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Power Quality Parameter Analysis Based VFD Fed Induction Motor on Different Speed Modes

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Abstract. In a different framework where the load changes over the long haul to time or a dynamic circumstances happens in various spaces, a variable frequency drive paired with a motor-driven system could offer energy reserve and expanded the power driven reliability. The primary purpose of a VFD is to save energy. Numerous power quality issues, including voltage, current will be examined in this research report. With the guide of the MATLAB curve fitting tool, the various power order attributes are anticipated for the alternate in loading that is based on no load, medium load and approximately to maximum burden. Voltage and current unevenness has been assessed with varying loads. The procedure was carried out using an experimental setup and a Fluke 302 power quality analyzer.

Keywords: Matlab Curve tool Fitting, Induction motor with drive set, Power quality measures , Control circuit mechanism.

1 Introduction:

Variable Frequency Drives:- A variable recurrence drive, sometimes referred to as an customizable speed drive framework, is utilized in electrical and mechanical framework to change the voltage and frequency in order to manage the torque and speed characteristics of an AC motor [1-3]. Here VFD is a power electronic tool which changes over one frequency of rotating current to one more frequency for running the alternating current motor in factor speed to save the energy [4],[5]. The below figure shows starting from number one is three phase supply then rectifier, later that DC bus, DC reactor and capacitor is there, then inverter, after that induction motor and control circuit consisting. The viability of semiconductor devices, control circuits for programming as well as hardware semiconductor devices, and drive configurations are all improved by the VFD system, which also helps to minimize system size[6].

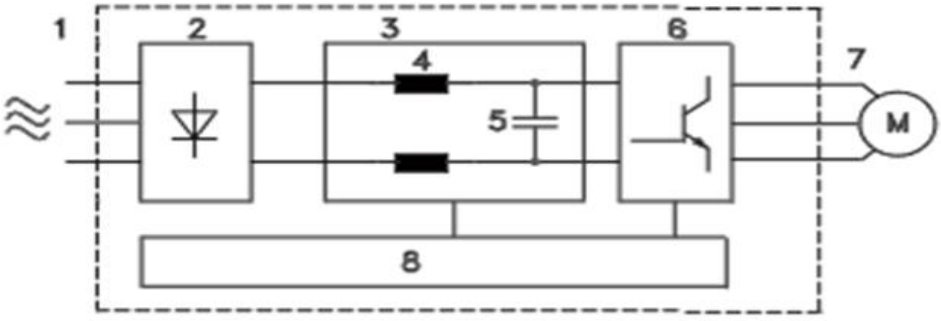

Figure 1 VFD Framework

2 Methodology

In this research paper work harmonics voltage and current spectrum is analyzed in various load conditions. In this work system the motor supply voltage and current value are 415Volt, 4.4Ampere. The power value of motor is 2.20kW, rated speed is 1440RPM and power factor value is 0.83. And the voltage of drive is near to 380V-500V, output current value is 12.5A, speed control ratio is 1:1000 of synchronous speed, starting torque is 110percent for 60sec and the efficiency of drive is 98%. Here meter is taken which is fluke meter for estimation purpose of different boundaries. The supply set up configuration of fluke meter is in three phase star connection. Nominal voltage of meter is 415V, its C.T. and P.T. ratio is 1:1, its ampere clamp type is I430 flex, and time interval is 3sec. Some IEEE principles are taken like voltage variety is less than ±10%, THD Voltage is (<8%) and current is (<5%), unbalance is <±3%.

3 Connection Diagram of Test Bench:

In the underneath diagram a test seat bench is made which is displayed beneath in the form of connection outline diagram. A three stage power input is there, then, at that point, current probe and voltage clamp is joined at each stage, later, then converter, bus and then inverter part is there, after that it is associated with induction motor. Later in below given figure we can see the hardware equipment setup of entire cycle in which test unit is directing. The generally recorded values will be store in the computer and continuing the work with the help of recorded values and with the assistance of Matlab curve fitting tools techniques.

