VFD Application on Induction Motor Control

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Abstract- *This paper presents the application and working principle of Variable Frequency Drive. The performance of VFD is also described. The simulation model is simulated using MATLAB Simulink and their results are also analyzed. effective speed control are analyze. The common applications of VFDs are in air handler, chiller, pumps and tower fans. In paper analyze result shown the total harmonic distortion (THD) that means the distortion in source and torque production is less.*

Keywords-operation of VFD,MATLAB simulation,THD analysis.

I. INTRODUCTION

In many application we went to use the induction motor like as commercial, industrial, and utility electrical motors are converted electrical energy into mechanical energy. Those induction motors may be part of a cutting tools, pump, traction or they may be connected to some other form of mechanical equipment such as conveyor or mixer. In many of these application like as pump, blower, mixer the speed of the induction motor is determined primarily by its mechanical design and loading. For an increasing number of these applications,

However, it is necessary to control the speed of the system by controlling the speed of the induction motor.

Before discussing variable frequency drives it is necessary to understand some of the basic working like as rectifier, inverter, and filter are associated with drive operation. We are familiar to us some other context.

II. BASIC OPERATION OF DRIVES

For understanding of VFD operation first required to understand the five basic think are given in below.

1. Line voltage – in case of three phase or single phase.
2. Input section – in case of transformer, rectifier and filter.
3. Control section – the controller is real word input and performs the required operations.
4. Output section – in section base of drive circuit includes of inverter and cycloconveter.
5. Motor – it's already desired.

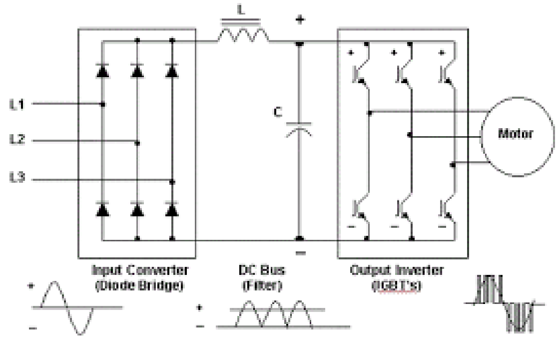

Figure 1: VFD Circuit Diagram

First supply voltage is pass though the rectifier its convert AC voltage to DC voltage. The three phase supply is fed to three phase diode base rectifier its convert the dc six pulse output its output is given to filter and its filter is filter out the supply and and get the smooth and low harmonics supply. Last stage is inverter is consist of semiconductor switch like as MOSFET, IGBT or GTO. Inverter convert DC supply to AC supply for a desired frequency.

We know that the synchronous speed of induction motor is depend upon the supply frequency. Therefore varying the supply frequency we can vary the synchronous speed.

$$NS = \frac{120\ F}{P}$$

Where,

NS= synchronous speed (in RPM)
F= frequency of the supply in hertz
P= no of magnetic pole

III. CONSTANT V/F RATIO OPERATION

All variable frequency control of drive we keep it the V/F ratio is constant because of the magnetic flux ϕ is taken constant. Whenever machine design they will will be taken maximum flux density if density is increases core will be saturated and the flux is directly proportional to the torque.
The equation is given as:

$$V=4.44\phi * f * N$$
$$V/f = 4.444 \times N\ \phi m$$

Where;

F= Supply frequency
N= No. of turns
Φ= magnetic flux

N is the number of turns per phase and F is frequency. If we change frequency synchronous speed changes but with decrease in frequency flux will increase and this change in value of flux causes saturation of rotor and stator cores. So, it's important to maintain flux, Φ constant. i.e. if we decrease frequency flux increases but at the same time if we decrease voltage flux will also decease causing no change in flux and hence it remains constant.

That is reason to we taken the V/ f ratio constant. Hence its name is V/ f method. For controlling the speed of three phase induction motor by V/f method we have to supply variable voltage and frequency.

