

Comparative Performance Analysis and THD calculation Of Carrier Signal Based IGBT & MOSFET Single Phase Inverter

Biswamoy Pal¹, Aniruddha Mukherjee²

¹(Electrical Engineering Department / University of Engineering & Management, Jaipur / India)

²(Electrical Engineering Department / University of Engineering & Management, Jaipur / India)

Abstract : In this paper comparative performance analysis of MOSFET based & IGBT based single phase inverter has been evaluated. The paper compares overall THD of output voltage of these two proposed inverters. Here sinusoidal PWM scheme has been used which compares a sinusoidal reference voltage with a carrier based modulating signal to generate gating pulse for inverter circuit. Power quality of inverter output voltage has a great importance now a days which depends on overall THD. This paper describes how THD of inverter output voltage can be controlled by varying frequency of carrier signal frequency.

Keywords: SPWM, IGBT, MOSFET, THD, MATLAB SIMULINK.

I. INTRODUCTION

The dc-ac converter, also known as inverter, which converts fixed dc power to ac power at desired output voltage & frequency. This dc power input is obtained from dc battery or from rotating alternator through rectifier. A VSI inverter employs thyristor or IGBT or MOSFET or power BJT as switch. Here inverters are implemented using IGBT & MOSFET [1][2]. Such inverter switches are turned on when they are supplied with a gating signal. SPWM technique is widely used to provide gating signals to inverter switches. In SPWM technique a reference sinusoidal signal of constant frequency is compared with a carrier based signal. Frequency of carrier signal can be modulated to vary overall THD of inverter voltage [3].

Power Quality of an inverter output voltage has a great role on the equipments to which it is connected. One important factor of power quality is THD. THD of an inverter output voltage depends on the carrier signal frequency. This paper how inverter voltage output THD gets changed with the change in carrier signal frequency [4]. THD of output voltage causes distortion of output voltage. For any system it is desired to keep %THD as minimum as possible [5].

II. Spwm Signal Generation

PWM techniques are used to generate gating pulse for switching devices of inverter. By varying width of pulses turn on and turn off time of inverter switches can be varied. Which in turn helps to get variable output voltage at desired frequency. Besides this THD of output voltage can be controlled by controlling carrier signal frequency. Over other PWM scheme sinusoidal pulse width modulation scheme is advantageous because its pulse width varies in proportion to the reference sinusoidal voltage amplitude. The advantage of using SPWM scheme is that it reduces lower order harmonics [6]. Here a carrier based modulating signal is compared with a reference sinusoidal signal. When reference signal is greater than modulating signal pulses are on and vice versa. This PWM signal is then sent to the diagonal switches of inverter, i.e.; S_{11} & S_{22} . For that time other switches are off as they do not get any gating pulse to their gate terminals. A NOT gate is used to generate another PWM pulses which is just opposite to the first PWM pulse. This newly generated PWM pulse is applied to the gate terminals of S_{12} & S_{21} . Which implies when S_{12} & S_{21} are on other two switches are off. SPWM techniques are widely used because it gives less distortion in output harmonic voltage. Although such PWM scheme has frequent switching which leads to high switching loss, these are used as these improve power quality. The block diagram in fig. 1 shows how a SPWM signal is generated.

