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MATLAB SIMULATION OF SINGLE TUNED PASSIVE FILTER TO PROVIDE REACTIVE POWER COMPENSATION AND TOMINIMIZE THD

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ABSTRACT

This paper presents MATLAB simulation of the single tuned passive filter to provide reactive power compensation and to minimize THD in an industrial distribution system. The three-phase power system is designed by using the actual data collected from industry and single tuned passive filter is designed. This system is modeled and simulated in MATLAB. The resulted current and voltage waveforms before and after the filter are turned on are shown.

KEYWORDS: *Passive Filter, MATLAB, THD, Single Tuned Passive Filter, Distribution System*

Article History

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INTRODUCTION

Now a days, nonlinear loads are created by nonlinear devices, in which the current is not proportional to the applied voltage and are the major sources of harmonic distortion in a power distribution system. These harmonics may cause malfunction and overheating of equipment's in the system. Other problem include transformer heating and overloading, meter errors and power cable failures to name a few. To overcome such problems, harmonic mitigation is becoming important for both utilities and customers. Filtering harmonics using a passive filter is one of the earliest methods used to address harmonic mitigation issues. These power quality problems led to Implementation of standards and guidelines such as IEEE-519 for controlling harmonics on the 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.

Many studies have been carried out on harmonic mitigation using different types of filters. The problem of harmonics in distribution systems has been studied by using passive filters. The MATLAB simulation of the single tuned Passive filter has been discussed. This type of filter has the advantages in terms of low hardware cost and can be used to improve system power factor because it provides reactive power to the power system. Passive filters are considered as one of the cheapest and most economical ways for mitigating harmonics. This paper shows the simulink model of a power system and voltage and current waveforms before and after the filter is turned on in an industrial distribution system.

OBJECTIVE

The main objective of this paper is MATLAB simulation of the single tuned passive filter to provide reactive power compensation and to minimize THD from the data collected from the actual power system.

Power System Data

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

Table 1: System Parameters

Parameter	Phase1	Phase 2	Phase 3
p.f	0.738	0.694	0.751
Frequency(Hz)	50.09	50.09	50.09
Phase angle(degree)	42.4	46.1	41.4
Real power (kW)	18.4	19.2	21.0
Reactive power(kVAr)	16.8	19.9	18.4
Load resistance(ohm)	2.0826	1.7590	1.8202
Load inductance(mH)	6.0533	5.8133	5.1081

Table 2: System Harmonic Data

Order of the Harmonics		1	3	5	7	9	11	13	THD (%)
Phase1	Inst. Current(A)	91.8	0	16.9	18.4	0	0.9	0	27.4
	Inst. Voltage(V)	258.9	0	4.2	5.9	0	0	0	2.8
Phase2	Inst. Current(A)	101.9	0	15.9	23.2	0.9	0.9	0	27.8
	Inst. Voltage(V)	258.5	0	3.9	7.9	0	0	0	3.4
Phase3	Inst. Current(A)	105	1.5	14.3	23.9	0	0.8	0	26.8
	Inst. Voltage(V)	254.8	0	3.3	7.2	0	0	0	3.1

Matlab Simulink Model

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

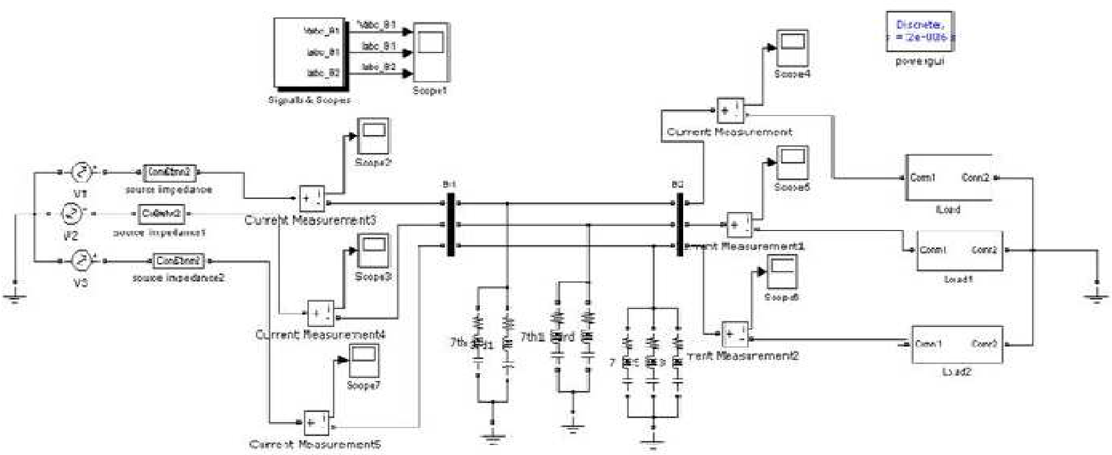

Figure 1: Mat Lab Simulink Model of Designed System

Single Tuned Passive Filter Design from Actual Data

The data is collected for the industry C' Cure Building Products. This three-phase system and single tuned power filter is designed.