IV. ADVANTAGES OF VFD

1- Smooth starting
2- smooth acceleration & deceleration time
3- stopping methods
4- reversal of motor
5- reduce harmonics
6- increase power factor
7-Energy saving at low speed is proportional to the N^3(Pu)*full speed power

V. SIMULATION CIRCUIT

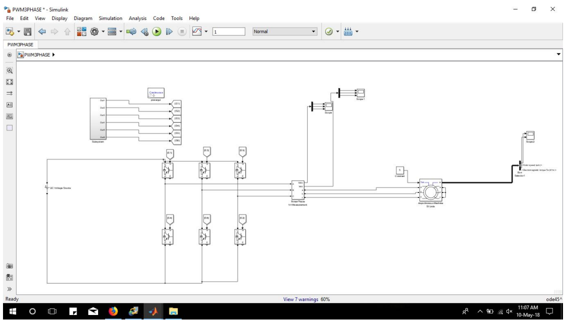

Figure 2: Simulation Circuit of VFD

Power Electronics is the technology associated with efficient conversion, control and conditioning of electric power by static means from its available input form into the desired electrical output form. An inverter is a circuit which converts a DC power into an AC power at desired output voltage and frequency. The DC power input to the inverter maybe battery, fuel cell, solar cell or other DC source. But in most industrial applications, it is fed by a rectifier. This configuration of AC to DC converter and DC to AC inverter is called a DC link at network frequency is rectified and then filtered in the DC link before being inverter to AC at adjustable frequency. Rectification is achieved by standard diode or thyristors converter circuits and inversion is achieved by the circuit techniques.

Simulation of 5 HP, 4 pole motor is done with an inverter using Pulse Width Modulation (PWM) technique. Frequency and amplitude of output voltage is varied by using PWM technique and these controlled voltage and frequency are used to control motor speed.

VI. WAVEFORM ANALYSIS

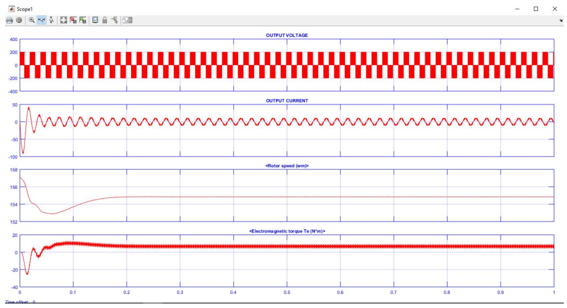

Figure 3: Waveforms of Voltage Current, Speed and Torque

The voltage, current, speed and torque waveform are analyzed.

VII. PERFORMING HARMONICS ANALYSIS USING THE FFT TOOL IN MATLAB

powergui opens the FFT Analysis Tool dialog box to perform Fourier analysis of simulation data signals. The dialog box provides access to all the simulation data signals that are defined in your workspace. This tool can also be activated from the powergui block dialog box by selecting FFT Analysis. MATLAB workspace should have a struct variable including time with the results of the simulation. (E.g. you can use the scope blocks to log data into the workspace note that this needs to be struct with time)

Table 1: Parameters of FFT present in powergui block

Input	Ib
Singnal number	2
Start time	0.3
Fundamental frequency	50
Maximum frequency	5000
Frequency axis	Harmonic order
Display style	Bar (relative to Fundamental)

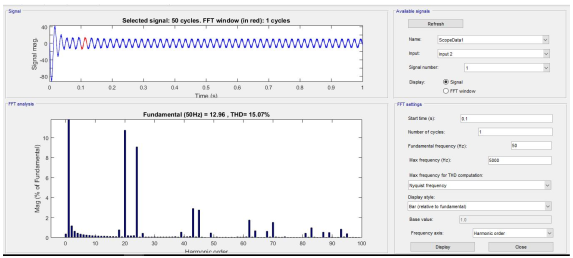

Figure 4: FFT analysis of Asynchronous motor current

VIII. RESULT

The simulation result is being calculated from a 4 pole Asynchronous motor of 3 HP and the Harmonics analysis using FFT tool of simulation of maximum frequency 5000 Hz.

Fundamental frequency	Syn.Speed (RPM)	THD of voltage	THD of current
80	2400	68.60 %	3.89 %
75	2250	69.06 %	3.74 %
70	2100	70.21 %	3.77 %
65	1950	68.25 %	4.64 %
60	1800	68.28 %	10.74 %
55	1650	68.50 %	18.67 %
50	1500	68.98 %	20.41 %
45	1350	68.51 %	21.12 %
40	1200	68.90 %	21.07 %
35	1050	68.72 %	20.19 %

It is clear that THD (C) level decreases with as the value of fundamental frequency increases from 50Hz.

IX. CONCLUSION

Thus from analysis is it clear that the increases frequency speed will be increases. Change in frequency the THD will be change with increases frequency THD of current will be decreases. Thus the Variable Frequency Drive can serve both in case of Speed Control of Motor as well as energy savings. Other techniques like Soft starter does not prove as much efficient as does variable frequency drive because there are many benefits of variable frequency drive like it provides a control over motor starting and stopping, Likewise it gives versatility to motor action.

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