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Enhancement of Power Quality using active power filter in a Medium-Voltage Distribution Network switching loads

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***Abstract*--- This paper Discuss about the problem occurring in the medium voltage distribution network such problems reactive power, harmonics and unbalanced load current compensation of Medium voltage Distribution systems. It proposes a simple and inexpensive solution to enhance power quality when a particular connection to the high voltage transmission network. It presents the design of a active power filter and BLDC motor connected to MV level of power distribution system it main task is to regulate 132 kV voltage level. Reconfiguration of the power delivery network imposes new constraints in a distribution substation so that the reactive compensation should be increased. The topology of a shunt hybrid active filter is analyzed. The possibility of different levels of reactive power compensation is implemented. The proposal shows very good performance for different load demands. This scheme is simulated using MATLAB/SIMULINK for Brushless DC (BLDC) motor loads. Results are presented to verify the effectiveness of the control of sinusoidal by using active power filter (APF).**

***Index Terms*—** Active power filter, harmonic distortion, power quality, reactive power, BLDC, THD, passive filter, pcc.

INTRODUCTION

The increase of non liner loads and equipments are the major problems for the purpose of harmonics as well as unbalance loads such as power supplies voltage distortion and current harmonics problem for utilities at distribution systems [1],[3]. Then, power electronics appears as an essential interface to improve power quality [2]. The usage of point of common coupling loads to the unbalanced and distorted currents and three phase distorted voltages. Active power filter uses power electronic switching to generate harmonic currents that cancel the harmonic currents from a non linear load.

The use of traditional compensation with capacitor banks and passive filters produce harmonic propagation, i.e., harmonic voltage amplification due to the resonance between line inductances and shunt capacitors. Therefore, different active solutions have been continuously analyzed in recent years [4]–[6]. A lot of research on different topologies has been done. To improve power quality [5]. The correct placement of the active filters in a distribution system has been investigated [7]. A lot of care is taken on different control strategies to obtain the desired objectives [8]–[13].

Voltage distortions in different points of the network, together with the working conditions of the capacitor banks, were verified by means of harmonic flow [14]. Therefore, a hybrid solution is proposed here to solve the particular problem of enhancing the 132-kV level in a radial connection of the medium-voltage (MV) network. Among all the compensation alternatives, the hybrid topologies appear very attractive in the distribution networks where some passive compensation is already installed. In particular, the hybrid shunt active filter formed with the connection of a low-rate active filter in series with one or several passive filters is gaining attention [4], [9]–[10].

Different filter using to improve power quality [5]. The main use of compensation with capacitor bank and active power filter the main advantage of Active power filter in a distribution systems [7] which includes methods like Instantaneous reactive power theory, modified p-q theory, synchronous reference frame theory, instantaneous $id-iq$ theory. The implementation of a new control algorithm for a three phase shunt active filter to regulate load terminal voltage, eliminate harmonics, correct supply power-factor, and balance the nonlinear unbalanced loads. A three-phase insulated gate bipolar transistor (IGBT) based current controlled voltage source inverter (CC-VSI) with a dc bus capacitor is used as an active filter (AF).

II. SYSTEM SPECIFICATIONS

The 132 Kv network distribution systems is connected to the 500kv high voltage transmission system two points work on the radial network connected to only one point demand at different substations [14].the loads at different substations at commercial and residential . So it is difficult to identify harmonics sources in case of industrial plants. The system can represented by an ideal voltage source of 132kv connected to two transformers. 132 KV/34.5/13.8 kV and 15/10/15 MVA. There are no load at 34.5kv level both transformers are connected in parallel to 13.8 KV .where capacitor bank are placed the short circuit power at 13.8 KV is nearly 150MVA .based on power flow and harmonics studies on network [14].power demand 20.9 MVA with $\cos\varphi$=0.78 harmonics peak currents are

I_5 =50.3A, I_7 =35.1A, I_{11} =15.1A,and I_{13} =11.4A, resulting in a total harmonics distortion of THD_1 =5%