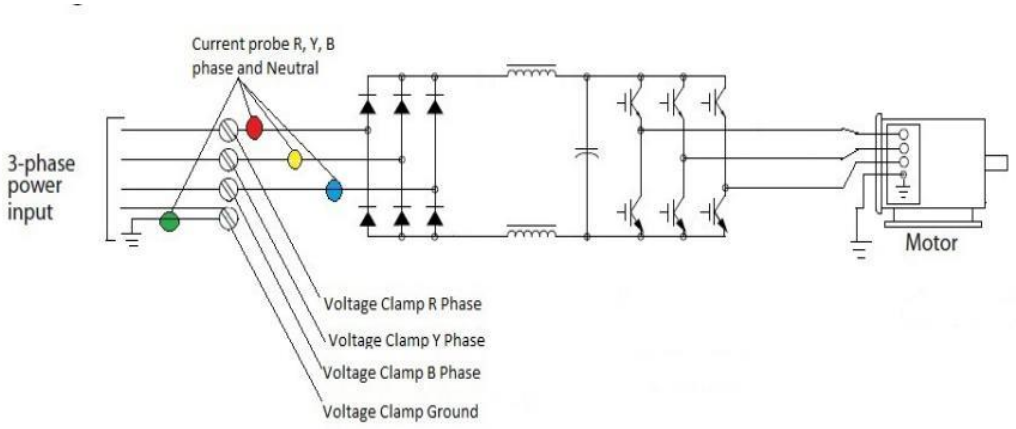

Figure 2 VFD Experimental Setup

4 Estimation of Power Quality Parameter:-

Testing the above test setup or experimental arrangement, we assess the harmonic spectrum of voltage and harmonic spectrum of current and then also evaluate their productivity too.

4.1 Harmonic spectrum of Voltage

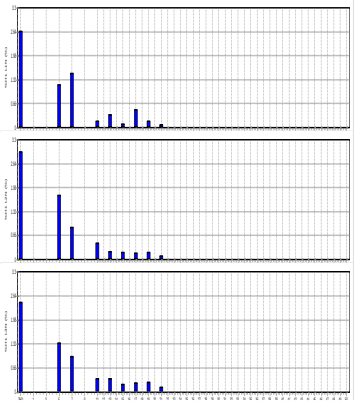

Figure 3 No load Voltage harmonic spectrum

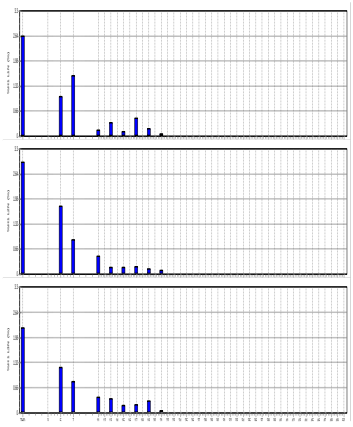

Figure 4 load 1KW Voltage harmonic spectrum

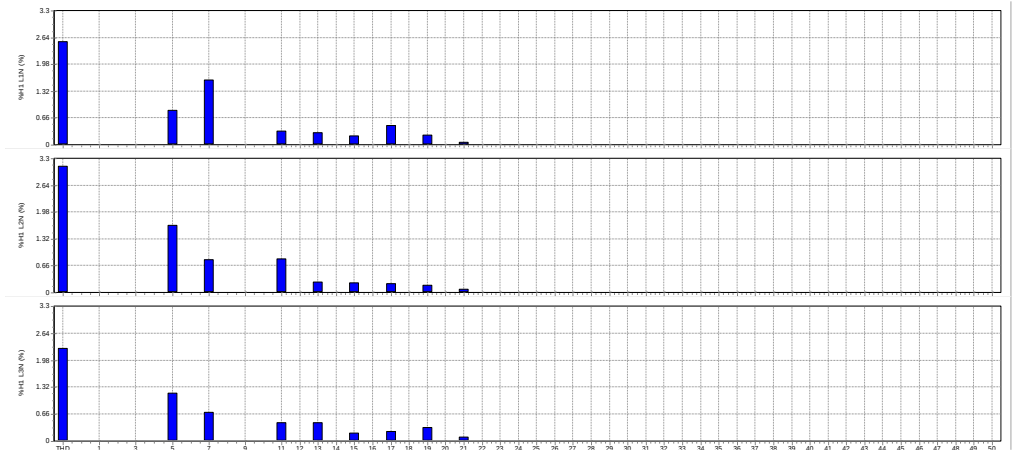

Figure 5 load 1.7KW Voltage harmonic spectrum

The below tabulation represents the observation made from the phase voltages during no load, load of 1kW and load of 1.7kW.

