INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATIONS AND ROBOTICS
ISSN 2320-7345

MODELLING OF SMES BASED DVR MODEL IN SIMULINK

[1]Shruti Agrawal, [2]Lumesh Kumar Sahu

[1,]M.Tech Research Scholar, EEE Department, Kalinga University Raipur (Chhattisgarh)
[2,]Asst. Professor, EEE Department, Kalinga University Raipur (Chhattisgarh)

Abstract: - In this paper, A SMES predicated DVR model is presented and Modelled with the avail of simulink block. Superconducting magnetic energy storage(SMES) is considered as the future energy storage contrivances. In this work SMES is utilized for storing the DC energy and at the time of Requisite provide this energy to the main line with the avail of DVR (Dynamic Voltage restorer). Simulation Result shows the emolument competency of this DVR

Keywords: PI (Proportional Integration), VSC (Voltage Source Converter), DVR (Dynamic Voltage Restorer), SPWM (Sinusoidal Pulse Width Modulation).

I. INTRODUCTION

Now day's power systems have been witnessing tremendous changes and drastic perturbances in electric power generation and system, power Transmission, distribution of potency , and culminate-utilizer facilities. Wide applicability of puissance electronic contrivances in power system engineering makes the quality of the power a paramount aspect in today's power scenario[1]. It is the responsibility and obligation of the utility to provide a pristine sinusoidal voltage of obligatory magnitude and frequency at all the time and without any delay to its consumers. But, in realism, it is not feasible to optically discern ideal waveforms. The waveform of the voltage gets perturbed from ideal waveform cycle due to frequent occurrence of supply distortion like voltage sag, voltage swell, interruptions, flicker fluctuations etc. and withal due to the heftily ponderous utilization of non-linear nature loads. Such voltage perturbance deplorably affects the performance of equipments connected in the system[2]. The industries such as process industries, semiconductor industries, petrochemical industries, chemical industries, paper mills etc. utilize apparatus and equipment's which are very sensitive to voltage perturbances. Poor quality of the voltage may cause in termination of the process, data loss in digital contrivances etc., and hence engender astronomically immense financial loss to consumer[3-6]. Out of the different voltage distortions, voltage sag is a frequent perturbance which in power system. Voltage sag is responsible for 92% of the interruptions in industrial installations. So with the aim of surmounting this deficiency SMES predicated DVR is utilized for amending the performance of potency system as it is of high power rating with optimum efficiency than any other energy storage contrivances[7]. This paper present a super conducting magnetic energy storage unit, as the energy storage unit of DVR.

II. PROPOSED DVR

A. Configuration of SMES based DVR

Dynamic Voltage Restorer (DVR) is one of the efficient customizable power contrivances that can be utilized for ameliorating power quality from any kind of electrical perturbances in the distribution line. The DVR can be utilized for forfending and recuperating or recuperating the voltage quality to the sensitive load. A set of three phase voltages with a congruous amplitude and period can be injected through injection transformer and must be in phase with the grid voltage. A DVR is a solid state power electronics switching contrivance consisting of either GTO or IGBT, a bank of capacitor as an energy storage implement and injection transformers.

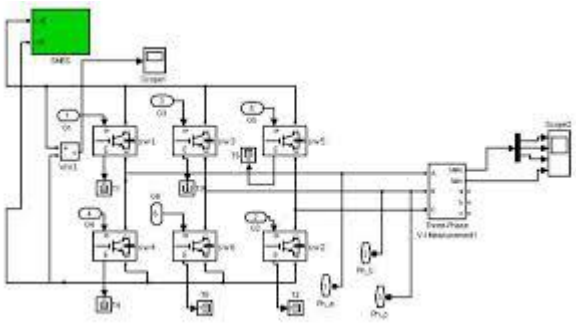

Figure 1 SMES based DVR

B. SMES Device

SMES systems are a budding technology which exploit the properties of superconducting material to store energy in magnetic fields. SMES systems have very expeditious charging and discharging times which build them an alluring energy storage system for mitigation of sag. Another benefit of SMES systems is the very low losses due to the superconducting characteristics. It consists of super conducting magnetic energy storage unit, bank of capacitor , VSI, low pass filter and voltage induction transformer. It compose of main system and its sub systems. The super conducting coil is the consequential section of SMES system, which is placed in a cryostat or dewar which consist of a vacuum vessel and a liquid vessel. Liquid vessel keeps the system temperature under control by providing opportune cooling setup cryogenic system, it withal keeps the temperature below the critical temperature. Conclusively a transformer is additionally utilized which perform the puissance system connection and co-ordination and PCS operating voltage will trim down to acceptable levels.

