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ANALYSIS AND MITIGATION OF HARMONICS IN 11KV DISTRIBUTION SYSTEM

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ABSTRACT

Power quality is major problem in power distribution system and harmonic distortion is one of them. Harmonic distortion problem occurs due to uses of nonlinear loads like adjustable speed drives, power electronics converters, electronic ballasts etc.. Large considerations of these nonlinear loads have the potential to raise harmonic voltage and currents in a power distribution system to unacceptable high levels that can adversely affect the system. In this paper we consider 11kv distribution line and for mitigation of this harmonic distortion, shunt active power filter is widely used in a distribution system. We are interested Shunt active power filter using instantaneous active and reactive power (p-q) theory for compensating the load current harmonics and reactive power. The advantage of the p-q theory is that it is instantaneous and it works in the time domain.

KEYWORDS: Harmonic distortion, p-q theory, SAPF.

I. INTRODUCTION

In power system categories are generation, transmission, distribution & utilization. At all levels power quality is main issue. Any power problem manifested in voltage, current, or frequency deviations that result in failure, disoperation or even damage of customer equipment is considered as a power quality problem. Different power quality problems are power frequency disturbances, power system transients, electromagnetic interference, electrostatic discharge, power system harmonics, poor power factor (PF), grounding and bonding problems etc.. Many big industries, commercial and industrial electrical loads include power transformers, welding machines, arc furnaces, induction motor driven equipment such as elevators, pumps, and printing machines etc., which are mostly inductive in nature. These loads create serious power quality problems. Poor PF & harmonics are two most important & serious power quality problems nowadays.

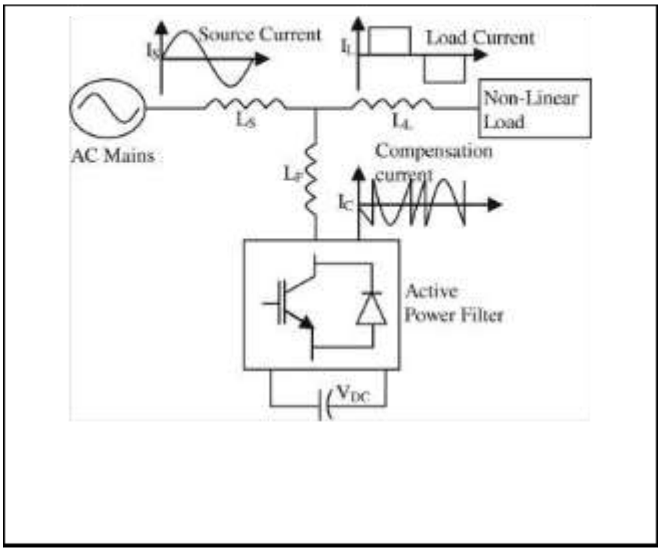
Today's scenario power quality is major problem and it is affecting at all levels of power system we are focusing on distribution side, because source of harmonics are fluorescent lamp, television, computer and printer, UPS and adjustable speed drive etc. the combination of these different nonlinear loads can result in high voltage distortion levels, neutral conductor overload, motor heating, transformer heating etc. problems. So, we must have to overcome these problems by mitigation harmonics.

Mitigation of harmonics, passive and active filters is used for this. passive filters are known to cause resonance, so it will be affecting on power distribution system and distribution frequency also effect on filtering characteristic. In active power filter most of used power electronics concept to compensate harmonics current which are produced by nonlinear load & eliminate harmonics from the system. In shunt active filter instantaneous p-q theory is used.

II. SHUNT ACTIVE POWER FILTER

It is the most widely used and dominant form of APFs to compensate the load current harmonics and reactive power as well. It is connected in shunt to the distribution supply at PCC and it injects harmonic current that is equal in magnitude to the load harmonic current but having 180 degree phase shift to cancel out the load current harmonics and the source current becomes sinusoidal. Figure.1 shows the system configuration of Shunt Active Power Filter design. For an increased range of power ratings, several shunt active power filters can be used combined together to withstand higher currents. This configuration consists of four different categories of circuit, namely inverter configurations, switched-capacitor circuits, lattice structured filter and voltage-regulator-type filters.

