International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 104-107 www.ijaem.net ISSN: 2395-5252

Design and Analysis of a 3-phase Induction motor under a Balance and unbalanced voltage conditions

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Date of Submission: 28-03-2023 Date of Acceptance: 07-04-2023

ABSTRACT: A three-phase induction motor is one of the most popular and versatile motor in electrical energy and power system and many industries because of his features like self starting, high capability, easy maintenance, low cost and better reliability. It Can be performed very well when it operate using a balanced three Phase power supply within the correct frequency. However, deviations from this cause a significant decrease in power and Efficiency and Torque.
In terms of harmonic the induction motor are also affect to the electrical power system. If an Induction motors operates by unbalanced power systems to generate an additional current harmonic. These harmonics cause additional power loss in the machines.
In this paper, we have study on the analysis of unbalance voltage on its performance and parameter of three phase induction motor like current, efficiency, power, torque, increase temperature, speed and comparison between a different-different voltage conditions.

KEYWORDS: Induction Motor, torque, slip, speed, simulation, temperature.

I. INTRODUCTION

Three phases Induction Motor is a very important class of machines which is used in many industrial, commercial and domestic applications. A important operating characteristic of a induction motor became a very popular used in a industries. A three phase induction motors are design to operate under a three phase balance voltage conditions, but a very small value of a voltage unbalance that is occurred by the introduction of a negative sequence voltage and increase the current at a certain limit. A three phase induction motor is supplied by unbalanced three phase system have been investigated and to be obtain its quantities by re-solving into a balanced three phase components. The proposed designs of a three phase induction motor have been simulated in the MATLAB/SIMULINK software.

UNBALANCE VOLTAGE CONDITIONS:-

In a power system, the three phase voltage generation is balance and sinusoidal form but normally it will be unbalanced at distribution end and the point of utilization for some reasons. In a three phase voltage balance sinusoidal distribution system the 3 lines with neutral voltage magnitude is equal and the phase displacement from each other by 120 degree angle.

VOLTAGE UNBALANCE CONDITIONS:

A three phase induction motor connected via three phase unbalance power system have been investigate to find out its quantity by resolving into a three phase balance component. It's known as symmetrical comport method. A three phase induction motor fed up from the unbalance three phase system can't be determined by a classical method, wherever the symmetrical component methods should be use. In a simulation method of a machine, there we can measure parameter of current, voltage and power subsequently with its harmonics value and comparison also made for both the analysis techniques.

TYPE OF UNBALANCE VOLTAGE:

UNBALANCE VOLTAGE UNDER TWO PHASE: -

In this type of circumstance occurs when a heavy load of three phaseInduction motor and does not haveenough compensation. In this type of condition, first two phases will have higher voltage drop withcompared to third phase.

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$$\%\,\text{LVUR} = \frac{\text{max voltage deviation from the avg line voltage}}{\text{avg line voltage}} \cdot 100$$

UNBALANCE VOLTAGE UNDER THREE PHASE: -
In this type of circumstance occurs when a heavy load of three phases and not in balance condition, In the type of condition the three phase under unbalance voltage.

UNBALANCE VOLTAGE UNDER SINGLE PHASE: -
Normally, capacitors are used to balance out the reactive power in a machine. in order to keep a system voltage at its recommended level. The voltage of this phase will be greater than the rated value if one of the three phase voltages has been over compensated.

UNBALANCE VOLTAGE OVER TWO PHASE: -
The voltage of these two phases will be greater than the rated value if two of the three phases have been over compensated.

Formula:-

Torque = (S1 - S2) x R x D x Constant

$$\%\ \text{VUF} = \frac{\text{negative sequence voltage component}}{\text{positive sequence voltage component}} \cdot 100$$

Slip = Ns – Nr / Ns

VOLTAGE UNBALANCE OVER THREE PHASE:-
The three phase voltage will be higher than the rated number and not equal if the three phase voltage has been over compensated to varying degrees. When a factory is shut down but capacitors are still connected to the system, this kind of scenario typically happens at the line.

$$V_p = \frac{V_{ab} + a \cdot V_{bc} + a^2 \cdot V_{ca}}{3}$$

$$V_n = \frac{V_{ab} + a^2 \cdot V_{bc} + a \cdot V_{ca}}{3}$$

COMPARISION BETWEEN DIFFERENT-DIFFERENT VOLTAGE UNBALANCE DEFINITIONS:
The three major definition of a voltage unbalance are as below:

NEMA Definition: - The NEMA (National Equipment Manufacturer's Association) definitions of voltage also known as the line voltage unbalance rated (LWR), is given by max. max voltage deviation from the average line voltage by average line voltage.

IEEE definition: - The IEEE definitions of voltage unbalance, also known as phase voltage unbalance rated (PVUR) is given by: maximum voltage average from the average phase voltage by average phase voltage.

$$\%\,\text{PVUR} = \frac{\text{max voltage deviation from the avg phase voltage}}{\text{avg phase voltage}} \cdot 100$$

The only difference between the IEEE's definition of voltage unbalance and NEMA's is that the IEEE uses phase voltages as compared to line-to-line voltages. Again, the phase angle information is lost because only magnitudes are taken into account.

