MATLAB SIMULINK MODEL OF SOLAR WATER PUMPING SYSTEM USING MODIFIED TIBC

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Abstract— Solar Water Pumping was an important development for this world because agriculture is the basic element for the growth of every nation. In agriculture the main part is irrigation this is developing day by day by using new technologies. The best solution for all the energy deficiency and for ecofriendly irrigation purpose is Solar Water Pumping Method. The main part for this solar water pumping is the converter for boosting the solar output of the panel. There are various converters available for boosting the output voltage of solar panels. Similarly in conventional system usually DC motors were used thus the boosting of the output of panels was not much essential But in the case of ac motors converters are very essential for boosting the small output of panels. Here the converter used for solar water pumping method is Modified TIBC and the MATLAB Simulation of the entire System that is solar water pumping using three phase induction motor is analyzed.

Index Terms—TIBC, Solar Water Pumping

I. INTRODUCTION

Energy Crisis is considered to be one of the worst problems faced by the world. Even though the modern generation is more dependent on the fossil fuels. The challenge of depletion of energy resources is an important problem to be taken care of. Electricity is an important energy resource for this 21st century due to the development in science and technology. Electricity production mainly depends on water, thermal, nuclear. One of the main issue in this electricity production is all are depend to various nonrenewable energy resources.[1] The Solution for this is utilizing the renewable energy resources available in this earth, thus one of the best method is using solar energy for electricity production. Solar Energy is one of the most efficient and sustainable energy resource because this is renewable, inexhaustible, widely available, ultimate source of energy etc.

Agriculture is an important sector for every nation in this world and the most important part of this agriculture is irrigation system. This is very much important because only by proper irrigation methods good yield will be obtained. In this technical world irrigation is mostly done by means of electricity. So electricity has great role in the irrigation purpose because now a days all are using high powered motors for pumping, this can be run only by means of electricity. So one of the best alternative is by using a solar panel, thus the required energy for running these motors can be produced. [2]

In Solar Water Pumping System the main part is the input to the motor control unit. The output of solar panel is very small so this voltage has to be boosted by using a proper converter. So designing a good, efficient converter is very important for this Solar Water Pumping System.

II. SOLAR WATER PUMPING

Solar Water Pumping System is a simple and ecofriendly method which can be used for this future world. This system is very suitable for this hectic world due to the deficiency in the non-renewable energy resources and an ecofriendly one. The design of this system is very simple and reliable [3] and the simple pictorial presentation is shown in figure 1. The system contains a solar panel, electric pump controller, Motor, Water tank and this is the simple structure of a solar water pumping system.

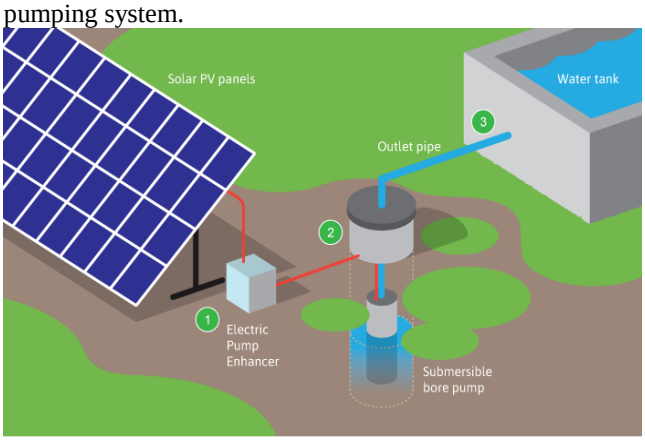

Fig. 1. Solar Water Pumping Method

There are basically two types of water pumping methods such as battery coupled and direct coupled water pumping system. In [4] Battery Coupled Water pumping system charge from the solar panels are stored in the batteries and from this the energy for running motors are

taken. The block diagram of Battery Coupled Water Pumping system is shown in figure 2.

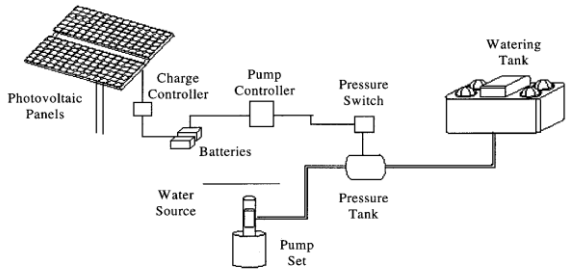

Fig.2 Battery Coupled Water Pumping System

In direct coupled water pumping system there is no batteries the energy for running motors is directly taken from the panels and it is converted to a voltage capable for the motor to run. The block diagram of the direct coupled solar water pumping is shown in figure 3.