C. Control Section

Sag in Voltage is artificially engendered in a simulation at load terminals by three phase faults block which is utilized for this vary purport. In the next step, Load voltage is converted into a per unit voltage quantity.
Comparison of the applied voltage with the reference voltage is then performed which engender the error signal which is then again victualed to the PI (Proportional Integration) controller.
The output voltage is then given to the SPWM(Sinusoidal Pulse Width Modulation) control predicated triggering circuit. In this control circuit, three phase sinusoidal voltage is engendered which is alimented to the load voltage. Error signal is processed by the PI(Proportional Integration) controller to engender the congruous angle δ to drive the error to zero. The input to the PI controller is the actuating signal which is the difference voltage between Vref and Vin
The output of the controller gives the required firing sequence. Main job of the controller in the DVR circuit is to detect the voltage sag/swell in a system. Calculation of the rectifying voltage, engendering the trigger pulse, rectification of the any anomalies in the series voltage injection along with the terminate the triggering pulse after events is over are some other function performed by the controller. Controller withal take care of charging and discharging of the capacitor in the DC energy link during the absence of Voltage sag/swell , by shifting DC-AC inverter in to rectifier mode.

The dqo transformation or Park's transformation is utilized in this simulation to perform DVR controlling.
The depth of the sag and amount of phase shift information is given by the dqo method. In this method, first of all a-b-c reference voltage is converted in to a d-q-0 reference. Zero phase sequence of the d-q-0 is ignored here for simplicity. The detection of the sag and Swell is carried out in each of the three phases. Quantified terminal voltage is denoted by Va, Vb,Vc . Voltage detection is carried out when the supply voltage drops below to 90% of the reference voltage while the voltage swell is detected when the supply voltage goes up to 25% of the reference voltage. The error signal from the control is utilized here as a modulation signal for engendering the commutation pattern for the switching the power switches (IGBT's) of the voltage source converter.
temperature under control by providing opportune cooling setup cryogenic system, it withal keeps the temperature below the critical temperature. Conclusively a transformer is additionally utilized which perform the potency system connection and co-ordination and PCS operating voltage will trim down to acceptable levels.

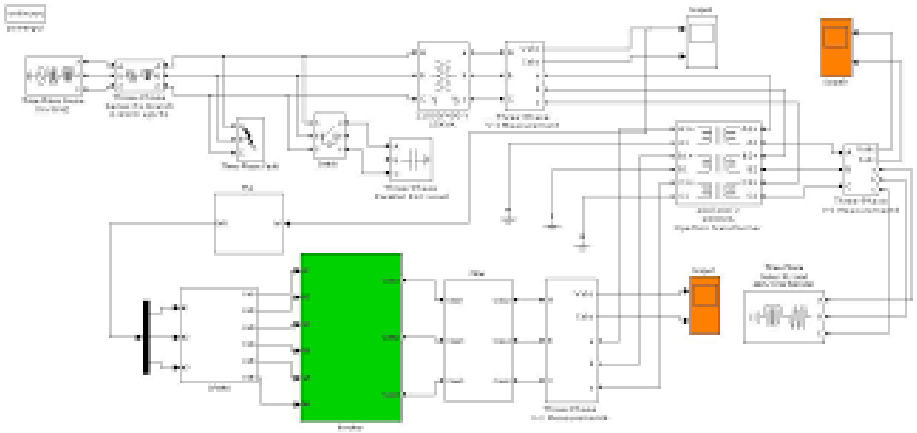

Figure 2 Proposed Simulink Block of SMES based DVR

This commutation pattern is generated with the help of the sinusoidal pulse width modulation method. PLL circuit is used to generate the sinusoidal voltage of unit amplitude and in phase with the line voltage.

