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Harmonic Mitigation Technique: Magnification of using Active Power Filter over Isolation Transformer

Jyotsana Kaiwart[1], Uma P. Bala Raju[2],

M.Tech Scholar, Department of EE, Bhilai Institute of Technology, Durg, India [1]

Assistant Professor, Department of EE, Bhilai Institute of Technology, Durg, India [2]

ABSTRACT: This paper discusses the main features of Isolation transformer and also "how much it can reduce harmonics in a particular system in terms of Total Harmonic Distortion". This also discusses the comparison in between the effects of using Isolation transformer and the Harmonic filters. Both are used to mitigate the harmonics from any system. Generally, both are used, where nonlinear loads are responsible for harmonics in system. Harmonic contents in any system causes different problems like poor power factor and, hence, reduction in efficiency of system. The Isolation transformer isolates the two parts connected between them.

KEYWORDS: Isolation Transformer, Active Power Filter, Total Harmonic Distortion (THD)

I.INTRODUCTION

In this paper, firstly, the main features of Isolation Transformer are listed. Then, the effects of Isolation Transformer in the system in terms of THD are given. Also, the THD of harmonics content in system (without Isolation transformer) is given. These harmonic contents are due to the nonlinear loads present in the taken system. This system consists of a source, a transformer, a rectifier and pulse generator set as nonlinear load.
The main features of Isolation Transformer are

- Unity Transformation ratio
- Delta-Wye winding configuration
- Electrostatic shield or Faraday screen in between primary and secondary winding
- Bypasses the common mode- and transverse mode- noises

II.SYSTEM MODELS AND DISCUSSIONS

Here, a MATLAB simulation model of a simple system is taken. This system consists of a three phase source (500kV, 60Hz), a three phase transformer (1200MVA, 450/200/200 kV, 60Hz) and a thyristor rectifier and synchronised 12 pulse generator. This can be seen in figure (1). The current harmonics in the system is 12.60%. The complete waveforms of currents at bus B1 and B2 are shown in next section.

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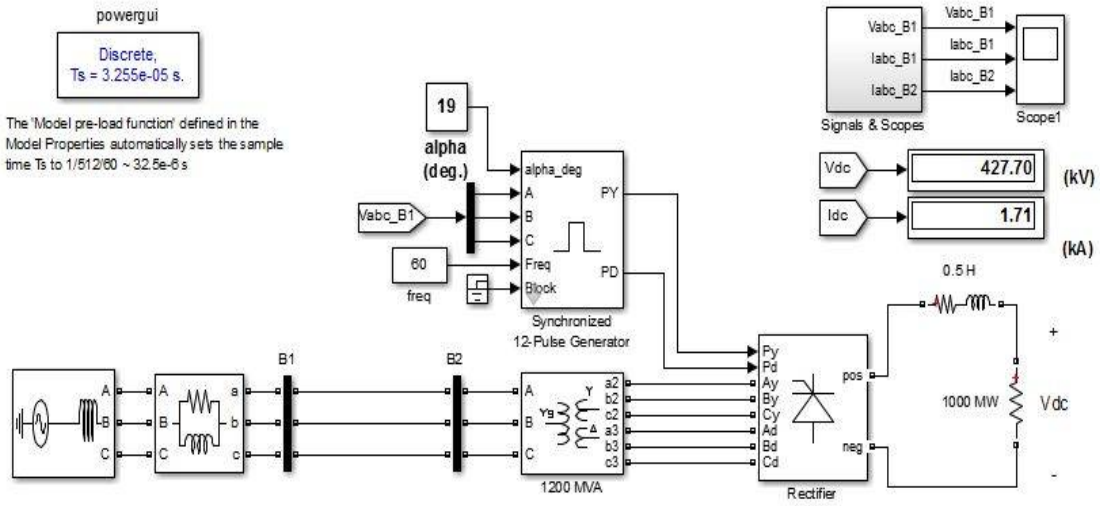

Fig (1):-

The figure (2) consists of one Isolation transformer in addition to figure (1) components. The rating of Isolation transformer is 100kVA, 500/500V, 60Hz. Now, the THD of new system is 1.67% in primary side (at bus B1) and 13.48% at secondary side (at bus B2). The complete waveforms of currents at bus B1 and B2 are shown in next section.