The dominant harmonic components are the 5th and the 7th. Therefore, two single tuned shunt filters are designed using the above analysis. These filters parameters are shown in the following table

Table 3: Filter Parameters

Parameters	Phase 1		Phase 2		Phase 3	
	5th	7th	5th	7th	5th	7th
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

SIMULATION RESULTS

In this section, the system is simulated on the MATLAB. Fig.2 to 13 shows the ac Current and voltage waveforms and harmonic distortion of the simulated system before and after the filter is turned on.

The two filters tuned frequencies are (5) and (7). After the designed filter is turned on, current and voltage harmonics components are majorly suppressed. The resulted current/voltage waveforms and harmonic distortion are shown in Fig.2 to 13. After the filter is on the THD reduced effectively.

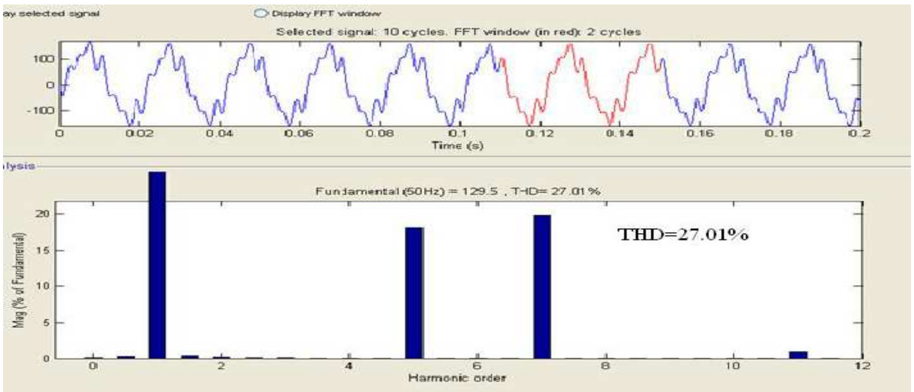

Figure 2: Phase1 Current waveform and Harmonics before Filter is Turned on

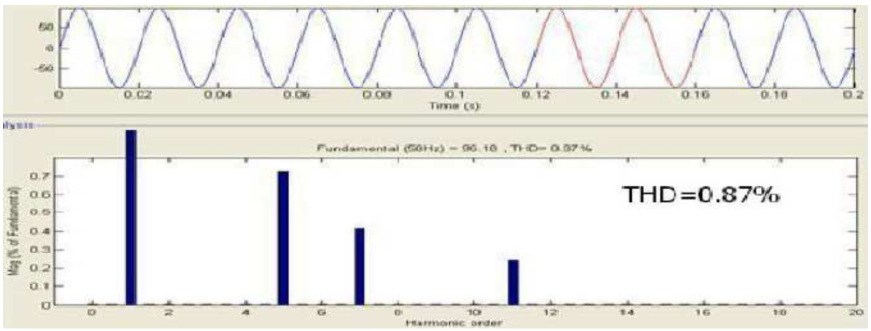

Figure 3: Phase1 Current Waveform and Harmonics after Filter is Turned on

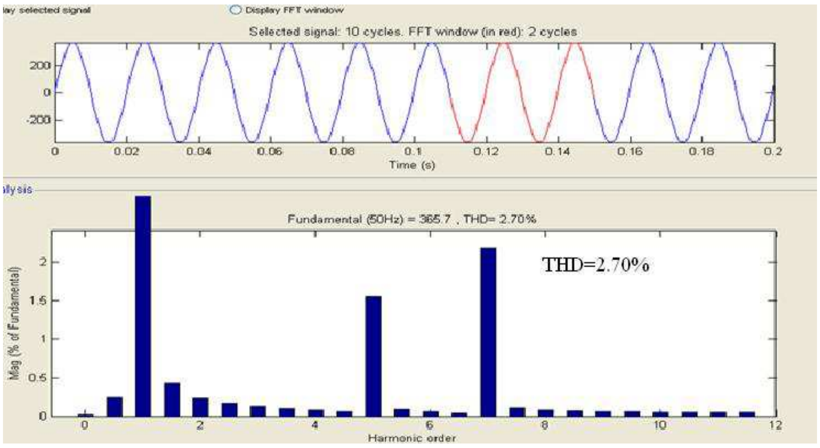

Figure 4: Phase1 Voltage Waveform and Harmonics before Filter is Turned on

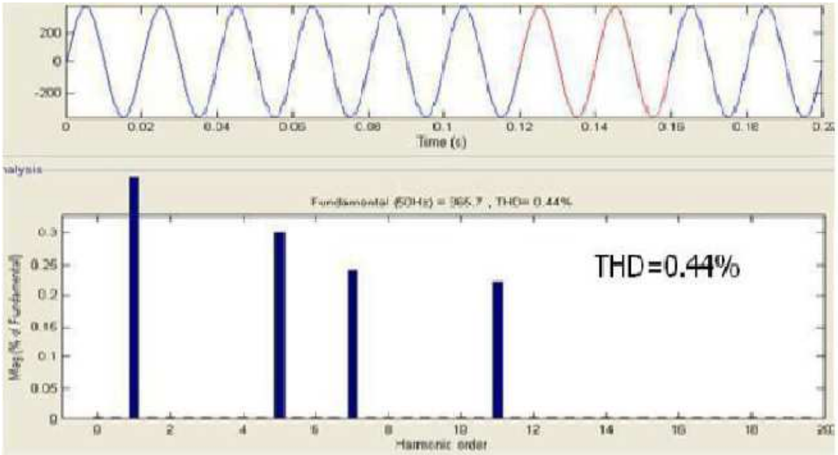

Figure 5: Phase1 Voltage Waveform and Harmonics after Filter is Turned on

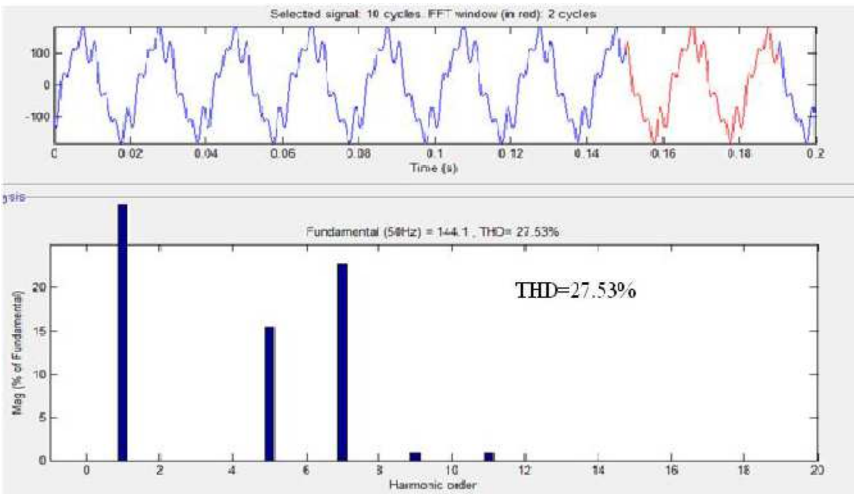

Figure 6: Phase2 Current Waveform and Harmonics before Filter is Turned on

