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INDEX

Greenhouse Environmental Parameters Monitoring and Controlling

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Abstract- *In India the earning source of many people is farming but many of them uses the manual system for farming. The caring of the crops with manual one is troublesome for farmers and this also affects the health of crops. Farming can be done using various new technologies to yield higher growth of the crops and their more production. The objective of our project is to work for the same mentioned above in affordable cost for farmers. In this project we are going to check the parameters like temperature, light, humidity, and soil moisture which are important for any type of crop so that the health of the crop can be improve. The project works automatically and hence reduces the man power. The main moto of our project is to yield the healthy crops and reduce the manpower.*

Keywords- greenhouse, Arduino Uno, sensors, LCD and interface.

I. INTRODUCTION

Greenhouse is an artificial climate-controlled structure which is made-up of a glass or translucent plastic roof and it is used for various applications such as off-season growing of vegetables, floriculture, planting material acclimatization, fruit crop growing and plant breeding etc. These structures of the greenhouse range in size from small size sheds to industrial large sized buildings. A miniature greenhouse is also known as a cold frame.The interior of a greenhouse when exposed to sunlight it becomes significantly warmer than the external ambient temperature and protects its contents in cold weather.

Most of the farmers in rural area use the conventional method for farming .By using this conventional method it takes lots of efforts to take the care of the plant . For any farmer it is very hard to take proper care of their crops manually . And due to the manual work the nutrients and the growth of that particular crop are as per the requirement.

It is necessary for farmers to change the method of farming as per the technology changes. The effectiveness of the plant creation inside greenhouse depends fundamentally on the conformity of ideal atmosphere development conditions that attains the high return at very low cost, great quality as well as low natural burden. For attaining these objectives a few parameters, like light, temperature and humidity, soil moisture must be controlled ideally in certain criteria by warming, lighting, ventilation and water creation. Growth of the plants is directly dependent on the water and nutrients of the soil in which it is grown. Growth of the plants directly depends on the water and nutrients of the soil in which it is grown. The water content, soil and salts form a soil solution which providesnutrients to plants. Ventilation is the important component in a successful greenhouse, especially in hot and humid tropical climate condition. Greenhouses and their growing plants can become prone to problems if there is no proper ventilation.

The proposed system consists of a framework that gathers the data which is identified with greenhouse environment and yield status and control the system automatically in view of the gathered data. By throatily observing periodic conditions, this study has the reason for securing connection between sensors flags and reference estimations. Control programming will give information finding of ongoing show. Through long time running and functional utilizing, the framework has been demonstrated that it has numerous points of interest. To monitor the environment inside greenhouse different parameters have been considered such as light, temperature, humidity, soil moisture etc. using different sensors like DHT11 temperature and humidity sensor, LDR, soil-moisture sensor etc. which will be interfaced with Arduino controller. It is a closed loop system that will execute control action to adjust temperature, humidity, light intensity and soil moisture if any unwanted errors (high/low) occur.

II. METHODOLOGY

Green house environment monitoring system consist of Four sensors are interfaced with Arduino controller. The temperature sensor LM35 is used for sensing maximum temperature. When temperature exceeds from a defined level, the system automatically turns on the fan. Humidity is measured by using the humidity sensor DHT11. If the humidity of the environment is below the defined levels, sprays are automatically turned on and if the humidity level

exceeds from the defined level sprays are automatically turned off. For detecting light intensity LDR is used. To resolve the problem of low light, artificial lights are used. Here in this project 100-Watt bulb is used for demonstration. When light intensity is lower than a defined level, the artificial lights turns on, and when the light intensity comes in normal range artificial lights automatically turns off. Two probe soil moisture sensor FC28 is used and placed in soil. It detects the moisture percentage in the soil and as per requirement it turns ON the dc motoring pump. The current status of the system is displayed on LCD.

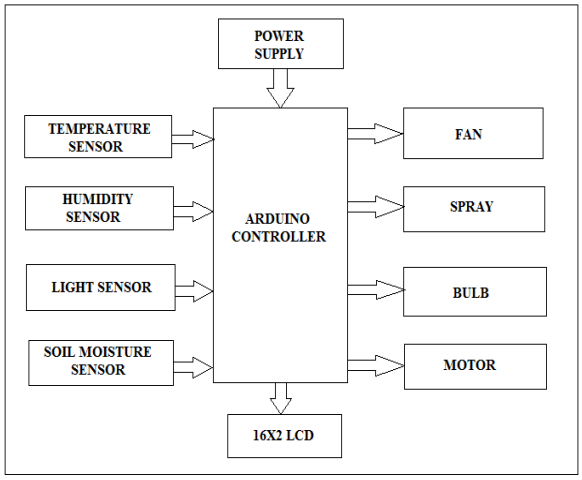

Fig1.Block diagram of proposed design

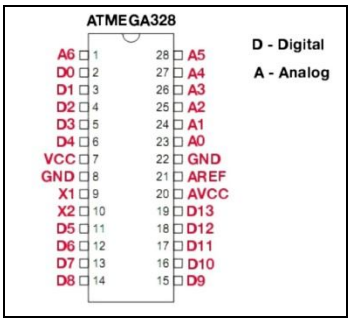

Fig2.Pin diagram of arduino controller

(i)Sensors

LM35 is precision IC temperature sensor in which output is proportional totemperature (in °C). Due to sealed circuitry, it is not subjected to other processes or oxidation. With LM35 temperature can be measured with more accuracy comparative to the thermistor. It possesses low self-heating and does not cause more than 0.1°C temperature rise in still air. The operating range of LM35 is from - 55°C to 150°C.The output voltage changes by 10mV/°C rise or fall in the embosoming temperature, and its scale factor is 0.01V/ °C.

Fig3.Temperature sensor-LM35

DHT11 is a humidity and temperature Sensor which have a temperature & humidity sensor complex with a calibrated digital signal output. High reliability and excellent long-term stability is ensured by the exclusive digital-signal-acquisition technique and temperature and humidity sensing technology. This sensor includes a resistivetype humidity measurement component and NTC temperature measurement component, and it is connected to a high-performance 8-bit microcontroller and it offers excellent quality, fast response, anti-interference ability as well as cost-effectiveness.

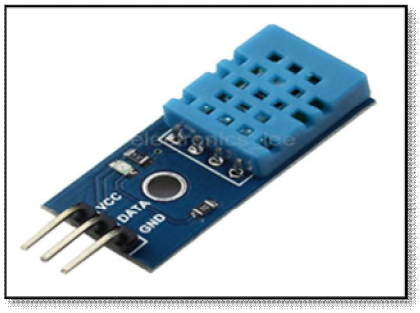

Fig4.Humidity sensor-DHT11 sensor

Light intensity sensor module adopts LM393 voltage comparator as the main chip. And it is perfect suitable for light control applications. When module is powered by 3.3-5V voltage the onboard power indicator will be turned on. Visible light which is seen by the human eye is measured by LDR which is a variable resistor. LDR is a resistor which has internal resistance increase or decrease depends on light intensity levelimpinging on the sensor surface. The characteristic of this type of sensor is it issmall in size and have fast response. The brightness of the surrounding environment and the light intensity can be detected(compare with the photoresistor, directivity is relatively good, can perceive the fixed direction of the light source).

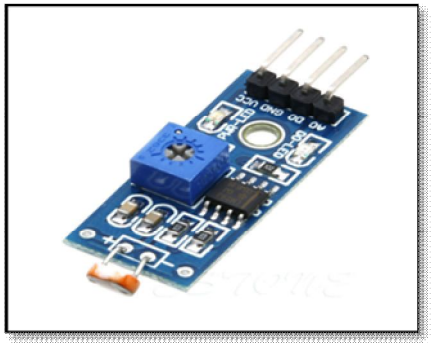

Fig5.Light intensity sensor-LDR

The FC28 Soil Moisture Sensor is a simple breakout for measuring the moisture in soil and similar materials. The soil moisture sensor is pretty straight forward to use. The two large exposed pads function as probes for the sensor, together acting as a variable resistor. This is a simple water sensor, can be used to detect soil moisture. Module Output is high level when the soil moisture deficit, or output is low.

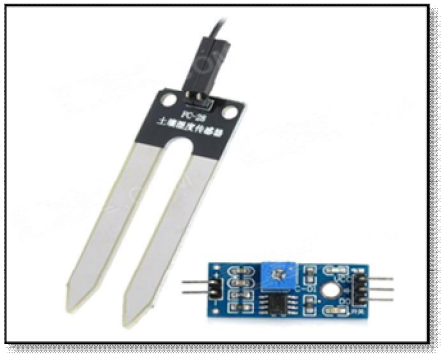

Fig6.Soil moisture sensor-FC28

(ii)voltage regulator

7809 is a 9V fixed three terminal positive voltage regulator IC. The IC has features such as safe operating area protection, thermal shut down, internal current limiting which makes the IC very rugged.

Output currents up to 1A can be drawn from the IC provided that there is a proper heat sink. A 9V transformer steps down the main voltage, 1A bridge rectifier which uses 1N4007 diodes rectifies it and capacitor C1 filters it and 7809 regulates it to produce a steady 9Volt DC.

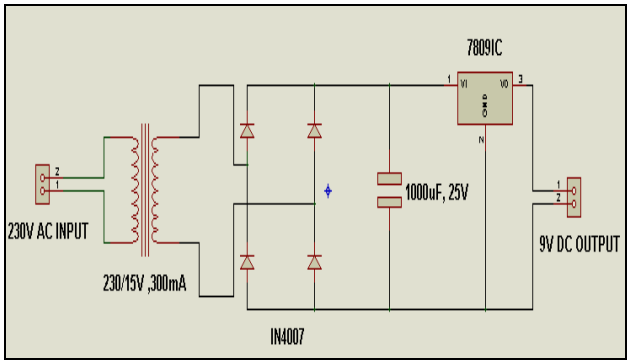

Fig7. Voltage regulator

(iii)LCD display

For indication of the present status of parameters Liquid Crystal Display is used. 4-bit interfacing of LCD with Arduino controller is done. The LCD display supposed to used is 16*2 green backlight display. As the display is 16*2 it will show all four-parameter status simultaneously.

IV. SIMULATION DIAGRAM

For the simulation purpose Proteus software is used. Working with the Proteus is simple and, in this software, there are different types of microcontrollers, components are inbuilt. The 3D view of software improvers the visualization effect. Changes can be done very easily in Proteus.

In simulation temperature sensor, light sensor, humidity sensor, moisture sensor is interfaced with Arduino microcontroller. For indication of current status of parameters, the LCD display is used. The Fig8 shows the simulation for standstill condition and after running simulation we get the readings for the all four parameters.

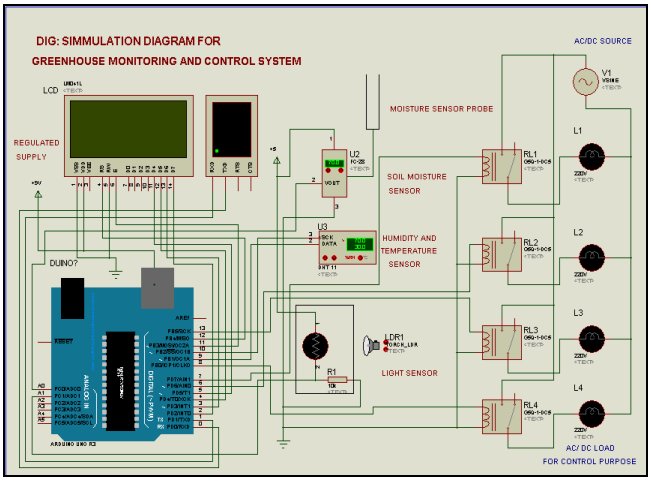

Fig8.simulation diagram at standstill condition

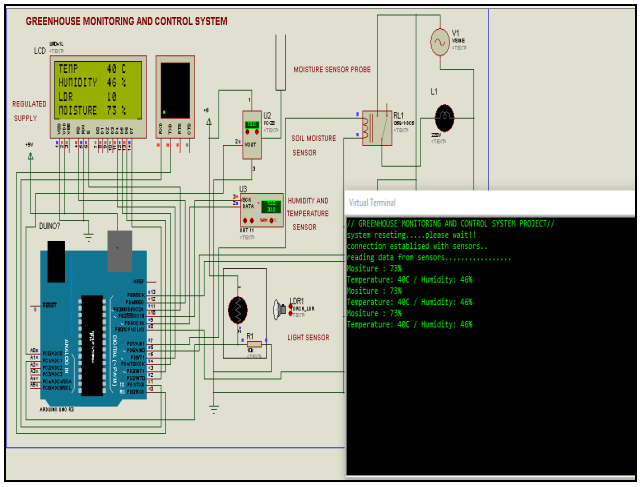

Fig9.simulation diagram under running condition

The LCD display shows the status of parameters as:
1.Temperature -40℃
2.Humidity -46%
3.Light intensity -10
4.Soil moisture -73%

V. CONCLUSION

The purpose of this project is to design and build a working prototype monitoring and control system for green house environment this system allows user to monitor temperature, humidity, moisture and light intensity. The system is able to reduce the complexity and maintenance of the existing system by referring the set parameter values and simultaneously providing a flexible and precise form of maintaining the greenhouse environment.