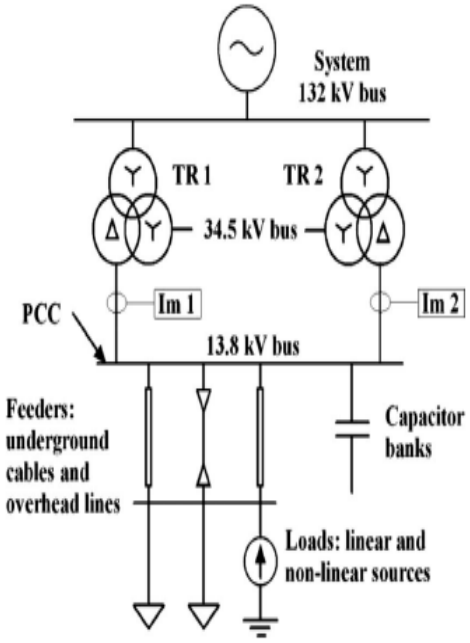

Fig .1. One line diagram of network model

Fig.1. one line diagram of network model for DS a three phase model of the network is constructed on MATLAB/SIMULINK non linear loads take discontinuous current and thus it inject harmonics .reactive power compensation can increase the steady state transmissible power and the voltage profile along the line since reactive power is used for voltage control in distribution system

III. HYBRID ACTIVE FILTER COMPENSATION

The hybrid active power filter consists of passive filter connected in series with a controlled voltage sources the active power filter is used to compensate harmonics while reactive currents are damped by the passive filter the structures of the proposed SHAPF fig 3 (a) Three phase pulse width modulation (PWM) voltage source converter (VSI) connected in series with one or more passive filter there are connected to grid systems without need of transformers .the passive filters consists of simple LC filters near certain harmonics frequencies .

Basically active power filter acts a controlled voltage source the system line currents to become sinusoidal

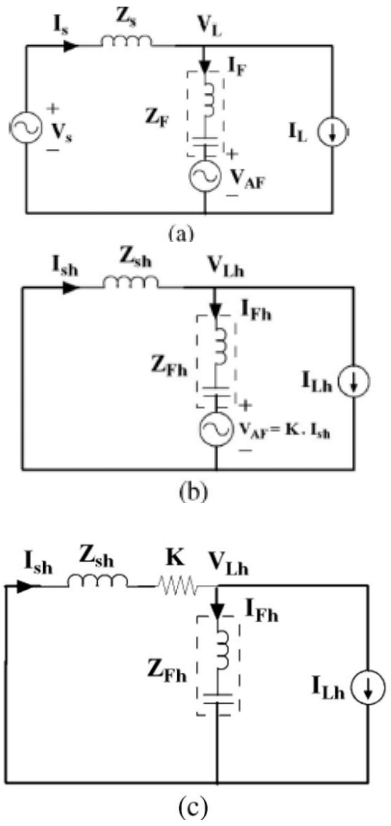

Fig.2. single -phase equivalent circuits of the system with hybrid active power filter connected (a) total equivalent circuit (b) Equivalent circuit for harmonics component (c) Resistive equivalence of the harmonics filter

DESIGN OF HYBRID ACTIVE FILTER

The control systems has two main parts while generating the voltage references of PWM VSI 1) Eliminate the harmonics from the line currents 2)control the dc voltage of the VSI therefore the analysis and design of the SHAPF may be sub divided into the passive filter PWM VSI and the control block. Hybrid Active Power Filter (HAPF) topologies have been developed to solve the problems of harmonic currents and reactive power effectively.

A. PASSIVE FILTER

The passive filter has three main functions reactive compensation absorption of harmonics currents produced by the load and coupling of the inverter to grid .because load is variable of different levels of reactive compensation .

B. COMPARISION OF PASSIVE FILTER AND ACTIVE FILTER

	Passive filter	Active filter
Harmonic control by order	Very difficult	Possible via parameters
Harmonic current control	Requires filter for each frequency	Simultaneously monitors many frequencies
Dimension	Large	Small
Weight	High	Low
Influences of a frequency variation	Reduced effectiveness	No effect

C.PWM VSI

The PWM VSI is a two level three phase VSI with IGBT [2],[12]-[15] using sinusoidal modulation

The inverter is connected to the 13.8 Kv bus or point of common coupling (pcc) through the passive filter since the LC filter presents high impedances at the ripple produced by the inverter output voltage where as the inductor of each passive filter function like coupling inductors to connect the converter to the network the passive filter at lowest frequency is connected in order to better filter harmonics generated by the PWM .

When higher harmonics are required for the SHAPF the voltage level in the dc side the voltage rating for the power IGBT and the switching frequency required to follow the references currents are higher the hysteresis current control based hybrid shunt active filter to improve the Quality of Power in distribution line by minimizing the harmonics .

