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REDUCTION OF HARMONICS IN AC DRIVES & WAVELET SYNTHESIS

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Abstract
AC drives with variable speeds are becoming more and more common in various commercial and industrial loads. This paper examines the current situation of direct converters and provides an overview of the generally used current source converter technologies, such as pulse width-modulated current-source inverters (CSIs) utilized VFD system modulation methods. The suggested workflow entails utilizing Matlab/Simulink simulation tools to simulate three-phase PWM Current Source Inverter fed Induction Motor (CSI-IM) drive systems. This piece of writing mostly offers a unified method for producing pulse width-modulated patterns for inverters and rectifiers that use three phases of current. The motor current waveform has harmonics produced by this conversion process. This study focuses on the use of filters to mitigate motor current harmonics and FFT analysis to analyze them for smooth motor performance. The filter employed in Passive filters reduce harmonics. Because of this, the filter only lowers the fifth and seventh order harmonics. The work also involves wavelet analysis and the investigation of signals in the form of motor current. The FFT Analysis and Wavelet Analysis use very distinct methodologies. Two methods are available for performing wavelet analysis: wavelet programming and graphical approach. Wavelet programming is carried out using an M-file, which contains a software built for motor vehicle analysis.

Keywords: Harmonics, Total harmonic distortion (THD), variable frequency drives (VFD), power factor, current source inverter (CSI), Fast Fourier Transform (FFT), Wavelet.

Introduction

The current source inverter fed induction motor system forms the basis of the proposed work. A current source rectifier is connected at the front end, which rectifies the 6.6 Kv ac voltage to create DC. The inverter again transforms the dc voltage into ac and then gives the induction motor with power. Given that GTOs and SCRs are the switches utilized in the rectifier and inverter.This needs a pulse to be triggered. The discrete six-pulse generator, which is coupled to the gates of the rectifier and inverter and has six switching devices in each section, provides the triggering pulse. The system produces harmonics as a result of the switching procedures. Because of the switching period, the inverter's ac output is not sinusoidal the primary source of harmonics, which is taken by the switches and is in quazi square form. Six switches are utilized, so the 5th and 7th harmonics are harmful to the system. Therefore, lowering this harmonic order is the primary goal. Low pass filters are employed for this purpose in order to minimize the harmonics. By choosing the values of the inductor and capacitor, an LC filter is employed. Therefore, the filter used in this system is passive. The bus receives the induction motor's output bar that displays mechanical quantities, the rotor, and the stator. Since the stator side current is our primary concern, we select bus-bar amounts of the stator. An attached scope can view the waveforms. Wavelet is used to analyze the signal of the current waveform. A set of MATLAB-based utilities is called the Wavelet Toolbox. It offers tools for statistical applications utilizing wavelets and wavelet synthesis, as well as tools for the analysis and synthesis of signals and images. packets inside the MATLAB framework. There are two types of tools available in the toolbox:

Methodology

In a system where the loads fluctuate over time, adding a variable frequency drive (VFD) to a motor-driven system may result in energy savings. A motor linked to a VFD can have its operating speed

adjusted by varying the motor supply voltage's frequency. This enables constant control over process speed. Systems with motors are frequently intended to support peak loads with a safety margin. This frequently results in systems that run at reduced load for prolonged periods of time being inefficient with energy. Motor speed adjustment allows for more precise motor output to load matching and frequently leads to energy savings. The rectifier portion of the VFD essentially transforms the ac supply into dc, an inverter section that transforms the dc supply into an ac supply, and a dc choke that smooths the dc output current which the induction motor receives. The VFD is made up of switching components like IGBT, SCR, GTO, and diodes, among others.

