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Application of Flywheel for Energy Storage System

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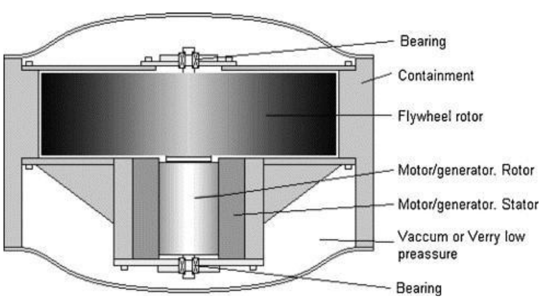
Abstract: **The world's energy sources are derived from conventional sources i.e. fossil fuels. These are non renewable energy sources and are limited on the earth whatever energy generated from these primary energy sources should be utilized optimally. A fly wheel is an inertial energy storage device which absorbs mechanical energy and serves as reservoir, storing energy during the period when the supply of energy is more than requirement or in other words, flywheel can store electricity from the electrical supply system in the form of kinetic energy, and can dispense that energy back to the electrical supply system in quick bursts. It is significant and attractive for energy futures sustainable. The key factors of flywheel energy technology, such as flywheel material, Flywheel shape and its supporting assembly are described, which directly influence the amount of energy storage . It is very suitable to such applications including, Cloud Mitigation for Solar PV, Mitigation for Wind, Wind/Diesel/Flywheel Hybrid, Stabilization of Distributed Generation (DG) Systems, Peak Power Support, Frequency Response Reserve (FRR), Uninterruptible Power Supply (UPS), Reactive Power Support (VAR support) and many other applications, with the view of new technologies the cost of Flywheel technology can be lowered and this technology will play a vital role in securing global energy sustainability.**

I. INTRODUCTION

Several hundred years ago mechanical flywheels used to keep machines run smoothly from cycle to cycle, thereby possible the industrial revolution. During that time many designs where implemented, but it took until the early 20th century before flywheel rotor shapes as well as rotational stress were thoroughly analyzed. Invented in 1970s flywheel energy storage was approach as a primary object for electric vehicles and stationary power backup. At the same time fiber composite rotors where ready, and in the 1980s magnetic bearings started to appear.Thus the potential for using flywheels as electric energy storage is established by extensive research. More recent improvements in material, magnetic bearings and power electronics make flywheels a another choice for a number of energy storage.



Flywheel Energy storage Module

A flywheel stores energy in a rotating mass. Depending on the inertia and speed of the rotating mass, a given kinetic energy is stored in the form of rotational energy. The flywheel is placed inside a vacuum containment to avoid friction-loss from the air and terminated by bearings for stability.

Kinetic energy is transferred in or out of the flywheel with electric machinery that can operate either as a motor or generator depending on the load angle. When motor is acting, electric energy applied to the stator winding is converting into torque and giving to the rotor, causing it to rotate and gain kinetic energy. In the state of generator kinetic energy stored in the rotor applies a torque, which is converted to electric energy.

II. VOLTAGE SAGS AND BLACKOUTS COMPENSATION

There are two rotating machine is used induction motor and dc generator induction motor is used as a load we have to used rectifier to ac to dc in our college setup dc motor used with flywheel coming ac source is converted into dc by connecting the rectifier from dc machine generate dc voltage sag compensator connect to dc side .

After compensate the voltage sag we get stable dc and these gives to ups (uninterupted power supply) UPS is nothing but inverter it converter dc to ac when normal power supply on what we get from voltage sag compensator then it convert to dc to ac by this converter and gives to load simultaneously stable dc from voltage sag compensator also used to charge the battery we will used it for blackout compensation when there is blackout dc machine will be shut down so in that case power store in battery used , battery gives output to ups then ups supply to load we get uninterrupted supply for load.