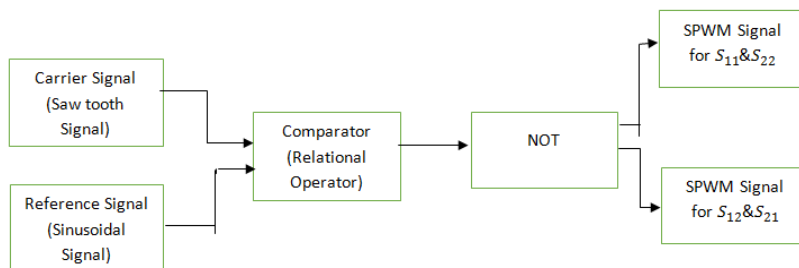


Fig.1: Generation of SPWM Signal For four inverter switches

III. Single Phase Spwm Igbt Inverter Circuit Design In Matlab/Simulink

The simulation of single phase SPWM IGBT inverter is designed in MATLAB/SIMULINK environment. Fig. 2 shows the Simulink diagram of the proposed model. For simulation purpose SIMPOWER SYSTEM tool box is used. Here four IGBT switches are used for switching purpose. In order to operate these switches SPWM signals are generated. Here a saw tooth signal is compared to a reference signal, and generates PWM signal. Overall THD of the output voltage is evaluated using FFT analysis. Here, frequency of carrier signal is varied and harmonic contents of output voltage for each modulation index is observed.

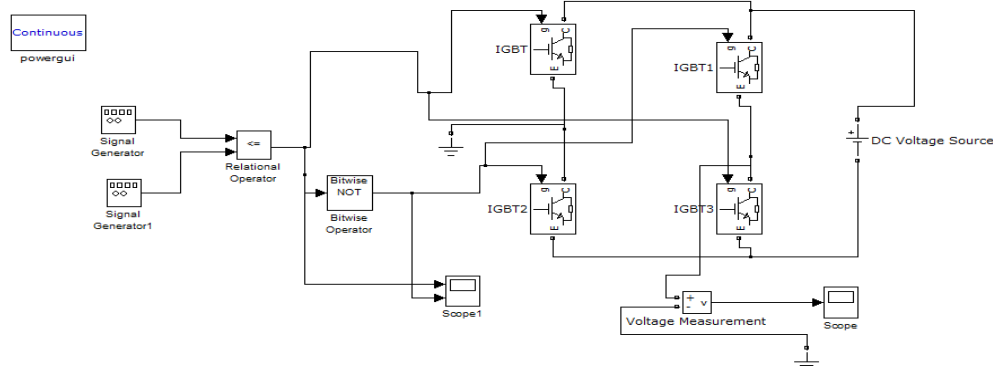
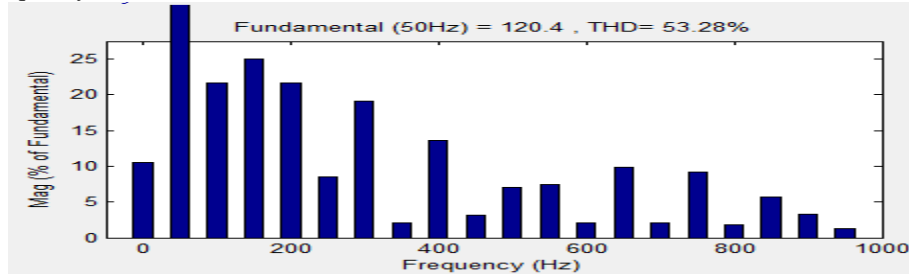


Fig.2: Circuit Diagram of SPWM Single Phase IGBT Inverter in MATLAB

IV. Simulation Results Of Spwm Based Igbt Inverter

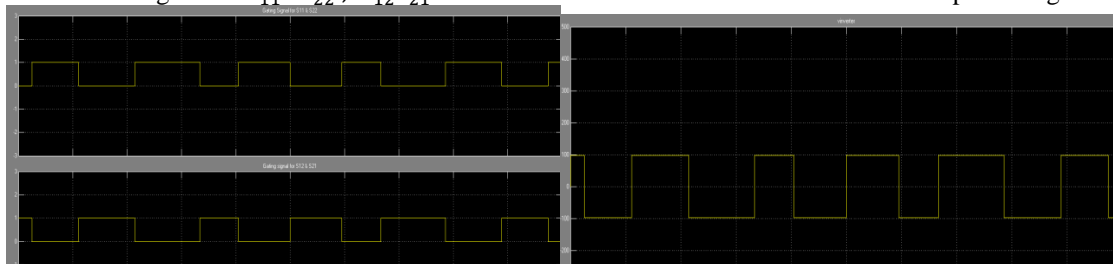
Here inverter performance is analyzed for different carrier signal frequency range higher than reference signal frequency and overall % THD of output voltage is evaluated for all these different carrier frequencies, which is simulated and the results are shown in fig. 3.