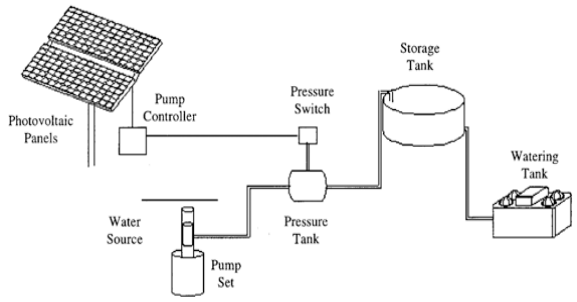

Fig 3. Direct Coupled Solar Water Pumping System

III. PROPOSED SYSTEM

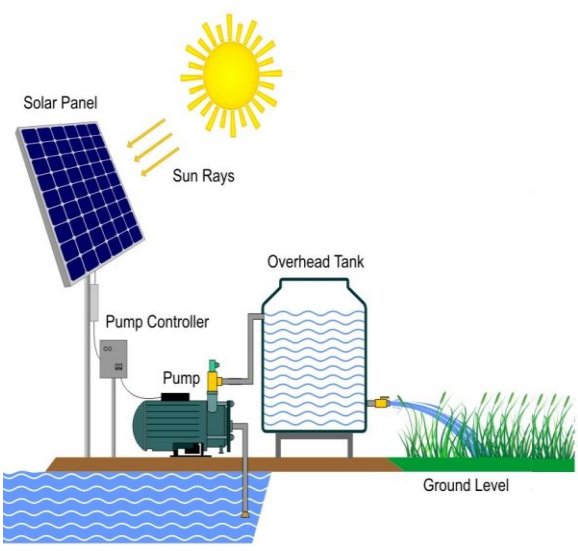

Fig .4 Solar Water Pumping System

The main part for this solar water pumping is the converter for boosting the small voltage of the panels. The figure shown in fig no. 4 gives the pictorial representation of the whole system proposed. In this the main area is the pump controller, there a new converter is designing for boosting the small voltage to a large value. The proposed converter for boosting the small voltage to large value is Modified two Inductor Boost Converter (TIBC)[5].

The block diagram of the proposed system is shown in figure 5. The main parts in this proposed system is a solar panel for energy harvesting, a DC-DC converter for boosting the small voltage of the panels to a large value, inverter for converting the dc to a three phase voltage and three phase motor for running.

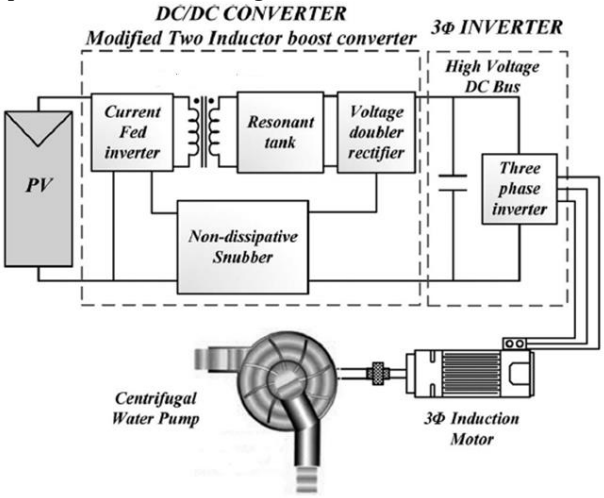

Fig. 5 Block Diagram of the Proposed System

The proposed converter for boosting the small DC voltage to large value is Modified TIBC [6]. The block diagram of this converter is shown in above figure and the three main parts for this converter is resonant tank, snubber circuit and voltage doubler rectifier. Normally there are many types of power electronic converters such as boost converter, buck boost converter for boosting the small voltage to a large value. The problem of these converters is it is not applicable for high power applications. When normal boost converters are using there large input filter capacitors have to be placed. This makes the system bulky and more complicated. [7] The specialty of Modified TIBC when compared with conventional TIBC is it is more efficient and reliable. There is an additional circuit for modified TIBC called snubber circuit, this helps the system to work even under low load conditions. Conventional system is not applicable for low load application because at some instants the output capacitor can't give voltage to the load, but the inductors are storing energy. The circuit diagram of conventional system is shown in fig 6.

