Modelling Of PSO - Multilevel Converter To Compensate Unbalanced Voltages

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Abstract: This paper proposes a concept of multilevel H-bridge converter based STATCOM to compensate the voltage fluctuations. The control structure of STATCOM is implemented with conventional PI and PSO controllers. The reference signals required for the PSO controller is obtained by dc link voltage of STATCOM. Both the proposals can be controlled to the various objectives such as regulation of voltage,reactive power and harmonic cancellation and unbalanced remuneration. An interesting application for APF based on the PSO can be an increase in the quality of the energy and exposition of the electric train traction power supply system. Pont h based on APF as well as the control strategy they offer is simulated

Keywords: Multilevel Converter with medium voltage- large current, Harmonics,unbalanced compensation, PSO Controller

1. Introduction

The medium voltage DG systems converters are used to control AC systems. This makes the network load to operate under undesirable conditions, that is to say a reactive, uncontrolled power and execution of a significant imbalance [1]. Therefore, it is linked in a problem of avoid ability must be resolved at the same time to reach the level of quality of energy is acceptable. Multi-level Diode (DCMC) and Diode (FCMC) (FCMC) (FCMC), which introduces FBCC decreased total loss with higher reliability [2]. A Delta-connected FBCC cannot produce zero sequence component that crosses a four-wire neutral. In addition, unbalanced load balancing using FBCC STAR-CONNECTED facing few complications. Suppose that the FBCC connected APF is to balance three different active power supplied by sources. Then the average actual power of an individual has good circulation in or out of the connected individual complete bridge converter series (leg). It is a good result, accumulation of DC link or unload the capacitor at the foot of it. In other words, the current is not balanced on the connected star FBCC imposes an active power of uneven exchange with the FBCC foot [3].

Therefore, this paper a novel type of topological H-BRIDGE was proposes as the APF to achieve maximum compensation MV-LC load, i.e, elimination of harmonics, compensation of reactive powers and in particular to balance the DG systems [4,5]. Therefore, here H-BRIDGE proposed consisting of parallel connection of several H-BRIDGE converters. The major differences between conventional H-Bridge and parallel connected H-Bridge: 1) two or more H-Bridge DC-link general terminals; and 2) the existence of clutch inductors that reduce currents that are very circulating among them. H-BRIDGE generate waveforms for a higher quality network as compared to the H-BRIDGE, easing fears of conductive electromagnetic interference in large applications today [6-7]. This article was originally focused on the description of the H-BRIDGE-based APF, both power and control circuits of the proposed algorithm.

2. Statcom H-Bridgecontroller

The HBCC bridge-based APF is connected to parallel as shown in fig1. Each star connected HBCC has three or four legs.Here, in this case one HBCC is connected to positive leg and other one connected to negative leg. To compensate for the load of three distorted wires, the converter can consist of two HBCC finishing three legs. The number of identical switches is ‘n’ and (N+1) is the number of levels in H-bridge converter [8-9].

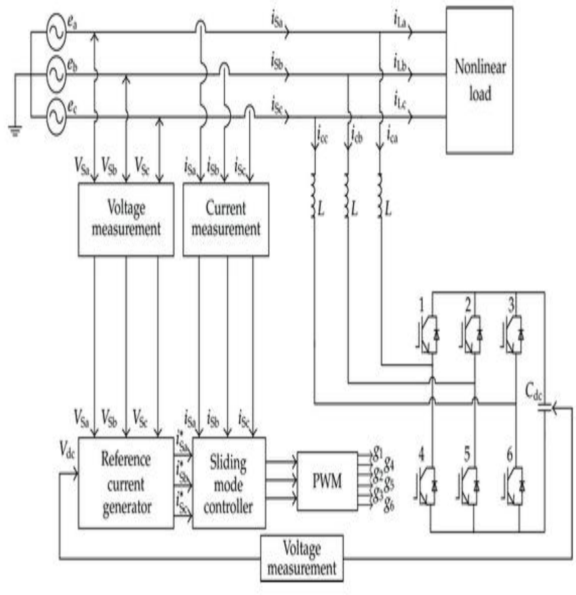

Figure 1: Structure of APF circuit

Figure 1 shows the structure of active power filter which is used to maintain the voltage regulation of dc-link capacitor. Given the detailed description of the proposed H-BRIDGE in Figure 2, [10] respectively, at any instance HBM is able to produce both VCM and zero. Hence, the voltage generated from flowing HBM n varies in [0, VDCM], whereVDCM = nVCm.

