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DESIGN OF A MULTI-PULSE CONVERTER FOR FIELD ORIENTED CONTROL OF INDUCTION MOTOR FOR HARMONIC REDUCTION

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Abstract

It is well known that undesirable harmonic currents may be generated in a field control of induction motors because of the switching components used in the rectification and inversion proces. The rectification of AC power to DC power itself may in general produce undesirable current harmonics. These non-linear components cause severe current harmonics that may not be tolerated by either a shutdown of the device or unacceptable powering of the devices. The great majority of power electronic equipment operates from an ac source but with an intermediate dc link. Thus, a significant opportunity exists to facilitate power electronics applications by using ac to dc rectifiers that produce low harmonic current in the ac source. Multi-pulse converters in general and non-isolated multi-pulse converters in particular can be applied to achieve clean power which is of major interest in higher power ratings. In general, by increasing the number of pulses in multi-pulse converters THD (total harmonic distortion) can be reduced and other associated performance parameters can be enhanced. The twelve pulse and a twenty four pulse multi- pulse converter is being designed in this work. The total harmonic distortion is being compared with a conventional six pulse type of multi level converter. The model is being simulated in a MATLAB simulink environment and results are being discussed.

Keywords: power quality, , multi pulse converter, total harmonic distortion

I. Introduction

Three-phase controlled rectifiers have a wide range of applications, from small rectifiers to large High Voltage Direct Current (HVDC) transmission systems. They are used for electro-chemical process, many kinds of motor drives, traction equipment, controlled power supplies, and many other applications. In modern power electronics converters, a three-phase controlled converter is commonly used especially as a rectifier in interfacing adjustable speed drives (ASD) and renewable energy in electric utilities [5], [6]. We noticed earlier that a standard six pulse rectifier caused a predictable harmonic spectrum consisting of the 5th, 7th, 11th, 13th, 17, 19th…harmonics. For three phase power system rectifiers, the harmonics, which will normally be present in the input current harmonic spectrum, can be identified by the following equation: h = k p +/-1

Where, k is an integer (1, 2,3,…) and p is the number of rectifier pulses on the dc bus waveform for one cycle of ac input voltage. In this paper we deal with the reduction of Total Harmonic Distortion using Multi-pulse AC to DC Conversion scheme. A twelve pulse and twenty four pulse multi level converter is being simulated in a field oriented controlled induction model and total harmonic distortion is being reduced. A lot of efforts have been performed to reduce harmonic contents in the utility line currents of controlled converters [4]. Passive filters have been used in many researches with different configurations [15], but this technique suffers from bulky, heavy filter elements and sometimes causes resonance problems. Active filters have been used in many researches and it seems to be an interesting option, but this technique suffers from complexity and high cost [5], [16]. Hybrid solutions using active filters and passive filters are used in high-power applications to improve passive filter performance [6]. An increasing number of pulses reduce the harmonic contents in a line current. However, this technique is heavy, has high cost, complex construction, needs to be large in size, and it is not readily available from the manufacturer [18]. Early work in third harmonics injection techniques has been used in [3], [4], [8]. Some other literatures use switches in the main path of power flow,

which increase the switching losses and reduce the system reliability. Injection of third harmonic current to line currents can be achieved by using LC branches tuned around the third harmonic frequency [16].

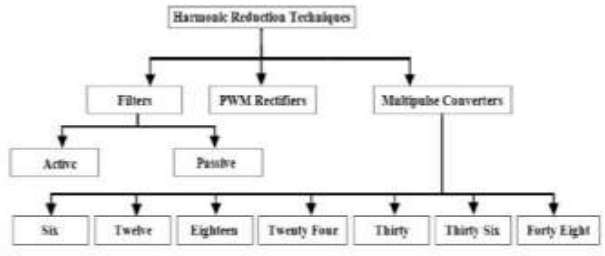

Figure 1. Various Harmonic Reduction Techniques

II. Multipulse Converter

Pulse number is defined as the number of pulses in the dc output voltage within one time period of the ac source voltage. In high-power applications, AC-DC converters based on the concept of multipulse, namely, 12, 18, 24, 30, 36, 48 pulses are used to reduce the harmonics in ac supply currents. These are named as multipulse converters. They use either a diode bridge or thyristor bridge, which is connected with special arrangement of zigzag transformer. This zigzag transformer also reduces second harmonics.