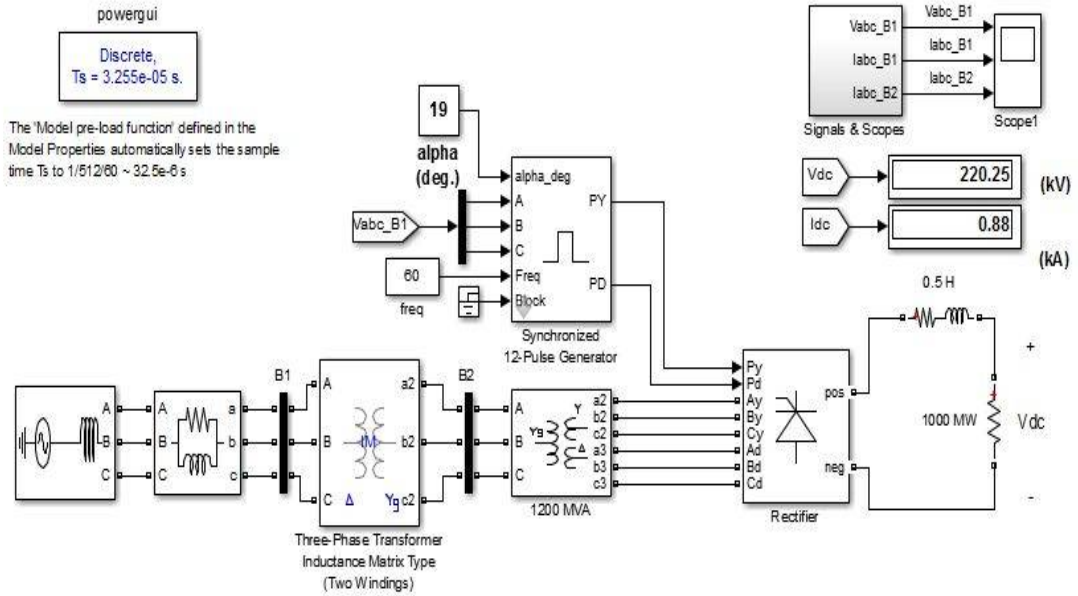

Fig (2):-

The figure (3) consists of the four filters in addition to figure (1). The ratings are

- One 150 MVAR C-type high-pass filter tuned to the 3rd harmonic (F1)
- One 150 MVAR double-tuned filter tuned to the 11/13th (F2)

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- One 150 MVAR high-pass filter tuned to the 24th (F3)
- One 150 MVAR capacitor bank

This simulation model is taken from paper titled as "Harmonic mitigation for power quality improvement"[1]. Now, the harmonics in system is 0.70% in primary side (at bus B1) and 8.98% at secondary side (at bus B2). The complete waveforms of currents at bus B1 and B2 are shown in next section.

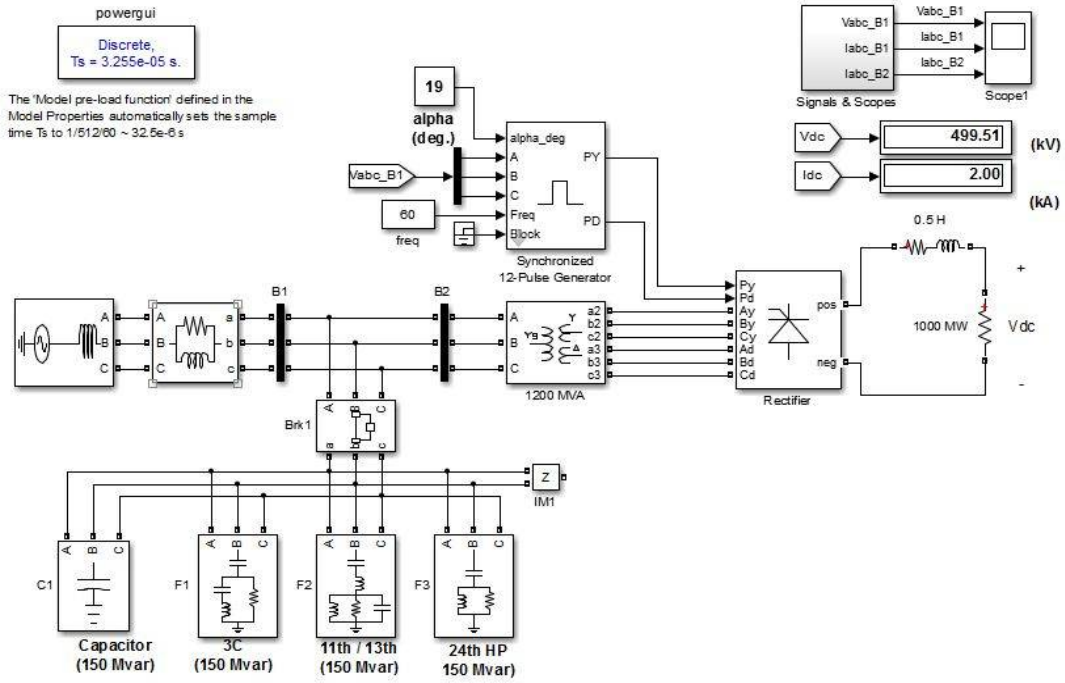

Fig (3):-

III.EXEPERIMENTAL RESULTS

The waveforms of voltage and current at bus B1 and the waveform of current at bus B2 of different simulation models are shown below. The waveform figure (4) shows the waveforms of Vabc, Iabc at Bus B1 and Iabc at Bus B2 for the simulation model given in figure (1) i.e. system without any filter and isolation transformer .