Figure:1



Shunt Active Power Filter

For an increased range of power ratings, several shunt active filters can be combined together to withstand higher currents Here in shunt active filter joint to PCC with coupling inductor & in SAF consider voltage source inverter with DC link capacitor.

Here,

$$I_s + I_f = I_L, \quad (1)$$

$$I_s = I_L - I_f \quad (2)$$

For non-linear load;

$$I_L = I_{L,f} + I_{L,h} \quad (3)$$

Now, by applying SAF it provides $I_f = I_{L,h}$

So, we get source current $I_s = I_{L,f}$

As per upper discussion we tell that source current is free from harmonics i.e. sinusoidal source current. Now, for controlling this shunt active filter; there are two categories like as frequency domain analysis & time domain analysis. The time domain analysis is superior over the frequency domain and of great interest in recent years. In time domain analysis particularly p-q power theory is most useful another important characteristic of this theory is the simplicity of the calculations, which involves only algebraic calculation. In p-q theory use Clarke transformation for transform voltage & current from the abc to αβ0 coordinates after this transformation we get the instantaneous power on these coordinates. By using this controller the shunt active filter compensate dynamically harmonics current.

III. P-Q THEORY

In p-q theory use Clarke transformation for transform voltage & current from the abc to αβ0 coordinates after this transformation we get the instantaneous power on these coordinates. From Clark transformation we get V_α, V_β & V_0 from V_a ,V_b & V_c respectively and same as I_α, I_β & I_0 from I_a ,I_b & I_c .The advantage of this transformation is that to separate Zero-sequence from the abc-phase component. The *p-q* theory can be defined in three-phase systems with or without a neutral conductor.

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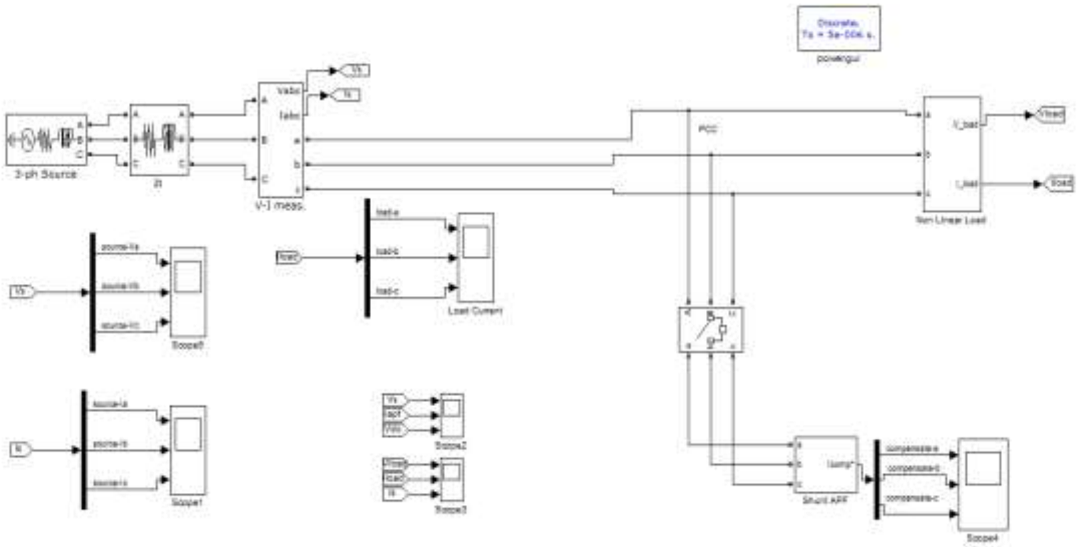
IV. SIMULATION AND RESULT

Figure:2



Simulation Circuit of Distribution system using SAPF

Table 1: IHD & THD value of source current (with & without SAF)

Harmonic Number	Without SAF IHD (%)	With SAF IHD (%)
3	0.17	0.30
5	14.47	0.51
7	7.22	0.61
9	0.15	0.14
11	5.88	1.23
THD	18.83	2.10

V. CONCLUSION

For power quality improvement and compensate harmonics current used shunt active power filter, In 11KV distribution line without shunt active filter THD value is very high i.e. 18.83% but when applying Shunt active power filter THD value is 2.12%. This value is below 5% as per IEEE 519-1992 standards.

VI. REFERENCES

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