For carrier frequency 60 Hz



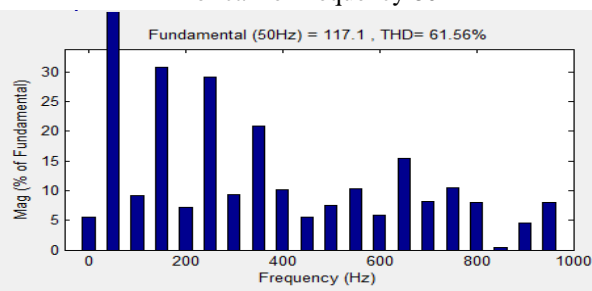
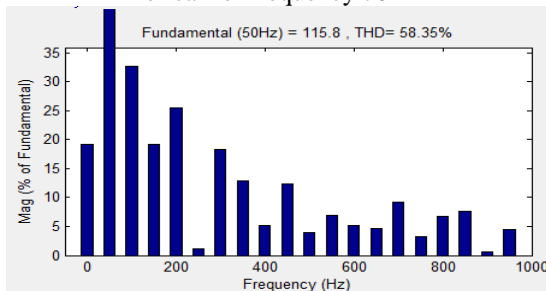
SPWM signal for S_{11} & S_{22} , S_{12} S_{21}

Inverter Output voltage



For carrier frequency 70 Hz

For carrier frequency 80 Hz



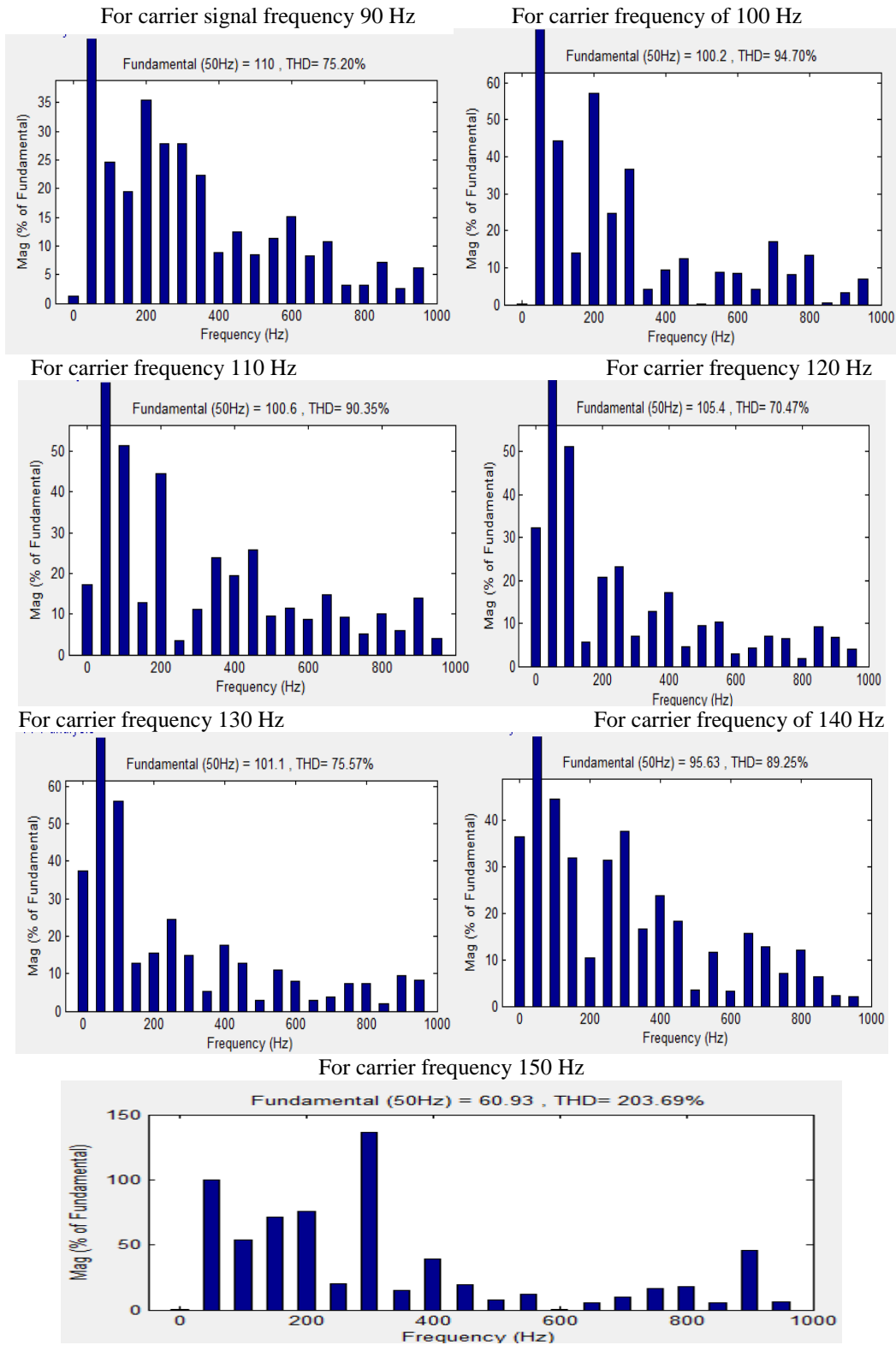


Fig.3: % THD of IGBT inverter output voltage with change in carrier signal frequency

V. Single Phase Spwm Mosfet Inverter Circuit Design In Matlab

Here four MOSFET switches are used to design this inverter. The design & simulation of the circuit is done in MATLAB/SIMULINK environment as shown in fig. 4. The proposed design of single phase MOSFET inverter is same as discussed earlier in IGBT based inverter. The same design is proposed intentionally to compare performance analysis of MOSFET based inverter with IGBT based inverter. Here quality of these

inverters are assessed by evaluating overall THD of inverter output voltage. Overall THD of output voltage of these two inverters are compared for a particular carrier signal frequency and the results are shown in fig. 5.