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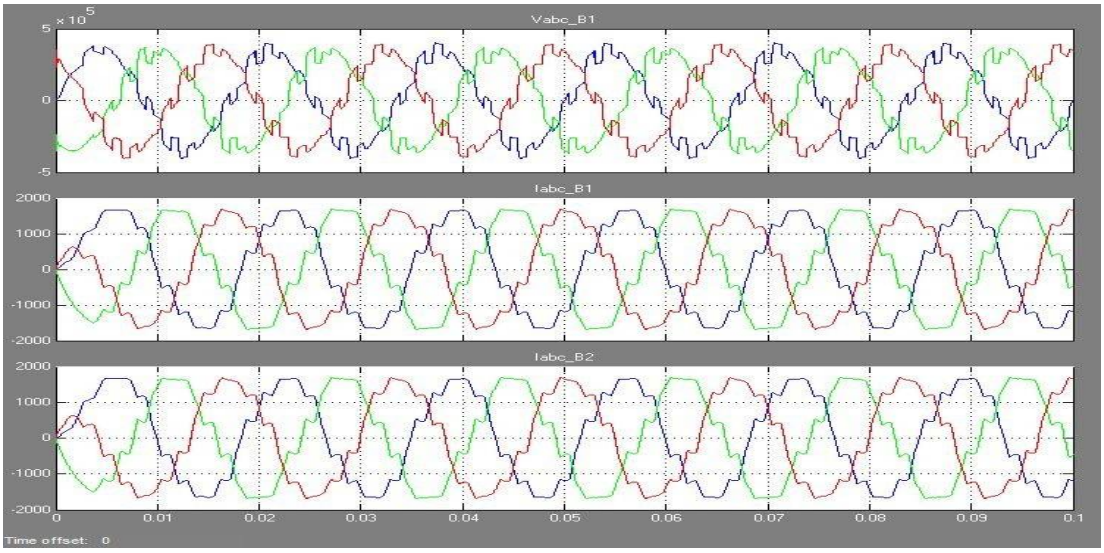

Fig (4):-

The waveform figure (5) shows the waveforms of Vabc, Iabc at Bus B1 and Iabc at Bus B2 for the simulation model given in figure (2) i.e. system with Isolation transformer .

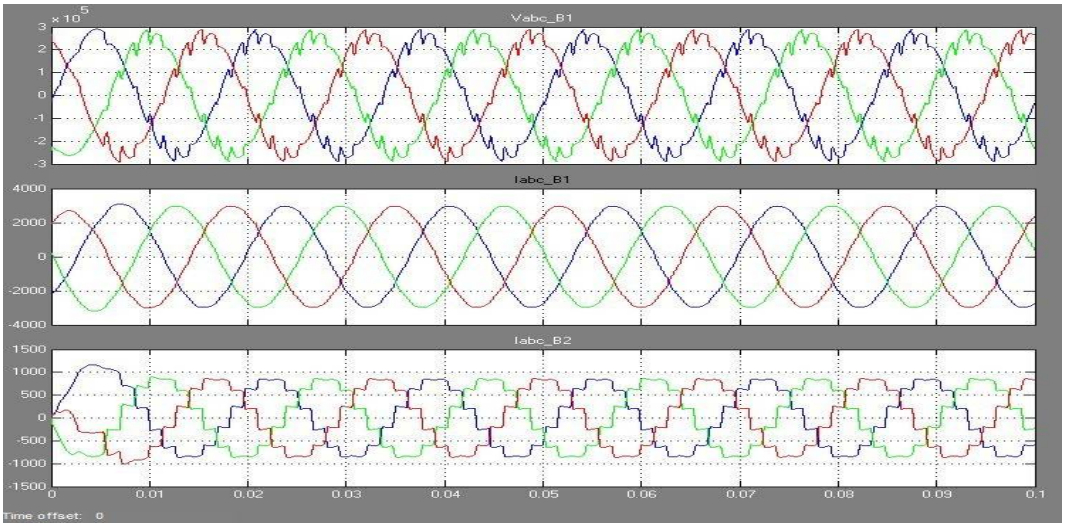

Fig (5):-

The waveform figure (6) shows the waveforms of Vabc, Iabc at Bus B1 and Iabc at Bus B2 for the simulation model given in figure (3) i.e. system with the four filters .