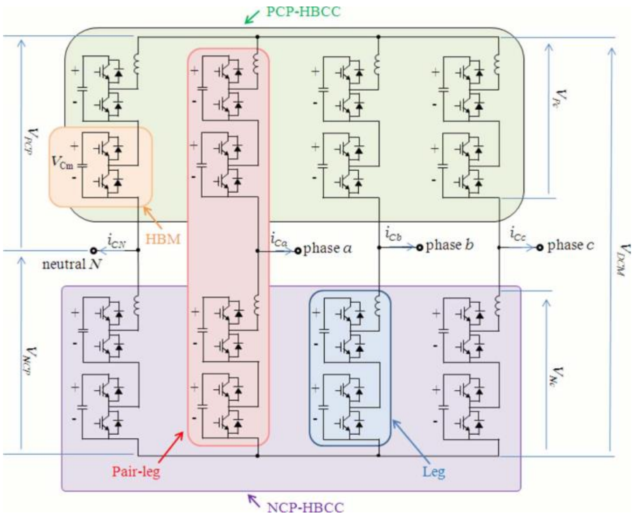

Figure 2: H-BRIDGEMulti-Level Converter Model

Particle Swarm Optimization

Swarm intelligence techniques is one of artificial intelligence, this technique is based on the collective behavior of a system of decentralized and self-organized. The main advantage of this technique for applying optimization proposed for the hybrid system is to get less oscillation in the system compared to the conventional P & O. Appropriate literature survey method, which previously only applied techniques PSO as photovoltaic systems for extracting the maximum power [17].

The expression for identification of current position of particle and G_{best} is shown as,

$$v_{n+1} = v_n + c_1 rand1()*(P_{best,n} - CurrentPosition_n) + c_2 rand2()*(g_{best,n} - CurrentPosition_n)$$

Analysis of PSO Technique:

The main aim of PSO technique is to track the best optimal solution from the system using maximum number of iterations required to converge. However, the dc link voltage of the multilevel converter is not constant, because it depends on the system stability conditions. The proposed PSO algorithm shown in figure 3 is to propose a new optimization every instant based on the present system conditions. The expressions for fetching new optimization is shown below [18-19],

$$|v(i+1) < \Delta v|$$

$$(pi(k+1) - pi(k) / pi(k) > \Delta p)$$

Step 1: Selecting the parameter: Identify the fitness value of the proposed converter i.e dc link voltage.

Step 2: PSO Initialization: Here, PSO particle is usually initialized at random from the basic values.

Step 3: Evaluate the physical form: Fitness assessment particles I will do after the PWM digital controller sends commands according to the cycle, which is also the position of the particle I.

Step 4: Identification of best fitness in both global and local. This identification is done by comparing Gbest and Pbest with one another.

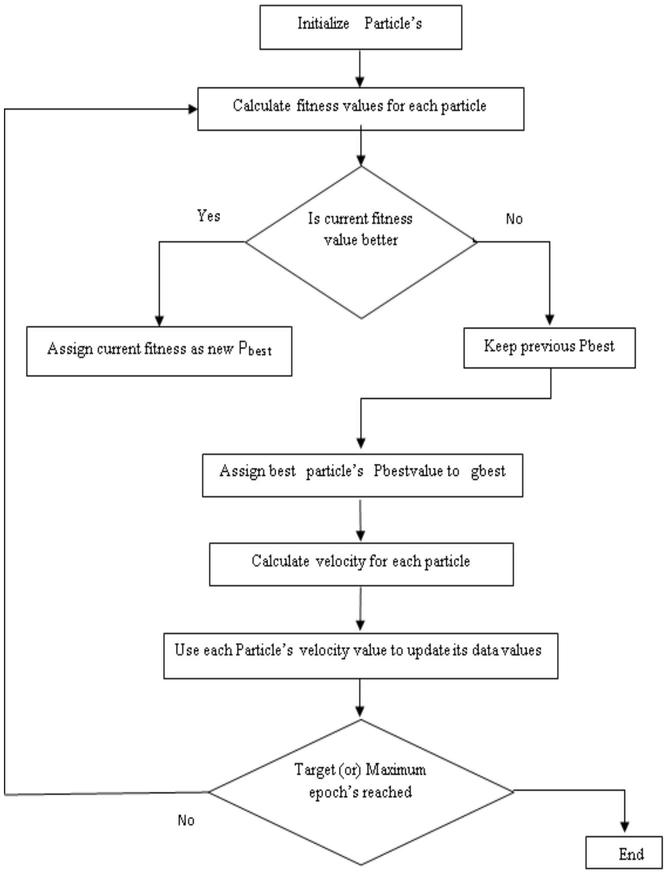

Fig 3: Algoritham for PSO Technique

H-Bridge-Basedapf

Here, the Pont H based on the proposed APF for complete compensation for MVLC loads such as electric traction system. A basic structure of APF has two bridge H, shown in FIG. 4 [11-13]. Although all the bridge h has same electrical specifications, all the NCP legs connect together, and the same thing is done for altogether the legs of PCP to reach a better arrangement for capacitor voltage. Therefore, voltage on HBM capacitor arrangement has managed without energy transfer circuitor additional connection.