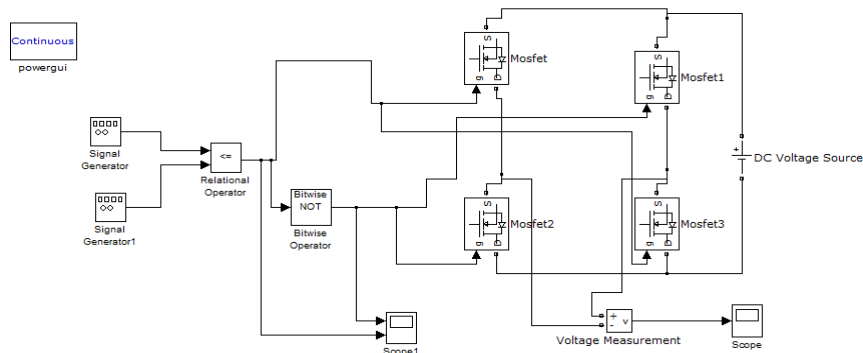
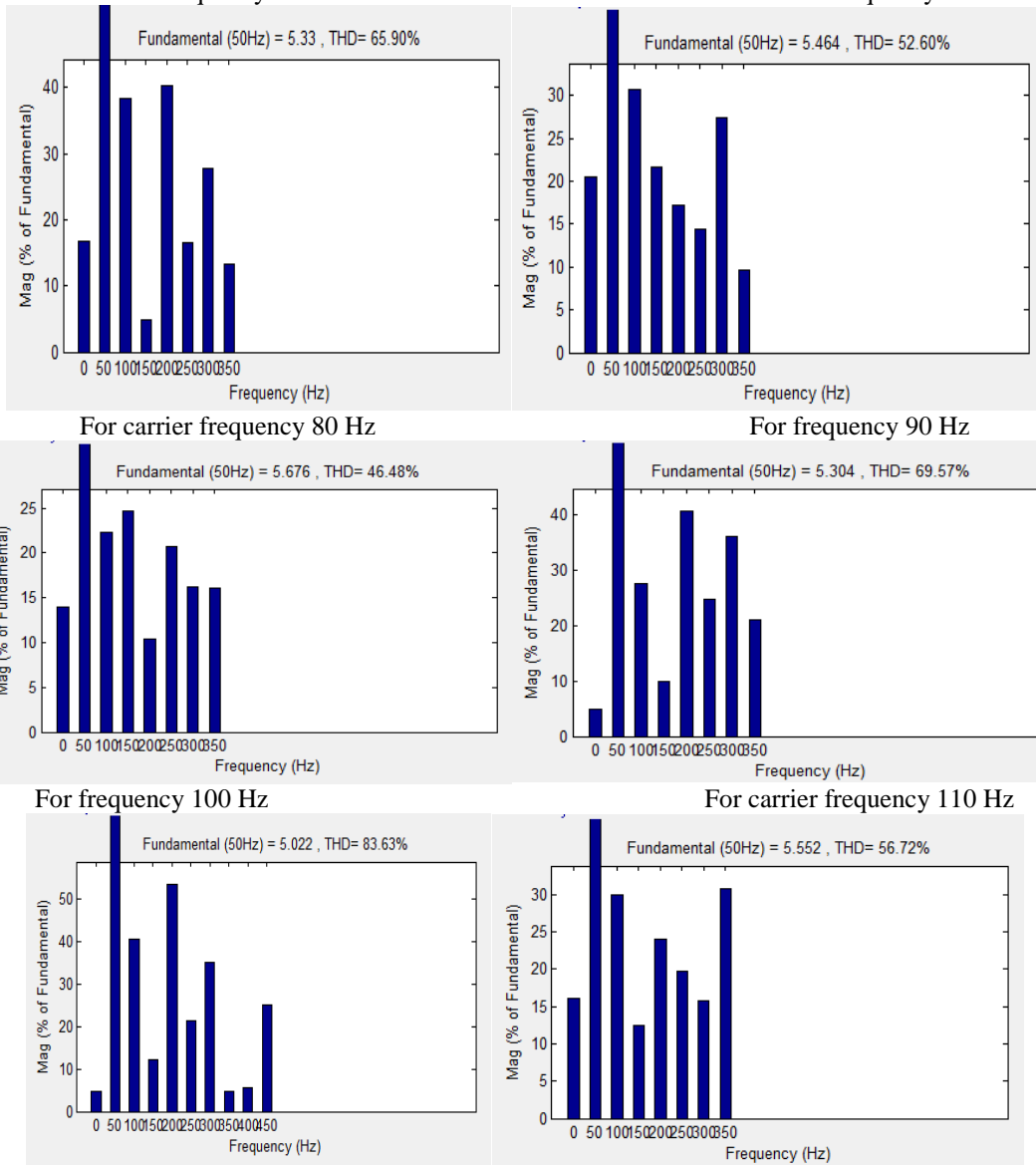


Fig.4: Circuit Diagram for MOSFET based single phase inverter in Simulink
For carrier frequency 60 Hz For carrier frequency 70 Hz