Table 1 Observation Made From the Phase Voltages

Parameter	Unit	THD	5th	7th	11th	13th	15th	17th	19th	21th
Red Phase	%	2.6	1.20	1.39	0.19	0.39	0.10	0.59	0.19	0.09
Yellow Phase	%	3.1	1.80	1.1	0.61	0.41	0.39	0.4	0.49	0.1
Blue Phase	%	2.4	1.30	1.1	0.61	0.61	0.40	0.49	0.5	0.1

Table 2 No load Harmonic spectrum of voltage

Parameter	Unit	THD	5th	7th	11th	13th	15th	17th	19th	21th
Red Phase	%	2.59	1.2	1.39	0.2	0.4	0.1	0.6	0.2	0.1
Yellow Phase	%	3.1	1.8	1	0.59	0.3	0.29	0.4	0.3	0.1
Blue Phase	%	2.1	1.19	0.8	0.6	0.59	0.4	0.5	0.59	0.1

Table 3 1KW load Harmonic spectrum of voltage

Parameter	Unit	THD	5th	7th	11th	13th	15th	17th	19th	21th
Red Phase	%	2.5	0.8	1.39	0.4	0.39	0.3	0.5	0.3	0.1
Yellow Phase	%	3.01	1.8	1	0.99	0.3	0.29	0.3	0.39	0.99
Blue Phase	%	2.49	1.3	0.69	0.6	0.59	0.3	0.4	0.49	0.1

5 Observation for Voltage:

For this specific experiment the harmonics percentage for three phase is different as we can see in all load tables. THD for the yellow phase is the maximum then red and blue phase. And the level of magnitude from 5th to 21th harmonics are not decreasing in nature. Their magnitudes are varying in nature.

6 Reason:

VFD has a rectifier toward the front which draws a non sinusoidal current which causes voltage harmonics. At that point induction machine is stacked the current drawn by the rectifier increases so THD of a loaded machine is more than the THD of the machine under zero load.