A. Modelling of EH-Bridge Converter:

Considering the current sharing discussed for the H-Bridge-based APF, the expression for instantaneous voltages is calculated using the following expressions [14-15],

$$\begin{bmatrix} V_{NX-ref} \\ V_{px-ref} \end{bmatrix} = \begin{bmatrix} V_x - L_f \dfrac{(i_{cx-ref} - miC_x) f_{sc}}{2m} + \dfrac{V_{DCM}}{2} \\ V_x - L_f \dfrac{(i_{cx-ref} - miC_x) f_{sc}}{2m} - \dfrac{V_{DCM}}{2} \end{bmatrix}$$

The carrier signal is used for all displaced air-driven bridge with respect to reduce APF output ripple current as follows:

$$\tau = \frac{1}{f_{c1}^{nm}}$$

3. Simulationdiagram And Results

The simulation is done based on the figure 1 [16]. The simulation diagram for the proposed grid interfaced system with APF is shown in figure 4.

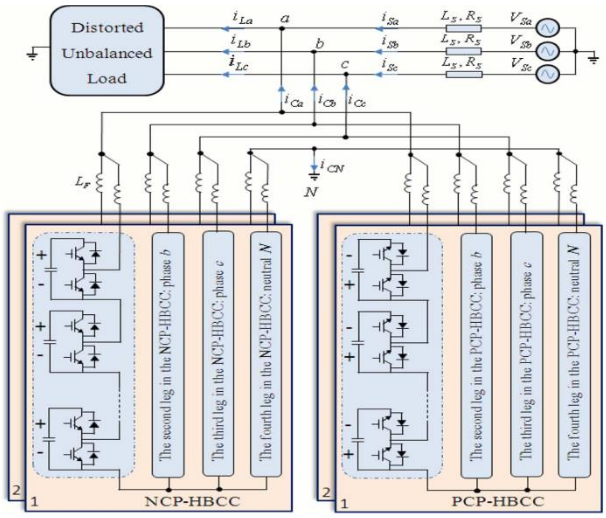

Fig 4: Structure of H-BRIDGE Active Power Filter

This proposed system is tested and verified using MATLAB Simulinkand they are linked together using MATLAB of the PSIM. Suppose that 25 kV network providing the deformed unbalanced loads in the electric rail applications. The separate simulation is defined for the H-Bridge-based Pont H and APF at ± 15 MVA.

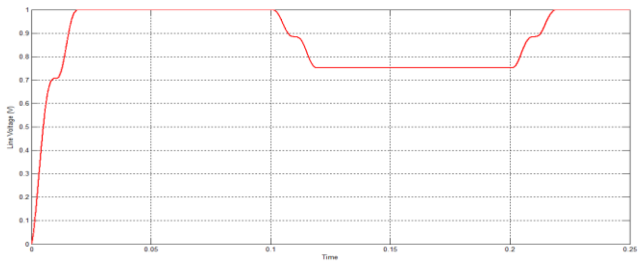

Figure 5: Simulation Result for Line Voltage under RMS without DAPF

Figure 5, shows the simulation result for RMS line voltage of proposed system without Active Power filter. Here, the system is affected by fault condition during the period 0.1s to 0.2s. The effected sag condition in line voltage is shown in figure 5. The sag condition is reduced by implementation of active filter in proposed system. The compensated line voltage and its active power is shown in fig6 and fig7. Figure 8 shows the simulation result for line current. 21.32% is the THD for line current as shown in fig9.

