ABSTRACT

Power Quality (PQ) has been a highly remarkable issue in distribution network. Increasing use of semiconductor based electronic equipment, non-linear loads and rapid addition of non-conventional energy sources into grid network throws challenges for the PQ environment.

PQ is affected due to the disturbances in transmission and distribution lines of the power system network. Roughly, 91 percentages of PQ issues are caused by voltage sag and harmonics. The voltage sag is a major concern in the transmission and distribution system due to the disturbance at remote bus. The harmonic currents are generated by non-linear loads present in the system. The modern industrial equipments are more sensitive to PQ problems and it is necessary to maintain better quality of electrical power.

Superconducting Magnetic Energy Storage (SMES) coil based Dynamic Voltage Restorer (DVR) with optimal controllers are proposed to improve the PQ. The SMES based DVR provides a technically advanced and economical solution to voltage sag compensation. The voltage restoration process involves real power injection into the distribution system and it depends on energy storage capacity of DVR.

The three kinds of optimal controller techniques with SMES based DVR have been proposed for PQ improvement, namely

i. Optimized Dual Fuzzy Flow (ODFF) controller.
ii. Phase Alternate Fuzzy Controller (PAFC)

iii. Sophisticated Neural Network Controller (SNNC)

The first optimal controller uses least active power which is stored in the SMES system for voltage sag compensation. It reduces Total Harmonic Distortion (THD) and sag compensation time during extreme variation in the phase voltage level.

The second optimal controller is based on phase adjustment as pre-sag compensation to restore amplitude and phase angle of the sensitive load voltage. Further it uses the phase change approach based on direct quadratic (d-q) synchronous reference frame to determine DVR reference voltage.

The third optimal controller uses SNNC based Voltage Sag Compensator (VSC) integrated with SMES device. The initial and steady state voltage sag compensation for sensitive loads have been carried out through SNNC theorem. The THD reduction has been achieved by Fast Fourier Transform (FFT) algorithm with SNNC theorem.

Three phase four-wire distribution system has been considered for simulation experiment. The proposed feed forward control strategy of the DVR shows that there has been a significant reduction in THD and improvement in the voltage sag compensation. In addition, an improvement in power factor, proper reactive power injection at the time of voltage sag and exact phase angle during the voltage injection process has been achieved.