III. SIMULATION RESULTS

To validate the proposed technique for implementation of SMES predicated DVR a MATLAB simulation is carried out. A MATLAB simulation is carried out in following steps for analysis purport from fig 4.3.2. The first simulation was done without DVR and a three phase fault is applied to the system at point with fault resistance of 0.001ohm and for a time duration for 0.2-0.7 secs The second simulation is carried out at the same scenario as above but predicated DVR is now introduced at the load side to compensate the voltage sag occurred due to the three phase fault applied.. The working of SMES predicated DVR for voltage emolument at 0.001Ω fault resistance. The DVR performance in presence of SMES is analysed for symmetrical 3phase fault .
Step1. Generation of voltage sag due a three phase fault in the transmission line without SMES predicated DVR. Triple line to ground fault.
Step2. Generation of compensating voltage utilizing d − q theory.
Step3. Implementation of SMES predicated DVR.
Step4. Emolument of voltage sag for type of fault utilizing SMES predicated technology.
Triple line to ground fault.

In order to carry out the testing of the above mentioned method of DVR, simulation model was designed and developed under the MATLAB environment in SIMULINK. Simulation of the simulink model is carried out in MATLAB.

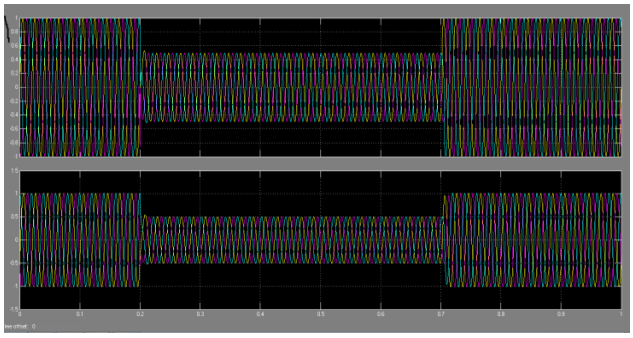

Figure 3 Simulation of three phase load voltage & current without DVR with three phase fault

Fig 3 represents the emolument without DVR with simulated three phase fault utilizing SMES coil as storage coil. Here transition time of 0.2-0.7 seconds of fault occurrence is taken with fault resistance of 0.001 ohm is taken. On occurrence of 3 phase fault the voltage profile of the system reduced from +1 pu to-1 pu then to 0.5 pu to -0.5 pu . Thus reducing the entire voltage profile to 50% of the fault .On abstraction of three phase fault voltage profile has recuperated as system is able to withstand these transients and able to retain its stability.

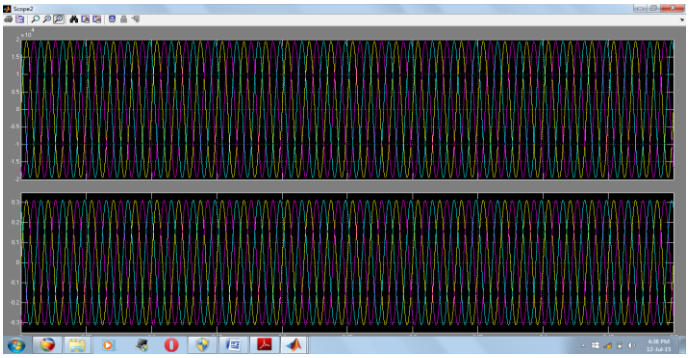

Figure 4 Compensation with DVR without three phase fault from

without simulated three phase fault utilizing SMES coil as storage coil..Thus the entire voltage profile remain same to 100% (+22 kv to -22 KV) despite DVR remain in standby mode & the injection voltage in lieu of missing voltage is zero as the entire voltage profile is maintained.