Harmonic spectrum of current

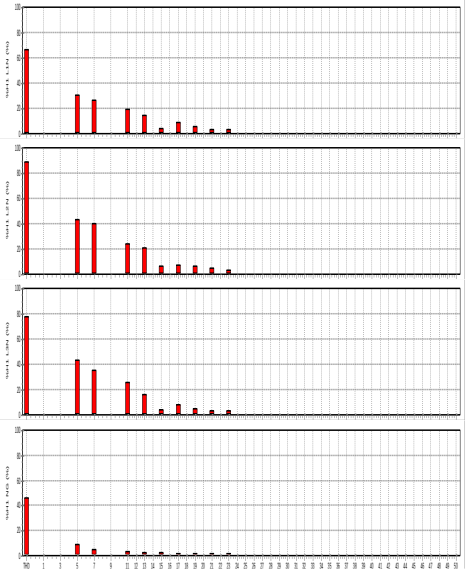

Figure 6 Current harmonic spectrum during no load

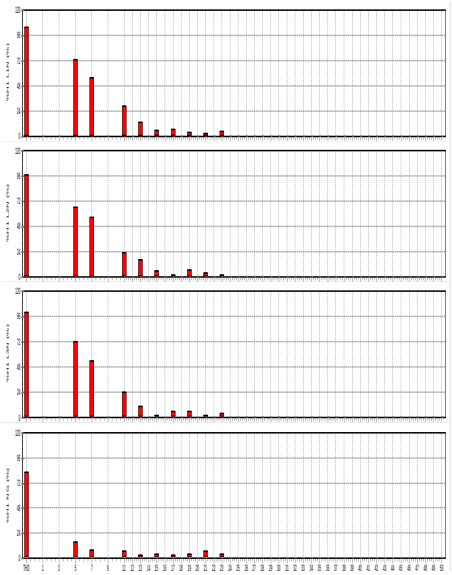

Figure 7 Current harmonic spectrum during load

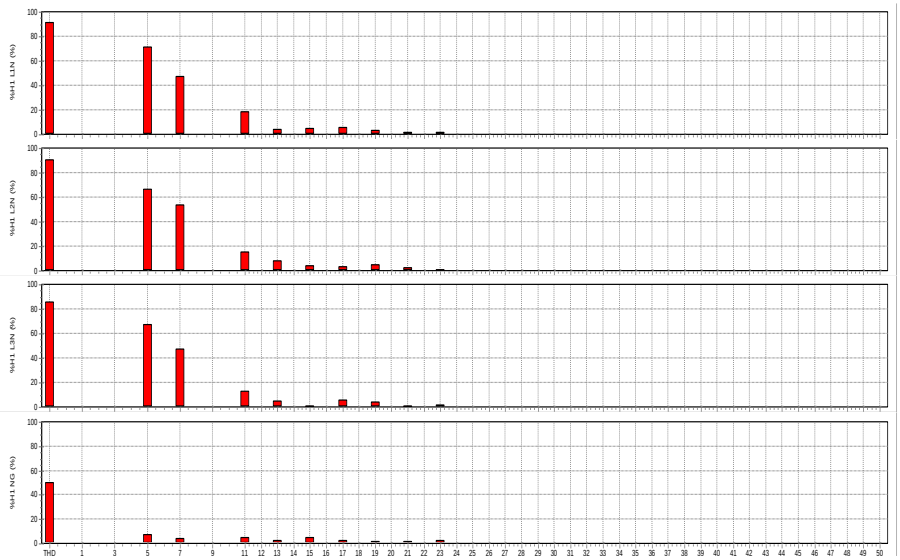

Figure 8 Current harmonic spectrum during load 2

The below tabulation represents the observation made from the harmonic spectrum of current during no load, load of 1kW and load of 1.7Kw.

Table 4 1.7 KW load Harmonic Spectrum of Voltage

Parameter	Unit	THD	5th	7th	11th	13th	15th	17th	19th	21th
Red Phase	%	64.9	29.9	28.0	20	17.9	6	10	6	4.0
Yellow Phase	%	90.09	41.98	40	24.9	21	5	6.0	5	3
Blue Phase	%	77.09	43	36.0	28	18.0	2	5	2.99	2

Ground	%	46.08	10	4	3	1	1	0.5	0.5	0.49

Table 5 No load Harmonic spectrum of voltage

Parameter	Unit	THD	5th	7th	11th	13th	15th	17th	19th	21th
Red Phase	%	105.01	74	60	28	15	7	8	7	7
Yellow Phase	%	97.6	67.0	60	22	18	5	2	6	3
Blue Phase	%	97.02	75	55	30.0	12	2	6	5.9	2
Ground	%	82.05	19	4	3	3	3	3	3	4.1

Table 6 1KW load Harmonic spectrum of voltage

Parameter	Unit	THD	5th	7th	11th	13th	15th	17th	19th	21th
Red Phase	%	105.0	70	50	19	5	6	8.02	5	1
Yellow Phase	%	97	65	52	14.98	8	5	4	6	4.1
Blue Phase	%	97.0	68	58.0	12	5	1.01	5	4	1
Ground	%	82	10.0	5	5	1	5	1	0.7	1

7 Observation for Current:

For this specific experiment the harmonics percentage for three phase is different as we can see in all load tables. THD for the yellow phase is the maximum then red and blue phase. And the level of magnitude from 5th to 21th harmonics are not decreasing in nature. Their magnitudes are varying in nature.

8 Reason:

VFD has a rectifier on the front side which draws a non sinusoidal current. When induction machine is stacked the current drawn by the rectifier increases so THD of a stacked machine is more than the THD under no load.

