Condition Monitoring of Induction Motor

Lagandeo Kumar Singh, Komal, Pankaj Kumar Sharma

***Abstract*— Condition monitoring of induction motor have been a challenging task for the engineers and Researchers mainly in industries. There are many condition monitoring methods, including Vibration monitoring, thermal monitoring, chemical monitoring, acoustic emission monitoring but all these monitoring methods require expensive sensors or specialized tools. Whereas current monitoring out of all does not require additional sensor. Current monitoring techniques are usually applied to detect the various types of induction motor faults such as rotor fault, short winding fault, air gap eccentricity fault, bearing fault, load fault etc. In current monitoring, no additional sensors are necessary.**

***Index Terms*— Induction motor, Simulink / Mat lab, Faults in motors**

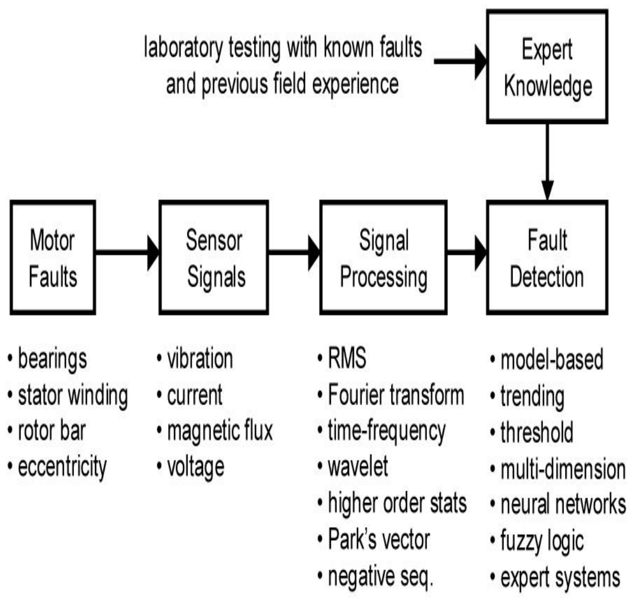
I. INTRODUCTION

An induction motor or asynchronous motor is a type of alternating current motor where power is supplied to the rotor by means of electromagnetic induction. In a three-phase induction motor the three phases produce a rotating magnetic field (as in a three-phase synchronous motor). A stationary conductor will see a varying magnetic field and this will induce a current. Current is induced in the field coils in the same way that current is induced in the secondary of a transformer This current turns the rotor into an electromagnet which is dragged around by the rotating magnetic field. The rotor always goes slightly slower than the magnetic field. This is the slip of the motor. An electric motor turns because of magnetic force exerted between a stationary electromagnet called the stator and a rotating electromagnet called the rotor. An induction motor is sometimes called a rotating transformer because the stator (stationary part) is essentially the primary side of the transformer and the rotor (rotating part) is the secondary side. The induction machine is used in wide variety of applications as a means of converting electric power to mechanical power. Pump steel mill, hoist drives, household applications are few applications of induction machines. Induction motors are most commonly used as they offer better performance than other ac motors.

II. CONDITION MONITORING

Condition monitoring of electric machinery can significantly reduce the cost of maintenance and the risk of unexpected failures by allowing the early detection of potentially catastrophic faults. In condition based maintenance, one does not schedule maintenance or machine replacement based on previous records or statistical estimates of machine failure. Rather, one relies on the information provided by condition monitoring systems assessing the machine's condition. Thus the key for the success of condition based maintenance is having an accurate means of condition assessment and fault diagnosis. On-line condition monitoring uses measurements taken while a machine is operating, to determine if a fault exists. Figure shows a block diagram of the general approach. Each of the blocks will be discussed in turn in this paper. Starting from the left, common motor faults are shown. Different types of sensors can be used to measure signals to detect these faults. Various signal processing techniques can be applied to these sensor signals to extract particular features which are sensitive to the presence of faults.

Motor current signature analysis (MCSA) is one of the most powerful methods of online motor diagnosis for detecting motor faults. Using MCSA has advantages such as no estimation of motor parameters and the simplicity of current sensors and their installation.



. **Fig.1.4** The on-line condition monitoring process.