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Plc Based Position Control of An Electro-Hydraulic System

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Abstract- *With each passing days, the automation industry is reaching newer heights. Thus, more and more appropriate and precise selection of controller has been seen as an important aspect in industrial sector. Now a day due to application of hydraulic servo mechanism, it has been automated with the use of PLC and SCADA due to its precise and simulated application in the industry. With the advantages of PLC over others it has its vast application in field of Industrial Automation. PLC includes multiple input-output ports to monitor process variable with improved HMI and networking capabilities to perform a controlled application. This paper describes position control of EHS using PLC by using a proportional valve, Electro Hydraulic piston movement has been controlled by using proportional valve. Input given to the Proportional valve has been controlled using PLC ladder via program has been to get the desired position.*

Keywords- PLC; Electro-Hydraulic System (EHS); SCADA; Proportional Valve.

I. INTRODUCTION

In the advance hydraulics, Hydraulics has always have closely interlink with electrical and electronics control techniques. And to an ever increasing degree, combined system is now also being applied in the area of mobile hydraulics. Two techniques deal separately during the design and project engineering stages. The combination of these two systems is regarded as a single unit during trouble shooting and repair. The hydraulic proportional valves are currently used in a wide range of application involving high proportional control system.

The electrohydraulic system has been widely used in various industrial and machining sectors such as aerospace, high precision machining technology, elevator, robotic manipulator etc. because of its high torque to weight ratio. The EHS system includes various parameters such as temperature, pressure, wear- tear of components etc. which gives its non-linear and time varying output and thus results in complex design of a suitable controller for the system. Other parameters such as internal leakage of the valve, variation in fluid property such as compressibility, load disturbance, actuator's friction may further leads to the non-linear translational of the system.

But due to precise and robust control requirement in many applications, various control methods are applied and have been implemented to develop precision control over Electro-Hydraulic System.[1]

II. LITERATURE SURVEY

A. Problem Statement

In the existing Electro Hydraulic Servo System, the position control is done by positioning the object (10kg load) at minimum or maximum length of Stroke (i.e.at 0 or 300mm) ,the main objective is to positioning the object at any position between 0 to 300mm using PLC to program the working and using SCADA for graphical user interface

B. Objectives

Following are the main objectives:

- To study the EHS system in control system lab.
- To study and select cost effective valve for fluid control mechanism.
- To study and select effective position sensor.
- To design ladder diagram programming logic for electro-hydraulic system to control position of mass of 10kg using PLC.
- Prepare GUI using SCADA.

C. Electro-Hydraulic System

Due to its ability to provide large driving force, high response speed with continuous operation and possible speed reversal, hydraulic servo systems are widely used in many industrial applications such as in aeronautics, gear systems and in various numerical machine tools.

Altogether combining the flexible and precision electrical techniques of signal processing and measurements along with high pressure hydraulic mechanism, hydraulic servo system provides large force for lifting and moving of large heavy loads.

Having non-linear dynamics, internal leakages, load sensitivity, flow pressure relationship and other uncertain parameter due to fluid compressibility; control of hydraulic systems are somewhat difficult. To overcome this problem various control approaches are proposed by many researchers[2],[4],[5]. The response of hydraulic system can be made fast compared with the electric devices of same power rating, by applying electrical signal instantaneously (possible with very low power level) even at large distance between the source of control signal & actual mechanism, including the valve itself. Thus, EHS system uses this technique of low power electrical signal processing to precisely control the movement of large power pistons and motors. This interface between hydraulic equipment and electrical equipment is called as "hydraulic servo valve" and is used in various applications such as in control of aeroplane actuator as one of them.

D. *Block Diagram*

A simple Electro hydraulic system consists of hydraulic pump, reservoir/fluid tank, pressure relief valve, double acting single rod hydraulic cylinder; load connected to the cylinder and controller. The schematic system is shown in Fig2.

When the voltage is applied to the solenoid valve, the current sets up in the coil of the valve producing flux around it which results in an electromagnetic force to open the orifice of the valve. Thus, leading the pressurized fluid from reservoir to port through the proportional valve. Fluid flow respectively builds up pressure on piston of hydraulic cylinder. This pressure head leads to drive the piston and eventually drives the piston and eventually drives the load connected to it.
The load displacement is fed back to the controller through the position sensor which respectively controls the input of the solenoid valve.[3]

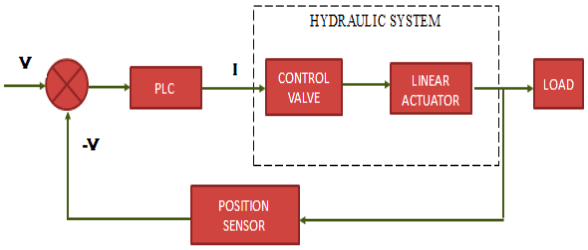

Fig 1. Block diagram of Electro Hydraulic system

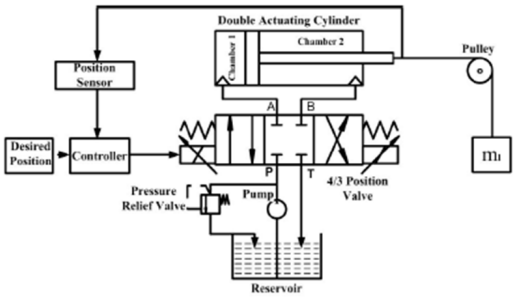

Fig 2. Schematic diagram of Electro Hydraulic system

EQUIPMENTS	DESCRIPTION
PLC	AB micrologix 1400 controller : • L-base unit ; • 32 pins(20 Digital i/p and 12 Digital o/p); • 2 i/p and o/p analog channels; • Serial ports – RS 232,RS 485; • Ethernet ports – 10/100 Ethernet/IP port; • LEDs/indicator lamps,Push Buttons,Switches; • PLC software – RS Logix 500; • SCADA Software – Factory Talk View Studio
Control valve	Proportional Valve: • Maximum Pressure: 350 bar • Repeatability: ± 1% • Hysteresis: ≤ 5%
Linear actuator	Double-acting cylinder : • Bore: 40mm • Stroke length: 300m • Rod diameter: 18mm
Load	10 kg mass
Position Sensor	Linear Potentiometer Position Sensor : • Range: 300mm • Output: 5kΩ to 5vdc • Linearity: ± 1%

E. *Experimental Setup*

HYDRAULIC POWER PACK – INLINE FILTER - DOUBLE ACTING SINGLE ROD CYLINER - PROPORTIONAL SOLENOID VALVE-CONTROL VALVE - TEMPERATURE INDICATOR - LINEAR POSITION SENSOR - LOAD(10 KG) – PLC

The experimental setup as shown in Fig.3 consists of hydraulic pack which has a primary drive: capacitor start capacitor run motor with reservoir (capacity20L) filled with Hydraulic Oil ISO 22 along with solenoid valve. The valve is used to regulate the flow of fluid to the double acting single rod cylinder with 40mm bore and 300mm stroke length across which the load (mass =10Kg) is hanged vertically using a pulley and rope. Alongside the cylinder linear potentiometer (5kΩ to 5V DC) is connected to give the feedback to the controller - PLC (CATALOG NO.: 1766- L32 B W A A). PLC, as a result will give the controlled output supply to the solenoid valve to control the forward and backward position of the piston. The inline filter in system is used to clean and filter the oil from the cylinder before porting it to the reservoir of power pack as there is always a chance of addition of 1 million particles greater than 1 micron per minute to the oil which may lead to wear and contamination of metal parts of the systems. The temperature indicator added with the power pack is to indicate the temperature of the fluid (oil) which should be below 50^0C

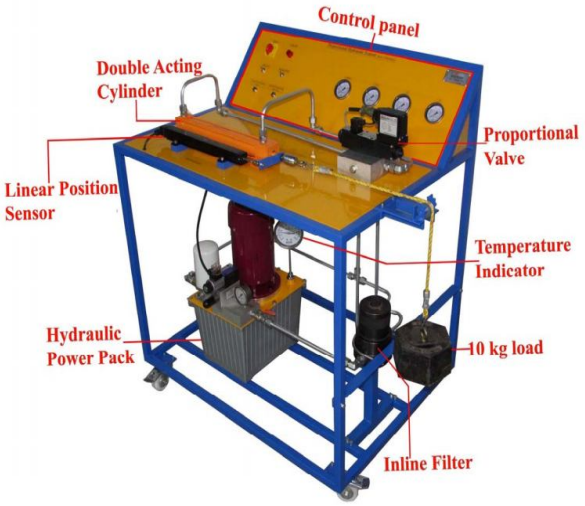

Fig.3- experimental Setup

F. Applications

The electrohydraulic system has many applications in the industrial sector and with the remote control of PLC can further be used with high accuracy. Some of the basic applications are:

1. Lift platform:

Switched directional control valves are used to control the hydraulic motors and the extension or retraction of the individual cylinders. Their speeds are controlled through proportional flow control valves.

2. Molding pressure control:

In the case of particularly strongest requirements on the work piece precision it is possible to control the material pressure at the centre of the mold.

3. Machine tool:

The linear motions of the feed drive are best performed electro-hydraulically

III. FUTURE SCOPE

With increasing automated control over the system the manual operated system will all be replaced by advanced hydraulic techniques by the end of the decade. Thus laying foundations of following advantages:

1) Heavy equipment can be lifted efficiently at construction site.
2) Can be used as handling equipment in aerospace industry
3) Electrohydraulic system with distributed control is opening its doors to open architecture.
4) Accurate prediction of when to exactly replace component so as to help scheduling maintenance.
5) Variable displacement pumps systems in off-road systems.

IV. CONCLUSIONS

Thus from this project we can conclude that the position control of EHS has been done in most cost efficient way and high performance manner and following are the concluding remarks:

1) PLC has reduced the error of the system and smooth the movement of the piston stops at the exact desired position and reduces the vibration of the piston when it extends or retracts.
2) From the comparative study of the valves we can conclude proportional valve used in system is more effective, efficient and cost effective.
3) Successfully developed ladder diagram programming logic for electro-hydraulic system to control position of mass of 10kg using PLC.

4) By using SCADA, we use the graphical interface to test the program, thus reduces energy and time.
5) Successfully implement graphical description of the EHS system using SCADA.

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Harmonic Mitigation Techniques For Synchronous Alternator

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Abstract- *The general effect of harmonic mitigation technique in electrical machines are well known and have been extensively studied. There are various harmonic internal and external mitigation techniques. In this paper internal techniques are studied which includes damper bar cage, stator skewing and pole skewing. An excel tool is implemented for design of 10 KVA synchronous generator by conventional method. Methods suggested in this paper can be tested on appropriate software and appropriate mitigation technique for 10 KVA salient pole single phase synchronous generator will be selected.*

Keywords- harmonics; damper bars; skewing; salient pole synchronous generator..

I. INTRODUCTION

Practically waveform is not sinusoidal because of uneven distribution of flux in machine. This non-sinusoidal waveform is due to presence of harmonics.A typical case of 10 KVA alternator is considered which has THD content of 5%. Efficiency of alternator is most important parameter for analysis performance of machine and it is affected by harmonics. Harmonics can be effectively addressed by various magnetic circuit and electrical circuit design aspects.

Various mitigation techniques are used like optimization in design and by using filters. In design parameters like distribution, chording, skewing can reduce harmonics in machine.

II. LITERATURE SURVEY

A. A Fast Method for Modelling Skew and Its Effects in Salient-pole Synchronous Generators (SG)

In this paper finite element method is used to analyse Total Harmonic Distortion (THD) in current and voltage in a Stator Skewed SG. A single slice (SS) method is implemented to measure THD at no-load and with load operations. For further validation experimental measurements were performed and comparisons showed excellent similarities. However further at higher loading the validation of this technique weakens. The SS method reduces the computational time by 22 hrs as compared to multiple slice (MS). The proposed SS method achieves its goal of fast and accurate technique for modelling skew in Synchronous generator.

B. Improved Damper Cage Design for Salient-pole Synchronous Generators

In this paper modifications in rotor damper bars geometry is done to reduce damper cage loss and the output voltage THD in salient-pole Synchronous Generator. The validation of Finite Element Method of a 4-MVA synchronous machine is tested at several loading conditions by comparing with experimental results. Magnetic permeability of the stator slot wedge, bar pitch and asymmetric displacement of damper bars are the main parameters which are investigated.

C. Design and Analysis of Synchronous Alternator for Reduction in Harmonics and Temperature by Short Pitch Winding

For manufacturing synchronous alternator full pitch winding is used and stamping design is kept constant. As stamping design cannot be changed as the may lead to increase in cost so major concentration was made on distribution winding. Use of distribution winding gave benefits in terms of reduction in harmonics, temperature rise and resistive drop. To reduce or to eliminate harmonics short pitching was done i.e. when coil is pitched short $\frac{\Pi}{n}$ or $\frac{3\Pi}{n}$ no harmonic of order n survives in the coil emf. The triplen harmonics that may be generated in a three-phase machine are normally eliminated by star connection of the phases. At time of winding design the attention is mainly directed for the attenuation of 5^{th} & 7^{th} order harmonics by adopting a suitable chording angle. Chording angle of 30^0 i.e. coil- pitch = 150^0. Advantages were that short pitching reduces high frequency harmonics, eddy current and hysteresis losses. Chording helps to reduce vibration level. Finally, they concluded that time resistance of 2/3 winding pitch is more than 5/6 winding pitch

which is measured by heat run test therefore temperature rise of 2/3 winding pitch is more than 5/6 winding pitch.