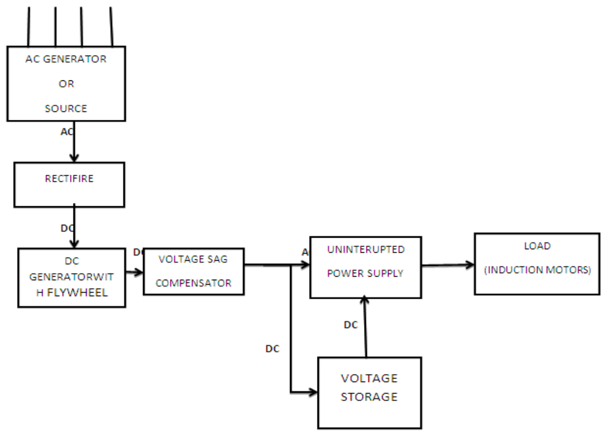


FIG.1. BLOCK DIAGRAM

III. UNINTERRUPTIBLE POWER SUPPLY (UPS)

A global industry expresses for Uninterruptible Power Supply (UPS) systems. Beacon's flywheels have the capability to supply extremly good backup power. As a replace for battery-based UPS , flywheel technology has the advantage of being virtually maintenance-free compared to maintenance-intensive and low reliable battery-based UPS. As Beacon scales up production of its flywheels for frequency control, we expect to lower costs based on the curve and affected by volume production. More time , we expect to be able to participate in the UPS market in a variety of secondary applications, especially those requiring much reliable and minimal need for maintain. Our core technology can use as part of a flywheel with a higher power-to-energy ratio, cost-effectively depending with some UPS application requirements.

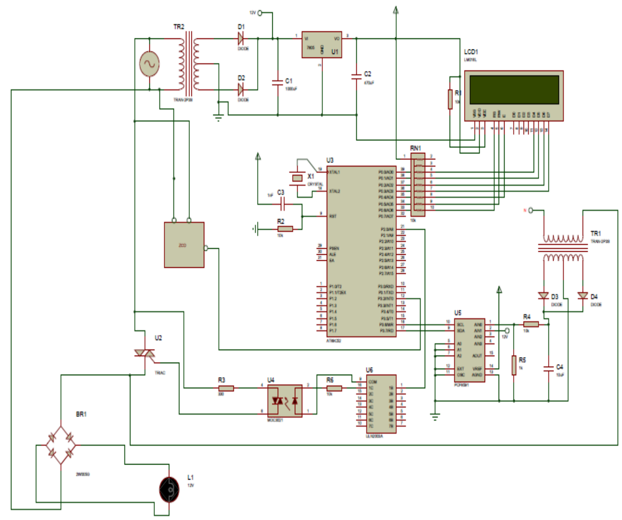


FIG.2.CIRCUIT DIAGRAM

IV. CASE STUDY

In the protection mode, the SEIG generates the output voltage resonating with the self-excited capacitor and its magnetizing inductor. The self-excited capacitor is an exciter of the induction generator. Therefore, the output voltage of SEIG varies with the capacitance of self-excited capacitor

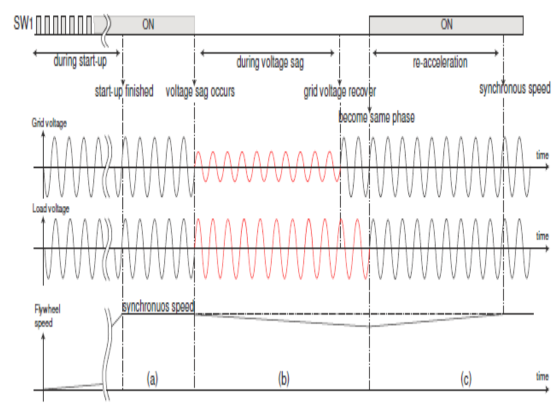


Figure 2: Operation chart of the inverter-less voltage sag compensator. (a) is idling mode and (b) is protection mode, and (c) is re-acceleration and idling mode.