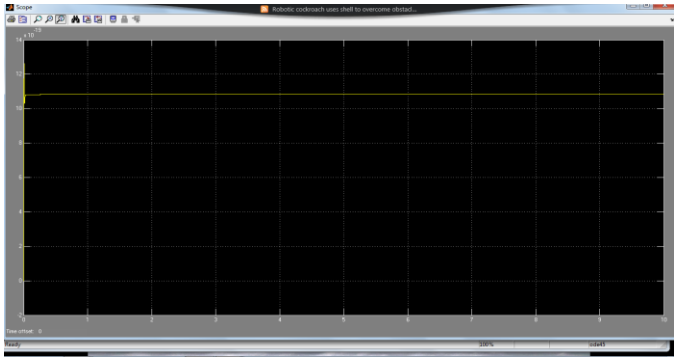

Figure 5 DC Current through SMES coil during standby mode

Figure 5 Represents the DC current flowing through SMES coil during normal mode .The coil having charging and discharging time as 0.3 sec/0.7 sec

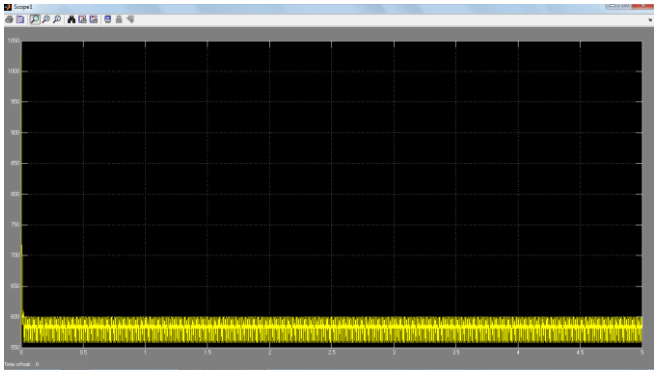

Figure 6 DC link voltage of SMES coil

Figure 6 Represents the DC voltage across capacitor .This is the dc link to link voltage feed to dc-dc chopper is basically a pulsating DC converted into pure DC at chopper output terminal.

IV. CONCLUSION

This paper present the SMES(superconducting magnetic energy storage) predicated dynamic voltage restorer (DVR) for mitigating the voltage sag/Swell in line voltage. In this model SMES is utilized as a DC storage unit which store the DC energy during the mundane mode of DVR operation and at the time of Voltage sag/Swell this SMES unit provide the emolument voltage to the line with the avail of Controller. The result obtained from the simulation reveals that this SMES predicated DVR is able to compensate the voltage sag/Swell during the line faults and at the same time able to give e3xcellent voltage regulation. This SMES predicated DVR compensate the voltage sag/swell in both balanced and un-balanced load

V. REFERENCES

[1] N.G. Hingorani, ―Introducing Custom Power in IEEE Spectrum,‖ 32p, pp. 4l-48, 1995.

[2] IEEE Std. 1159 – 1995, ―Recommended Practice for Monitoring Electric Power Quality‖.

[3] P. Boonchiam and N. Mithulananthan, ―Understanding of Dynamic Voltage Restorers through MATLAB Simulation,‖ Thammasat Int. J. Sc. Tech., Vol. 11, No. 3, July-Sept 2006.

[4] M.H.Haque ―Compensation of distribution system voltage sag by DVR and DSTATCOM‖ Power Tech Proceedings, 2001 IEEE Porto, Volume: 1, 10-13 Sept.2001 Pages: 5 pp. vol.1.

[5] IEEE Task Force on Benchmark Models for Digital Simulation of FACTS and Custom-Power Controllers,T&DCommittee,‖ Detailed Modeling of Superconducting Magnetic Energy Storage (SMES) System‖, IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 21, NO. 2, APRIL 2006.

[6] Jianxun Jin and Xiaoyuan Chen, ―HTS Inductive Magnetic Energy Storage with Power Control Technology.―

[7] H.P. Tiwari, Sunil Kumar Gupta ,‖DVR Based On Fuel Cell: An Innovative Back-Up System,‖ , International Journal of Environmental Science and Development, Vol.1, No.1,April2010,ISSN:2010-02.