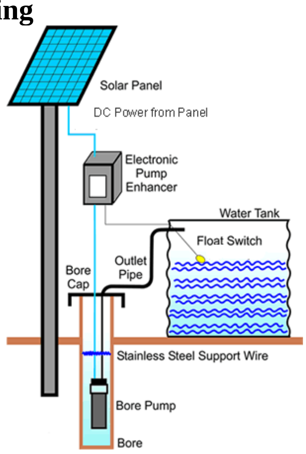



**Fig -1**: Solar power used for water pumping application

### 2.2 Solar Water Helical Screw Pump

Progressive cavity pumps are a unique type of rotary positive displacement pump. turning inside a double-threaded helical stator. Their pumps work upon the progressive cavity principle, using a steel helical drive shaft, turning in an outer rubber jacket, shaped in the form of a double helix. Pumps of this type work well at low speeds, as well as the design speed and the discharge is approximately proportional to the speed. Provided the pump is run over the correct range of heads, the efficiency is high.

**Fig -2**: Solar power used for water pumping application

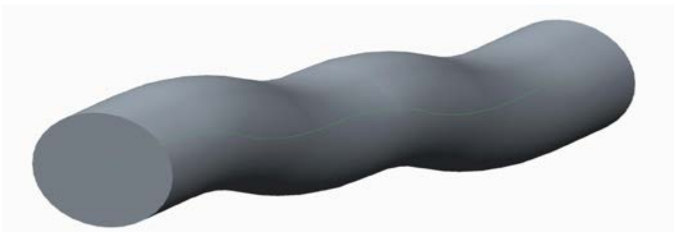


**Fig -3**: Helical screw pump rotor of model [a]

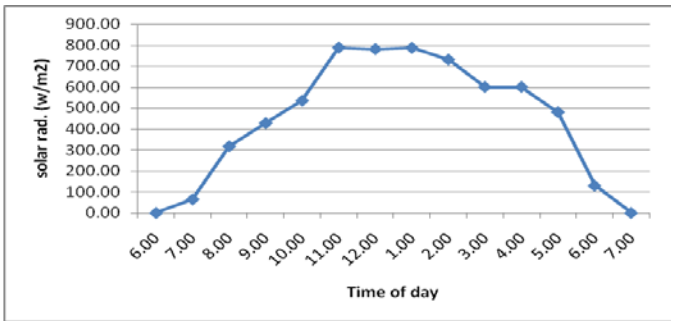
**Fig - 4**: Helical screw pump rotor of model [b]

### 2.3 Analysis

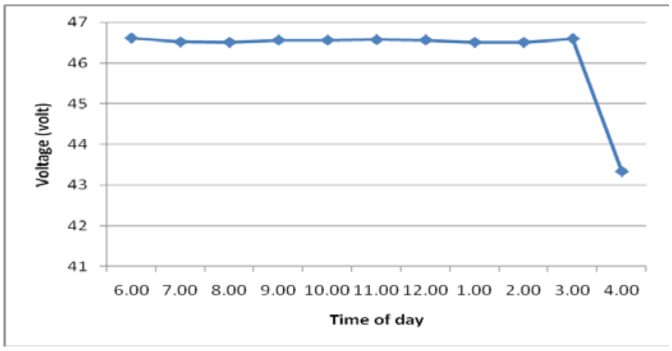
**Formulae used:**

1. Panel power (watt) = Current (A) × Voltage (V)
2. Motor Power in Watts = V x I× cosine Φ
3. Pump power in Watts = $\frac{\text{Head (mtr) x Q (lpm) x1000}}{6120}$
4. Inverter Efficiency (%) = $\frac{\text{AC power out of controller}}{\text{DC power into controller}}$
5. Panel Efficiency (%) = $\frac{\text{DC power from solar panels}}{\text{Sun power incident on panels}}$
6. System Efficiency (%) = $\frac{\text{Power in pumped water}}{\text{Sun power incident on panels}}$
7. Pump Efficiency (%) = <u>Power in pumped water</u>