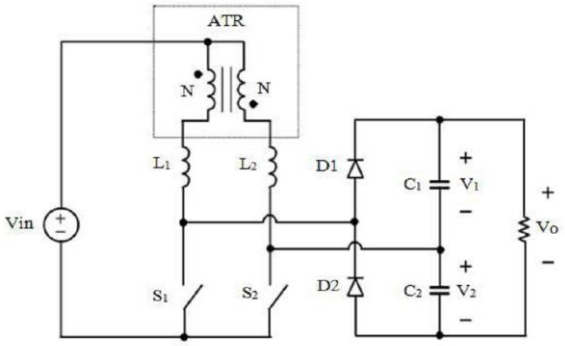

Fig. 6 Conventional Two Inductor Boost Converter

The modified TIBC is shown in fig 7. In this there is a snubber circuit formed by [8] two diodes and a series capacitor is the solution for the drawback of conventional TIBC. This snubber circuit can deliver the stored energy in the inductors to the output side at low power application.

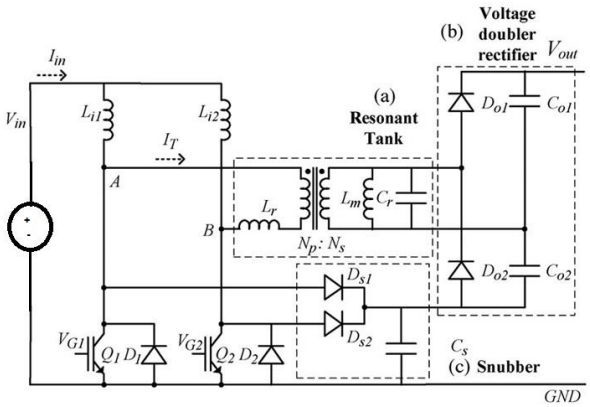

Fig. 7 Circuit of Modified Two Inductor Boost Converter

The entire proposed system is simulated in MATLAB and output waveforms are analyzed. The entire system includes the solar panels for energy production, the converter for boosting the voltage and the three phase motor.

IV.MATLAB SIMULATION

In the MATLAB Simulink first developed is the modified TIBC and the model is shown in figure 8.

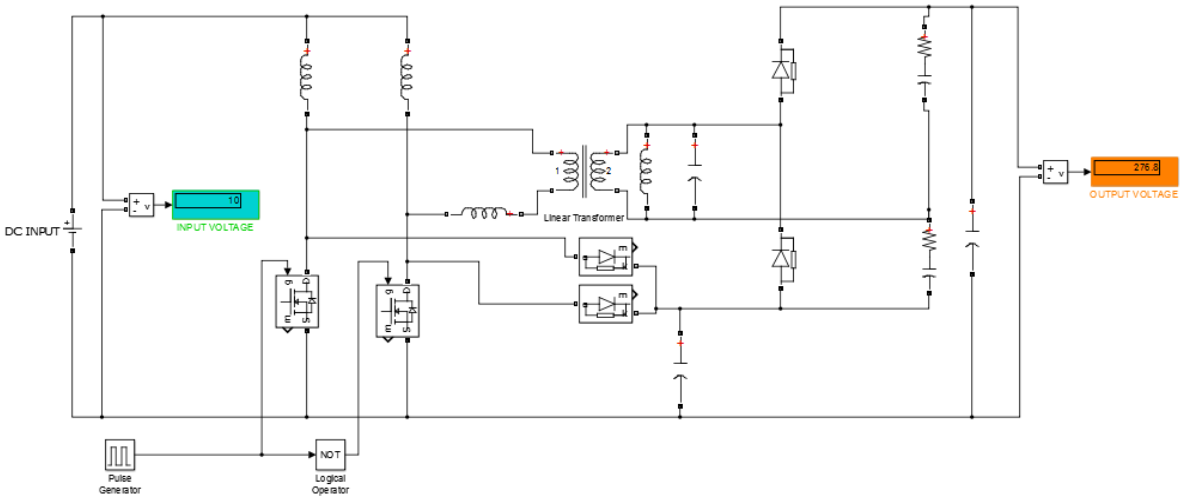

Fig. 8. MATLAB Model of Modified TIBC

From the figure the output RMS value obtained is 274.5 V for a input of 10V is shown. The input and output waveforms voltage waveforms are shown in figure 9 and 10.