6 pulse thyristor converter

Three-phase six-pulse converter six thyristor are connected in a bridge manner. A three-phase supply is connected across the input terminal of the converter. The output of this converter is connected to the dc load. Because thyristor are unidirectional, dc current flows only in one direction. For generating 6 pulses per fundamental ac cycle synchronized 6-pulse generator is used. Figure.2 shows 6-pulse thyristor converter with resistive load.

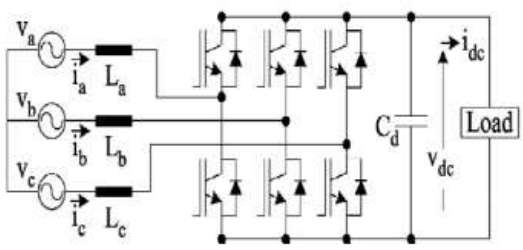

Figure 2. 6-Pulse thyristor converter

12-Pulse Converter

The 12-pulse method has been also used for reduced facility harmonics distortion. In these case two set of non linear load are fed by two phase shifted transformer winding with the using of twelve pulse converter 5th and 7th harmonics can be cancellation on primary side of transformer. From H= np±1 so that 11th and 13th harmonics are present. 12-pulse rectifier 5th, 7th 90% cancelled still has 11th, 13th, 17th, 19th etc.

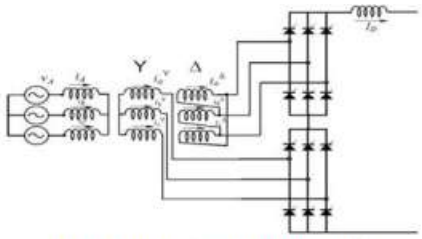

Figure 3. 12-Pulse controlled rectifier

Advantages of multi pulse converter

The Efficiency and unity input power factor at input mains. Harmonics reduction and regulated output voltage is obtained using twelve pulse PWM rectifier. As the number of pulses increases harmonic reduction will be better and hence a better DC link output voltage is achieved. Here we descried harmonic reduction technique in fig multi-pulse converter using uncontrolled and controlled rectifier figure 1 given below the various techniques used widely for the reduction of harmonics [19]-[20].