D. Effect of skewing and pole spacing on magnetic noise in electrical machinery.

The operation of rotating electrical machinery over a wide range of speeds often leads to the emission of intense magnetic hum due to resonant vibration of the machine frame at some speeds in the running range. These vibrations may lead to creation of harmonics in the system. It is possible to reduce the exciting force on frame to zero by suitable disposition of field poles with respect to armature or vice versa. The existing of such forces may be due periodic change of reluctance in the magnetic circuit, due to slotting of stators and rotors has been considered. To overcome with such forces, pole skewing method was implemented i.e. pole is inclined with respect to armature slots or slots are inclined with respect to poles. Machine operates in four modes of vibrations. For such modes of vibration work input should become zero for pole skew of one slot pitch and maximum for unskewed this is applicable to only first, second and fourth modes of vibration. In third mode of vibration it becomes zero for unskewed poles and maximum for pole skew of one slot pitch. To overcome the problem of third mode of vibration pole spacing technique is used. The disadvantage of using pole spacing is that chording advantage is lost. To eliminate this disadvantage herringbone skewing is done. In herringbone skewing, they skewed the pole one-slot pitch on either side of its centreline and at the same time keep it symmetrical about this centreline, thus established a condition of zero resultant exciting force for the third mode as well as for the other modes of vibration.

III. STANDARD DESIGN PROCEDURE

To study mitigation techniques it is necessary to know the design of synchronous generator by conventional method. An excel tool was implemented for studying the conventional method of designing synchronous generators. As vessel for studying the design a 10 KVA salient pole single phase synchronous generator is considered. The temperature in stator and rotor field is brought within limit in accordance to H class insulation. The inclusion of slot fill factor was done to know the percentage of conductor material within the winding area of a slot, indicating how full the slot is and how difficult it will to wind. The mitigation technique used should not increase the limits of temperature rise, losses and efficiency defined in conventional method. The total harmonic distortion in 10 KVA alternator is 5%, with 3rd harmonic as dominating harmonic. The purpose for studying of different techniques is to achieve THD level less than 5%.

IV. HARMONIC MITIGATION TECHNIQUE

The main cause of harmonics is the non-sinusoidal field form, if this is made sinusoidal then harmonics would be eliminated. Different methods for elimination of harmonics are distribution, chording, skewing, fractional slot windings, and large length of air gap. Some more mitigation technics are described below.

A. Damper Cage Design

The main reasons for provision of damper cage are as follows:

1) Damping oscillation caused by a periodic shock due to short circuits.
2) Terminal voltage is balanced during unbalanced loading.
3) Overheating of pole tips of single phase generators is prevented.
4) During current surges in armature winding there is reduction in insulation stress level of field winding.
5) Preventing distortion in voltage waveform.

Most sensitive parameters to damper cage loss and voltage THD are asymmetric displacement of damper bars, the bar pitch and magnetic permeability of the stator slot wedge.

- Magnetic Permeability of the stator slot wedge

By using different materials for slot wedge, slotting effect on the air-gap flux density can be reduced. Increasing permeability of slot wedge material reduces slotting effect on rotor surface as well as damper bars. With higher permeability the stator surface which faces the main air-gap becomes more isotropic. With increase in permeability slot flux leakage also increases which causes in less flux crossing the air-gap. This will result in higher voltage drop and torque reduction. For reducing voltage drop excitation current can be increased but at a cost of extra copper loss. An appropriate material can be selected which maintains balance between resulting slot flux leakage and quality of air-gap flux density.

- Bar Pitch

The effect due to damper bar pitch is an important player in terms of damper cage loss. The damper bar pitch (d) strongly relates to the stator slot pitch (s). It can be varied from 0.8s to 1.2s. The damper cage is kept symmetric with respect to the polar axis and the bar pitch is varied and the results are studied. The irregular damper bar pitch interacts

with stator slot in a way to reduce air-gap dependent harmonics.

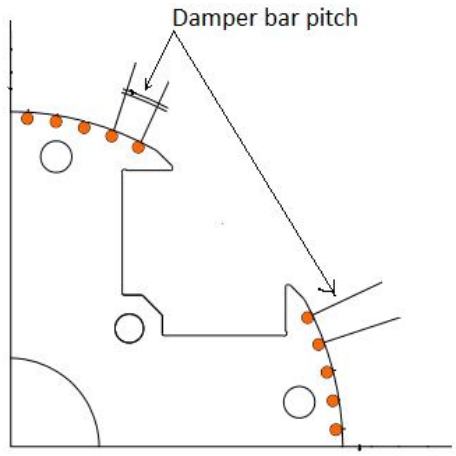

Fig.1. Damper bar pitch

- Asymmetrical displacement of damper bars

The damper cage can be displaced by a particular angle as a fraction of the stator slot pitch with respect to the polar axis to improve voltage THD. The improvement in THD should be done considering significant margins of losses in damper cage.

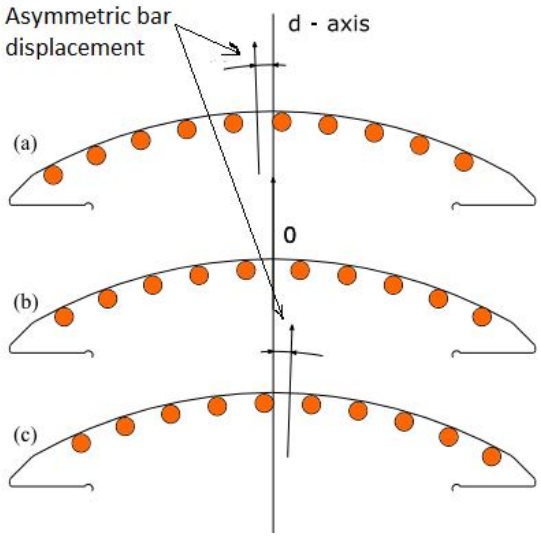

Fig.2. Asymmetric bar displacement

B. Skewing of Stator Slots

By providing skewing following aspects can be achieved

1) Reduced harmonics
2) Reduced vibrations
3) Reduced Tooth Ripples

Along the axial length of stator slot appropriate angular offset can reduce oscillations in air-gap flux density due to tooth harmonics.

There are some drawbacks of skewing and they are:

1) Output voltage reduced.
2) Reduction in torque available at shaft.

Skewing produces better winding distribution but at cost of reduced winding factor which in turn reduces performance. Damper cage losses are reduced as the slot harmonic effect is reduced due to slot skewing.

C. Pole Face Design

Most of electrical machineries creates noise and vibrations in the system. These vibrations are due to the periodic forces in the system which are of magnetic origin. The existence of forces is due to:

1] Change in magnetomotive force.
2] Slotting of stators and rotors resulting into periodic change of reluctance in magnetic circuit.
3] Distortion of the iron circuit due to magnetostriction.
The main reason for vibration of frames is the pulsating forces on poles arising due to periodic alteration of magnetic reluctance between each pole and a slotted armature.

- Forces on pole

The force on any pole body can be resolved into steady state component and a component which is variable in magnitude and direction. From fig 3(a) there is a variable force at point A of pole face which has a moving vector that describes closed curve C_A similarly with point B that has moving vector C_B. But in pole face elements that are selected randomly, however their phase relationship are not known so instead of comparing pole face elements we can consider parallel strips extending from pole tip to pole tip refer fig 3(b). Advantage of using this directed pole element is that phase relations can be known through their geometric considerations. The configuration of armature slots under pole strip is shown in fig (4) whole of the magnetic forces is distributed over its length and combined effect of these forces may be represented by resultant. It is apparent that pole is made inclined tangentially with respect to slots i.e. we are dealing with the skewed poles hence teeth and slots under pole strip are in phase among different strips. If these forces are not simple harmonics forces we may separate into harmonic constituents and phase displacement between corresponding harmonics at the pole ends and it will be $2\pi n$ where n is order of harmonics.

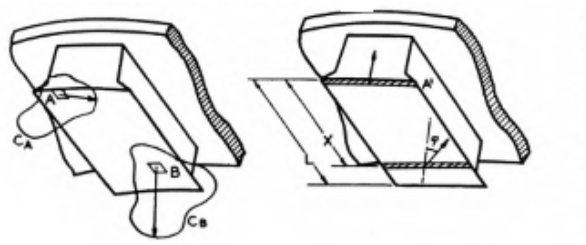

Fig 3(a) fig 3 (b)

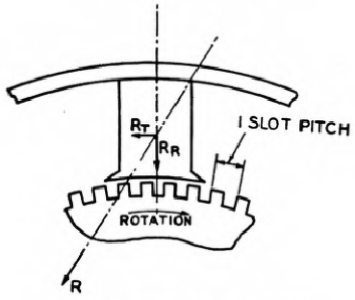

Fig 4
Forces on a pole

- Modes of vibrations

In case of motors the modes of vibration are due to presence of lumped pole masses which constituent principle masses of system.

First mode of vibration: In this mode poles are situated at antinodes which moves radially and each pole moves parallel to itself whereas adjacent poles are out of phase. Fig 5(a)

Second mode of vibration: in this mode poles are situated at the nodes of frame vibration and rotate from side to side as the slope of elastic line at nodes changes during motion. Fig5 (b)

Third mode of vibration: In this mode the poles are again at antinodes of the frame motion. The characteristic of this mode is that poles do not move radially but rotates in radial plane about tangent to frame cylinder midway between its end. The ends of each pole and adjacent poles are out of phase. Fig5(c)

Fourth mode of vibration: This mode involves extension and compression of frames. The frame goes periodic changes in diameter and remains circular in entire motion. The poles move radically and all are in phase. Fig 5(d)

Knowing the position of the poles in various modes the direct measure of this effect is given by input to vibration by forces. The energy input should be zero for all the modes of vibrations. The work input is zero for per pole in first, second and fourth mode of vibration for skewed poles whereas it is maximum for unskewed pole. In third mode of vibration work input is maximum for skewed poles for 2/3 of slot pitch and it is zero for unskewed poles.

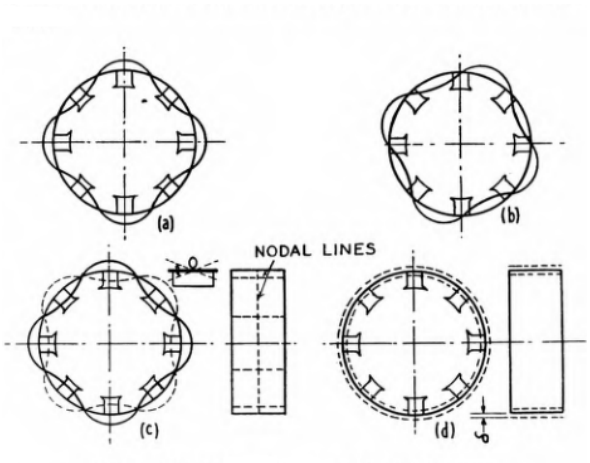

Fig 5 Modes of Vibrations

- Pole spacing

To overcome with the problem of third mode of vibration pole spacing can be implemented. The effect of pole spacing is that adjacent poles are made in phase when number of slots are divided by number of poles and made out of phase by dividing number of slots by number of pairs of poles. This will eliminate third mode of vibration but will also prevent excitation of first and second modes. Thus, both skewing and pole facing has to be done to eliminate all forces from four modes of vibrations. The disadvantage of pole spacing is that the advantage of chording is lost. So to avoid this we have to use another method which is independent of pole spacing i.e. herringbone skewing.

- Herringbone Skewing

In partial skewing only first, second and fourth modes of vibration are eliminated, to eliminate all four modes pole shape should be symmetrical with respect to its centreline in order to obtain in phase forces. In herringbone skewing we skew the pole one slot pitch on either side of its centreline and

at same time keep it symmetrical about this centreline it establishes a condition of zero resultant exciting force for third mode as well as for the other modes of vibration. Refer to fig 6.

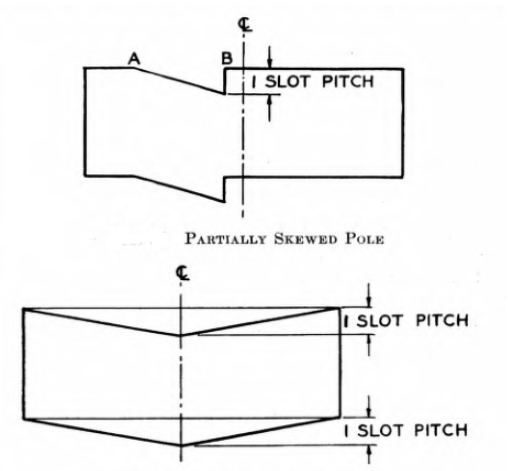

Fig 6. Herringbone skewing

V. COMPARISON OF DIFFERENT METHODS OF MITIGATION

Methods and point of Comparison	Method (A)	Method (B)	Method (C)
Method for reducing harmonics	• Influence of damper bar pitch • Influence of asymmetric bar displacement	Pole arc skewing with respect to armature slots.	Skewing of Stator slots
Magnetic design	Irregular bar pitch interacts with open slot in such a way that air-gap parasitic harmonics are reduced.	Disposition of field poles with respect to armature.	Stator slots inclined with respect to rotor poles.
THD reduction	Lower than 3% THD can be achieved	From 6.25% to 1.6% THD can be achieved	From 3-5% THD can be achieved.
Limitation of this method	Low THD's can be achieved but at the cost of ohmic losses which then generate heat and resulting in deterioration of total machine efficiency.	Advantage of chording of armature winding is lost.	Output voltage drop.