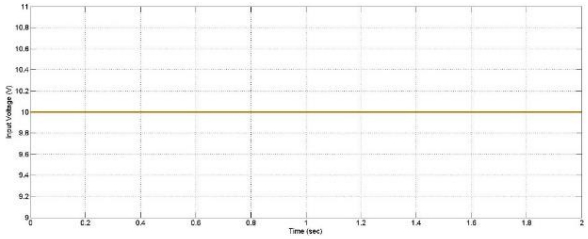

Fig 9 Input Voltage of Modified TIBC

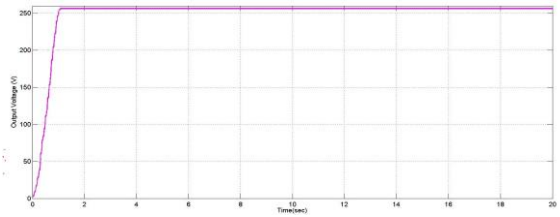

Fig 10. Output Voltage of the Modified TIBC

The entire system is developed in MATLAB and it is shown in figure 11. Here in this figure the input supply to the boost converter is given from the solar panel. The parameters of solar panel is shown in the table I.

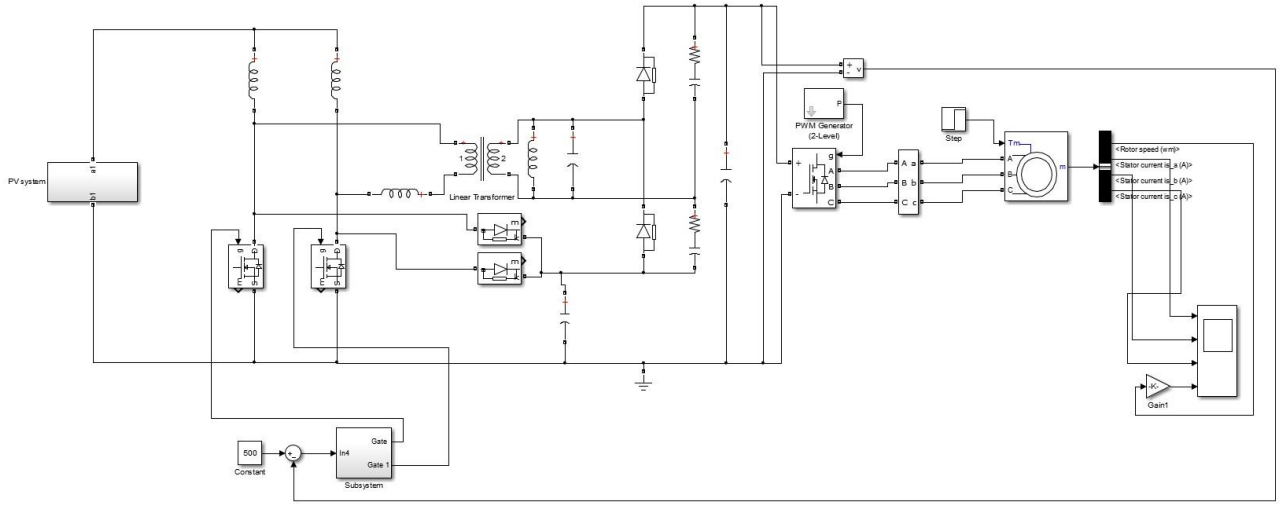

Fig.11 MATLAB model of the Full System

Table I- Solar panel Parameters

Short circuit Current	5.45
Open circuit Voltage	22.3 x 3
Current at Pmax	4.95
Voltage at Pmax	17.2 x 3

The MATLAB model of solar panel is shown in figure 12. In this figure the output voltage obtained is 17.1 and the output power is 68.833