III. Simulation model and result

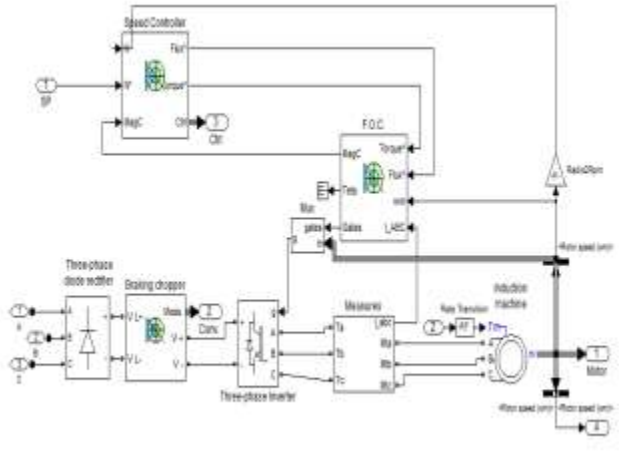

Figure 4. Rectifier –inverter section of six pulse FOC induction motor

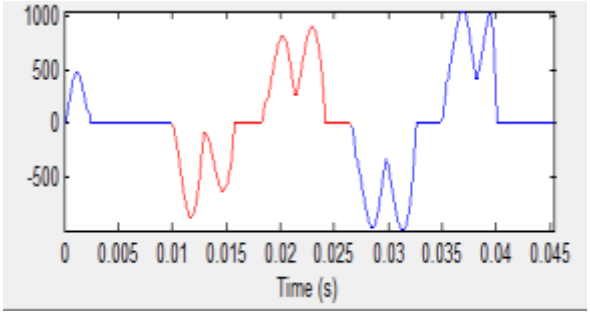

Figure 5. Source current waveform of six pulse FOC induction motor

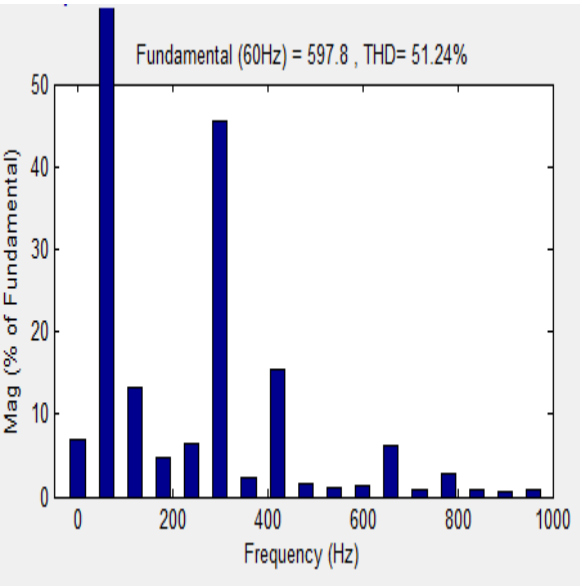

Figure 6. FFT window of six pulse FOC induction motor

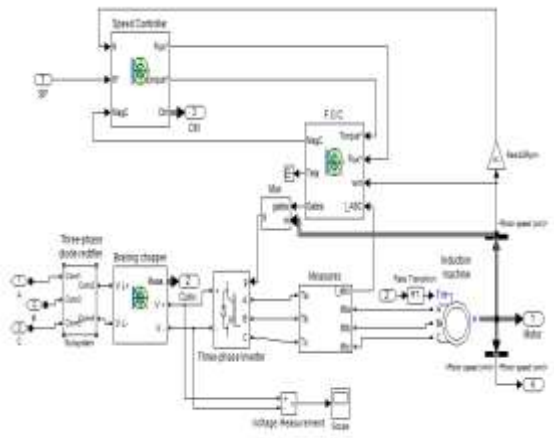

Figure 7. Rectifier –inverter section of twelve pulse FOC induction motor

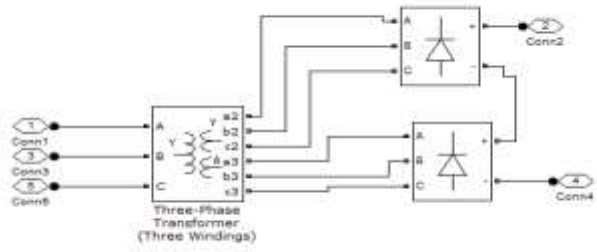

Figure 8 .Subsystem parameters in twelve pulse FOC induction motor

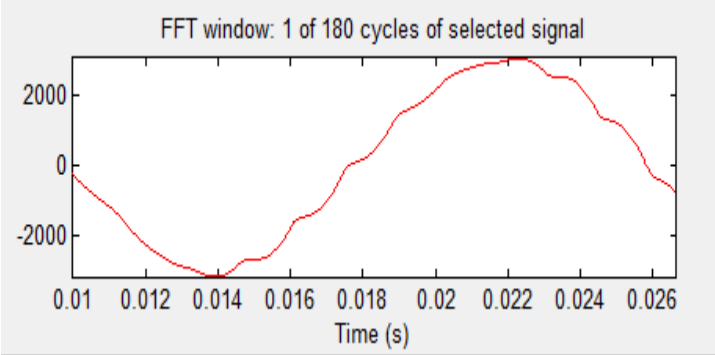

Figure 9. Source current waveform of twelve pulse FOC induction motor

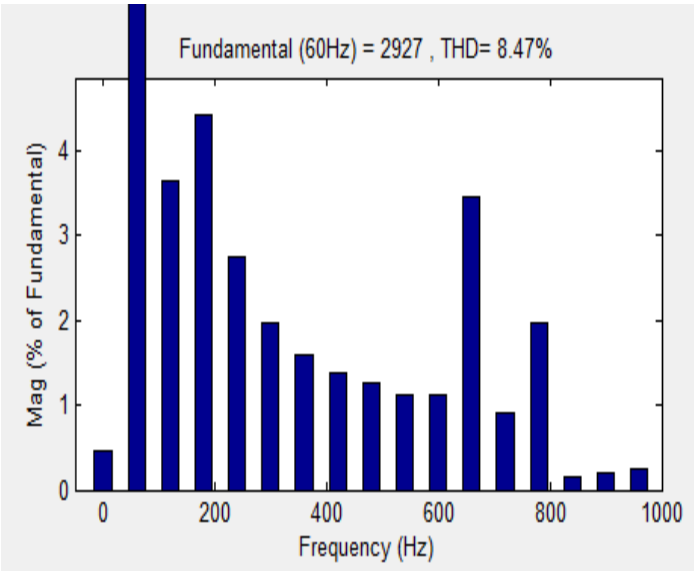

Figure 10 .FFT window of twelve pulse FOC induction motor

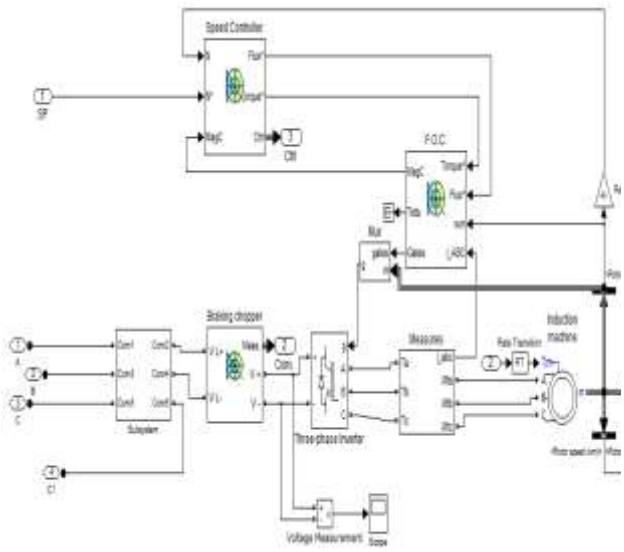

Figure 11. Rectifier –inverter section of twenty four pulse FOC induction motor