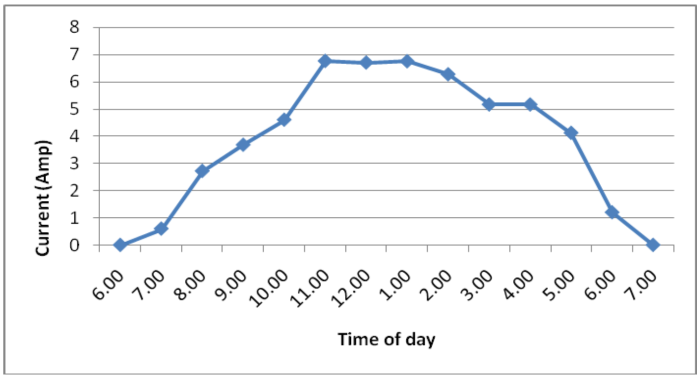
AC power out of controller



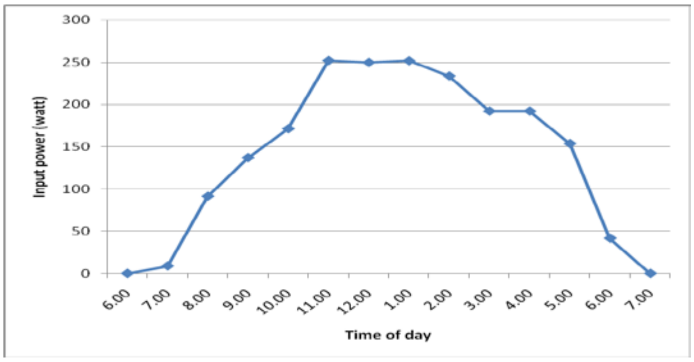

**Graph -1:** Daily solar radiations in a day time



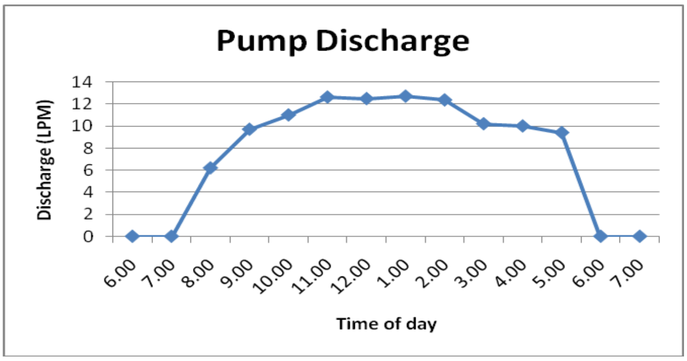

**Graph -2:** Pattern of Solar Irradiance over the whole day



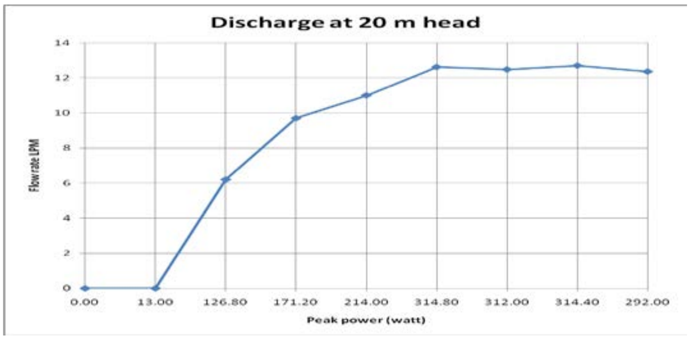

**Graph -3:** Current generated by Solar panel




**Graph -4:** Power drown by the helical screw pump




**Graph -5:** Discharge of the pump Vs Time of day




**Graph -6:** Discharge at 20 m head of the pump Vs Panel power (watt)

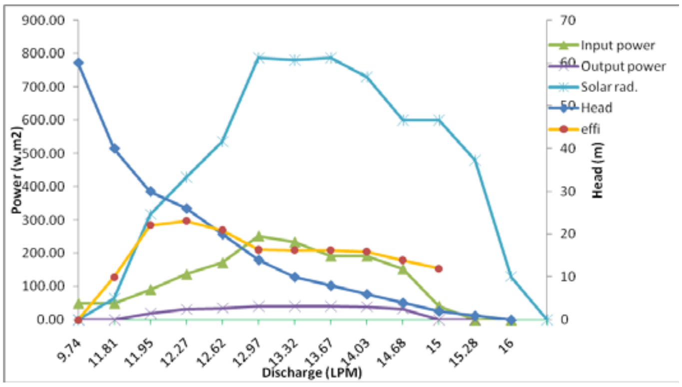



**Chart -7**: System curve of solar water supply system

## 3. CONCLUSIONS

All the variations of radiation, discharge, power, head and efficiencies are shown in the graph no 7. The conclusions of this study are found as follows.