V. CONCLUSIONS

1] An attempt is made in this paper to present different techniques for harmonic reduction in case of alternator.

2] By improving damper cage design, the irregular bar pitch interacts with open slot in such a way that air gap parasitic harmonics are reduced. In this method low THDs can be achieved but at the cost of ohmic losses.

3] By skewing of pole arc, the input energy during vibrations should be zero and thus harmonics are reduced. The disadvantage of this method is that the effect of chording of armature winding is lost.

4] Skewing of stator slots results in inclination of stator slots with respect to rotor poles which reduces THD level at the cost of output voltage drop.

5] The combination of above methods can lead to better mitigation of harmonics.

6] Use of design software can lead to optimum design that mitigate harmonics.

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Power Factor Improvement For 3 Phase Induction Motor Using PLC

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Abstract- *In this paper we describe the power factor improvement of three phase induction motor using switching of shunt capacitors and controlling of those capacitors are done by programmable logic controller.At no load condition motor is operated at low power factor as it draws large magnetising current. Active power delivered by motor is low which is used for compensate the no load losses. It is necessary to make power factor unity to avoid penalty from electrical distributors. So it is neccessory to improve power factor of induction motor, as it is operated at lagging power factor. Automatic improvement power factor techniques used in the industries. Power factor mostly operated near to the unity to make system efficient and stable.*

Keywords- Induction motor (IM), Pogrammable logic controller (PLC), Zero crossing detector (ZCD), Capacitor bank, Current transformer (CT), Potential transformer (PT).

I. INTRODUCTION

In the present generation, power factor has one of the major and important issue. Any motor that operates on ac requires apparent power, but apparent power is addition of active power and reactive power. The load is consuming active power. Reactive power is also important for load, because reactive power is the power demanded by the load and returned to the power source. Power factor is the ratio between the useful (active) powers to the total power consumed by an electrical equipment or motor i.e ratio between KW and KVA.Also it defines,to perform a useful work how much of electrical power utilized.

The idealy power factor is unity. If power factor is less than unity it means that excess power is required to perform the actual work. The basic idea for Power factor improvement of a motor, we have to connect a capacitor in parallel with the device which having low power factor. One of traditional method for power factor correction is static type compensation, in which static type capacitors are used for power factor correction. Therefore capacitors should not subject to rapid on-off conditions.

Power Factor Improvement:

This can be achieved by the addition of capacitors to the electrical network which compensate for the reactive power demand of the inductive load ,which reduces the burden on the supply. The addition of external capacitor not affect the operation of the equipment.To reduce losses in the power system and to reduce the electricity bills power factor correction is required. usually capacitors are added to neutralize as much as possible the magnetizing current. Capacitors contained in most power factor correction equipment draw current that leads the voltage, thus producing a leading power factor.

If capacitors are connected to a circuit that operates at a normally lagging power factor the extent that the circuit lags is reduced proportionately. Typically the corrected power factor will be 0.92 to 0.95. Some power distributors offer incentives for operating with a power factor of better than 0.9, for example, and some penalize consumers with a poor power factor. There are different ways that this is metered but the net result is that in order to reduce wasted energy in the distribution system, the consumer is encouraged to apply power factor correction. Most network Operating industies now penalize for power factors below 0.9.

Advantages of power factor improvement :

a) Efficiency of induction motor increases due to reduction of power consumption.
b) Due to reduced power consumption there will be less greenhouse gases(generation is less).
c) Reduction of electricity bills .
d) Extra KVA available from the same existing supply(increases capacity)
e) Reduction of I^2R losses in transformers,distribution network and induction motor (heat loss reduced).

The Causes of Low Power Factor:

The cause of low power factor is due to inductive loads. The current in an inductive load lags behind the voltage. Therefore power factor is lagging. That inductive load is responsible for low power factor are as follows:

i. Low power factor is caused by inductive loads such as lighting ballasts.
ii. Three phase induction motor operate at a power factor of about 0.8 lagging at full load. At light loads this motor work at a very small transformers, induction motors, generators and certain Power factor in order of 0.2 to 0.3 lagging. Single phase induction motor at power factor of about 0.6 (lag)
iii. A induction motor draws magnetizing current from the supply. At full load current does not affect the power factor much but at light load the primary current power factor is low
iv. Electric discharge lamp , arc lamp, industrial heating furnaces, welding equipment operate at low lagging power factor.

Power Factor Improvement Methods :

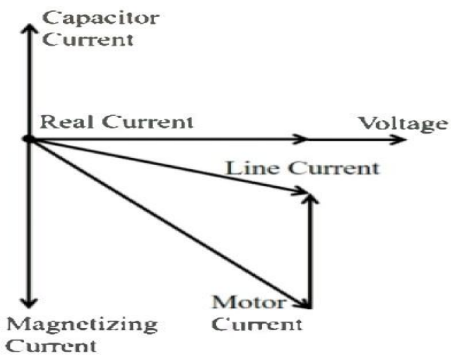
1. Capacitor Bank
2. Synchronous Condenser
3. Phase Advancer

Power Factor of Induction Motor:

The current drawn by an induction motor from the source is the vector sum of the magnetizing current (imaginary current) and working component (torque producing component or real current).

The imaginary current component is required to overcome the reluctance of the air gap present between the stator and rotor of the induction motor by producing the required flux in the air gap. It does not contribute to the actual working of the motor, but contributes to the power dissipated in the supply and distribution system.

The real current of the motor depends on the load on the induction motor. At no-load operation, an induction motor has a very low pf of about 0.2 to 0.3lagging, as it draws a large imaginary current component and a small real current component to meet the no load losses.

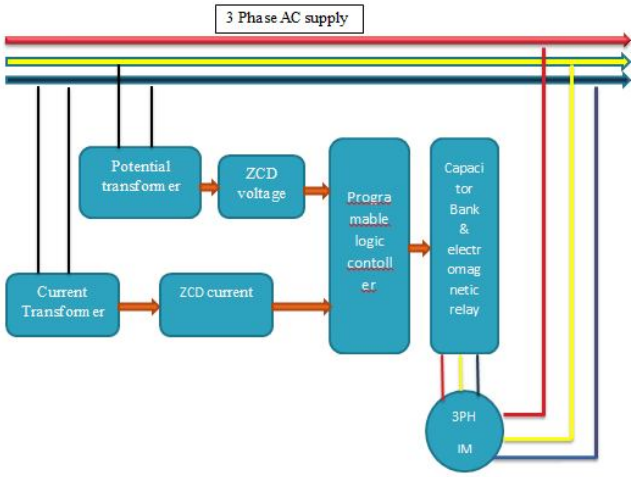


Under loaded condition, the IM draws a larger amount of real current to meet the increased load and losses while the magnetizing component of the current remains almost constant.

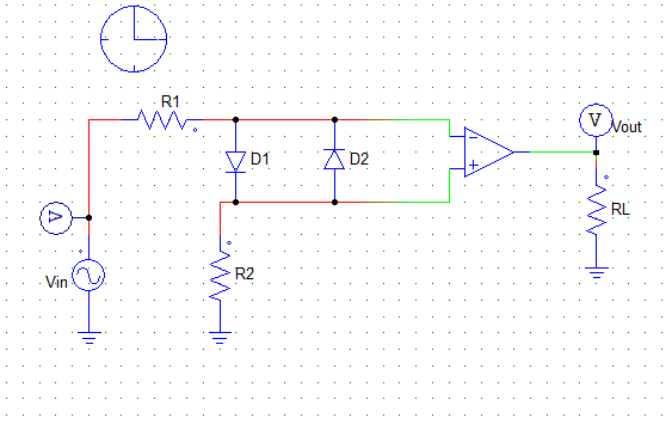
As a result, the pf of the motor is increased. The pf is about 0.6 to 0.8 lagging. At different loading conditions the pf of an induction motor can be improved to a range of 0.9 to 0.95 lagging by use of appropriate capacitor banks in parallel with the IM.

These capacitors provide the required reactive power for the induction motor i.e. the capacitors provide a leading current to the induction motor in phase opposition to the magnetizing current component, as shown in Fig. resulting in pf improvement even at no load condition.

II. BLOCK DIAGRAM:



Zero Crossing Detectors:



The zero crossing detectors converts sine-wave to square-wave . The reference voltage in this case is zero.

The output voltage waveform shows when and in what direction an input signals crosses zero volts.

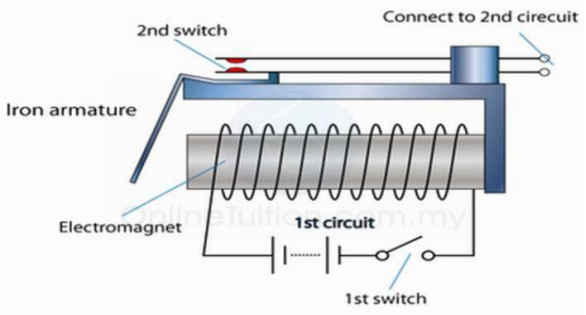
If input voltage is a low frequency signal, then output voltage will be less quick to switch from one saturation point to another.

If there is noise in between the two input nodes, the output may fluctuate between negative and positive saturation voltage is V_{sat}.

Electro Magnetic Relay :

These are varying much reliable devices and widely used on field. The operating frequency of these devices are minimum 10-20ms.That is 50Hz –100Hz. The electromagnetic relay operates on the principle magnetism (electromagnetic induction).

When the base voltage appears at the relay driver section, the driver transistor will be driven into saturation and allow to flow current in the coil of the relay, Which create a magnetic field and the magnetic force produced due to that will act against the spring tension and close the contact coil .



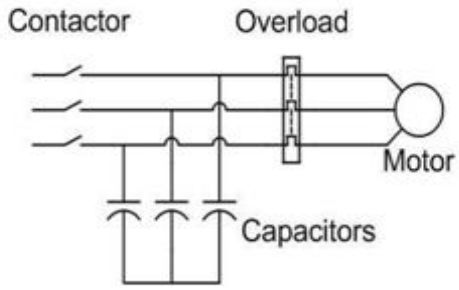
The electromagnetic relays normally having 2 contact points. Named as normally closes (NC) , normally open (NO). Normally closed points will so a short CKT path when the relay is off. Normally open points will so a short CKT path, when the relay is energized.

Capacitor Bank:

As a large amount of the inductive or lagging current on the supply is due to the magnetizing current of induction motors, it is easy to correct each inductive magnetizing current of the induction motor.

In many installations employing static power factor correction, the correction capacitors are connected directly in parallel with the motor windings. When the motor is Off Line, the capacitors are also Off Line.

When the motor is connected to the supply, the capacitors are also connected providing correction at all times that the motor is connected to the supply



This removes the requirement for any expensive power factor monitoring and control equipment.

In this situation, the capacitors remain connected to the motor terminals as the motor slows down. An induction motor, while connected to the supply, is driven by a rotating magnetic field in the stator which induces current into the rotor.

When the motor is disconnected from the supply, there is for a period of time, a magnetic field associated with the rotor. As the motor decelerates, it generates voltage out its terminals at a frequency which is related to its speed.

The capacitors connected across the motor terminals, form a resonant circuit with the motor inductance. If the motor is critically corrected. It is imperative that motors are never over corrected or critically corrected when static correction is employed.

Loading Test of 3 Phase Induction Motor:

3 phase delta connected 7.5HP 12A 420V 1500rpm 4pole IM

Sr. No.	I_{ac}(Amp)	W_1(watt)	W_2(watt)
1	1	60	0
2	2	90	20
3	2.3	130	50
4	3.8	200	90
5	5	260	120
6	7.1	360	140
7	8.9	440	160

From above observation table found out that power factor is vary in between 0.5 to 0.84 from no load to full load.

IV. CALCULATIONS

By using two wattmeter method we can calculate the actual power factor of induction motor as,

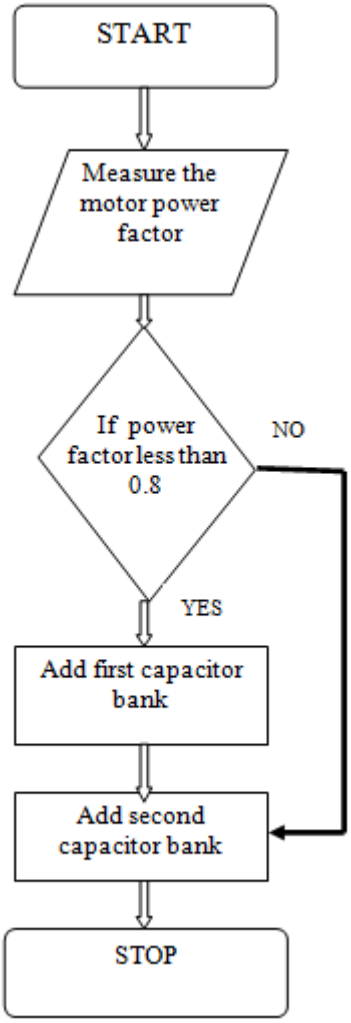
$$\cos\varphi = \cos\tan^{-1}\sqrt{3}\,\frac{W_1 - W_2}{W_1 + W_2}$$

Corrective KVAR calculated as,

KVAR = Total connected load[tan $\cos^{-1}$ (actual power factor)-tan $\cos^{-1}$(required power factor)]

Sr.No	I_{ac} (Amp)	Actual PF	KVAR Required	Capacitor (Microfarad)
1	1	0.5	6.96	128.6
2	2	0.67	3.269	60.41
3	2.3	0.79	2.916	40.58
4	3.8	0.83	1.052	19.44
5	5	0.84	1.01	18.67
6	7.1	0.79	1.62	29.94
7	8.9	0.78	1.766	32.64

V. FLOW CHART



APPLICATIONS :

Electricity industry: power factor correction of linear loads.