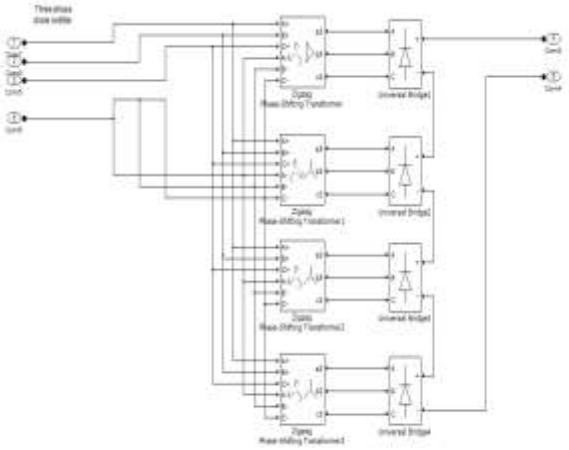

Figure 11. Subsystem parameters in twenty four pulse FOC induction motor

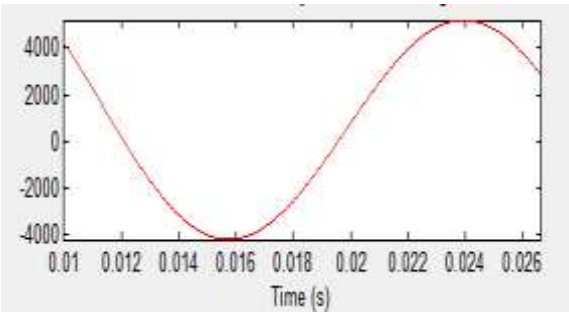

Figure 12. Source current waveform of twenty four pulse FOC induction motor

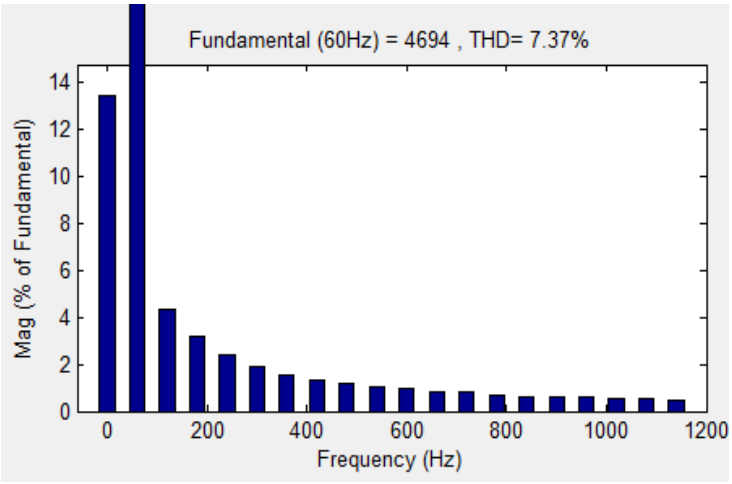

Figure 13. FFT window of twenty four pulse FOC induction motor

IV. Conclusion

From the results shown in the figures it is clear that the total harmonic distortion in a source current waveform can be considerably reduced by using the multi pulse converter and increasing their pulse number. It is seen that the THD of 6 pulse converter is 51 %, in the twelve pulse converter it is reduced to nearly 8 %, and in a twenty four pulse converter it is reduced to 7.37 %. Thus it is concluded that power quality problems based on harmonics can be considerably reduced on using the multi pulse converters.

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