Comparative Study of THD in Two-Level Inverter and Three-Level Inverter Fed AC Drives

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Abstract--- During the operation of AC motors theMultilevel voltage source inverters are prefer over conventional two level inverter as it offers several advantages, such as better output voltage with reduces total harmonic distortion (THD). The main objective of this paper is to compare the total harmonic distortion with current and voltage waveform of Induction motor to two-level and three level diode clamped inverter. The sinusoidal pulse width modulation technique (SPWM) is use for the control of both two-level and three level diode clamped inverter.

Keywords: - Induction Motor, AC Motor, Multi-Level Inverter, Two-Level Inverter, Total Harmonic Distortion (THD), SPWM**.**

I. INTRODUCTION

Now a days AC drives are widely used in industries. Harmonic in AC motor is one of the important factor which affects the efficiency of the motor. Harmonics in AC drives are produce due to non-linear loads and improper switching devices such as converter used with the motor. As the harmonics are produced in the winding of the motor, the copper losses and core losses are increases. There is also rise in temperature of motor, thus the dielectric stress on the insulation increases, and due to this the life of the motor decreases, this is due to presence of harmonics in the AC motor.

II. PWM

AC load may require constant or adjustable voltage at their input terminals. When such loads are fed by inverters, it is essential that output voltage of the inverters is so controlled as to fulfill the requirement of ac loads.

The various methods for the control of output voltage of inverters are as under:

a) External control of dc input voltage.
b) External control of ac output voltage.
c) Internal Control of inverter.

Output voltage from an inverter can be adjusted by exercising a control within the inverter itself. The most efficient method of doing this is by pulse width modulation control used within an inverter. In this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components.

The advantages possessed by PWM techniques are as under:

The output voltage control by this method can be obtained without any additional components.

With this method, lower order harmonics can be eliminated or minimized along with its output voltage control. As higher order harmonics can be filtered easily, the filtering requirements are minimized.

The main disadvantage of this method is that the SCR's are expensive as they must possess low turn on and turn off times.

PWM techniques are characterized by constant amplitude pulses. The width of these pulses is, however, modulated to obtain inverter output voltage control and to reduce its harmonic content. Different PWM techniques are

a) Single Pulse Modulation
b) Multiple Pulse Modulation
c) Sinusoidal Pulse Modulation.

In PWM inverters, forced commutation is essential. The three PWM techniques listed above differ from each other in the harmonic content in their respective output voltages. Thus choice of a particular PWM technique depends upon the permissible harmonic content in the inverter output voltage. Pulse width modulation (PWM) techniques have been widely accepted as a good control strategy for inverters. The fundamental voltage and the harmonic content can be controlled by using PWM techniques.

III. TWO LEVEL INVERTER

The figure 1 shows the conventional two level inverter. Six self-commutating switches (Thyristor, MOSFET, IGBT etc.) are used for the construction of Two level inverter as shown in figure 1.

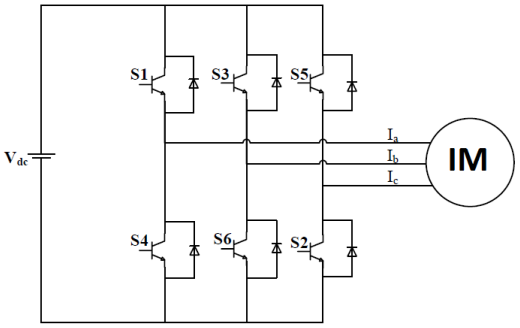

Fig. 1: Two Level Inverter

The table below showing the 120^0 mode of operation of Two level inverter in which two switches are conducting at the same time interval.

Table 1: Switching States of Two Level Inverter

S1	S2	S3	S4	S5	S6
ON	OFF	OFF	OFF	OFF	ON
ON	ON	OFF	OFF	OFF	OFF
OFF	ON	ON	OFF	OFF	OFF
OFF	OFF	ON	ON	OFF	OFF
OFF	OFF	OFF	ON	ON	OFF
OFF	OFF	OFF	OFF	ON	ON

IV. THREE LEVEL INVERTER

For multilevel operation 12 pulse, 24 pulses, 36 pulse, 48 pulse converters are used. The ac side of converter is connected to magnetic interface. Magnetic interface has many disadvantages, such as :

1. It consumes large space.
2. Dynamics is slow.
3. About 40% losses take place in transformer.
4. It is very bulky.
5. It is more prone to failure.

Because of this reasons now a day's multilevel inverters are used.

