SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 6 | June 2021 - Peer Reviewed Journal

FLYWHEEL STORAGE SYSTEM

Vishal V. Mehtre[1], Rupsi Sharma[2]

[1]*Assistant Professor, Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, Maharashtra, India*

[2]*Student, Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, Maharashtra, India*

ABSTRACT

For the efficient use of available renewable energy in the form of solar,wind,geothermal, etc, reliable energy storage system is used so that variations in supply and demand can be smooth. The flywheel energy storage is a long lifetime uninterrupted power supply. Flywheel storage system is an alternative form of energy storage used in application like UPS ,etc. This requires high power to energy ratio. For long run storage it's important that there is less amount of power loss or dissipation due to friction. In this way the flywheel storage system can store kinetic energy for very long time and durable.

KEYWORDS: *Need for energy storage, Flywheel working principle, Kinetic energy, Flywheel components Power converter, Frequency regulation, Flywheel in uninterruptible power supply system , Flywheel versus battery*

1. INTRODUCTION

FESS known as Flywheel energy storage systems stores electric energy in terms of the kinetic energy. FESS is variable technology for energy storage because it is environment safe,can sustain infinite charge/discharge cycles,and has higher power. Flywheel energy storage system is between high power.A high power electric machine is fitted with some extra weight to sustain the power for a long enough time. Energy storage system play an essential role in providing continuous and high-quality energy. Energy storage flywheel are usually supported by active magnetic bearing AMB systems to avoid friction loss.So it can store energy at high efficiency over a long duration. FESS are competitive for applications that need frequent charge/discharge at a large number of cycles. Flywheel also have the least environmental impact amongst the latest technologies,since it contained no chemicals. So it makes FESS a decent candidate for electrical grid regulation to improve distribution efficiency.

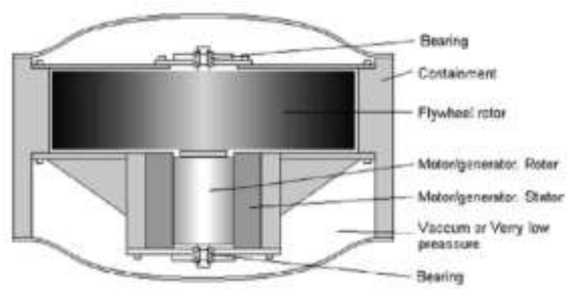

Figure 1. Basic scheme of the FES system

2. NEED OF ENERGY STORAGE

Energy storage system (EES) should provide three main functions, first, it plays a significant role in reducing the price of electricity by storing the electrical energy in off-peak hours to use it later in peak times. Second, it improves the power quality and prevent power fluctuation especially when it

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is associated with renewable energy system such as solar energy and wind energy due to the changes in the climate. Third, energy storage system helps to achieve the balance between the proper amount of the generated electricity with the varying demand, this can be achieved by monitoring second-to-second fluctuations in demand. Consequently, the need for energy storage system can be summarized in the need of flexible and continuous supply to consumers even during the power network failures, such as voltage sag which happens due to overload and can last for milliseconds, A UPS system based on energy storage system keeps supplying the electricity to the load during the sag period. As a result, energy storage system helps to utilize more generated power from renewable energy with high reliability and flexibility.

3. **WORKING PRINCIPLE OF FESS :** Unlike the Electrochemical based battery systems, the FESS uses and electromechanical device that store rotational kinetic energy E ,which is function of the rotational speed W and the rotor primary moment of Inertia.

A FESS consists of several key components such as rotor/flywheel ,a bearing system to support the rotor/flywheel, a power converter system for charge and discharge, including an electric machinand power electronics. And other components,
To achieve a higher energy capacity, FESS either inside a rotor with a moment of Inertia or operate at a fast spinning speed.Most of the flywheel rotors are made of either composite or metallic materials.When spinning the rotor is supported by operational bearings. The bearing can be either mechanical or magnetic. When spinning the rotor is supported by operational bearings are preferred for minimal standby loss and maintenance requirements. A mainstream choice is an electric machine like a motor/generator such as the device depicted.A motor/generator coverts the kinetic energy to electricity and vice versa.

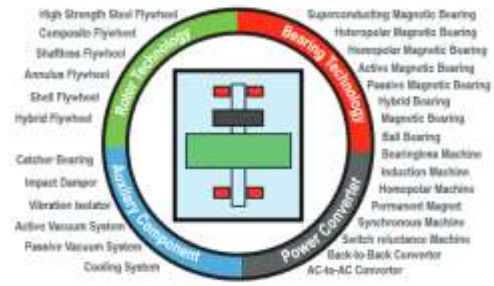

Figure 2. A overview of system components for a flywheel energy storage system.

4. **CONSTRUCTION OF FLYWHEEL ENERGY STORAGE SYSTEM FESS :** Mostly modern high speed Flywheel storage systems consists of a massive rotating cylinder (a rim attached to a shaft) that is supported on a stator- the stationary part of an electric generator by magnetically levitate bearings. To maintain efficiency, the flywheel system is operated in a vacuum to reduce drag.the basic principle is using the electric motor to drive the flywheel to rotate at high speed,converting electric energy into mechanical energy to be stored,when necessary the flywheel decelerate and the motor runs as a generator,converting the kinetic energy of the flywheel into electricity, so the acceleration and deceleration of the flywheel realize the storage and release of electric energy.the basic structure of the flywheel is shown in the figure.

Figure 3. Components of Flywheel System

Advantage of FESS

PMSM : higher power density,high efficiency small form factor
IM less cost more rugged simple construction
SRM more rugged simple construction
BM high integration level
MGR no power electronics more rugged simple construction

Disadvantages Of FESS

Higher cost less robust
Lower power density less efficiency
Higher slip ratio
Complex control less mature
Higher cost and complexity
Less mature

5. COMPARISON BETWEEN FLYWHEEL AND BATTERIES

The advancement in enerygy storage system have lead us to many energy storage devices but the anicient and still in use popular device is battries, so let's see the comaparison between these two rivals.

Category	Flywheel (4340 steel)	VRLA Battery
Life Span (Years)	20	5
Efficiency	95%	85%
Power Density (W/kg)	115	35
Hazardous Material	None	Yes
Maintenance	Limited	Extensive
Operating temperature	40 ˚	25 ˚
Embedded carbon emission (CO_2/kg)	2.23	1.14
Total energy storageweight for 1MW (kg)	3,084	14,693
Total embedded carbon(CO_2/kg)	6,785	16,750
15years replacement	0	3
Total life cycle embedded carbon	6.785	67,002
Cost ($ / kWh)	~1000	~360

Table 1: Comparison between flywheel and VRLA battery

6. CONCLUSION

In this paper, some of the characteristics of the flywheel storage system have been discussed which will be helpful to select the flywheel storage system over battries will will be very efficient and it improve the power quality and enhancement of the network reliability and stability.We have also gone through the construction and the working principle behind the Flywheel Storage System. Flywheel Storage System are now used extensively in many applications related to power system such as telecommunications, utilities load leveling, and even in some additional applications in satellite engineering as well.

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