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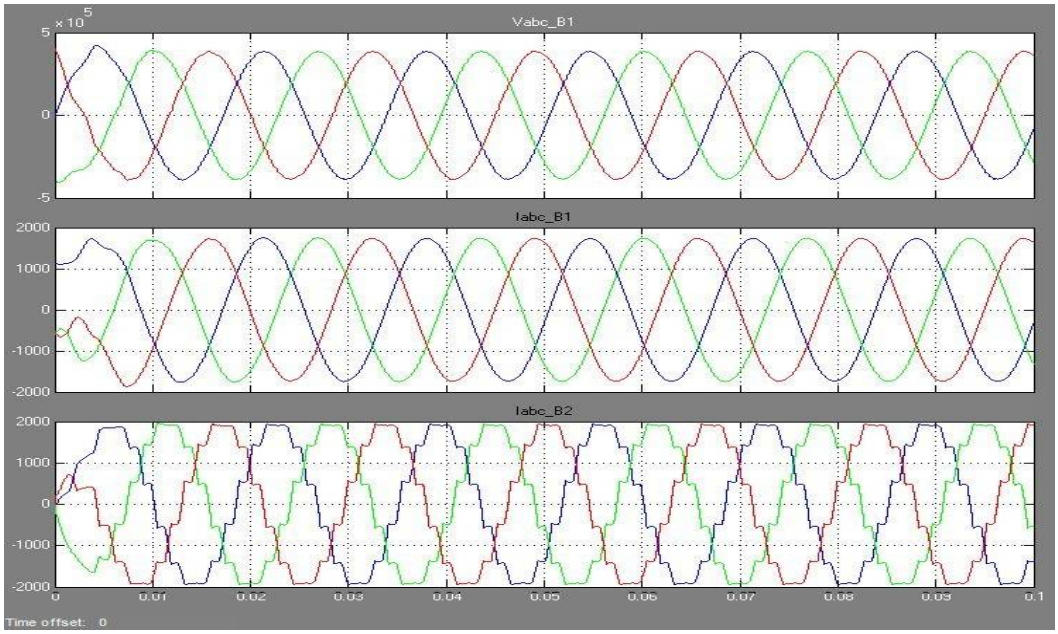

Fig (6):-

IV.CONCLUSION

All the three conditions are studied. The THD and fundamental magnitude of voltages and currents can be calculated from FFT (Fast Fourier Transform) of the entire simulation model.

- For the system without any harmonic mitigation techniques i.e. fig (1). The following table is derived from FFT analysis and waveform in figure (4) for the figure (1).

Values of	Magnitude at fundamental frequency 60 Hz	Total Harmonic Distortion %
Vabc at bus B1	3.488e+05	17.79
Iabc at bus B1	1664	12.60
Iabc at bus B2	1664	12.60

- For the system with isolation transformer i.e. fig (2). The following table is derived from FFT analysis and waveform in figure (5) for the figure (2).

Values of	Magnitude at fundamental frequency 60 Hz	Total Harmonic Distortion %
Vabc at bus B1	2.66e+05	8.86
Iabc at bus B1	2983	1.67
Iabc at bus B2	859.4	13.48

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- For the system with four harmonic filter i.e. fig (3). The following table is derived from FFT analysis and waveform in figure (6) for the figure (3).

Values of	Magnitude at fundamental frequency 60 Hz	Total Harmonic Distortion %
Vabc at bus B1	3.862e+05	0.88
Iabc at bus B1	1747	0.70
Iabc at bus B2	1955	8.98

It can be concluded from the Tables

- The voltage THD of the taken system is reduced considerably i.e. from 17.79 to 8.86 in case of using Isolation transformer. But, in case of using filters, it achieves even good value of 0.88.
- The primary current THD of the taken system is reduced from 12.60 to 1.67 in case of using Isolation transformer. But, in case of using filters, it reduces up to 0.70.
- The secondary current THD of the taken system is increased from 12.60 to 13.48 in case of using Isolation transformer. But, in case of using filters, it reduces up to 8.98.

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BIOGRAPHY

Jyotsana Kaiwart received B.E. (Electrical Engineering) degree from Chhattisgarh Swami Vivekananda Technical University, Bhilai, Chhattisgarh, India in 2014. She is presently pursuing M.Tech. (Industrial Drives and Control) from Bhilai Institute of Technology, Durg, India. Her current research interest includes different methods to mitigate harmonic efficiently.

Uma P. Bala Raju received B.E. in Electrical Engineering. She also completed her M.Tech. . Presently, she works as Assistant Professor in Bhilai Institute of Technology, Durg, India.