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Effect of Compensation and Detuning of Single Tuned Shunt Passive Filter on Harmonics of Industrial Distribution System

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A B S T R A C T

To mitigate the harmonic problems in industrial power system, the simple way is to use shunt passive filters. This paper presents the effect of compensation and detuning of single tuned shunt passive filter on harmonics of industrial distribution system. The three phase power system and single tuned passive filter is designed, modeled and simulated in MATLAB by using the actual data collected from industry is used.

Introduction

With recent development of power electronics technology, nonlinear loads are created, in which the current is not proportional to the applied voltage. Voltages and currents in the power system differ from a single sinusoidal frequency, then distortion is said to be present in the system and they are the major sources of harmonic distortion in a power distribution system. These harmonics cause faulty operation and overheating of equipment's in the power system. Other problems consist transformer overloading and heating, meter errors and power cable faults. To overcome such faults and problems, harmonic mitigation technique is more important for both service providers and customers. Filtering of harmonics using passive filter is one of the simple and earliest methods used to address harmonic mitigation issues. These power quality issues are led to implementation of standards and guidelines such as IEEE-519 for controlling harmonics on the distribution power system along with the recommended limits. The 5% voltage distortion limit was recommended below 69 kV while the limit on the current distortion is fixed in the range of 2.5% to 20% depending upon the size of the customer and the system voltage (1,2,3,4).

Many researches have been carried out on power harmonic mitigation using different types of filters. The problem of power harmonics in power distribution systems has been studied by using passive power filters (4-6). The MATLAB modeling and simulation of single tuned Passive filter has been studied. This type of filter has advantages in terms of low cost and can be used to improve system power factor because it compensates the reactive power to the power system. Passive filters are considered as one of the simple and most economical way for mitigating harmonics. This paper shows the effect of compensation and detuning of single tuned shunt passive filter on harmonics of industrial distribution system.

The main objective of this paper is to study the effect of compensation and detuning of single tuned shunt passive filter on harmonics of industrial distribution system

Power system data

The data is collected for the industry C'Cure Building Products. This three-phase system and single tuned power filter is designed and modeled in Matlab. A list of the system parameters and system harmonic data considered in the simulation is given in Table 1 and 2.

Matlab Simulink model

The Single tuned passive power filter consists of series combination of resistance, inductor and capacitor. Figure 1 shows the Matlab Simulink model of designed system. The main components of the above system are main supply, nonlinear load, single tuned passive filter.

Table.1 System parameters

Parameter	p.f	Frequency (Hz)	Phase angle (degree)	Real power (kW)	Reactive power (kVAr)	Load resistance (ohm)	Load inductance (mH)
Phase1	0.738	50.09	42.4	18.4	16.8	2.0826	6.0533
Phase 2	0.694	50.09	46.1	19.2	19.9	1.7590	6.0533
Phase 3	0.751	50.09	41.4	21.0	18.4	1.8202	5.1081

Table.2 System Harmonic Data

Order of the Harmonics		THD(%)
Phase1	Inst. Current(A)	27.4
	Inst. Voltage(V)	2.8
Phase2	Inst. Current(A)	27.8
	Inst. Voltage(V)	3.4
Phase3	Inst. Current(A)	26.8
	Inst. Voltage(V)	3.1

Table.3 Filter Parameters

Parameters	Phase 1		Phase 2		Phase 3	
	5^{th}	7^{th}	5^{th}	7^{th}	5^{th}	7^{th}
Qc(kVAr)	8	8	10	10	9	9
Xc(ohm)	8.3786	8.3786	6.6822	6.6822	7.2136	7.2136
C(uF)	379.91	379.91	476.35	476.35	441.25	441.25
Xl(ohm)	0.3351	0.1709	0.2672	0.1363	0.2885	0.1472
L(mH)	1.0668	0.5443	0.85	0.434	0.918	0.4686
R(ohm)	0.04117	0.0294	0.0328	0.0234	0.0354	0.0253
Q	40.7	40.7	40.7	40.7	40.7	40.7