True Definition: The definition of a voltage unbalance is known as the ratio of the negative sequence voltage component to the positive sequence voltage component. The percentage of voltage unbalance factor (%VUF) is given by:

The three-phase unbalanced line voltages Vab, Vbc, and Vca (or phase voltages) are divided into two symmetrical components, Vp and Vn, to provide the positive and negative sequence voltage components (of the line or phase voltages). The two equal parts are provided by:

Where a = $1\angle 120°$ and $a^2 = 1\angle 240°$

SIMULATION AND ANALYSIS OF THE BALANCE AND UNBALANCE OF A THREE PHASE INDUCTION MOTOR:

One of MATLAB's most powerful tools is Simulink. Simulink is an environment for model-based design and multi-domain simulation for embedded and dynamic systems. You can design, simulate, implement, and test a variety of time-varying systems, including controls and signal processing and its interactive graphical environment and adaptable set of blocklibraries.

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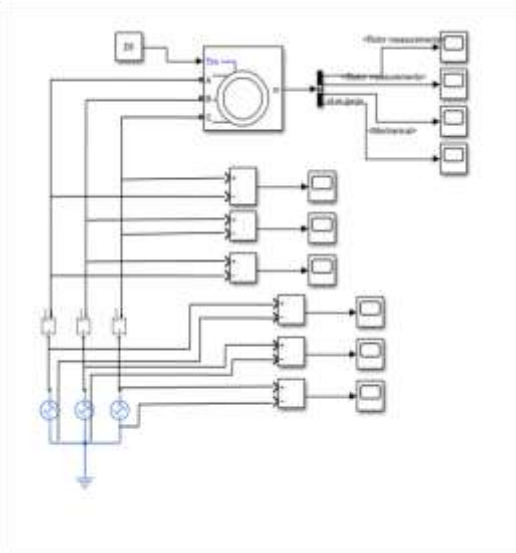

Fig: MATLAB SIMULINK MODEL

First of all, the machine having three phase balanced power supply & the final result will observe in the form of balance torque, voltage and speed.

When an unbalance voltage is introduce in the form of phase, torque and speed.

The final result can be analysed in a verity of unbalance parameter of a stator current, torque and speed of the three phase motor.

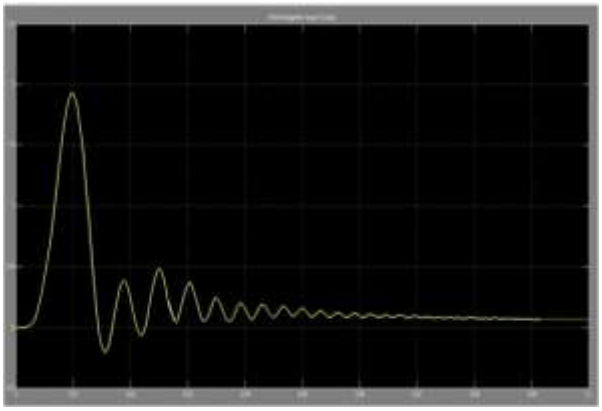

Fig: Unbalance Torque

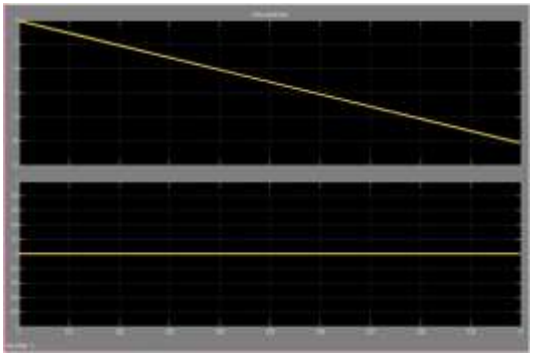

Fig: Speed under voltage unbalance condition

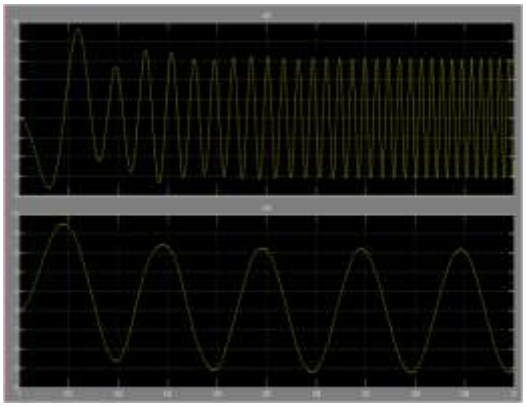

Fig: Result of balance voltage condition

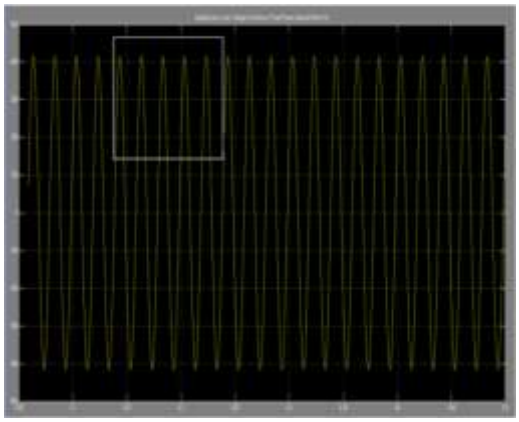

Fig: Result of balance voltage condition

II. CONCLUSION:

With the use of modelling and experimental analysis, an explanation of the three phase induction motor's fundamental abnormality is made. The single phasing condition can be seriously taken into consideration if there are sufficient readings and extra variation. The detection of unbalancing in the voltage applied is important because it can rise to high losses, heating, noise, vibration, tensional pulsations, slip, and torque. If the voltage is not in a balance condition, the machine's efficiency and average

output torque will suffer, and the ripple will grow dramatically, seriously harming the motor application. So, it is essential to evaluate the induction machine's unbalanced condition.

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