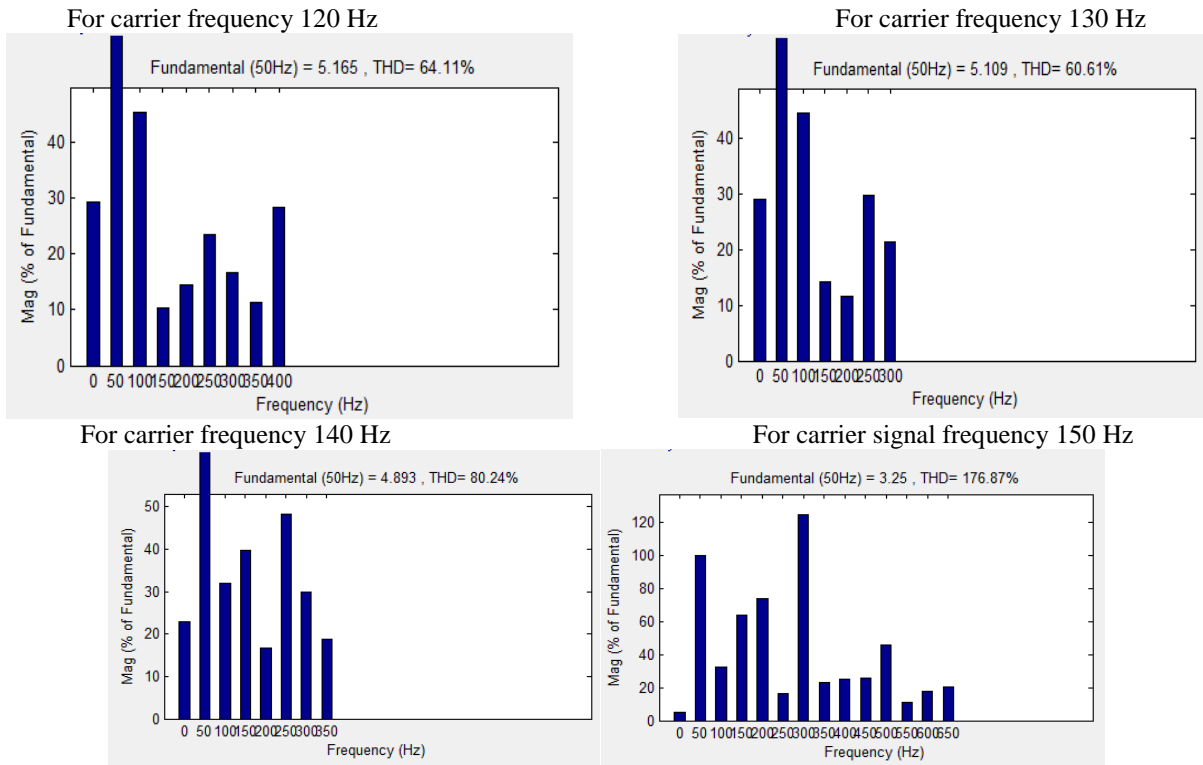


Fig. 5: % THD of MOSFET inverter output voltage with change in carrier signal frequency

IV. Comparative Study

Table 1: Comparison of overall THD of MOSFET based & IGBT based inverter for some particular carrier frequencies:

Carrier Signal Frequency	% THD of output voltage	
	For IGBT Inverter	For MOSFET Inverter
60 Hz	53.28	65.90
70 Hz	58.35	52.60
80 Hz	61.56	46.48
90 Hz	75.20	69.57
100 Hz	94.70	83.63
110 Hz	90.35	56.72
120 Hz	70.47	64.11
130 Hz	75.57	60.61
140 Hz	89.25	80.24
150 Hz	203.69	176.87

Graphs:

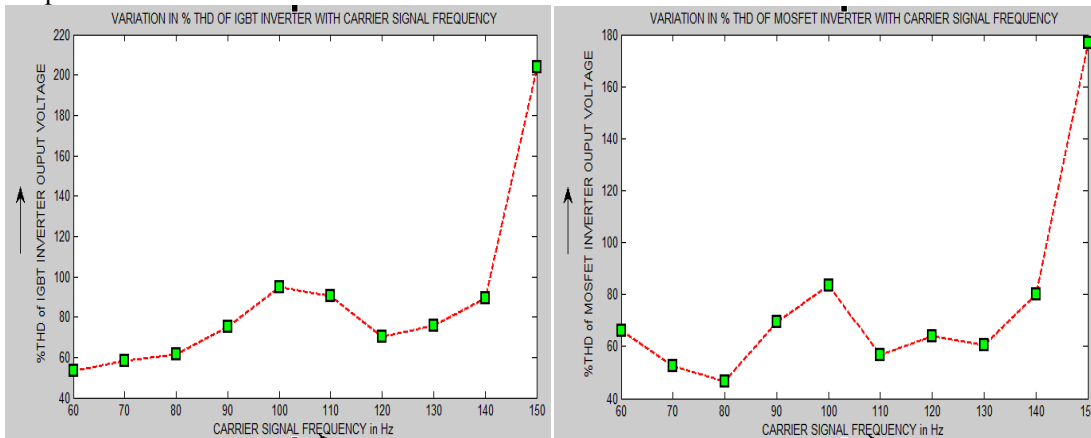


Fig.6: Comparative study of % THD of output voltage with carrier signal frequency of IGBT & MOSFET Inverter

V. CONCLUSION

In this paper simulation model of IGBT based & MOSFET based single phase inverter is designed & overall THD of inverter output voltage has been evaluated. This paper compares % THD of these two inverters output voltage for carrier signal frequency ranging from 60-150Hz. From the comparative study shown in fig. 6, it is concluded that for all the carrier signal frequencies (except 60 Hz) % THD of IGBT inverter output voltage is higher than MOSFET inverter. As in this design no harmonic filter is used, so overall %THD of IGBT inverter is higher than MOSFET inverter, since IGBTs result in large amount of harmonic distortion in output voltage of inverters, so IGBTs should not be used as power switch without harmonic filters [7].

REFERENCES

- [1]. P.S. Bhimra, *Power Electronics*, (Khanna Publishers , 2013)
- [2]. Pankaj H Zope, Pravin G. Bhangale, PrashantSonare, S.R. Suralkar, Design and Implementation of Carrier Based Sinusoidal PWM Inverter, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 1(4),2012.
- [3]. C.S. Sharma, TaliNagwani, Simulation and Analysis of PWM Inverter Fed Induction Motor Drive, *International Journal of Science, Engineering and Technology research (IJSETR)*, 2(2), 2013, 359 – 366.
- [4]. Amit Kumar Sharma, Tushar Deep Saxena, Sirazul Islam, Arun Kumar Yadav, Performance Analysis of Three Phase PWM Voltage Source Inverter Fed Three Phase Induction Motor Drive, *International Journal of Advanced Electrical and Electronics Engineering (IJAEED)*, 2(2), 2013, 45 – 52.
- [5]. Arindam Dutta, ThirtharajSen, S. Sengupta, Reduction in Total Harmonic Distortion in a Non – Linear Load with Harmonic Injection Method, *International Journal of Recent Trends in Engineering*, 1(4), 2009, 85 - 89.
- [6]. Vinamra Kumar Govil, YogeshChaurasia, Modelling and Simulation of PWM Controlled Cycloconverter Fed Split Phase Induction Motor, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 1(3), 2012, 126 – 131.
- [7]. Ahmed Riyaz, Atif Iqbal, Shaikh Moinoddin, SK. MoinAhmed, Haitham Abu – Rub, Comparative Performance Analysis of Thyristor and IGBT based Induction Motor soft starters, *International Journal of Engineering, Science and Technology*,1(1), 2009, 90 – 105.