Table.4 Current THD, Voltage THD and p.f before and after filter is turned on

parameter	**Current THD(%)**			**Voltage THD(%)**			**Power factor**		
Before filter turned on	27.4	27.8	26.8	2.8	3.4	3.1	0.738	0.694	0.751
After filter turned on	0.87	0.63	2.85	0.44	0.36	0.95	0.99	0.99	0.99

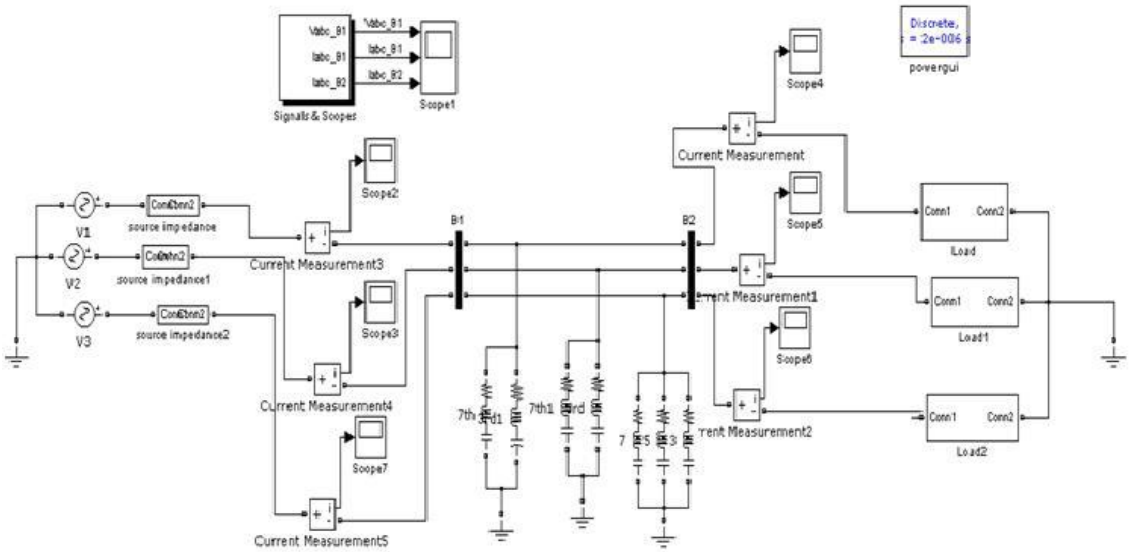
Table.5 Effect of compensation on THD

Compensation	Current THD (%)	Voltage THD (%)
80%	**1.09**	**0.56**
90%	**0.98**	**0.50**
100%	**0.87**	**0.44**
110%	**0.78**	**0.40**
120%	**0.70**	**0.37**

Table.6 Effect of detuning on THD

Detuning	Current THD(%)	Voltage THD(%)
3%	2.38	1.09
5%	4.05	1.81
7%	6.14	2.70

Fig.1 Matlab Simulink model of designed system



Designed single tuned passive filter data

The designed single tuned passive filters parameters are shown in following table 3. After simulation, the current THD, voltage THD and power factor are shown in following table 4.

Effect of compensation on THD

If the compensation of single tuned shunt passive filter is increased and decreased, the results are comes out.

From the table 5 it is clear that, if the compensation is increased, the current THD and Voltage THD getting decreased and if compensation is decreased, the current THD and Voltage THD getting increased.

Effect of dtuning on THD

If the detuning of single tuned shunt passive filter is increased, the following results are comes out. From the table 6 it is clear that, if the detuning is increased, the current THD and Voltage THD getting increased (7-11).

From the Result, it is concluded that, if the compensation is increased, the current THD and Voltage THD getting decreased and if compensation is decreased, the current THD and Voltage THD getting increased. If the detuning is increased, the current THD and Voltage THD getting increased.

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