Power Generation Using Irrigation Pump System

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***Abstract*— This paper describes power generation using agriculture irrigationpump system. Water flow in the agricultural irrigation pumps has kinetic energy that has the potential to generate electricity for energy storage purposes which can be used for domestic purposes. The inherent water pressure and flow inside the pipe which is used for usual activities is also used to rotate small scale hydro turbine to drive a generator for electrical power generation. This work aims to develop a small scale hydro generation system using agricultural irrigation pump system. The main principle is that water from the pipe is sent via nozzle to a turbine which is coupled to a generator which produces dc power. That dc power is stored in battery then stored power is converted into ac power using Inverter.**

***Keywords*—component; formatting; style; styling; insert (key words)**

I. INTRODUCTION

The hydro-power plays a very important role in the development of the country as it provides power at cheapest rate being perpetual source of energy. Nearly 24% of the total world power is generated using hydro-plants. There are some fortunate countries in the world where 90% of the nation`s power requirement is met by hydro-power [1]. There are few countries like Russia and Nepal where was vast hydro resources are yet to be harnessed. As the estimate of World Power Organization (WPO), the world hydro-potential is roughly 5000GW whereas only 200GW is presently developed (4% only) [2]

The role of water in the task of nation-building needs no emphasis. The power developed by the water source in the world plays a very important role in the development of world and nations. The ocean of the world holds 317 million cubic miles of water which contains 97.2% of the total water exists on earth. Agriculture research data book 2012 based on its survey year by year to increasing irrigation pump system. The hydropower plant can be classified according to the size of electrical power it produces as shown below [3]

TABLE I : CLASSIFICATION OF HYDROPOWER PLANT

Power	Class
>10 MW	Large
<10 MW	Small
<1 MW	Mini
<100 kW	Micro
<5 kW	Pico

Pico-hydro is a term used to describe the smallest system, covering hydroelectric power generation under 5kW.This project aims to reduce the maximum demand of electricity board [4].

The data below shows year by year increasing level of irrigation pump system. In the year of 2002, irrigation pumps were 1, 09,000, it continuously increases every year. and it reaches 1,68,00,000 at the end of 2012

TABLE **2:** AGRICULTURAL RESEARCH DATA BOOK-2012

Year	**Diesel pumps**	**Electric pumps**	**Total**
2002	83,000	26,000	1,09,000
2003	1,23,000	47,000	1,70,000
2004	2,30,000	1,60,000	3,90,000
2005	4,71,000	4,15,000	8,86,000
2007	15,46,000	16,18,000	31,64,000
2008	23,59,000	24,38,000	47,97,000
2009	31,01,000	35,68,000	66,69,000
2010	59,68,000	63,49,000	1,23,17,000
2011	46,59,000	96,96,000	1,43,55,000
2012	51,00,000	1,17,00,000	1,68,00,000

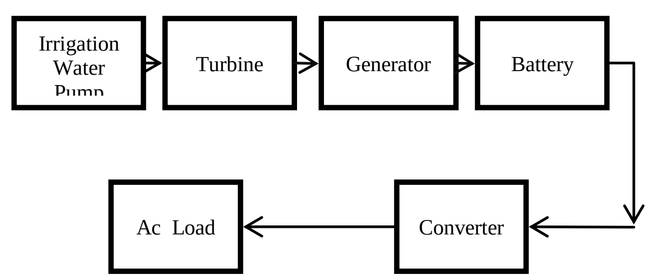

Fig. 1: BLOCK DIAGRAM OF THE SYSTEM

In our country agriculture mostly requires irrigation pump system. Our objective is to generate electrical energy during process of irrigation. Water flowing from the irrigation pump is allowed to enter the power generation unit, which houses the turbine and the generator. When water fallson the blades of the turbine the kinetic and potential energy of water is converted in to rotational motion in the blades of the turbine. The rotating blades cause the shaft of the turbine to rotate. The turbine shaft is enclosed inside the generator. In most hydroelectric power plants there is more than one power generation unit. There are various types of water turbines such as Kaplan turbine, Francis turbine, Pelton wheels etc[6]. The type of turbine used in the hydroelectric power plant depends on the quantity of water and the total power generation capacity .Here Francis turbine is used. On comparing the turbine pulley and generator pulley, turbine pulley should be larger than generator pulley to increase the efficiency of Dc generator. A 12V, 5A Battery is used to store the dc voltage. The generated voltage is regulated to 12V because battery charging needs constant voltage and then applied to converter. The converter used here is inverter circuit to convert the 12V dc into 230V ac. After that it is connected to domestic load.