In order to comprehend the output voltage characteristics with varying capacitance of the self-excited capacitor and the load capacity, a basic test model composed of an 11-kW, 200-V (line-to-line rms) squirrel-cage induction motor with a heavy flywheel of 220kJ was manufactured Under the condition of idling mode after the flywheel speed becomes approximately synchronous speed, the SW1 is opened and the flywheel discharges the stored energy to a resistive load.

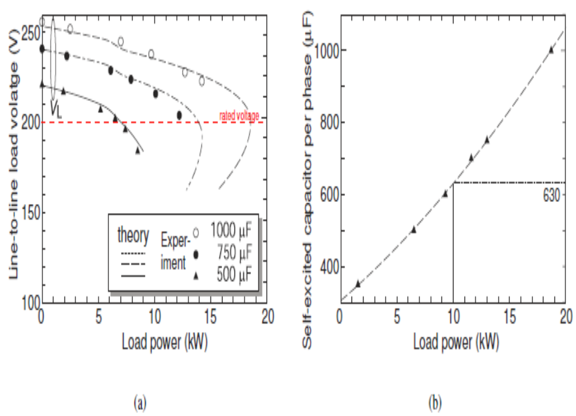
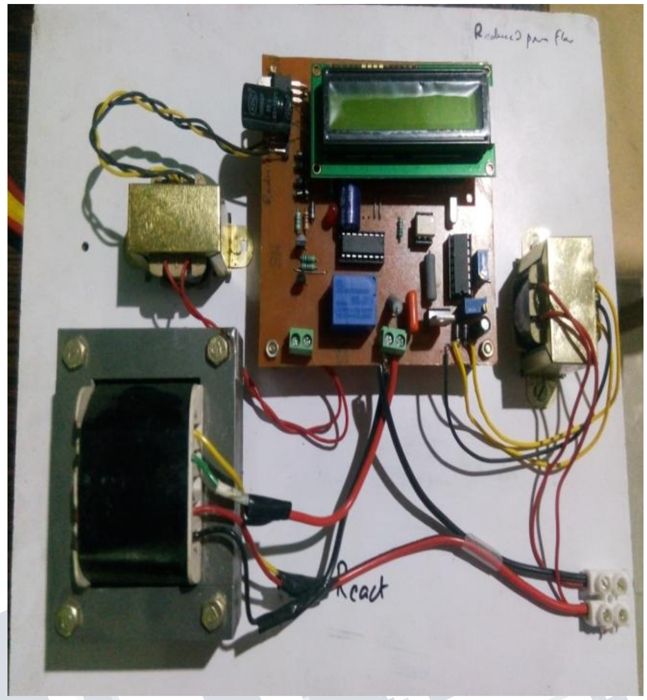
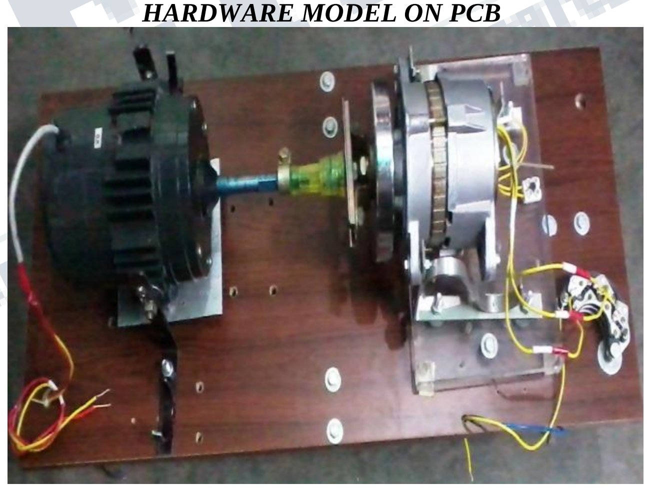