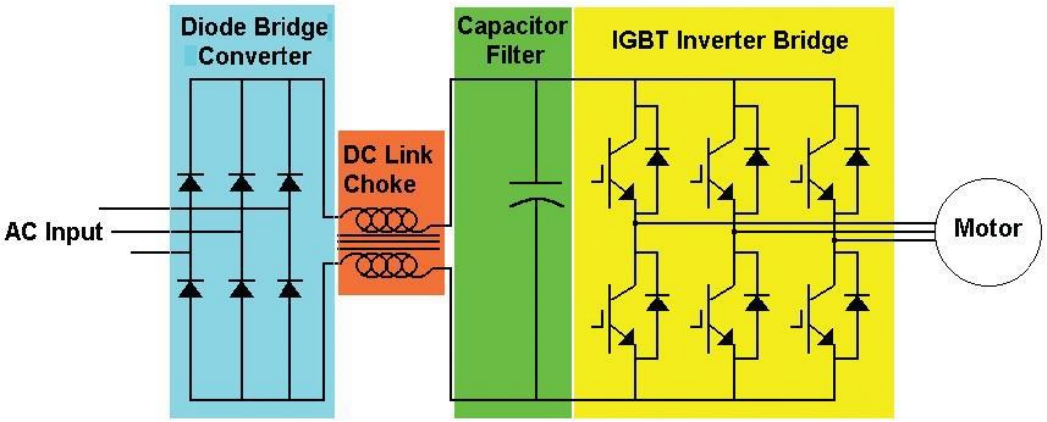

Fig.1: Generalized Variable Frequency Drive

There are two main sections to a VFD:

A. Rectifier stage: Three-phase 50 Hz electricity from a normal utility supply (208, 460, 575, or higher) is converted to either a fixed or adjustable DC voltage using a full-wave, solid-state rectifier.

B. Inverter stage: Electronic switches turn on and off rectified dc voltage by transistors or thyristors. and generate a waveform of voltage or current at the chosen new frequency. The degree of distortion varies on the filter's and inverter's design.

Simulation of System

The current source inverter fed induction motor system forms the basis of the proposed work. A current source rectifier is connected at the front end, which rectifies the 6.6 Kv ac voltage to create DC. A DC choke coil is used to smooth the voltage before applying it to the inverter; this eliminates ripples. The DC power is once more converted by the inverter into AC power and then feeds the induction motor. Given that GTOs and SCRs, the switches utilized in the rectifier and inverter, needs to initiate a pulse. The discrete six-pulse generator, which is coupled to the gates of the rectifier and inverter, provides the triggering pulse. Each segment contains six switching devices. The system produces harmonics as a result of the switching procedures. The inverter's ac output is not sinusoidal because of the switching time required by the

The fundamental source of harmonics is switches &, which is in quazi square form. Due to the usage of six switches, the harmonics which the fifth and seventh are hazardous to the system. Therefore, lowering this harmonic order is the primary goal. By choosing the values of the inductor and capacitor, an LC filter is employed. Therefore, the filter used in this system is passive. The induction motor's output is sent to the bus bar, which displays the mechanical quantities, rotor, and stator. Since the stator side current is our primary concern, we select bus-bar amounts of the stator. An attached scope can view the waveforms. The motor is coupled to an FFT block current of any one phase, the harmonic order of which needs to be ascertained. An FFT spectrum window is attached to this FFT block linked,

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which shows the harmonic order ranging from 0 to 19th order. Additionally, a bar graph illustrating the harmonic order as indicated by the FFT spectrum is given. As a result, the task is split into two sections: one for before and one for after the filter is used. Following the simulation, it is noted that the fifth and seventh harmonics components are less than those without a filter, as the FFT spectrum block illustrates. A signal import is made to workspace by the use of wavelet programming, and analysis is done on the stator and rotor currents.

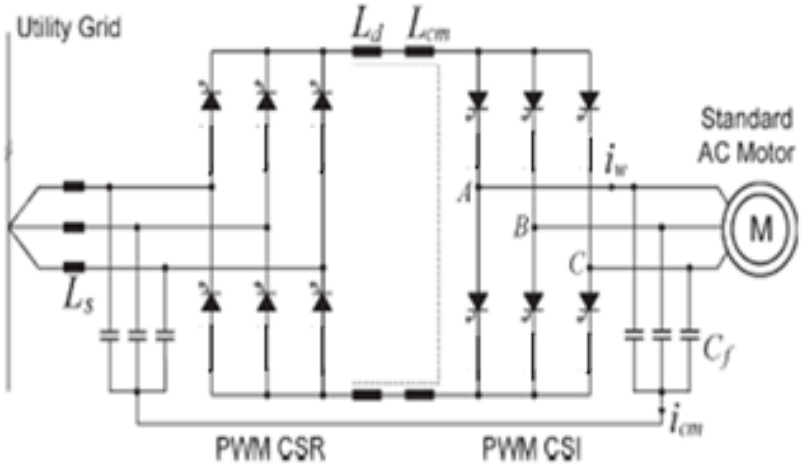

Fig.2: Simulation Diagram of CSI Fed Induction.