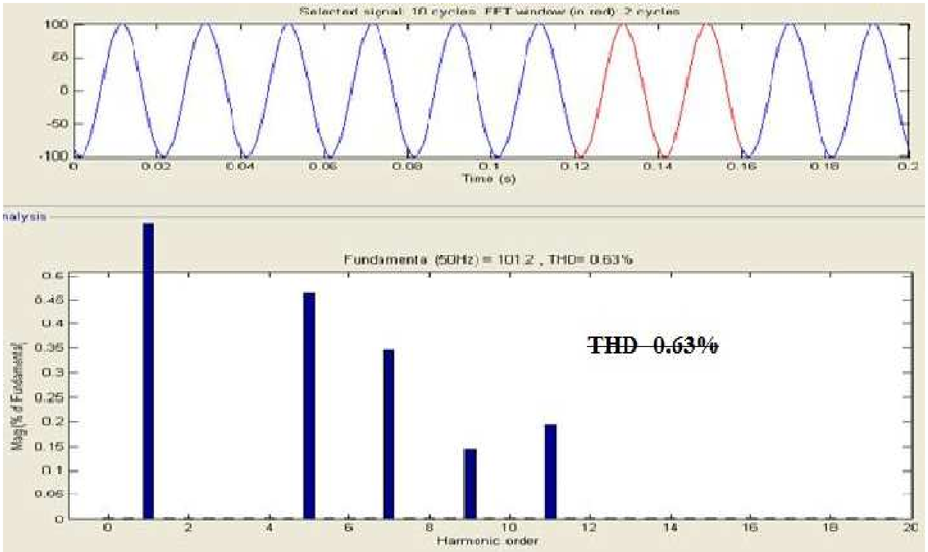

Figure 7: Phase2 Current Waveform and Harmonics after Filter is Turned on

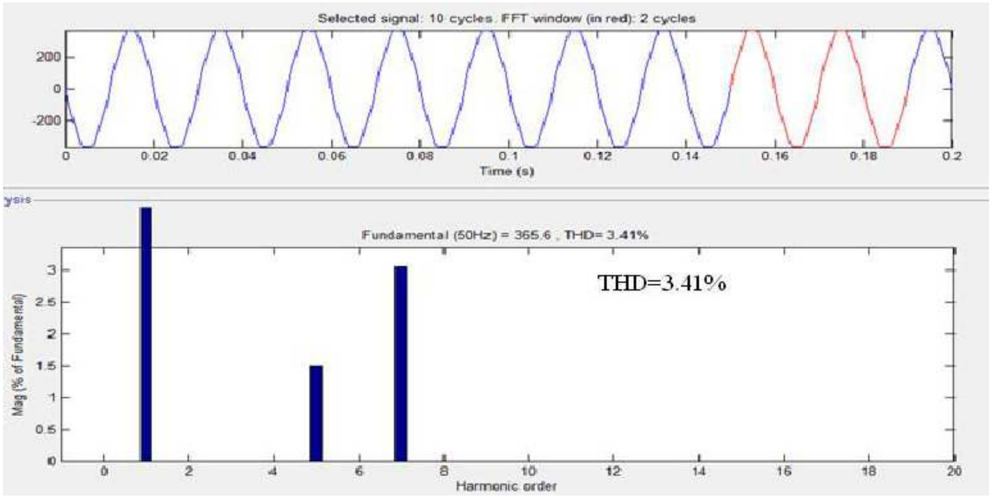

Figure 8: Phase2 Voltage Waveform and Harmonics before Filter is Turned on

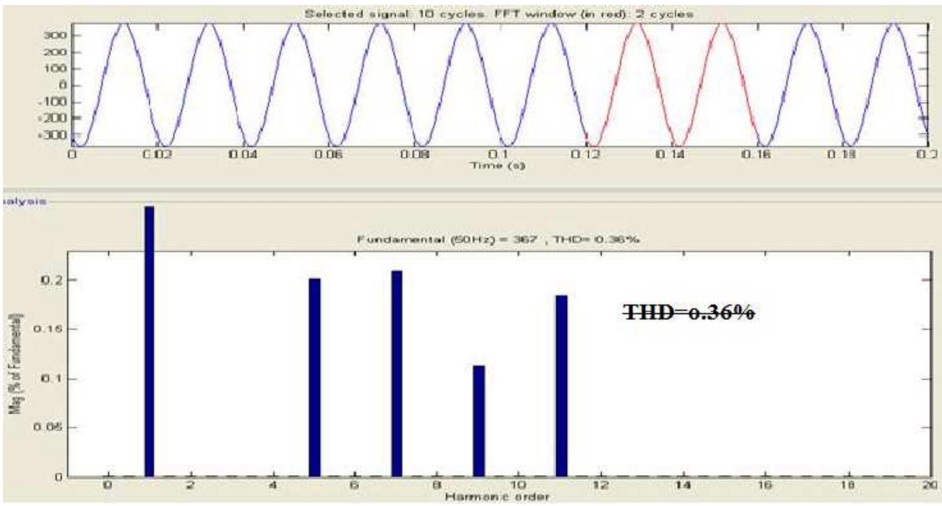

Figure 9: Phase2 Voltage Waveform and Harmonics after Filter is Turned on

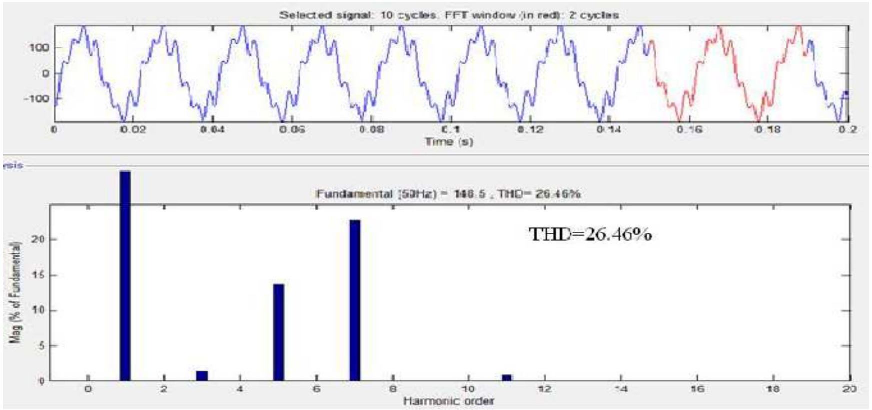

Figure 10: Phase3 Current Waveform and Harmonics before Filter is Turned on

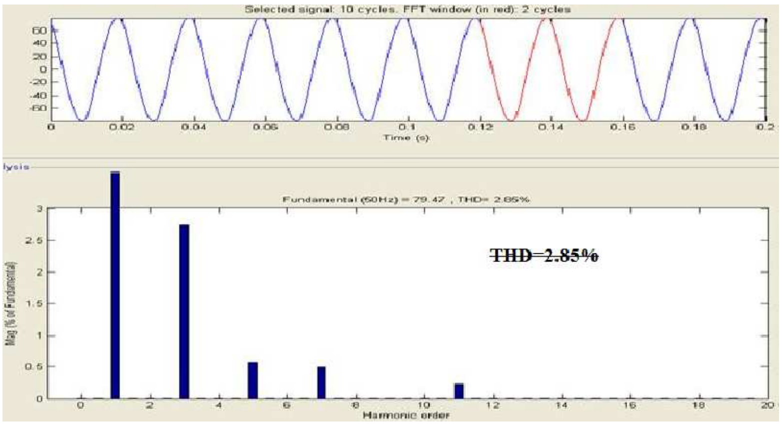

Figure 11: Phase3 Current Waveform and Harmonics after Filter is Turned on

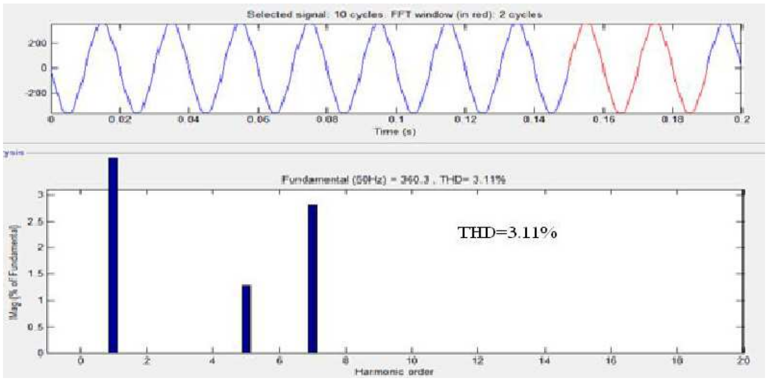

Figure 12: Phase3 Voltage Waveform and Harmonics before Filter is Turned on