II. DESIGN OF TURBINE

A. *Prototype Model & Its Description:*

A working model has been made and the experiment has been successfully conducted under the presence of the lab assistance and readings have been taken and verified.[7]

B. *Specification of Turbine:*

- Shaft Diameter -16mm
- Shaft Length – 1ft
- Turbine Blades - 10
- Blade Length – 50mm

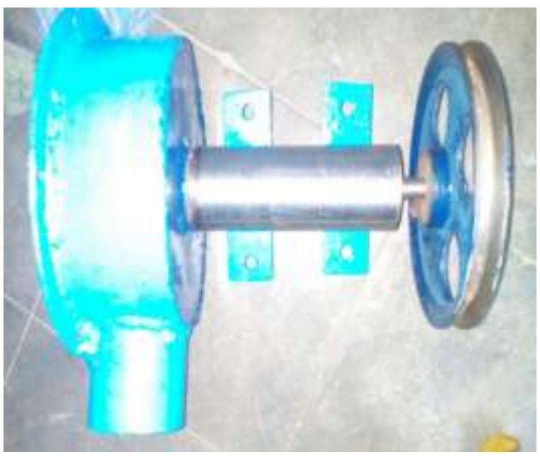

Fig. 2: Francis Turbine Model

For small and micro hydro schemes choices are limited to either Francis, propeller or Cross flow types. The specific speed Ns is another criterion for selection of a turbine operating at its optimum efficiency[7].

The specific speed is defined as

$$N_S = \frac{N\sqrt{P}}{H^{0.25}}$$

Where, N is rotational speed of turbine in rpm, p is output power in KW and H is net head in meter. The range of the specific speeds for various turbines is given in table 3.

TABLE **2:** SPECIFIC SPEED OF THE TURBINE

Type of Turbine	Specific Speed (rpm)
Pelton	8.5 to 47
Turgo	30 to 85
Cross flow	20 to 200
Francis	85 to 188

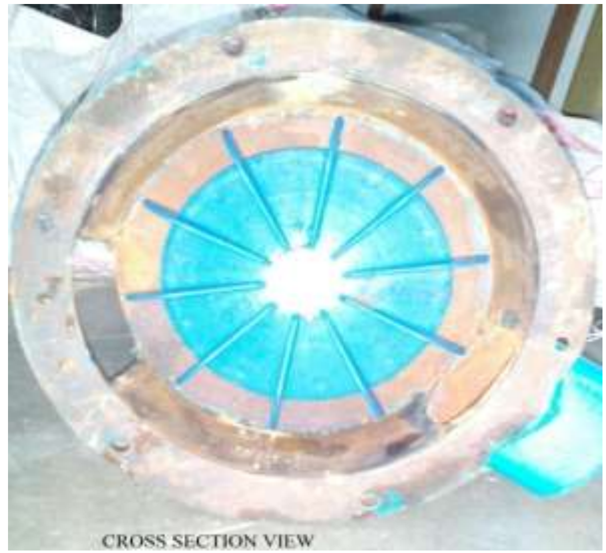

Fig. 3:Cross Sectional View Of The Turbine

This is the Francis turbine model. There are two valves in this turbine inlet and outlet. The water enter the turbine through inlet valve from pump and comes out through outlet valve and passes to the irrigational land.

III. DESIGN OF CALCULATION

In general, the feasibility of the proposed Pico-hydro system is based on the following potential input and output [8] [9].

Power equation:

Pin = H x Q x g ----------- (1)

Pout= H x Q x g x η - --------- (2)

Where,

Pin = Input power (Hydro power)

Pout = Output power (Generator output)

H = Head (meter)

Q = Water flow rate (liter/second)

g = gravity (9.81 m/s2)

η = efficiency

Based on the equation (1) and (2), both head and water flow rate are very important parameters in hydro power system. Head is a measure of falling water at turbine.

$$H = 0.704 \times P \quad \text{-------------- (3)}$$

Where,

H = Head (m)

P = Pressure (psi)

Efficiency:

$$\eta_{hydr} = (P_{hydr} / P_{motor}) \times 100 \quad \text{-----------(4)}$$

Where,

η_{hydr} = pump efficiency

P_{hydr} = water power (kw, hp)

P_{motor} = break power (kw, hp)

IV. BATTERY CHARGER CIRCUIT

Figure 4 shows a simple battery charging circuit which is used to charge the batteries using the DC voltage produced by the PMG. IC LM 317, an adjustable voltage regulator IC, is the heart of the circuit. The charging voltage and current is controlled by the transistor Q_1, resistor R_1 and POT R_5. When an uncharged battery is connected to the charging terminals, the current through resistor R_1 increases. This in turn increases the current and voltage from LM 317. When the battery is fully charged the charger reduces the charging current and the battery will be charged in the trickle charging mode. The batteries then can be used to operate different electrical appliances, both DC and AC (using an inverter), such as energy saving bulbs, fans, fluorescent lights and in some cases, even televisions.