This design provides a model that can be applied to any stand-alone solar-powered water supply system, especially in the rural areas.

This system is designed for 20 m head and gives best performance and it is clear that the discharge of the system almost remains constant at various heads. It stated that the discharge is in depending on the water head. The system is economically feasible in interior areas where no electricity or it is an alternate source of electricity.

The pump is seen to work at speeds that are as small as one-third of the centrifugal pump maximum speed which means that even at low solar radiations the pump will deliver water which lends the progressive cavity pump to solar-energy-powered operation at early and late in the day when the sun angle is small.
The efficiency of a small progressive cavity pump (45-60% is about the same as that of a small, multistage centrifugal pump.
It is a good alternate because the demand is in the face of solar radiation availability. Peak load can be reduced by using this technology.

## REFERENCES

[1] N. Hamrouni*, M. Jraidi and A. Chérif "Solar radiation and ambient temperature effects on the performances of a PV pumping system" Revue des Energies Renouvelables Vol. 11 N°1 (2008) 95 – 10695
[2] Brian D. Vick & R. Nolan Clark "Determining the Optimum Solar Water Pumping System for Domestic Use, Livestock Watering or Irrigation" Renewable Energy Policy and Marketing Conference Buffalo, New York May 11-16, 2009
[3] Shamaila Zia, Thorben Andersen, Sudipta Lai, Klaus Spohrer1, Wolfram Spreer, Rabindra Kumar Panda and Joachim Müller "Feasibility Assessment of photovoltaic pumping for irrigation in West Bengal, India" march 2010
[4] S. N. Singh, Snehlata Mishra & Vandana Neha Tigga "Design And Development Of Utility Interface Adaptive Solar Power Converter For Water Pumping System In Indian Villages. IJRRAS 2 (3) March 2010.
[5] Jawahar Lal Nehru National Solar Mission (JNNSM). 2011. Ministry of New and Renewable Energy. [online] Availableat: http://www.mnre.gov.in
[6] Sarabjot Singh Saini "Mitigation Initiatives Through agriculture Demand Side Management" August 2011.
[7] "Application Of Solar PV Based Pumping For Irrigation ": A Survey Report Submitted by Amit Desai (08D17008) Guide: Prof. Anand B. Rao, Dec 2012
[8] G. Ádám, K. Baksai-Szabó and P. Kiss "Energy production estimating of photovoltaic systems" in International Conference on Renewable Energies and Power Quality 28th March 2012.
[9] Dr. Dinesh Kumar Goyal "Schemes converged to harness solar power" Energy Next Volume 4-Issue 2, December 2013.
[10] S. Harishankar, R. Sathish Kumar, Sudharsan K.P,U. Vignesh and T.Viveknath "Solar Powered Smart Irrigation System" ISSN 2231-1297, Volume 4, Number 4 (2014), http://www.ripublication.com/aeee.htm.
[11] Solar Radiation Data for India from "RET Solar data software" available on the Net on www.retsolar.com
[12] Positive displacements pump vs. centrifugal pump from www.pumpschool.com from net.
[13] Design of Machine Elements, Module 6 Power screws, version 2, IIT Kharagpur.
[14] A. Petroselli,1 P. Biondi,1 A. Colantoni,1 D. Monarca,2 M. Cecchini,2 A. Marucci,2 and Cividino Sirio2 Received 22 August 2012; Accepted 23 September 2012 "Photovoltaic Pumps: Technical and Practical Aspects for Applications in Agriculture"
[15] "Positive displacement Pumps A guide to performance Evaluation" First Edition by Equipment testing Procedure committee of American Institute of chemical Engineers.
[16] Shankar Bhaskaran Narayanan Thesis On "Fluid Dynamic And Performance Behavior Of Multiphase Progressive Cavity Pumps In August 2011

## BIOGRAPHIES

1Mr. Methe Sangram S.
Department of Energy Technology; Department of Technology;
Shivaji University, Kolhapur.
sangrammethe@gmail.com

Author's Photo

2 Mr. C. H. Bhosale
Professor, Department of Physics;
Shivaji University, Kolhapur
Maharashtra, India

3 Mr. N.N Shinde
Professor, Department of Energy Technology;
Department of Technology,
Shivaji University, Kolhapur.

4 Mr. M. M. Wagh
Professor, Department of Energy Technology;
Department of Technology,
Shivaji University, Kolhapur.
Waghmahesh2006@gmail.com