VI. CONCLUSION

Low power factor is not that much of problem in residential consumers it become a problem in industry where multiple large motors are used. So there is requirement to improve the power factor in industry.

Generally for power factor improvement capacitor banks are used or try to correct the problem here we used the PLC based system for power factor correction. By using capacitor bank we can improve lagging power factor thereby system will be safe from different disadvantage of lagging power factor. By use of this system the power factor control becomes very fast and accurate than other methods and also the electric bill are reduced.

In a world of automation there is huge use of PLC in industries. Power factor is serious problem in industry due to inductive loads. So the power factor correction is also having a much importance. So along with other automation process the PLC can be used significantly for correction of power factor.

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"Tesla Coil Modification"

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Abstract- *Tesla coil is a high voltage ,high frequency testing source used in laboratories and testing departments of Mega Volt (MV) and High Volt (HV). Tesla coil is known as double tuned resonate transformercan produce high AC voltages at high frequency and low current. Scientist Nicola Tesla done huge research in this field. The purpose of tesla coil is to able to deliver power other than conducting wires and transmission lines too.Tesla coil has a medium of trasmission of elecrticity through air.The design needs low AC voltage and current. It uses high frequency transformer action and resonance occurs in the secondary circuit. The secondary circuit due to resonance action produces very high voltage in the range of tens to 100 kv.*

Keywords- NST(Neon Sign transformer), spark gap, Toroid, Capacitor bank.

I. INTRODUCTION

A Tesla Coil is an electrical resonant transformer circuit designed by inventor Nikola Tesla around 1891.Tesla coil was created to perform experiments in creating high-voltage electrical discharges. It consists of a power supply, a capacitor and coil transformer set so that voltage peaks alternate between two. Electrodes are set so that sparks jump between them through the air.

The Tesla coil is an air-core double-tuned resonant transformer which generates the high output voltage. Optimally, a capacitive electrode (top load)in the form of smooth metal sphere or torus attached to the secondary terminal of the coil. Its large surface area suppresses premature corona discharge and steamer arcs, increasing output voltage.

A high voltage supply transformer is used to step the AC mains voltage up to high enough voltage to jump the spark gap. Typical voltages are between 3-5 (KV).A capacitor that forms a tuned circuit with the primary winding of the Tesla transformer. A spark gap that acts as a switch in the primary circuit.

The Tesla coil uses high-frequency transformer action together with resonant voltage amplification to generate potentials in the range of tens to hundreds, or even thousands of kilovolts. We describe a range of experiments designed to investigate the Tesla coil action, ending up with the design and development of a touring Tesla coil with a carefully considered trade-off between portability and performance

The Tesla transformer is a fascinating device capable of creating spectacular effects: by generating high-voltage pulses with several Megavolts of amplitudes, it emits electrical discharges that easily extend for several meters and remind natural lightning. The tesla transformer is very familiar for more than a century to the scientific research and also used in several application nowadays.

Image: Tesla coil of our prototype

II. LITERATURE SURVEY

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The Tesla coil is an air core resonant transformer which generate the high output voltage. A capacitive electrode in the form of a smooth metal sphere or torus attached to the secondary terminal of the coil.

2. **Hardt N., Koeing,D.: Testing of insulating materials at high frequencies and high voltage based on the Tesla**

transformer principal. Conference record of the 1998 IEEE International Symposium on electrical Insulation,p.517-20,vol.2,1998.

The Capacitor and primary coil produces an LCR circuit that resonates at high resonant frequency. The secondary coil and top load also create an LCR circuit that must have a resonant frequency equal to the resonant frequency of the primary circuit .The high resonant frequency coupling of the primary coil with the secondary coil induces very high voltage spikes in the secondary coil.

3. **M. Sohel Rana, "Design and Construction of a Tesla Transformer using Microwave oven Transfer for Experimentation".** Innovative system design and Engineering ISSN 2222- 1727 (paper) vol, No. 12 2014.This papar focused on the step by step design of high frequency medIum size(1-3KW) air cored transformer commonly called called Tesla coil, that can be easily used for measurement and generally research

III. WORKING OF TESLA COIL

Tesla coil works on the principle of Elecromagnetic induction .which states that" A coil generating magnetic field induces a current in another coil as it placed into the field of former coil".

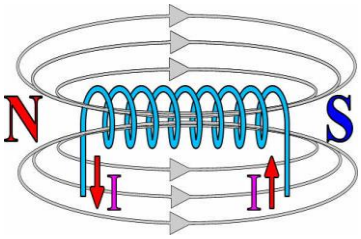

Fig: Mutual Induction

Capacitor charges from the high voltage power supply,the potential across the static spark gap electodes increases until the air between the spark gap ionizes allowing a low resistance path for a current to flow through the switch is closed. once the capacitor has discharged, the potential across the spark gap is no longer sufficient to maintain ionized air between the electrodes and the switch is open. This happens hundreds of times a second producing high frequency AC current through the primary coil. The capacitor and primary coil produces an LCR circuit that resonates at high resonant frequency.The secondary coil and top load also create an LCR circuit that must have a resonant frequency equal to the resonant frequency of the primary circuit.The high resonant frequency of the primary coil with the secondary coil induces very high voltage spikes in the secondary coil.

The top load allows a uniform electric charge distribution to build up and lightning like strikes are produced from this to a point of lowe potential ,in most cases ground.The coupling between the primary and secondary coils do not act in the same way as a normal transformer coil ,but works by high frequency resonant climbing or charging to induce extreamely high voltages.

Construction:

Tesla coil is an electrical resonant transformer was created to perform experiments in creating high voltage electrical discharges .capacitor charges from HV power supply. potential across the spark gap elctrodes increases until air between spark gap ionizes.This ionizes causes low resistance path for current to flow through it and path is like closed switch.

When capacitor gets totally discharge potential is no longer sufficient to maintain ionized air which acts like open switch.This happens hundreds of time a second which leads high frequency in primary. Primary coil, capacitor, resitance of primary coil togather produces LCR circuit.

Similarly tha secondary coil, top load (toroid) create another LCR circuit. This both circuits that is primary and secondary should have resonant frequency equal. It results high voltage spikes in secondary coil.

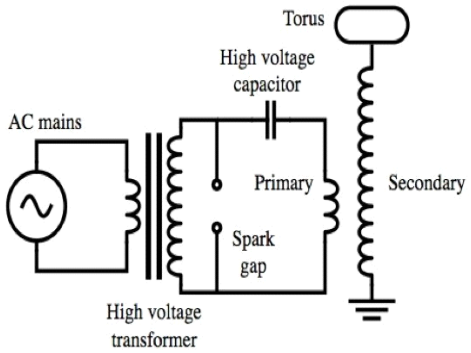

Fig: circuit of Tesla coil.

Tesla coil generates extream high voltages. It has six main parts first one is Neon sign transformer (15 KV). Second is capacitor bank (4.9μF).Third important part is spark gap which is made by two elecrodes seperated by air gap.

Forth part is primary coil haing(8)turns of guage wire which is at base of secondary coil.Fifth important part is secondary coil consisting of (918) turns which are of thin ,enamel guage wire.As Tesla coil is air core transformer no core present between primary and secondary windings.Sixth

important part is toroid which is made up of aluminium and placed at top of secondary coil. toroid acts as capacitor into the secondary circuit.

IV. DESIGN OF OUR PROTOTYPE

PRIMARY CAPACITANCE

The primary capacitor is used with the primary coil to create the primary LC circuit. A resonate sized capacitor can damage a NST, therefore a Larger Than Resonate (LTR) sized capacitor is strongly recommended. A LTR capacitor will also deliver the most power through the Tesla coil. Different primary gaps will require different sized primary capacitors.

Primary Resonate Capacitance (uF) = 1 / (2 × π × NST Impedance × NST F_{in})

Primary LTR Static Capacitance (uF) = Primary Resonate Capacitance × 1.2

Primary LTR Sync Capacitance (uF) = 0.83 × (NST Iout/ (2 × NSTF_{in}) / NST V_{out})

SECONDARY COIL

The secondary coil is used with the top load to create the secondary LC circuit. The secondary coil should generally have about 800 to 1200 turns. Some secondary coils can have almost 2000 turns. Magnet wire is used to wind the coil. There's always a little space between turns, so the equation assumes the coil turns are 97% perfect.

Secondary Coil Turns = (1/ Magnet Wire Diameter + 0.000001)) × Secondary Wire winding Height × 0.97

The capacitance of the secondary coil will be used to calculate the secondary LC circuit resonate frequency. Coil dimensions are given in inches.

Secondary Capacitance (pf) = (0.29 × Secondary wire winding Height + (0.41 × (Secondary Form Diameter / 2)) + (1.94 × √((Secondary Form Diameter / 2)^3) / Secondary Wire winding Height))

The height to width ratio should be about 5:1 for small Tesla coil, 4:1 for average sized Tesla coils about 3:1 for large Tesla coils.

Secondary Height Width Ratio = Secondary Wire Winding Height / Secondary Form Diameter

The length of the secondary coil is used to calculate the wire weight. In the past it was thought that the secondary coil length should match the quarter wave length of the Tesla coils resonate frequency. However, it has since been determined that it's unnecessary.

Secondary Coil Wire Length (ft) = (Secondary Coil Turns) × (Secondary Form Diameter × π) / 12

Magnet wire is typically sold by weight, so it's important to know the required wire weight.

Secondary Coil Weight (lbs) = π × ((Secondary Bare wire Diameter / 2)^2) × Secondary Coil Wire Length × 3.86

The inductance of the secondary coil will be used to calculate the secondary LC circuit resonate frequency.

Secondary Inductance = ((((Secondary Coil Turn^2) × ((Secondary Form Diameter / 2)^2)) / ((9 × (Secondary Form Diameter / 2)) + (10 × Secondary Wire Winding Height))))

TOP LOAD

The top load is used with the secondary coil to create the secondary LC circuit. Generally a toroid or sphere shape is used. The ring diameter refers to the widest length from edge to edge of a toroid shape. I've found several equations for different sized top loads. Without knowing which is the most accurate in any case, I use the average of all the equations.

For large or small toroids with ring diameter < 3" or ring diameter > 20", use the average of the 3 toroid capacitance calculations.

Toroid Capacitance 1 = ((1 + (0.2781 – Ring Diameter / (Overall Diameter – Ring Diameter))) × 2.8 × sqrt((π × (Overall Diameter × Ring Diameter)) / 4))

Toroid Capacitance 2 = (1.28 – Ring Diameter / Overall Diameter) × sqrt(2 × π × Ring Diameter × (Overall Diameter – Ring Diameter))

Toroid Capacitance 3 = 4.43927641749 × ((0.5 × (Ring Diameter × (Overall Diameter – Ring Diameter))$^{0.5}$)

Toroid Capacitance = (Toroid Capacitance 1 + Toroid Capacitance 2 + Toroid Capacitance 3) / 3

Ring diameter between 3" and 6"

Toroid Capacitance Lower = 1.6079 × Overall Diamete

Toroid Capacitance Upper = 2.0233 × Overall Diamete

Toroid Capacitance = (((Ring Diameter – 3) / 3) × (Toroid Capacitance Upper – Toroid Capacitance Lower)) + Toroid Capacitance Lower

Ring diameter between 6" and 12"

Toroid Capacitance Lower = 2.0233 × Overall Diamete

Toroid Capacitance Upper = 2.0586 × Overall Diamete

Toroid Capacitance = (((Ring Diameter – 6) / 6) × (Toroid Capacitance Upper – Toroid Capacitance Lower)) + Toroid Capacitance Lower

Small Tesla coils may use a sphere shaped top load.

Sphere Capacitance = 2.83915 × (Sphere Diameter / 2)

The total secondary capacitance includes the capacitance in the secondary coil and the capacitance of the top load. If you use multiple top loads, add their capacitance to calculate the total secondary capacitance. The total secondary capacitance will be used to calculate the secondary resonate frequency.

Total Secondary Capacitance = Secondary Coil Capacitance + Top Load Capacitance

The Secondary LC circuit resonate frequency will be used to calculate the amount of primary coil inductance required to tune the Tesla coil.

Secondary Resonate Frequency = 1 / (2 × π × √((Secondary Inductance ×0.001) × (Total Secondary Capacitance)))

V. TEST RESULT

When the distance between primary and secondary coil was very small then breakdown occuring at 20 KV.

we found that there were no spark between electrode so we tried changing distance between electrode at same voltage**.**

For resonance between primary and secondary coil we increased distance between coils by 3 inches for mutual induction.

	Primary values	**Secondary values**
Capacitance value	4.9µf	15.36µf
Turns used	7	918
Breakdown at voltage	15 kv for charging capacitor & dicharge through spark gap	15kvforincrease voltage in the secondary coil for dicharge through toroid
Spark gap distance	1 mm	1mm
Distance between primary and secondary	3 inches from secondary	3 inches from primary

At the above values sparks of high voltages occuring at 15kv supply.