When numbers of output voltage levels are greater than or equal to three levels then the converters are known as multilevel converters. They are classified as

1. Diode Clamped Multilevel Converters.
2. Cascaded Multilevel Converters.
3. Capacitor Clamped Multilevel Converters.

A. Diode Clamped Multilevel Converters.

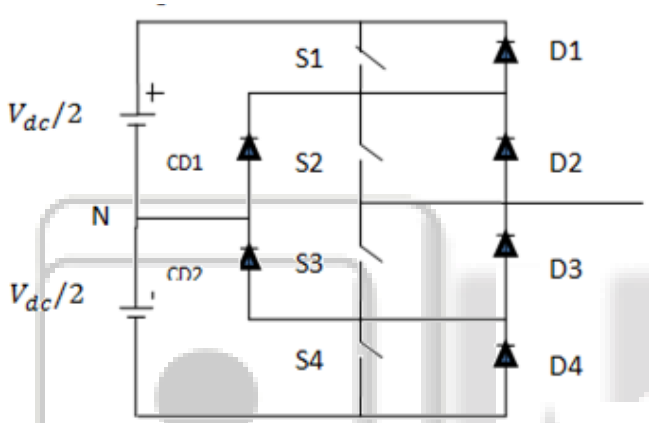

Figure 2: Diode Clamped Three Level Inverter

Above figure shows the configuration for diode clamped three level inverter. It has four switches in each phase of inverter.Each switch is made up of self-commutating device like MOSFET, IGBT, GTO, etc. and antiparallel connected diodes. Switching states and corresponding output voltages are given in table below:

Table 2: Switching States of Diode Clamped Three Level Inverter

MODES	SWITCHING CONDITIONS				O/P
	S_1	S_2	S_3	S_4	
MODE 1	ON	ON	OFF	OFF	$+V_S/2$
MODE 2	OFF	ON	ON	OFF	0
MODE 3	OFF	OFF	ON	ON	$-V_S/2$