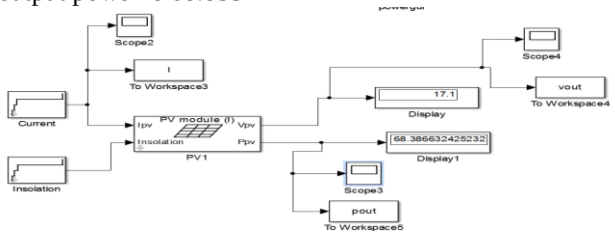

Fig. 12 MATLAB model of Solar Panel

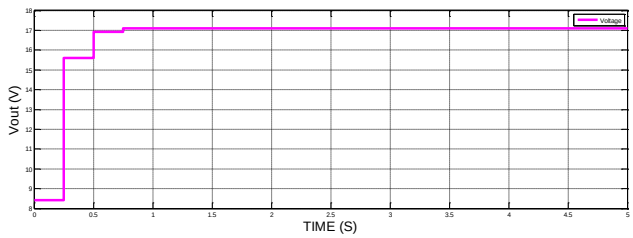

Fig.13 Output Voltage of panel

The Simulation output voltage wave form and the power for the panel is shown in figure 13 and 14. The change in both waveforms is due to the change in solar insolation.

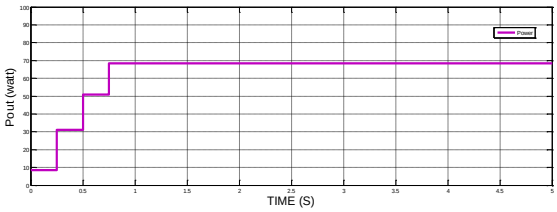

Fig.14 Output Power from the panel

The final system is simulated for a time of 1 second and the switching frequency here designed for the converter is 100 KHz. Here a PI control is used for the feedback control, [10] because then only the system will work properly. The waveforms obtained after the simulation of Torque, Speed, and Stator current all are shown in the results. Here the conversion of dc to three phase Ac voltage is done by a three phase inverter. The machine is 5.4HP, 400 V, 1430 rpm.

The speed graph is shown in figure 15 and from the figure the speed is constant for a time of 0.5 sec after that a torque is applied to the motor thus the speed will decrease.

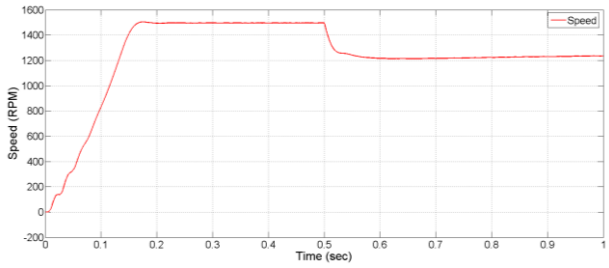

Fig 15 Speed Waveform of Entire system

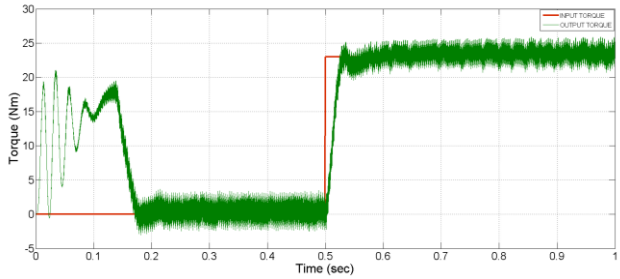

Fig 16 Torque Waveform of Entire system

The simulation output of torque is shown in figure 16, here the red line is the input torque applied to the system and the green lines is the output torque obtained. The changes taking place at 0.5 sec is due to the effect of torque applied. The stator current output is shown in figure17, the variations in the wave form is due to the presence of torque

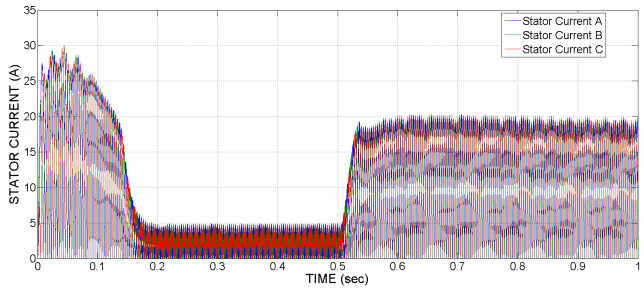

Fig 17 Stator Current Waveform of Entire system

V CONCLUSION

Solar Water Pumping System is wide popular now a days and the converter for boosting this voltage is developing[11]. Here the entire system is developed in MATLAB and the results are analyzed. Thus a new converter called Modified TIBC is designed and the waveforms show smooth running when connected to load. The software implementation can be implemented as hardware, and the application is more efficient, entire system is ecofriendly one and low cost.

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