FIG. 3 BASIC CHARACTERISTICS OF FLYWHEEL

During 0.3 seconds after the open test starts, the flywheel keeps approximately synchronous speed because of the test model with the heavy flywheel. Thus, optimal capacitances of self-excited capacitor depending on the load capacity are investigated by measuring the line-to-line load voltage at 0.3 seconds after the SW1 was opened. Fig. 3(a) shows that the load voltage decreases with a heavy loading. Fig. 3(a) also indicates that the optimal capacitances exist versus each load capacity in order to compensate the load voltage as rated voltage of line-to-line 200 V. Experimental results are in good agreement with steady state calculations of the SEIG by an iterative method[5, 6]. Fig. 3(b) shows the optimal relationship curve between the capacitance of self-excited capacitor and the load capacity. From these results, in order to compensate the 10-kW resistive load, the capacitor of 630 μF (2.6 kvar/phase) is optimal. When the load capacity changes largely in the idling mode, shift to the optimal capacitance according to the Fig. 3(b) is important. The effectiveness of the flywheel system is confirmed by the voltage sag test using tap changing of the auto-transformer. The concept of blackout delay system is proposed and the usefulness of this system is experimentally verified by the field tests of the real industrial robot



HARDWARE MODEL ON PCB



V. CONCLUSION

A technical description of a flywheel energy storage system has been outlined. The main system components, i.e. flywheel, electrical machine, power electronics interface, bearing system has been discussed in details. It has been shown that composite materials are more advantageous when building flywheel rotors due to its higher tensile strength to density ratio. They allow high-speed rotation and therefore high specific energy, which enables compact design. There are multiple options when choosing the electrical machines. It can be concluded that a permanent magnet synchronous machine have robust design, mainly due to its efficiency and high power density. Standard flywheel systems have storage time variation from of 5 to 30 seconds, where the power electronics interface is the most significant factor which can increase the capital cost. Despite this, current development is aimed at rotor cost reduction by achieving higher specific energy and reduced rotor mass. Advanced bearing are being actively developed including the use of HTS magnetic bearings, to provide reduced losses, higher efficiency, reduced running cost and longer bearing life. Both these developments are particularly significant to systems with longer storage times more than one hour, where the rotor and bearing costs become the most significant. Successful reduction of rotor losses and costs will make flywheel systems attractive to a wide range of applications. The main markets for flywheel systems are UPS systems, power quality improvement, and traction applications. Flywheels can be cost completation with batteries in UPS applications. There are already some applications of high power (low energy) flywheel systems for new requirements are emerging for stability achievement and protection of wind farms opposed to network voltage dips. The development of less reduced cost systems with longer storage times can make flywheels comparatively more competitive with batteries in stand-alone renewable energy systems. As the grid is likely to swing into dynamic system with future development of smart grid technology, the conclusion can be drawn that the functional requirements on the power interface of the FESS is expected to increase. It should be able to handle the load and improve the power quality.

FUTURE SCOPE

A low cost hybrid BLDC motor can be constructed by using car alternator and the Flywheel energy storage system. The modification can be made on the alternator side, and the permanent magnets can be fitted on the alternator rotor so that the frictional losses of slip ring are removed. The ESC (Electronic speed controller, which is used in toy helicopters to run brushless out runner motor) which has two wire DC input and three wire DC output and is a MOSFET based controller. The same controller is used to run alternator as a Hybrid BLDC motor. The flywheel can be installed on alternator rotor shaft and the same alternator can be used as motor/alternator. New and advance materialistic engineering should pick the technology and with the advancement in materialistic science the weight of the flywheel can be reduced. With more inertia the material can withstand the amount of angular momentum that the Flywheel itself posses and the complex design of flywheel can be made simple, with lowering the starting cost and the efficientiancy value of the FESS.

Then after there is a potential to use magnetic levitation as a way to prolong ate the life of FESS since there is no friction on the system because of the magnetic levitation there will be no wear and tear of the system and hence system could last for more years when compared with conventional storage system like batteries, solar cell etc.

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