Harmonics

The main issue with any industrial drive is harmonics. They seriously impair the motor that is linked and fed as a load by the VFD. A current source inverter fed (CSI) is what the VFD is.a current source rectifier is connected at the front end, which rectifies the 6.6 Kv ac voltage to create DC. In order to reduce this voltage earlier Utilizing a DC choke coil, it is applied to an inverter. This eliminates the waves. The DC power is once more converted by the inverter into AC power and then feeds the induction motor. Given that GTOs and SCRs, the switches utilized in the rectifier and inverter, needs to initiate a pulse. The gate is coupled to a discrete six-pulse generator that provides the triggering pulse of both the inverter and rectifier. Each segment contains six switching devices. The system produces harmonics as a result of the switching procedures. The primary source of harmonics is the inverter's ac output, which is in quasi-square shape and not sinusoidal due to the switches' switching times. Due to the usage of six switches, the harmonics which pose a threat to the system are the fifth and seventh. Therefore, lowering this harmonic order is the primary goal. For acting so meekly .It is necessary to apply a pass filter to lessen these harmonics.

Wavelet Analysis

The next natural step after a windowing technique with variable-sized areas is wavelet analysis. Long time intervals can be used to obtain more accurate low-frequency information, and shorter regions can be used to obtain high-frequency information when using wavelet analysis. Certain characteristics of the data can be revealed by wavelet analysis that other signal Aspects like as trends, breakdown points, discontinuities in higher derivatives, and self-similarity are overlooked by analysis techniques.
Moreover, because it provides an alternative perspective on the data compared to what conventional approaches offer. Often, wavelet analysis can reduce signal noise or compress a signal without significantly degrading it. Consequently, wavelet, i.e.one can perform a minute study of the signal during a fault using time-scale analysis.

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Result

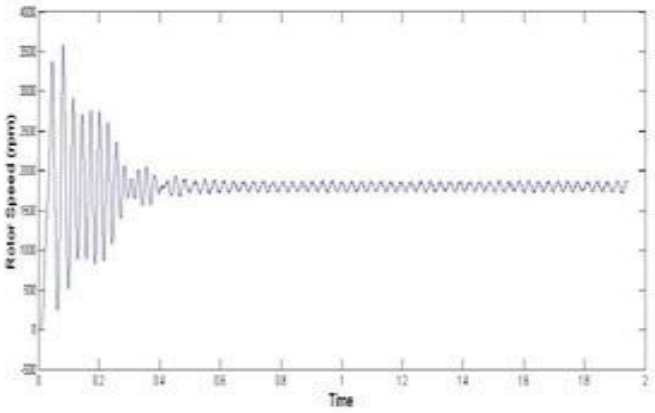

Fig.3: Motor speed without use of filter with ripple

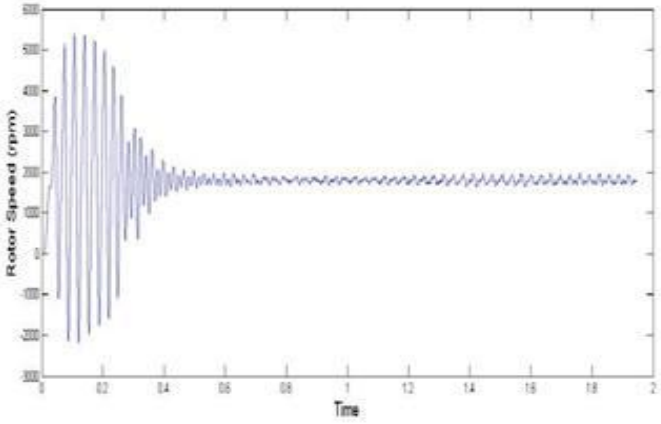

Fig.4: Thus we observe that when filter is used the ripples in the Speed is reduced .This is due to reduction in harmonics