VI. CONCLUSION

We are now able to transmit power without using wires but distance is limited as per our ratings.

We can now do the detail analysis of working ,design and operation of tesla coil.

Working principle of basic Tesla coil helps to design our model to produce sparks at high voltage across the toroid capacitor.

It is very efficient method for developing high voltage ,low currents,high frequency outputs.

Tesla coil cad and Tesla map software's are very useful in Tesla coil design as we can use it for experimental study and small ,medium & big Tesla coil model design.

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Development of An Energy Storage System For Hybrid Electric Vehicles Using Super Capacitor

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Abstract- *This paper aims in developing an effective and efficient energy storage system for hybrid electrical vehicle (EHV). For the effective storage here batteries along with super capacitors is been used. The installation of super capacitors is done by considering two major prospective. First experimental setup using super capacitors proves to be fine for data acquisition with fast charge/discharge property. The second approach is that simulating photovoltaic energy storage by super capacitors is covenant and accessible model along with equivalent circuits for photovoltaic conversion makes its superior. Also super capacitors provide rapid energy recovery along with regenerative braking.*

Thus with this power system loss of energy and stress of the main batteries gets minimizes during acceleration and deceleration mode. This system also reduces the high power demands of batteries. Due to which batteries average life expectancy and efficiency is increased.

In this paper the equivalent model for super capacitor is included which is used for simulating for automotive power systems. It includes soft switching bidirectional DC-DC converters which are used to connect the super capacitor with the battery for controlling instantaneous power flow. A prototype hybrid design is made for experimental calculations

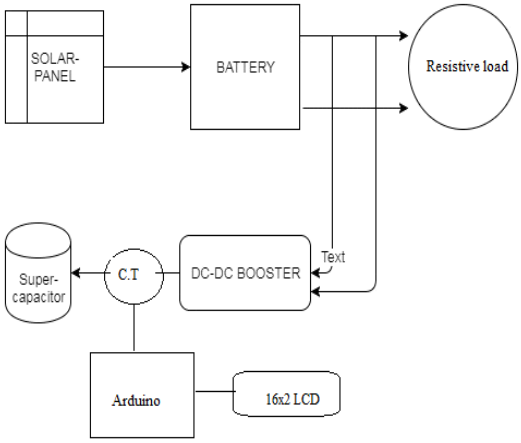
Keywords- DC-DC, Super Capacitors, EHV, Regenerative.

I. INTRODUCTION

The super capacitor is different from ordinary capacitor as they can be charged and discharge for many times also they can store energy with a higher rate than conventional electrolytic capacitors.

There are several of options like various batteries are available in market but super capacitors proves to be advantageous due to several reasons like longer life, rapid charge and discharge of energy.

BLOCK DIAGRAM:

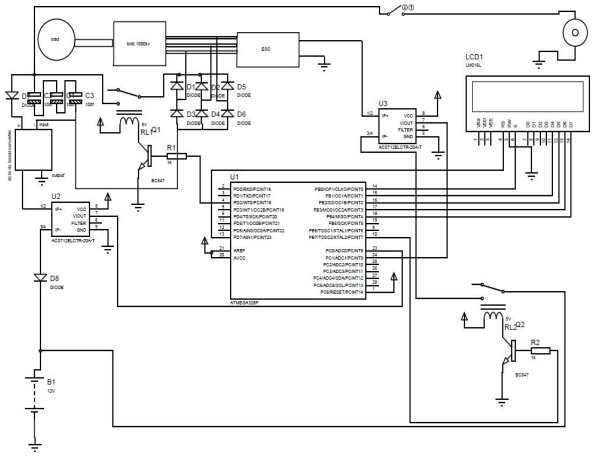


Though they currently are not able to compete with lithium based batteries in terms of energy density super capacitors are able to accept large sustained currents reliably and thus have improved power densities. These higher currents allow for potentially more energy to be stored during regenerative braking. Ultra capacitor based regenerative braking applications are currently, for the most part, restricted to hybrid buses and railway cars, where stops are predictable, and space is not too much of an issue. For this experiment these applications were outside of the author's budget, so a smaller scale electric bicycle was used instead, in order to measure ultra capacitors' ability not recoup braking energy.

II. METHODOLOGY

The braking system for a conventional vehicle is based on hydraulic braking technology. However, this traditional braking methodology causes a lot of energy wastage since it produces unwanted heat during braking. Thus, the invention of regenerative braking in electric vehicle has overcome these disadvantages moreover it helps in save energy and provides higher efficiency for a vehicle. In this system solar panel is used to store renewable energy from sunlight to run electric vehicle. And through charging circuit, energy stores in battery. Using battery power vehicle accelerate. In regenerative mode, the BLDC MOTOR act as a generator, it transfers the kinetic to electrical energy to restore the batteries or capacitors. Meanwhile, the brake controller

monitors the speed of the wheels and calculates the torque required plus the excessive energy from the rotational force that can be converted into electricity and fed back into the batteries during regenerative mode.



Despite this important advance in energy storage, they are still far from being compared with electrochemical batteries. Even Lead-acid batteries can store at least ten times more energy than Super capacitors. However, they present a lot better performance in specific power than any battery, and can be charged and discharged thousands of times without performance deterioration.

In a regenerative braking system, the trick to getting the motor to run backwards is to use the vehicle's momentum as the mechanical energy that puts the motor into reverse. Momentum is the property that keeps the vehicle moving forward once it's been brought up to speed.

III.CONCLUSION

In regenerative braking the efficiencies ranging from 8-15% are an improvement on the 10% efficiency target of most commercial systems. However, looking at the price tag, it's clear that installing this system on an electric vehicle is not economical based on the increase range it provides. With the lead acid battery pack used a range of about 10 miles was achieved, depending on how hard the user pushes the motor. With frequent regenerative braking one could hope to extend this range to about 11-12 miles. An interest in a particular activity may want to build their own capacitor based system for testing purposes, but investing in a lighter lithium ion pack and controller assist functionality would be the more costly choice at the moment. The cost of ultra capacitors may decrease in the near future making small scale systems like this possible.

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Design and Implementation of GSM Based Power Supply Control

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Abstract- *GSM Based Automation Energy Meter Reading System with Instant Billing. This paper proposed new based technique for metering purpose using this technique we can access data globally for managing & billing purpose. According to this technique interfacing of Arduino & GSM is done through respective module pins. This GSM module is interface directly to the remote central office through GSM network these data processing units communicate to the user to have an information about their billing this system is highly effective that it is eliminate drawbacks of conventional system & communication.*

Keywords- GSM; Arduino; Power Contro; Energy Bill; Smart meters.

I. INTRODUCTION

Today power generation cost recovery is major issue. Our model will overcome today's manual cost recovery system problem. Conventional method is when consumer do not pay the electricity bill or make delay of payment then utility cut power supply manually which require more time also human delay take the place.

We are introducing our project with Arduino, GSM Module, Relay and Interfacing of this equipment to Control the Supply of the user if the bill payment is not done within the certain limit of time. This will ensure that there will no delay in bill payment and which will reduce human effort.

II. PROBLEM STATEMENT

In current power system scenario, the control of power supply provided from the utility to customer is fully manually. If users due the payment exceed more than desired duration then the fine charged to the customer or they have to cut the power manually which includes labor cost and is time consuming.

Though there are the smart meters but to replace every conventional meter with smart meter is difficult job, more time processing, & will require huge amount of initial cost. To overcome this problem our one model can control more than eight customer user. Also this will require less initial cost. more than eight customer electricity meter. Also this will require less initial cost.

III. WORKING PRINCIPLE

In our project, Arduino is used for controlling whole the process. Here we have used GSM wireless communication for controlling mains power supply given to the customer. We send some commands like "#A.l1 on*", "#A.l1off*".After receiving given commands by Arduino through GSM, Arduino send signal to relays, to switch ON or OFF the mains power supply using a relay driver when the electric bill not paid in given duration of time.

IV. CIRCUIT COMPONENT

a. Arduino UNO
b. GSM sim800C Module
c. Relay 12 volt AC – 40 A
d. wires
e. LCD
f. Power supply
g. mobile

In this model we have used a prefix in command string that is "#A.". This prefix is used to identify that the main command is delivering next to it and * at the end of string indicates that instruction has been ended.

When utility send SMS to GSM module by Mobile, then GSM receives that SMS and sends it to Arduino. Now Arduino reads this SMS and extract main command from the received string and stores in a variable. If match occurred then Arduino sends signal to relay via transistor switch for turning ON and OFF the energy meter of the user and relative result also prints on LCD. Here in this project we have used 4 loads for demonstration. Maximum current rating of relay is to be selected so that it can handle maximum load of customer.

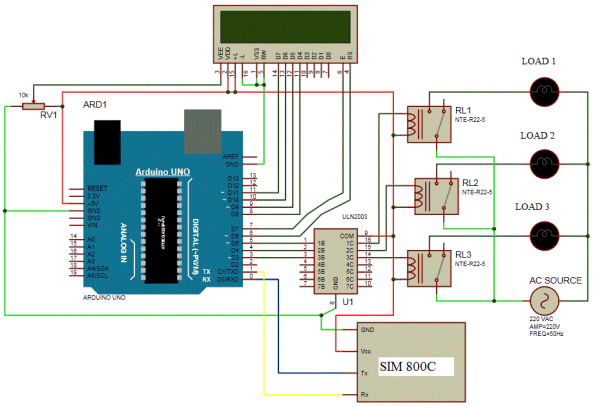

Fig.1. Circuit Diagram

V. CIRCUIT DESCRIPTION

Mainly there are four component Arduino UNO, GSM SIM 800C, Relay circuit & LCD. Arduino work on 5 volt dc supply it read the command from gsm & respective program in GSM on the basis of command make the respective arduino pin high or low which give 5 volt or 0 volt which will given to transistor for switching purpose of relay which work on 12 volt & which will make respective load ON or OFF.

VI. POWER SUPPLY

We required 5 volt DC two source & 12 volt DC one source. To get such output from 230 volt AC first we need to step down AC voltage from 230 volt to 15 volt AC. To convert into DC we need a bridge rectifier. With only DC bridge pulsating DC output is present at output to get constant DC output we need to add a capacitor in parallel with a proper value of capacitor by taking the current output.

7805 for +5 volt.
7812 for+12volt.

VII. RELAY CIRCUIT

Arduino output signal is of 5v on such small voltage relay can't operate . Relay required 12v coil to energized. So externally 12v coil is given to energized by external supply. So transistor is used in this case. By the transistor switching method Relay is operate. Transistor 2n222 is used.

- 30~40A switching capability
- NO: 40A 240VAC
- NC: 30A 240VAC
- COIL: 12VDC
- PCB coil terminal
- Design to support heavy load
- 2.5KV dielectric strength (between coil and contacts)
- Dust protected types available

VIII. GSM MODULE

GSM module SIM800c is has used in the project. It is like a mobile phone with all the facilities of receiving a message. It is communicated and programmed with AT commands.GSM has 5 output/input pin which can perform following function- audio input and output pins (for mic & speaker), control pin for mute, also to load the particular program one pin, power pin-ground pin, transmitter Tx & receiver pin Rx. RX and TX pins are used for the serial communication with the arduino. There are various AT commands to check the signal strength and connection and SIM status etc. Here the Hyper Terminal is used to initially interface with the computer to check the module. It also has an antenna to receive the GSM signal from the user's phone.

SIM800C

Supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. SIM800C features GPRS multi-slot class10/class12 (optional). SIM800C is a quad-band GSM/GPRS module that works on frequencies GSM850MHz, EGSM900MHz, DCS1800MHz and PCS1900MHz.

42 SMT package are on SIM800C, and include all hardware interfaces between the module and customer's boards. SIM800C can achieve almost all the space requirements in customers applications, such as smart phone mobile devices with a small dimension of 17.6*15.7*2.3mm

- Include 3 lines serial port
- Audio channel which include a mic input and a speaker output.
- General purpose input and output.
- Single SIM card interface.
- Support Bluetooth.

SIM800C is designed for power saving so that the current consumption is as low as 0.6mA in sleep mode.

- GSM : 850,900,1800 and 1900MHz
- RAM : 32Mega bit
- Bluetooth : (need software support)
- FLASH : SIM800C (24Megabit)
- Power supply : 3.4V ~4.4V DC
- Power saving : 0.88mA
- SMS storage: SIM card memory
- External antenna : Antenna pad
- Support SIM card: 1.8V - 3V

IX. CONCLUSION

According to this technique interfacing of Arduino & GSM is done through respective module pins. This GSM module is interface directly to the remote central office through GSM network this data processing unit communicate to the user to have an information about their billing this system is highly effective that it is eliminate drawbacks of conventional system & communication.

X. RESULT

- Power cut-off with efficient, fast & reliable technique.
- Cost efficient System.
- Time saving in operation performed by the device.