D. control system voltage generator

The control system measures at the secondary windings of the transformer (Im1 and Im2 in fig 1). Then supply current (i_{SA}, i_{SB}, i_{SC})

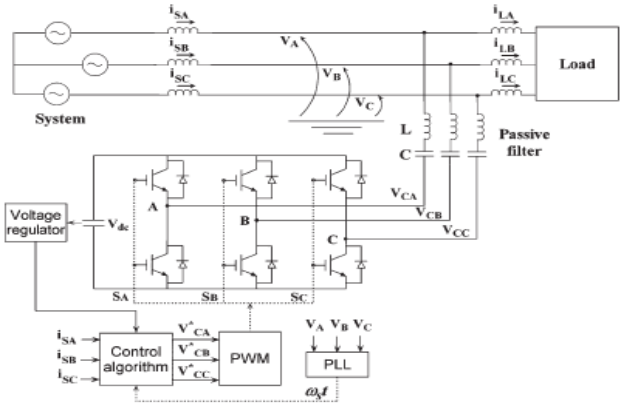

Fig. 3 (a), structure of the proposed SHAPF

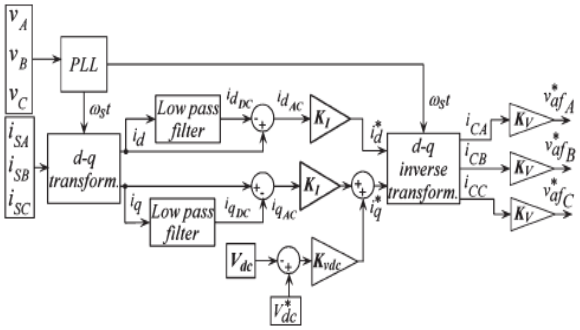

Fig.3 (b). Control block diagram of the SHAPF

A. *Active power filter control method*

In an active power filter, a controller determines the harmonics that are to be eliminated. The output of this controller is the reference of a three-phase current controlled inverter. The principle of a shunt active filter. The nonlinear load is connected to the power system and is supplied by the non sinusoidal current . The active power filter is connected in parallel to the mains, on the point of common coupling PCC, and supplies the current harmonics needed to maintain the source current sinusoidal. Traditionally active power filter shunt active filters were proposed as a means of removing

B. Application of BLDC MOTOR (brush less dc motor)

Bldc motor more advantage it has high power density has compared to other motors fast response and high power and size also small .where three phase source is connected to rectifier and inverter connected with the help of BLDC motor

Brushless DC motors will be more complex than normal DC motor Brushless DC motors (BLDC motors , BL motors) also called electronically commutated motors (ECMs, EC motors) are synchronous electric motors powered by direct-current (DC) electricity and achieving electronic commutation systems, instead of mechanical commutators and brushes . Brushless DC motors have got a higher power density than AC along with brush DC motors. A brushless DC motor (BLDC) is a synchronous electric motor electronically controlled commutation method. A Brushless DC Motors are employed in a number of applications in several industries.

The brushless dc motor is much better than the ac synchronous motor. The brushless DC motor is usually run at exact rates of speed from 100 revolutions per minute as much as 3000 rpm.

The primary advantages of brushless D.C. motors are:

- Low Maintenance
- No Brush Sparking

- High Operating Speeds
- High Efficiency
- Compact Size
- Fast Response

A three phase source supply is coming \rectifier source side connected to a shunt active power filter without no need of non sinusoidal harmonics so we need harmonics eliminates so we need to connected active power filter .

For drive applications but also in distribution systems the advantages of IGBT compared to thyristors are mainly the ability of turning off current actively .this leads to reduced filter size because of increased switching frequency and reactive power is no longer needed for the communication process.

Using reactive power compensation can increase the steady state transmissible power and the voltage profile along the line .since reactive power is used for voltage control in distribution systems.