V. SIMULATION RESULTS

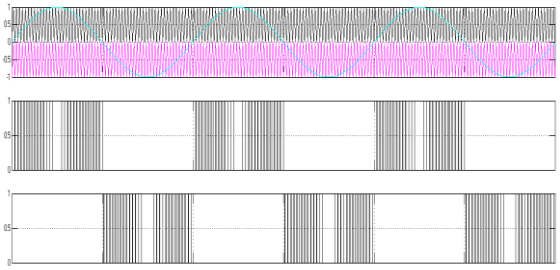

Fig. 3: Sinusoidal Pulse Width Modulation Technique

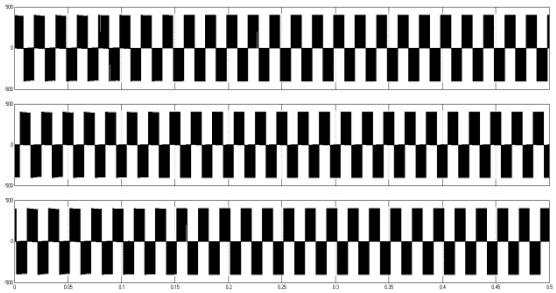

Fig. 4: Line Voltage of Two Level Invereter

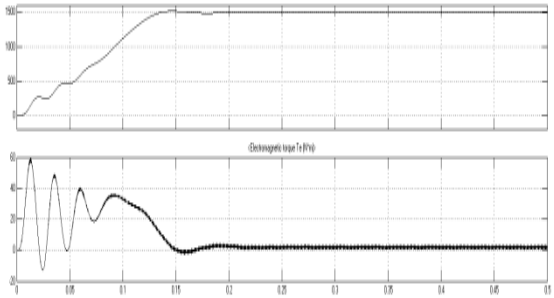

Fig. 5: Speed and Torques of 3 Phase IM with Two Level Inverter

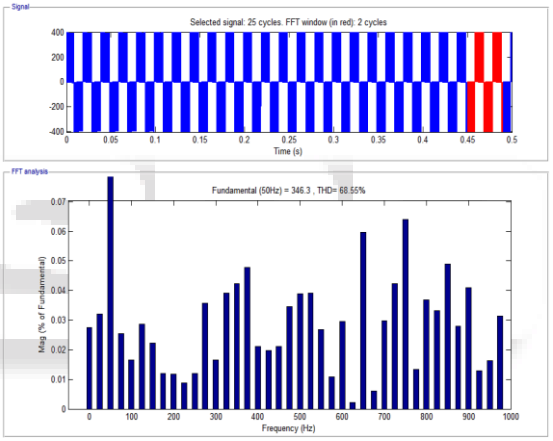

Fig. 6: THD in Line Voltage of Two Level Inverter

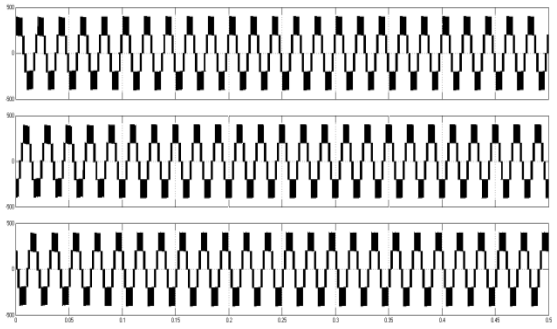

Fig. 7: Line Voltage of Three Level Inverter

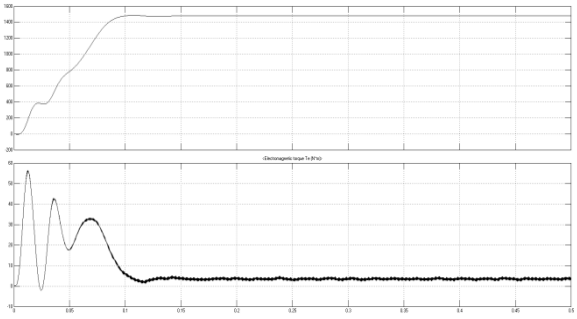

Fig. 8: Speed and Torques of 3 Phase IM

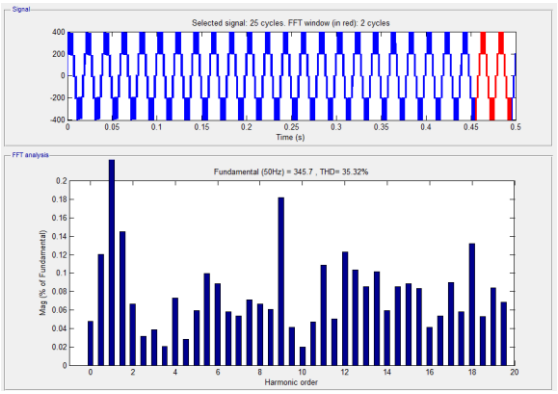

Fig. 9: THD in Line Voltage of Three Level Inverter

VI. THD IN INVERTERS

Two Level Inverter	Three Level Diode Clamped Inverter
68.55%	35.32%

VII. CONCLUSION

In normal inverters odd harmonics are present which causes distortion of the output waveform. By using the "THREE LEVEL DIODE CLAMPED INVERTER" we can eliminate some number of harmonics hence increasing the efficiency of the inverter.

REFERNCES

[1] J. Rodriguez, J.S. Lai, F. Z. Peng, 'Multilevel Inverters: A Survey of Topologies, Controls and Applications', IEEE Trans. On Ind. Electronics, **VOL.** 49, NO. 4, pp. 724-738, AUGUST 2002

[2] G. Durgasukumar, 'THD reduction in performance of multi-level inverter fed induction motor drive', Power Electronics (IICPE), 2010 India International Conference

[3] M.M.Renge, H,M,Suryawanshi, 'Five-Level Diode Clamped Inverter to Eliminate Common Mode Voltage and Reduce dv/dt in Medium Voltage Rating Induction Motor Drives', IEEE Trans. On Power Electronics, VOL. 23, NO. 4, pp.1598-1607, JULY 2008 .

[4] D. Soto, T. C. Green, 'A Comparison of High Power Converter Topologies for the Implementation of FACTS Controller', IEEE Trans. On Ind. Electronics, VOL. 49, NO. 5, pp. 1072-1080, OCTOBER 2002.

[5] A.Mwinyiwiwa, ZbigneiwWolanski, 'Microprocessor Implemented SPWM for Multiconverters with Phase-Shifted Triangle Carriers' IEEE Trans. On Ind. Appl., Vol. 34, no. 3, pp 1542-1549, 1998.

[6] Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, Third edition, Prentice Hall of India, New Delhi, 2004.

[7] Dr. P. S. Bimbhra, Power Electronics, Khanna Publishers, Third Edition, Hindustan Offset Press, New Delhi-28, 2004.

[8] M.M.Renge, H.MSuryawanshi, 'A DSP based SPWM technique for multilevel inverter', International Journal of Engg., Science and Technology, Vol. x, No. x, 2010