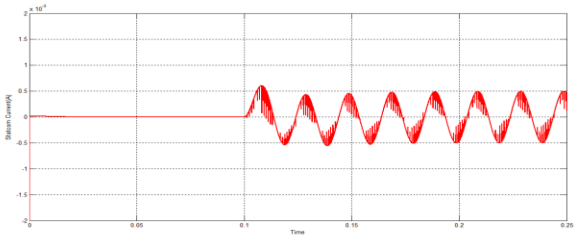

Figure 6: Simulation Result for Line Current under RMS without DAPF

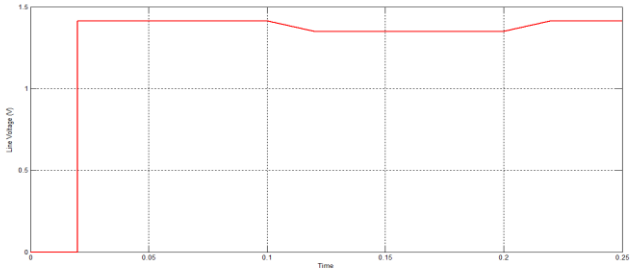

Figure 7: Simulation Result for Line Voltage under RMS with DAPF

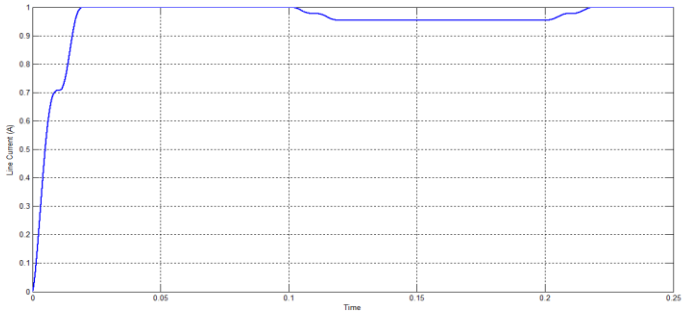

Figure 8: Simulation Result for Line Current under RMS with DAPF

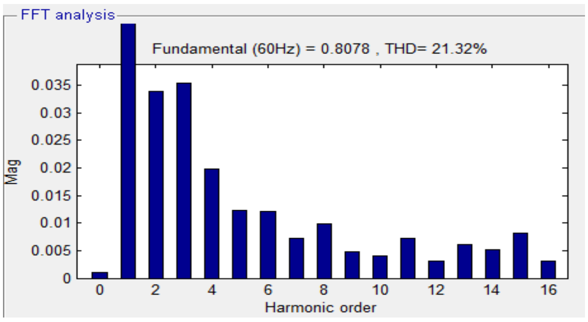

Figure 9: THD value for Line Current with H-Bridge Converter

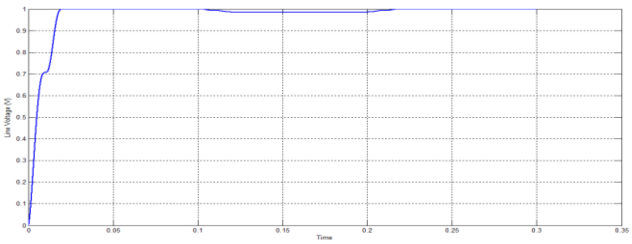

Figure 10: Simulation Result for Line Voltage under RMS with DAPF and PSO

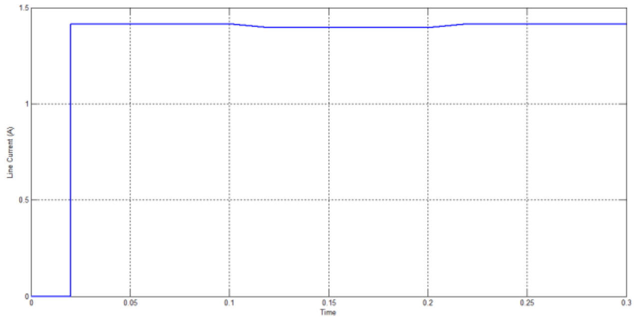

Figure 11: Simulation Result for Line Current under RMS with DAPF and PSO

The control structure of active power filter is implemented with particle swarm optimization controller to control the reference dc voltage. The compensated voltage of faulted current with PSO controller is shown in figure 10 and figure 11 shows the simulation result for line current. 9.92% is the THD for Line voltage with PSO controller. With these, the PSO controller produce better harmonic distortion and compensation as compared with conventional controller.

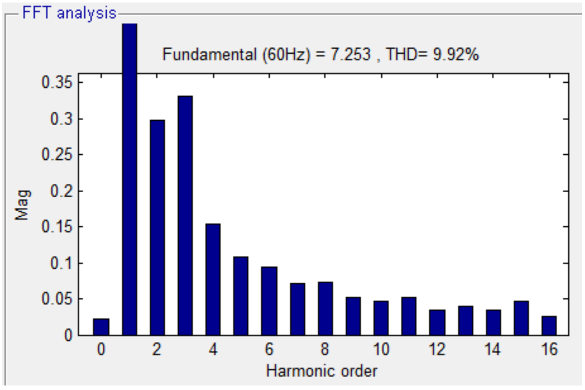

Figure 12: THD value for Line Current with PSO

4. Conclusion

A new type of PSO based Multilevel STATCOM controller is proposed in this paper to compensate unbalanced and distorted voltages effected by the presence of the loads and the harmonic source. The PSO is a modular optimization technique used to control the reference dc signals of STATCOM controller. Various control strategies recommended for the H-Bridge deck to engender the reference current for compensator, pursued by conventional PI controller to attain appropriate reference voltage. Additional controller, i.e, PSO is the responsible for regulation of entire DC binding capacitor voltage at the pre-determined level. The results of simulation were compiled for the both APF based on H-bridge and PSO.

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