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Design of Electronic Speed controller of Brushless DC Motor

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Abstract- *This paper discusses the construction and working principle of Brushless DC motor. The speed control of the BLDC motor can be done using PWM technique. The block diagram for speed control of BLDC motor is explained in this paper. A circuit design is proposed which contains arduino/controller, optocoupler, MOSFET inverter bridge. Six step control of BLDC motor using bridge inverter is simulated in Multisim.*

Keywords- BLDC, Electronic Speed Controller, PWM, Optocoupler, MOSFET, Multisim

I. INTRODUCTION

Drive systems are widely used in large number of industrial and domestic applications. Among various types of drives electric drives are undergoing technological advances. BLDC motor is one of the recent advancement which is gaining popularity in wide range of applications. The major advantage of BLDC motor over DC motor is its commutation technique. Conventional DC motor consists of commutator and brushes. However due to frictional losses at the brush-commutator surface, heat is generated, hence it is major drawback. In BLDC motor commutation is done electronically and as brushes are absent there is no scope of sparking and heat generation. Thus BLDC motors are more efficient and have noiseless operation.

BLDC motor has different construction than other conventional motors. The rotor is made up of permanent magnet and surrounds the stator which has windings.

In almost every motor driven application, speed control of motor is vital part of the design of that drive. Speed control of BLDC motor is dependent on electronic commutation circuit. It consists of microcontroller, driver circuit and feedback taken position sensors of motor. This speed control can be performed using various techniques. [4]
Simulation of BLDC motor using six step control is performed. In simulation results, the speed and torque characteristics of motor with respect to time are observed. By changing the duty cycle of PWM signal the voltage across the motor can be controlled and hence the speed of the motor.

II. CONSTRUCTION AND WORKING OF BLDC MOTOR

CONSTRUCTION

The construction of BLDC Motor is explained below

- STATOR – The stator of BLDC Motor is similar to that of induction motor. It is made of stacked steel lamination with windings which are placed in the slots. The windings are wound such that various number of phases are formed. As the number of phases increases the percentage of ripple present in the torque decreases.[5]

- ROTOR – The material used for the construction of BLDC Motor is permanent magnet. The magnet is arranged such that it forms pole pair that alternate between north and south pole.[1]

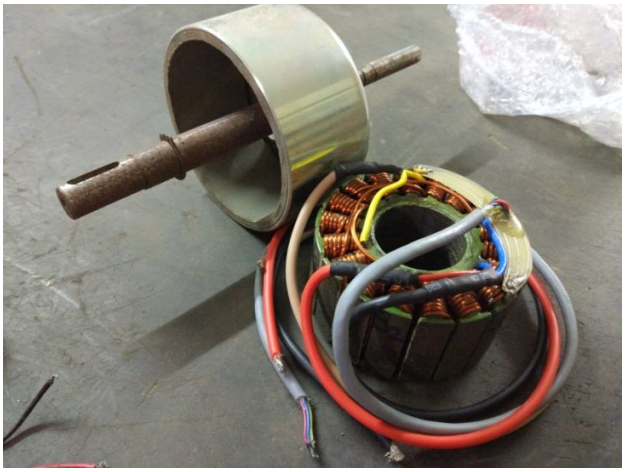


Fig 1: Constructional details

WORKING

The working principle of BLDC is attraction and repulsion between magnetic poles. The diagram shown below explains the operation of 3 phase motor. When one

of the phase is energized it generates a electromagnetic pole and attracts the nearest permanent magnet of opposite pole present in the rotor. Energizing the stator phases in particular sequence, will cause the rotation of rotor. The direction of rotation depends on the sequence of energisation of phases. This energisation process is done by using the PWM pins of microcontroller. Driver circuit is placed in between motor and microcontroller for amplifying the signal generated from PWM pins of microcontroller.[1]

Speed of the motor can be controlled by adjusting the duty cycle of the PWM signals. If the time for which one phase is energized is varied the speed of the motor will also vary. The motor is also dependent on supply voltage.But in this method, input voltage to the motor is kept constant.

Speed control is of two types, one is sensored control and other is sensorless control. In case of sensored control, hall sensors are used which determine the position of the rotor. And then this sensed position of rotor is given as a feedback to the microcontroller. Then PWM signal is generated based on this feedback signal. In case of sensorless control, Back EMF of the stator windings is taken as a feedback.[2]

III. BLOCK DIAGRAM FOR SPEED CONTROL OF BLDC MOTOR

The electronic control circuit used for controlling the speed of BLDC motor consists of microcontroller/arduino, driver and MOSFET bridge inverter circuit.[2][3]

- Arduino/controller: It is an open source electronic platform based on easy to use hardware and software. It reads the feedback from the BLDC motor and generates the required PWM signal.
- Driver Circuit: It consists of an optocoupler. Optocoupler is used for amplifying the signal generated by the PWM pins. Optocoupler gives the electrical isolation between motor and controller circuitry due to which the electronic circuit is protected from the transient currents drawn by the motor.
- MOSFET bridge inverter: It is used for energizing the motor phases in required sequence. By changing the triggering sequence of the MOSFETS in appropriate manner the direction of rotation as well as speed of the motor can be varied.
- Qx: MOSFET
- Ux: Opto-coupler
- CLx: Clock Pulses

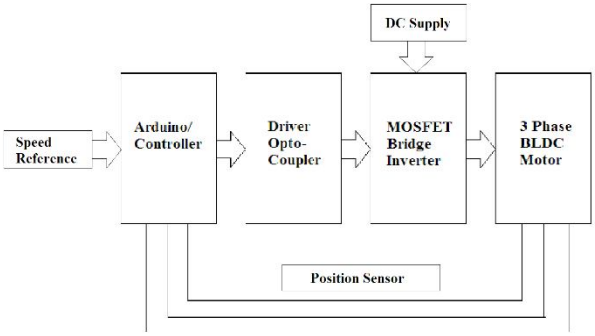


Fig 3: Block diagram of electronic speed controller

IV. CIRCUIT DIAGRAM OF ELECTRONIC SPEED CONTROLLER

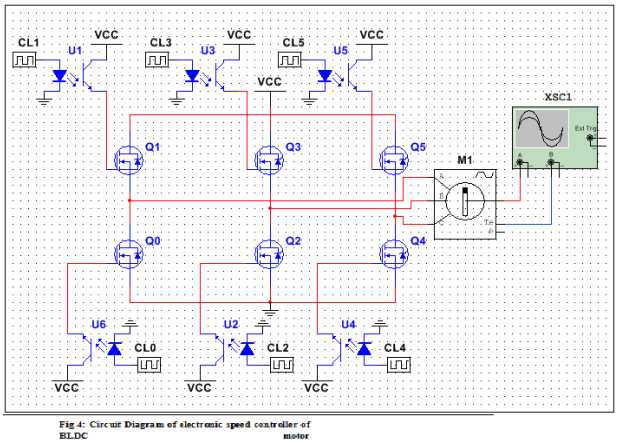


Fig 4: Circuit Diagram of electronic speed controller of BLDC motor

The circuit used for the design of controller is drawn using Multisim software.

- M1: BLDC Motor
- VCC: DC supply voltage
- XSC1: Oscilloscope

Instead of PWM pins of micro-controller, the clock pulses are shown for controlling the speed of the BLDC motor. As signal coming from PWM pins/clock pulses is of very low value. It is not sufficient to trigger the MOSFETs. Driver circuit helps to amplify the PWM signal. Optocouplers are used in driver circuit. Optocouplers provides electrical isolation which prevents microcontroller/arduino from drawing excess current from motor. MOSFET bridge inverter gives the six step control for BLDC motor.

Channel A of oscilloscope is connected to the shaft of the motor and the speed characteristics are observed. Channel B is used for observing the motor torque characteristics.

V.SIMULATION RESULTS

The circuit used for the design of six step control of BLDC motor is simulated in Multisim software, the speed and torque of the motor is observed for a particular period of time.

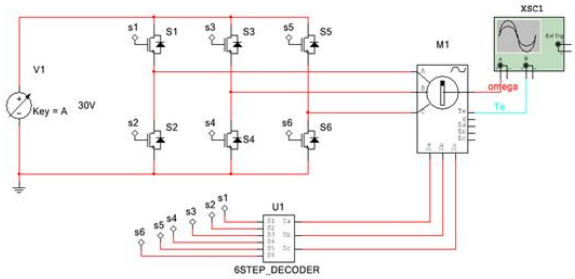
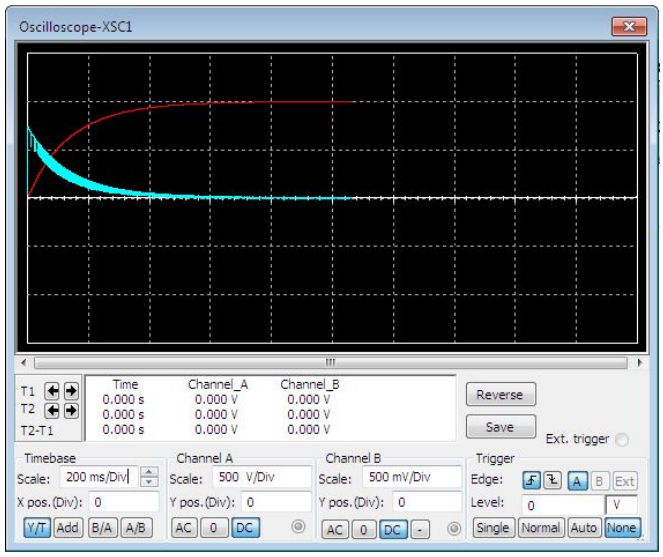


Fig 5: Six step control for brushless DC motor

VI. CONCLUSION

In this paper, three phase BLDC motor is studied which requires electronic commutation circuit. Internal circuit diagram of this electronic controller is designed using microcontroller, opto-coupler and MOSFETs. The six step control of BLDC motor using positioning sensor feedback is simulated in Multisim software. Speed and Torque characteristics with respect to time are shown in simulation results. Circuit designed for speed control gives satisfactory results. Hence design can be implemented practically.



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Generation of Electrical Energy From Overhead Water Tanks of Multistoried Buildings

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Abstract- *Water is an essential requirement for human being like as air, food etc. Multistoried buildings consist of overhead water tank for everyday use. Energy can be extracted from flowing of water, a MHTG may be fitted in water pipe. A MHTG converts potential energy of water into electrical energy. Study is done on prototype model. From the result ,electrical energy is estimated for 10 storied building on per day and per year basis. This performance of MHTG sets available in the range of head and discharge which are used for other application. The result is shown that, generated energy is less which is stored in the battery and used for small applications.*

Keywords- Overhead tank; MHTG-micro hydro turbine-generator set; discharge; generation

I. INTRODUCTION

Energy is important input in the process of economic, social and industrial development. Hydro power is a renewable source of energy. It is non-polluting and environmentally source of energy. Overhead tanks on buildings store large quantity of water. Potential energy is converted into kinetic energy. Moving water from water pipe line is fall on turbine ,the blades of turbine spins a generator and electricity is produced.[4]

In this work, by using MHTG with the dc generator , generate electricity and it is used for the domestic purpose.

Hydropower is an important resource, only a few recent projects in developed countries such as US and Canada have been reported. However, with improvements to small hydropower (SHP) and Mini hydropower (MHP), consist new devices, materials and improve in design and operation. The cost of SHP units has become more competitive.[3]

Early in the last decade, a United Nations report incisive that clean and renewable energy, SHP/MHP must be developed as a priority both for its economic benefits.

Energy demand is increasing day to day with fast growing of industrialization. Such conventional energy sources like coal, oil are going to last for few decade. Human being looking towards renewable energy sources for surviving. Research is going on for further development of renewable energy technologies.[1]

Potential energy is available with water stored in overhead tank on the buildings. Energy can be extracted from water by MHTG when it flows down from tank to flats. The energy is stored in battery which can be used for staircase lighting and other domestic appliances.[2]

II. METHODOLOGY

Overhead tank on buildings stores water for every day use. Energy can be extracted from flowing water when it is supplied to apartments. A micro hydro turbine may be fitted in water pipe line to convert potential energy of water into electrical energy.Paper describes techno-economic feasibility of the concept.Study is done on 5 storied building.

The literature survey carried by author indicates that, no such micro turbine generator set is available in market which exactly matches the application. Paper briefson performance of MHTG sets available in that range of Head and discharge which are meant for other applications. Electrical energy generation for 5 storied building is estimated on per day and per year basis. It is shown that, energy generated is not just sufficient to power staircase lighting of the building, but also in addition conserve substantial part of energy required for lifting water.

III. CONCEPT OF PROTO TYPE MODEL

The storage of water in the overhead tank on multi storey building used for domestic purpose. This water possesses potential energy because of head created it can be converted into mechanical energy with the help of turbine. By using velocity or water force a turbine can be rotated and electrical energy is generated. In this project we are going to generate a DC power by using DC generator. This method of generation of electrical energy has become very popular because it has low production and maintenance cost.