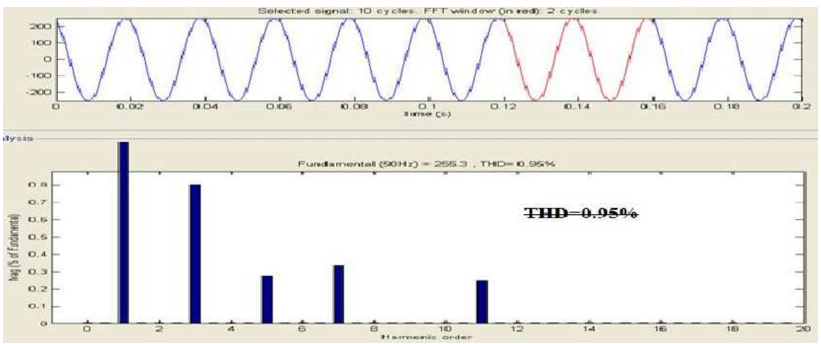

Figure13: Phase3 Voltage Waveform and Harmonics after Filter is Turned on

From the above simulated current and voltage waveforms before and after the filter is on, the current THD, voltage THD and power factor are shown in the following table

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

CONCLUSIONS

From the simulation, it is observed that, the current and voltage waveforms shows the current THD, voltage THD are reduced and power factor is improved after implementation of single tuned harmonic filter. This MATLAB simulation has presented a practical approach towards the use of passive tuned filters in industrial areas.

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