9 System efficiency

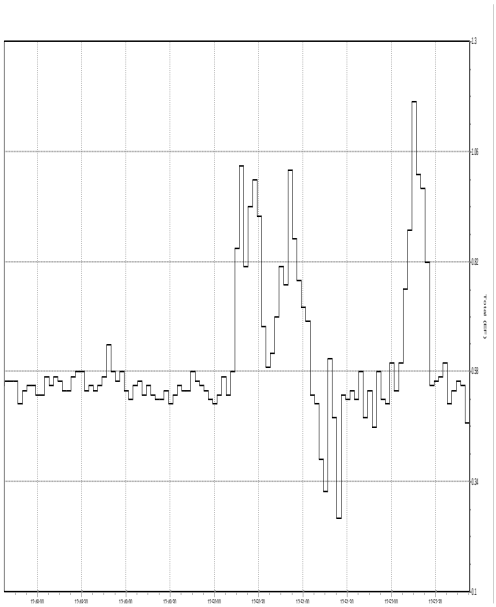

Figure 9 No Load System Efficiency

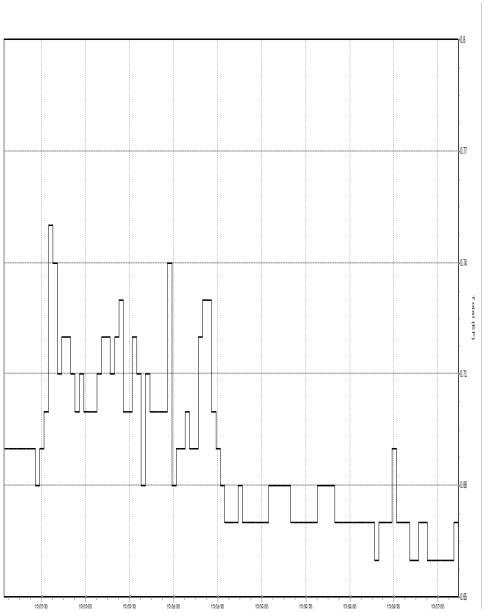

Figure 10 Load 1 System Efficiency

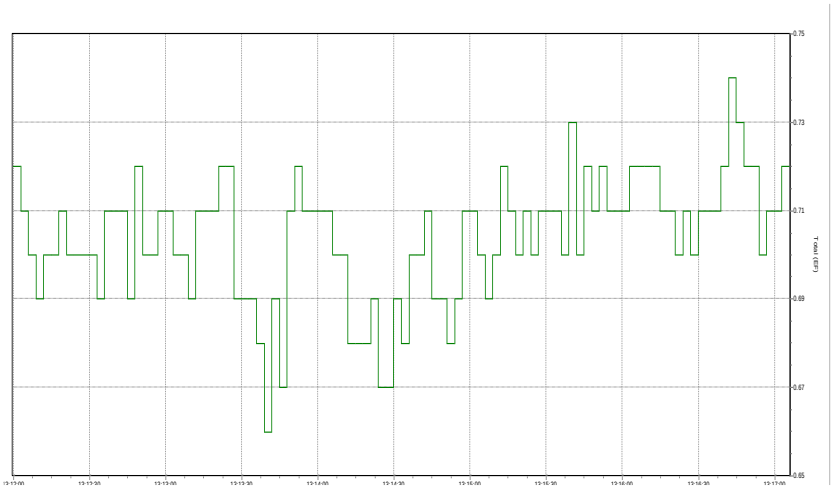

Figure 11 Load 2 System Efficiency

The below tabulation represents the observation made from the system efficiency during no load, load of 1kW and load of 1.7kW

Table 7 Observation Made From the System Efficiency

Parameter	Value	No Load	Load 1	Load 2
System Efficiency	%	55.48	68.74	72.91

10 Observation:

The above tabulation shows the variety in system productivity for various test cases.
As the load on an induction motor increases its efficiency increases.

11 Reason:

The unbalance in voltage (V) and current (I) diminishes when machine is stacked more, which brings in increase in system proficiency.
The power factor of the machine increments when the machine is stacked which also leads to an expansion in efficiency.

12 Conclusion and Future Scope:-

In this framework we analyzed the conditions for zero load, medium load which is 1KW and high load approx 1.7KW, that the voltage level harmonics is less than 8 percent and current level harmonics is also came under 5 percent which follows the IEEE standards. With the help of curve fitting tool of MATLAB the result work parameters are carried out. In the extended future scope on this study work, different powers like apparent, active and reactive power will also analyzed, includes power factor and others relative areas which help in to improve power quality of VFD fed induction motor by connecting various loaded conditions.

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