MATLAB/SIMULINK MODEL FOR BLDC MOTOR

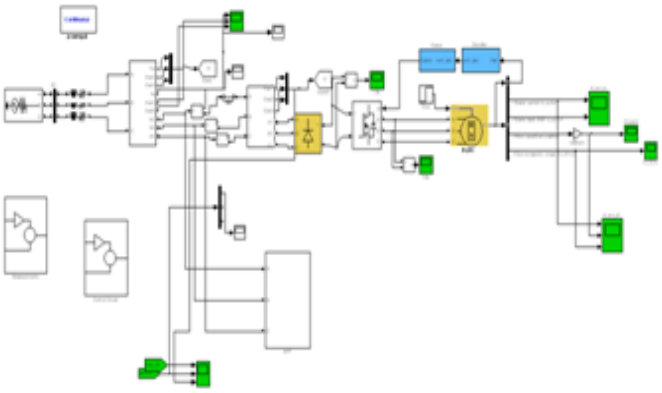

Fig 8(b) shows the Matlab /Simulink model of control block of bldc motor

SIMULATION RESULTS:

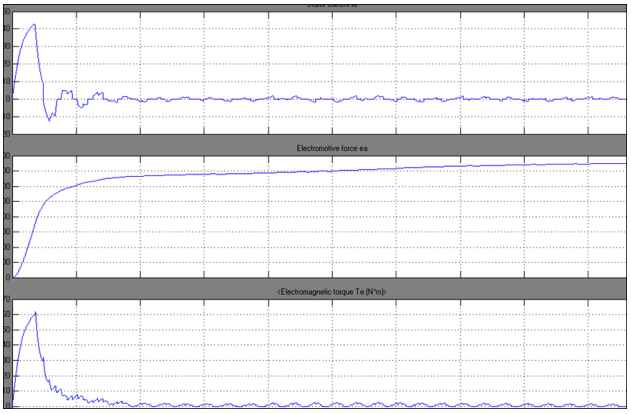

Fig 9(a) stator current, electromotive force, electromagnetic torque

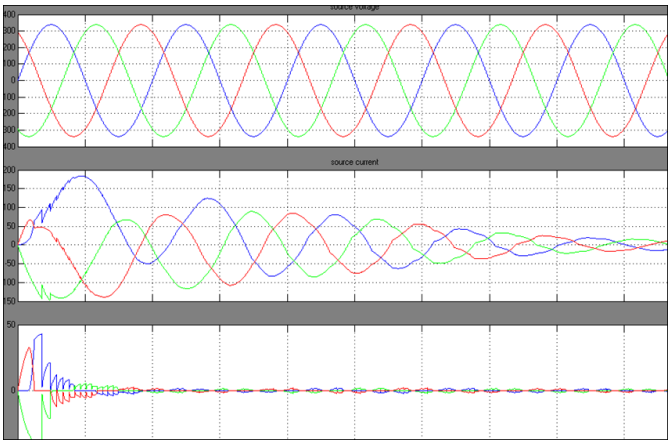

Fig 9(c) .source voltage and source current

IV. MATLAB SIMULATION

The unbalanced was realized by disconnecting phase-a from the diode bridge. The BLDC motor load is applied to the Bldc motor more advantage it has more high power density has compared to other motors fast response and high power and size also small

V. RESULTS AND DISCUSSION

The simulation of the Active power filter system is carried out with different types of loads i.e., a linear R-L load, a nonlinear load i.e., a diode bridge converter load and BLDC motor load. The load compensation is demonstrated for these types of loads using APFILTER system for as well as set. The following observations are made on the basis of obtained simulation results under different system conditions. Electronic devices. The current drawn by these modern devices is non-sinusoidal and therefore contains harmonics

B .ACTIVE POWER FILTER Operation under Non-Linear Load

Fig. 5 shows the performance of the ACTIVE POWER FILTER with under nonlinear loading conditions. The load compensation in terms of harmonic mitigation is also being provided by during this condition. Phase-a load is reconnected again to the diode bridge and the load is reduced to its initial value. BLDC MOTOR

C .ACTIVE POWER FILTER Operation under BLDC motor Load

In the above discussion we have connected source as active power filter set and loads like (linear ,nonlinear as well as BLDC loads) to be connected to v_{ccp} to maintain constant voltage by using BLDC motor to compensate unbalance loads and harmonics and reactive power compensation purpose

By generating maximum amount of reactive power and by sending active power it will be possible from source end to load end loads.

VI. CONCLUSION

IT has sinusoidal voltages at PCC and currents with compensated and equivalent linear balanced unity power factor loads.

In this paper, a to enhance power quality in a medium voltage distribution network has been proposed as a feasible active power filter topology for BLDC MOTOR applications. And torque speed characteristics. The active power filter feature several advantages such as the harmonics elimination power quality in a medium voltage distribution network A Matlab/Simulink based model is developed and simulation results are presented.

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