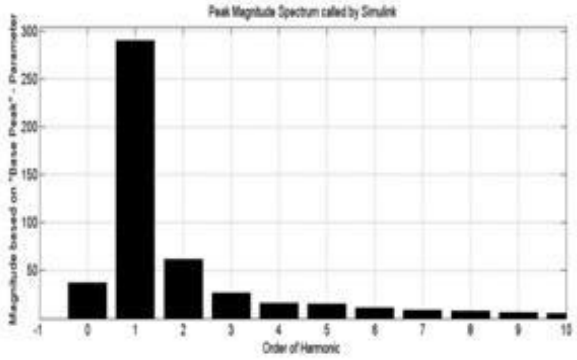

Fig.5: Bar-graph showing magnitude of harmonics without filter.

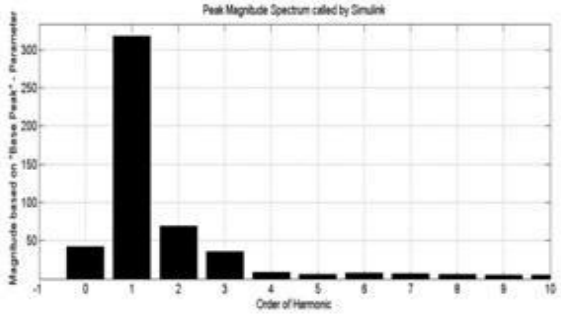

Fig.6: Bar-graph showing magnitude of harmonics with filter.

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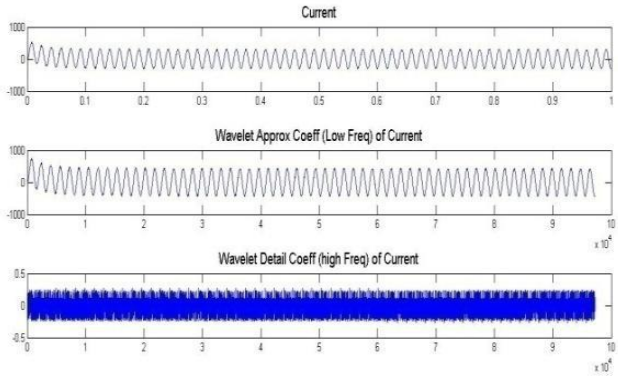

Fig.7: The waveform shows the low & high frequency component of stator current of phase A without use of filter. The higher frequency components are present.

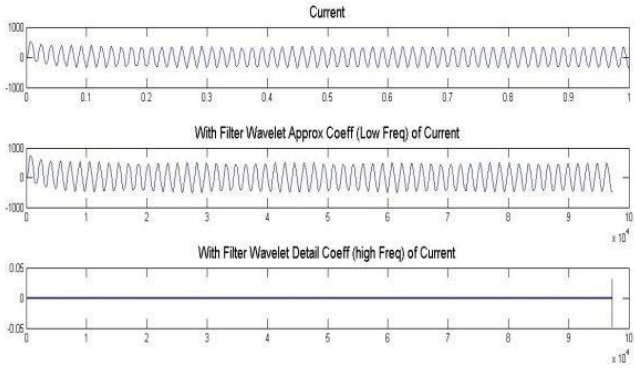

Fig.8: The waveform shows the low & high frequency component of stator current of phase A with use of filter. The higher frequency components are present.

Conclusion

Harmonics in the motor current were created by the CSI supplied Induction Motor drive simulation. The switching components employed in the rectifier and inverter portion produce these harmonics as a consequence. The fifth and seventh harmonics from all harmonic orders present issues because we use six pulse rectifier and inverter sections. We have employed an LC filter with harmonic reduction in order to usual values for the capacitor and inductor. Therefore, a passive filter reduces the 5th and 7th harmonic components. Through wavelet programming, we discovered that the application of a filter eliminates the higher frequency harmonics and also the precise moment when the rotor current faulted.

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