Study of Efficient Solar Water Pumping System
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Abstract—This paper focus on efficient water pumping system using solar energy. The system consists of Photovoltaic cell (PV), boost converter, single phase bridge inverter, LC filter and single phase Induction Motor. PID controller is used for feedback mechanism which control the voltage.

Keywords—PV Array, high level boost converter, Single phase bridge inverter, LC filter and Induction Motor.

I. INTRODUCTION

Sun is the most important renewable source energy. It is friendly to the environment. Now a days photovoltaic cell has many applications such as electrical power generation, automobile, agriculture, street light etc. The solar water pumping system are best in rural areas where there is no availability of power grid. Photovoltaic power-driven DC motor drives for pump and irrigation purposes are already in use but they are limited in application due to high cost and preservation problem commonly associated with DC DC commutated type machine. The attempt is made to use a single phase induction motor is more robust, less expensive and require less maintenance cost as compared to DC commutated motor. Boost converter is used to increase the DC output voltages. The LC filter is used to raise the inverter output voltage and decrease common mode noise to the motor using a LC filter pure sine wave is obtained can be directly used to drive a single phase induction motor. The PID controller is used to control the voltage. The pump is to convert mechanical energy into hydraulic energy. This paper also presents the design and analysis of boost converter. The AC pumping system powered by PV cell is simulated via MATLAB.

II. PHOTOVOLTAIC SOLAR CELL

A PV cell is a semiconductor diode that convert light energy into direct current (DC). A photovoltaic system employs solar panel and each comprising a number of solar cells which generate electrical power. A PV cell is essentially a large diode that produces a voltage when exposed to incident light. The PV cell are fabricated from silicon. The photovoltaic generator is a non-linear device and is typically describe by its equivalent circuit and V-I characteristic.

III. BOOST CONVERTER

Boost converter is a DC to DC converter, which convert DC input into DC output. The output of the boost converter is always high. It is a power electronics device that use in this system. The output of the PV cell is connected with the input of the boost converter and increases the voltage level. The average output voltage is controlled by the switching on and off time duration. The output voltage of converter is controlled by controlling the duty cycle. The voltage across the load can be step-up by varying duty cycle D. When switch is on the diode is reverse biased, and isolate the output stage. At the switch on mode the inductor charges the energy from the supply and store it.

Boost converter is a DC to DC step-up converter, whose output voltage is greater than input DC voltage. The boost converter is the medium of power transmission to perform energy absorption. The output voltage is controlled by the switching in and off time duration. At constant switching frequency, adjusting the on and off
duration of the switch is called pulse-width modulation (PWM) switching.

The voltage source provide the input DC voltage to the switching control to the magnetic field storage element. The boost converter may in wired directly into the electrical supply because of a permanent requirement becomes necessary to plug the device is required specially in the case of travelling equipment like use by band on the concert and other electrical devices is advisable for boost converter.

The voltage across the load can be stepped up by varying the duty cycle D.

IV. INVERTER

The inverter is essentially a device that converts electrical energy of DC form of AC. The purpose of DC AC inverter is to obtain DC power from a source and convert to AC. The household application an inverter receives DC supply from 12V or 24V batteries are connected in series to increase DC voltage level and then inverter converts to 240V AC via a pleasant frequency of 50Hz.

These DC to AC inverter have been extensively used for industrial applications are motor speed output voltage control tragedy power supply uninterruptible power supply. The DC to AC inverters operate to the Pulse Width Modulation technique is a very move on useful technique in width of the Gate pulses are controlled with Voltage reference. PWM inverter is used to become output voltage of the inverter at the rate voltage depends on the output load.

The predictable inverter of the output voltage change according to the change in the load and effect of the changing load to the PWM inverter correct the output voltage by changing the width of the pulse and output AC depend on the switching frequency and pulse width modulation.

The inverter are usually operated Pulse Width Modulation technique is very advance and useful technique in that the
pulse width is very using different method. PWM Inverter are used to gate rated output voltage according to the load. The output voltage change in load and using the PWM technique acceptable to the change in output voltage by changing the width of pulse. The width is depend on frequency and frequency depend on voltage and speed as shown below equation

\[ V = 4.44f \Phi m f \]

Inverter can be classified in two technique according to operation are

(i) Voltage source inverter
(ii) Current source inverter

V. LC FILTER

LC filter is used to convert the inverter output into pure sinusoidal wave and to eliminate the higher order harmonics. Second order LC filter is used. The inductive reactance \( XL = 2\pi fL \) is high for ac components. Therefore the ripples are reduced. If any ac current passes through L, it flows through the capacitor because of its low capacitive reactance.

\[ \text{Fig. : LC circuit diagram} \]

An LC circuit is a glorified model since it expect there is no dissemination of vitality because of resistance. Any reasonable execution of a LC circuit will dependably incorporate misfortune coming about because of little however non-zero resistance inside the segments and interfacing wires. The reason for a LC circuit is more often than not to sway with insignificant damping, so the resistance is made as low as could be allowed.

VI. SINGLE PHASE INDUCTION MOTOR

The main components of a single phase motor are the rotor and stator winding. The rotor is the rotating part, the stator winding helps in rotating the rotor. The direct-on-line (DOL) starter used in three phase induction motor along with the need for starters and it has been described first Two types of starters are star delta for motors with nominally delta coupled stator winding and auto transformer used for cage rotor induction motor are then presented. where both decrease in starting current and torque occur. The rotor resistance starter for slip ring wound rotor induction motor has been discussed and starting current decrease beside with increase in starting torque and additional cost is to be incurred. In the last sixth lesson of this module there is no starting torque in a single phase induction motor with only one main winding in the stator. The various starting methods used for such motors like say that the addition of another auxiliary winding in the stator or capacitor in series.

The winding usually in the stator of the single phase induction motor is a circulated one and the rotor of squirrel cage type and it is a cheap one as the rating of this type of motor is low unlike that for a three phase induction motor and stator winding is fed from a single phase supply and the flux in the air gap is alternating only not a synchronously rotating one created by a poly phase may be two or three winding in the stator of induction motor. This type of alternating field cannot produce a torque \((T)st = 0.0\) the rotor is stationery \((r = 0.0)\), the single phase induction motor is not self starting unlike a three phase one. The rotor is initially given some torque in either direction \((Wr ≠0.0)\) then instantly a torque is produced in the motor. The motor then accelerates to final speed is lower than its synchronous speed.

REFERENCES