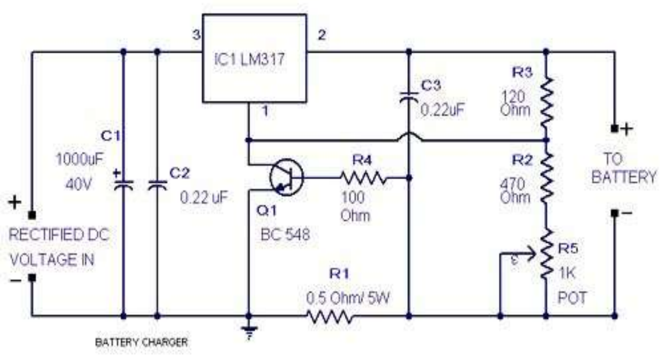

Fig. 4: Battery Charger Circuit using LM317

V. DESIGN OF INVERTER

This simple low power **dc to ac inverter** (**dc to ac converter**) circuit converts 12V DC to 230V or 110V AC. By doing simple modification it can also be converted from 6V DC to 230V AC or 110V AC. It can be used as inverter at home to deliver energy to light loads (electric bulb, CFL, etc) at the time of electricity failure.[10]

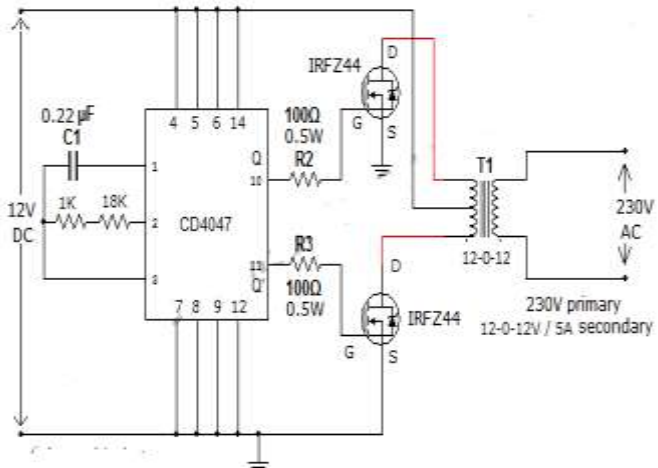

Fig. 5: Inverter Circuit

Fig. 6: Tested and Verified Inverter Circuit

A. IC CD4047B:

The CD4047B is capable of operating in either the monostable or astable mode. It requires an external capacitor (between pins 1 and 3) and an external resistor (between pins 2 and 3) to determine the output pulse within the monostable mode, and the output frequency in the astable mode. Astable operation is enabled by a high level on the astable input or low level on the astable input. The output frequency (at 50% duty cycle) at Q and Q outputs is determined by the timing components. A frequency twice that of Q is available at the Oscillator Output; a 50% duty cycle is not guaranteed. Monostable operation is obtained when the device is triggered by LOW-to-HIGH transition at + trigger input or HIGH-to-LOW transition at − trigger input. The device can be retriggered by applying a simultaneous LOW-to-HIGH transition to both the + trigger and retrigger inputs. A high level on Reset input resets the outputs Q to LOW and Q to HIGH [11].

B. Working of DC to AC Inverter:

The inverter circuit is built around IC CD4047 which is wired as astable multivibrator. IC CD4047The operating frequency of astable multivibrator is set to 50Hz.The power MOSFETs IRFZ44 are directly driven by the Q and Q' output of CD4047.The power MOSFETs are connected in Push Pull configuration (Power amplifier). The MOSFETs will switch according to the pulse from CD4047 astable multivibrator. Thus an AC voltage is transferred to the primary of transformer; it is stepped up to 230V.The transformer used here is step down transformer which is connected in inverted manner. That is, the primary of a 230V to 12V-0-12V step down transformer can be treated as secondary for this inverter project.110V AC, choose 110V to 12V-0-12V step down transformer in reversed way. (That is primary as secondary and secondary as primary)The inverter output is filtered by capacitor C2.Use suitable heat sinks for MOSFETs.

C.Special Features:

- Low power consumption: special CMOS oscillator configuration.
- Monostable (one-shot) or astable (free-running) operation.
- True and complemented buffered outputs.
- Only one external R and C required.

VI. EXPERIMENTAL RESULTS

Fig. 7: Experimental Setup 1

The water flow fall on the turbine from pump through the pipe line.

Fig. 8: Experimental Setup 2

In this setup the generator to generate electricity with the help of turbine. Because the generator is coupled with turbine.

Fig. 9: Speed Measurement Process

This is speed measurement process from that we can obtained 170 rpm in turbine.

Fig. 10: Voltage Measurement Process

This is voltage measurement process from that we can obtained 12.1 volts in generator.

Fig. 11: Experimental Setup 3

In this process the generator output voltage to maintained at constant 12 volts using regulator circuit and these constant 12 volt to store the battery with the help of battery charging circuit and 12V DC is converted into 230V AC using inverter circuit.

VII. CONCLUSION

Thus we have done a project on energy generation in agriculture, it helps in generation of energy from the wastage of water in agriculture pump. Its eco-friendly in nature. Thereby conservation of energy could be effectively done using our project.

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