

Modeling and Simulation of Superconducting Magnetic Storage System in Power Systems: A Review

Amit Kumar¹, Ashish Bhargav²

¹Research Scholar

²Professor Electrical Engineering Department, Bhabha Engineering Research Institute, Bhopal

Abstract - Subject field of the energy charging, storing and discharging characteristics of the Superconducting Magnetic Energy Storage system have been theoretically studied in the time to make an integrated mathematical model and the simulation model to analyses the characteristics of charging and discharging practically in MATLAB. In this dissertation a novel controller is designed for controlling the Magnetic Energy storage system ensure:

(a) Fast return of energy to the super-conducting coil under constant current mode and

(b) A constant and sinusoidal input supply current irrespective of the varying load demand with and without harmonics.

A special feature of this controller is its ability to smoothly charge the superconducting coil using constant current charging so that it can be ready for the next discharging operation as soon as possible..

Key Words: Zero Voltage Switching, Maximum Power Point Tracking, Photovoltaic Module

1. INTRODUCTION

Superconducting Magnetic Energy Storage Devices can store the excessive electronic energy as electromagnetic energy in high temperature superconducting inductors and releases the stored energy if required. MES is a large superconducting coil capable of storing electric energy in the magnetic field generated by the current crossing through it. The real Power as well as the reactive power can be absorbed or by release from the MES coil according to system power requirements. The advantage of MES devices compared to the other energy storage devices are high energy storage density, high energy storage efficiency, long application lifetime and few environmental pollutions. So, the major application of Superconducting Magnetic Energy Storage (SMES) system is in Power system load leveling, Power system stabilizers, Fault Current Limiter and voltage support for critical loads because of SMES high efficiency and speedy reaction to power demand. To develop the superconducting inductor or magnet used in MES system is mainly contributed from superconductivity field while the basic energy storage is contributed from the storage devices. Currently the

worldwide theoretical and observational studies of MES mainly focus on the interactive influences between Magnetic.

2. LITERATURE REVIEW

A limited number of studies have been undertaken on illumination and visibility in the context of their impact on superconductive magnet. The following segment depicts previous research work carried out by different investigators in India and abroad.

S Zahid Nabi Dar: In this paper, work on the superconductive magnetic storage system using a superconducting inductor in the network and verify its result mathematically and also by stimulation on MATLAB.

D. Sutanto: The paper describes about the controller used in SMES to control the discharging of the inductor and also introduces the study on current researches on power system application of SMES system.

H. J. Boenig: The paper introduces the first moving conduction cooled high temperature superconducting magnetic energy storage system built up in China.

M. A. Daugherty: The paper investigates the impact of integrating a Battery Energy storage system and Superconducting Magnet Energy storage across the DC us of static compensator.

J. R. Cave: The work the High Temperature Superconductor of the inductive type with iron core has been explained and fabricated by this report.

T. Verhaege: The Superconductor is cooled by liquid Nitrogen at 77K and the prototype less than 1kVA has been fabricated. The reasons which affect or degrade the operation of the Superconductor Fault Current Limiter are investigated.

K. Kajikawa: The design and simulation using the numerical calculation model in the computer of magnetic-shield type superconducting fault current with high Tc Superconductor limiter has been reported by in this report.

X. Y. Chen: In this paper the principle of the High Temperature Superconductor Fault Current Limiter with resistive and shielded core type has been excused.

Joe H. Chow: This paper describes formation of the America Superconductor in 1987 enhances the evolution of the High Temperature Superconductor applications.

S. P. Carullo: The aim of this MATLAB based Power System Toolbox is to supply a flexible environment for performing power system simulations.

3. THEORY

An overview of Energy stored in a normal inductor will fade out rather quickly due to the ohmic resistance in the coil when the power supply is disconnected. Obviously, this will not be an acceptable energy storage for use in a power system. The ohmic resistance has to be removed before an inductor can work for this purpose. This is possible by lowering the temperature of the conductors, and by this making the conductors superconducting. A superconducting wire is in a state where the resistance in the material is zero. In this state the current in a coil can flow for infinite time. This can also be seen from the time constant of a coil. There are constraints for a superconducting wire to stay superconducting.

In the U.S most of the work had been done in the University of Wisconsin and Los Alamos labs. A 30 MJ (8.4 KWh) SMES was installed and commissioned at Bonneville Power Administration (BPA) substation in Tacoma Washington, [1] it was designed primarily to damp the dominant power swing mode of the Pacific AC intertie. In 1984 Bechtel under contract from EPRI came out with a detailed design of a 1000 MW (5500 Mwh) set [2]. There have since been conceptual design improvements. The Japanese have been doing work on it and have come out with a conceptual design for a 1000 Mw set [3]. Work has begun for a 20 Mwh SMES unit for Madison Gas & Electric Company. Most of the research effort has been concentrated in optimizing the magnet design. The two important shapes for SMES applications are solenoid and the toroid from which there have been a lot of variations, like in solenoids there is the single tunnel [4], multitunnel [5], low aspect ratio [6], single layer, multilayer and in toroid's the variations are force balanced schemes [7] and quasi force free [8] structures.

4. CONCLUSIONS

The integrated MES mathematical model has been proposed and developed, with the simulated results obtained, which shows that the developed MES model with certain given input parameters can output the corresponding charging, and storing characteristics at any one time, e.g., the stored energy of the power inductor, the consumed energy of the power inductor of the developed MES.

The model proposes a method to link Superconducting inductor to Matlab function to design and to implement controlled SMES, by this design we came to know that the

Superconducting inductor is very energy efficient and conserves power for the discharging purpose.

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