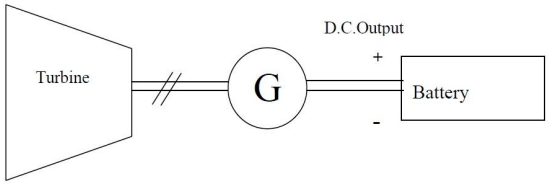


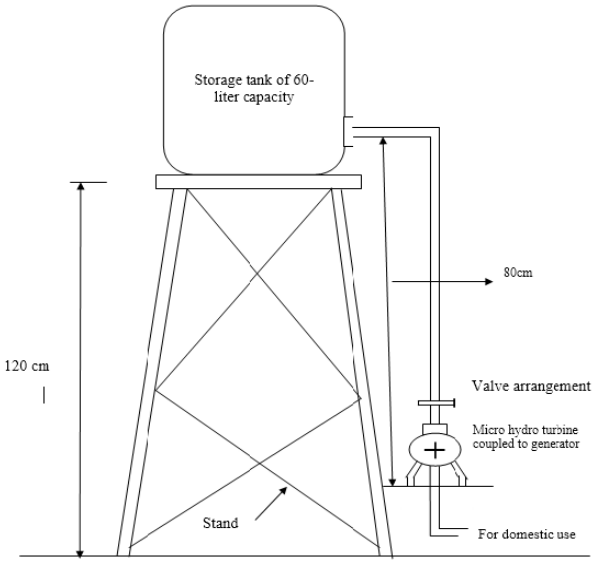
Fig -1: Micro Hydro Turbine System

3.1 POTENTIAL ENERGY OF WATER.

Mass that has been raised above the Earth's surface has a potential energy relative to the same mass on the Earth's surface. Running water over a turbine, some part of this potential energy can be converted into kinetic energy. This kinetic energy is then converted into an electrical energy. The amount of electrical energy that can be generated is equal to the potential energy of stored water**[1]**. This gravitational potential energy is equal to the product of mass, height, and gravitational constant (9.81 m/s2).

IV. ACTUAL IMPLEMENTATION BY PROTOTYPE MODEL

The regeneration of electrical energy can be obtained by converting the kinetic energy of water stored at top level. The same principle is established in a small model containing all the phenomenon of the micro-hydro generation plant.The model has storage of 60 liters' capacity. This storage tank is kept on the stand of the height of 120cm=1.20m. The height of outlet flow pipe from stand is 80cm=0.80m. So the total head up to the ground level is 1.6m. If the turbine is located in the path of the flow, electrical energy can be generated when the water flows downward.



PROTO TYPE MODEL

4.1 DESIGN OF MICRO HYDRO TURBINE GENERATOR

The minimum available water head for energy generation is around 3 metres for single storied building with addition of 3 metres for every added floor. The minimum water discharge produced by partial opening of a water tap is found to be fraction of a litre per second by measurements taken. Micro hydro turbine-generator sets can be made which can produce power with water discharge as low as 0.18 litres/second and those with water head as low 2 metres2. Literature survey carried out so far, indicate that micro hydro turbines are not available in markets, which exactly match this application. The water use is not continuous and so the discharge. That's why energy is required to be stored in battery. One micro hydro turbine-generator set to be commissioned on each floor. The Head availability ranges from 3 metres to 30 metres for 10 storied building.

4.2 CALCULATING THE GENERATED ENERGY FROM PROTO TYPE MODEL

1. Diameter of pipe use for discharge of water = 25.4mm.
2. Head available for ground floor turbine = 0.79m.
3. Time required to reach the water flow to turbine = 0.26 seconds.

Therefore,

Power generated = QgH k watt

where,

Q = water discharge rate in cubic meter per second.

$g = 9.81 m/s^2$

H = net head in meter (m).

Then,

$Q = (52.4*10^{-3})^3 / 0.26$

$Q = 6.302*10^{-5} m^3/sec.$

Therefore,

1.Power generated= QgH

$= (6.302*10^{-5})* 9.81*0.79$

$= 4.883*10^{-4}$ watt

Similarly,

As calculations are followed by:

Table 1: Generated energy from prototype model.

Sr. No.	Height(h) Meter(m)	Voltage(V) Volts	Power(P) Watts(w)* 10^{-4}
1	0	0	0
2	0.79	2.72	4.883
3	0.84	2.74	5.193
4	0.89	2.76	5.502
5	0.94	2.79	5.811
6	0.99	2.80	6.120
7	1.04	2.84	6.429
8	1.09	2.87	6.738
9	1.14	2.90	7.047
10	1.19	3.1	7.356

4.3 RESULT

From the above table of prototype model, it is seen that as per design specification MHTG is most useful.
The power generated is about $4.883*10^{-4}$ watt,We use this concept for 10 storied building.

V. ACTUAL GENERATED POWER:

Power generated is tested by connecting a pilot lamp at the terminals of generator.Voltage available is 3V and current is 0.95 m Amp. Valve arrangement can give better efficiency. The cost of proto type model for installing generator and turbine is obtained as Rs.1000.

VI. CALCULATING THE GENERATION ENERGY FOR 10 BUILDINGS

Assumption made

1. There are five flats per wings per floor.
2. The number of persons per flat is four.
3. 80 % of water is being used in morning four hours .This figure will be useful to find avg.water discharge.
4. One MHTG set is to be installed per floor.

Energy estimation

For 10 storied building water head available with generator at ground floor H=30m with floor height of 3m . Water consumption of 150litres per capita per day 4, with 4 persons per family & 5 flats per floor, total water consumption per floor, per wing is equal to

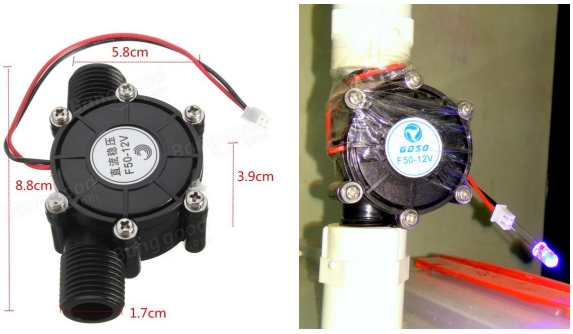
Water consumption =150*4*5=3000litres.
With 80% of water is used in morning 4 hours
Average discharge per floor in litres/second,Q=(3000*0.8)/(4*3600)
$=0.167 litres/second=0.167*10^{-3} m^3/s$
Available water power is given by Pa=1000*QgH Watts , Assuming overall efficiency MHTG set including losses in pipes to be of 50% (water to wire),

Table 2:Generated energy for 10 storey building.

Floor No.	Water head m	Power(p) Watt (w)	Electric energy Kwh	Cost of Energy in Rs.
1	3	4.91	0.0122	13.36
2	6	9.83	0.0245	26.83
3	9	14.74	0.0367	40.18
4	12	19.66	0.049	53.65
5	15	24.57	0.0613	67.12
6	18	29.49	0.0735	80.48
7	21	34.40	0.0858	93.95
8	24	39.32	0.0981	107.42
9	27	44.23	0.110	120.45
10	30	49.15	0.1226	134.25

VII. SUITABLE TURBINE

The turbine is required to be fitted in the pipeline. When all water taps are closed, water will be filled up in the turbine. So impulse type turbines will not be suitable for this application. Reaction turbines will be suitable in this case.



VIII. ENERGY STORAGE IN BATTERY

As the use of water and hence water discharge is not continuous, energy generated is required to be stored in battery. 12 V or 24 V batteries can be used. CFL lamps can be powered directly from batteries. For this purpose inverter circuits used in emergency lanterns which operate on 12 V dc supply will be most appropriate. For other loads inverters are to be used to convert 12 V/ 24 V dc into mains voltage.

IX. RESULT

Energy generated per day from 1st floor to 10th floor = 0.551 KWh
Energy generated per year =201.15 KWh
Cost of energy per year @ Rs.4 per KWh =938.85
Total energy generated per year for 10 storied building will be 0.551*365 KWh.
Cost of energy for 10 storied building will be Rs. 804.60 @ Rs. 4 per KWh.
Sum of energy generated for 1st to 10th floor per day will be 0.551 KWh.
Sum of energy generated for 1st to 10th floor per year will be 201.15 KWh.
Cost of energy generated for 1st to 10th floor per year will be Rs. 293679

X. CONCLUSION

From this result, we seen that by using this technology generated energy is stored in battery which can be used whenever required. Hydro electric energy has always important part of the world's electricity supply which provide harmless, reliable, cost effective electricity, and will continue to do so in the future.

XI. FUTURE SCOPE

Since, renewable energy is the future of the power generation as electricity to all by Shri Narendra Modi. A small MHTG set should be developed which can be fitted in water pipe line and that model should be fixed on each floor of multi storey buildings.

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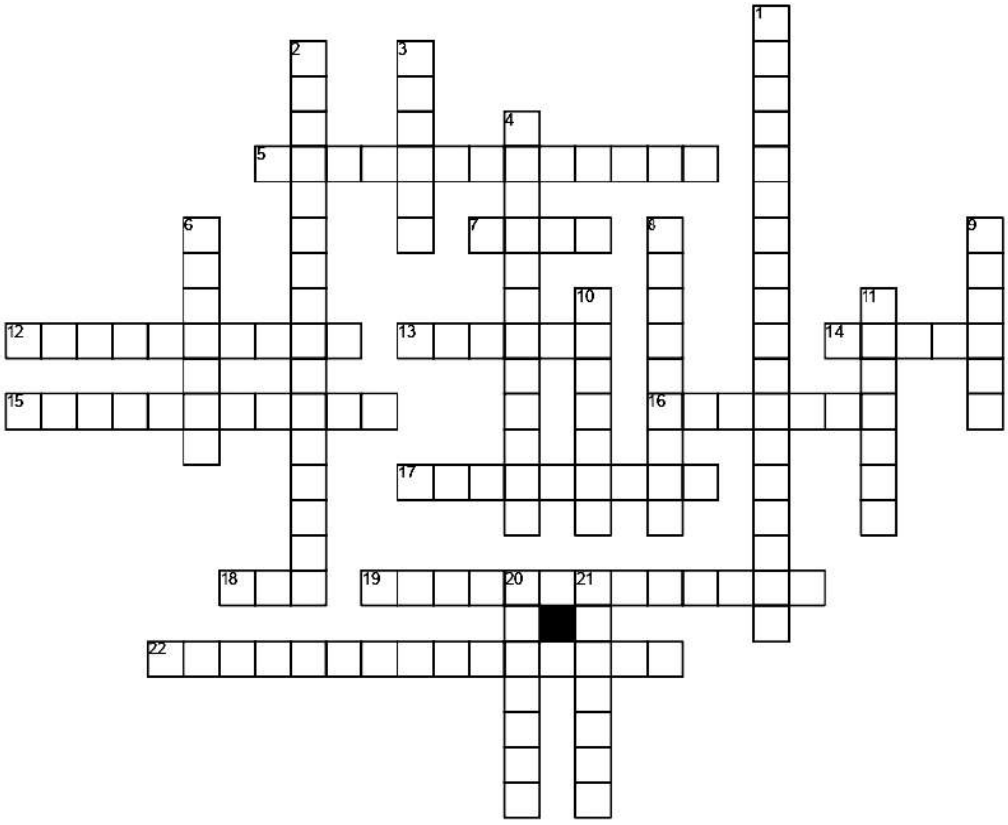
Crossword Puzzle



Across

5. An electric circuit with only one path through which charge can flow

7. Voltage unit

12. The opposition to the flow of electric charges in a material

13. One turns lights on and off with this

14. ____=work/time

15. A form of energy resulting from existence of charged particles

16. Series or Parallel

17. Does not conduct heat well

18. ___ Law states a relationship between voltage, current, and resistance

19. An electric current in which the flow of electric charge stays flowing in the same direction

22. An electric circuit with two or more paths through which charges can flow

Down

1. An electric current in which the flow of electric charge periodically reverses direction

2. Representation of elements using abstract symbols instead of realistic objects

3. SI unit:A and for short, "amp"

4. A unit of energy equivalent to one kilowatt of power sustained for one hour

6. Without this, a circuit would not work

8. Conducts heat well

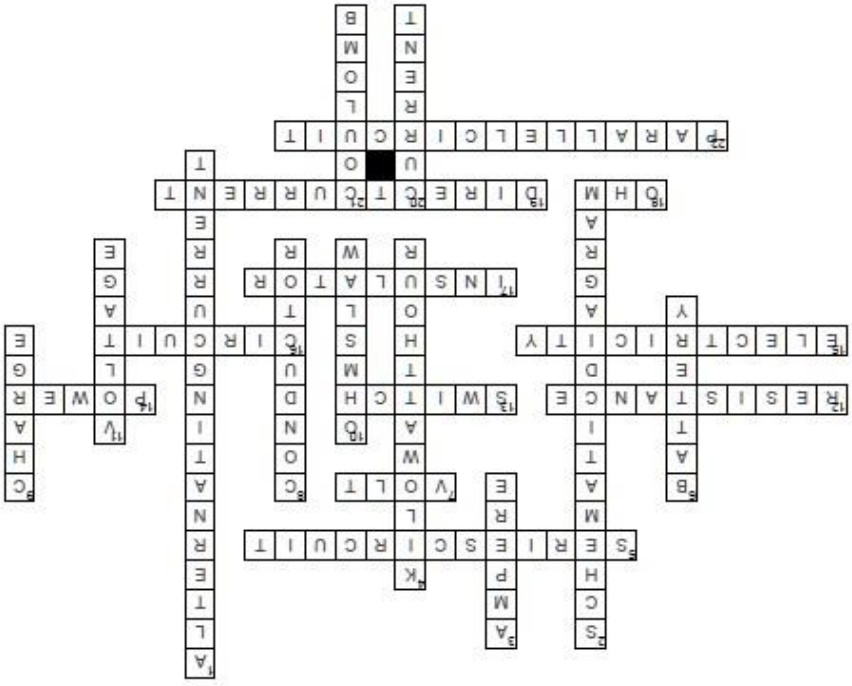
9. Positive or negative

10. V=IR

11. ___=IR

20. Electricity flows between these

21. Unit of electric charge



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