III. INDUCTION MOTOR FAULTS

Induction machine failure has found the most common failure mechanisms in induction machines. The main reasons for the motor faults are mechanical and electrical stresses. Mechanical stresses are caused by overloads and abrupt load changes, which may cause bearing faults and rotor bar broke and the electrical stresses may produce stator winding short circuits and result in a complete motor failure. These have been categorized according to the main components of a machine-

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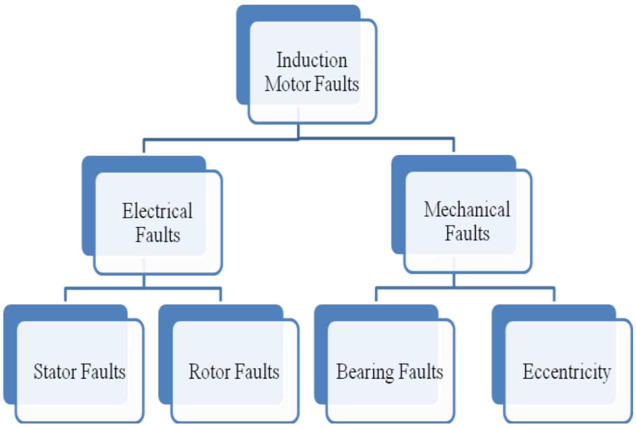

Fig.3.1 Classes of faults

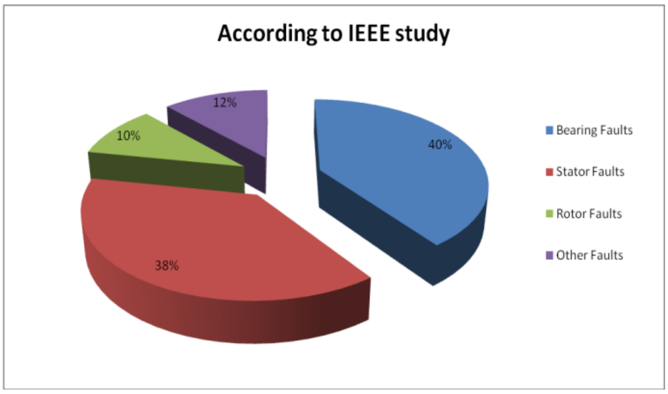

Fig.3.2 Causes of Faults

A. BEARING FAULTS

The majority of electrical machines use ball or rolling element bearings and these are one of the most common causes of failure. These bearings consist of an inner and outer ring with a set of balls or rolling elements placed in raceways rotating inside these rings. Faults in the inner raceway, outer raceway or rolling elements will produce unique frequency components in the measured machine vibration and other sensor signals. These bearing fault frequencies are functions of the bearing geometry and the running speed. Bearing faults can also cause rotor eccentricity.

B. STATOR FAULTS

Almost 40% of all reported induction machine failures fall into this category. The stator winding consists of coils of insulated copper wire placed in the stator slots. Stator winding faults are often caused by insulation failure between two adjacent turns in a coil. This is called a turn-to-turn fault or shorted turn. The resultant induced currents produce extra heating and cause an imbalance in the magnetic field in the machine. If undetected, the local heating will cause further damage to the stator insulation until catastrophic failure occurs. The unbalanced magnetic field can also result in excessive vibration that can cause premature bearing failures.

C. ROTOR FAULTS

Rotor faults account for about 10% of total induction machine failures. The normal failure mechanism is a breakage or cracking of the rotor bars where they join the end-rings which can be due to thermal or mechanical cycling of the rotor during operation. This type of fault creates the well-known twice slip frequency sidebands in the current spectrum around the supply frequency signal.

D. OTHER FAULTS

Eccentricity occurs when the rotor is not centered within the stator, producing a non-uniform air gap between them. This can be caused by defective bearings or manufacturing faults. The variation in air gap disturbs the magnetic field distribution within the motor which produces a net magnetic force on the rotor in the direction of the smallest air gap. This so called "unbalanced magnetic pull" can cause mechanical vibration.

IV. EFFECTS OF FAULTS

- Unbalanced air-gap eccentricity
- Unbalanced voltages and lines currents
- Increases torque pulsations
- Decreased average torque
- Increased losses
- Reduction in efficiency
- Excessive heating.

V. METHODS TO IDENTIFY FAULTS

- Electromagnetic field monitoring, search coils, coils wound around motor shafts

- Temperature measurements
- Infrared recognition
- Radio frequency (RF) emissions monitoring
- Noise and vibration monitoring
- Chemical analysis
- Acoustic noise measurements
- Motor current signature analysis (MCSA),
- Model, artificial intelligence and neural network based techniques.

VI. MODELING AND SIMULATION OF THREE PHASE INDUCTION MOTOR

In mathematical modeling, we try to establish functional relationships between entities that are important. A model supposedly imitates or reproduces certain essential characteristics or conditions of the actual – often on a different scale. It can take on various forms: physical, as in scale-models and electrical analogs of mechanical systems; mental, as in heuristic or intuitive knowledge; and symbolic, as in mathematical, linguistically, graphical, and schematically representations.

In the modeling of induction motor different parameters of different is being mask due to requirement. In showing model of induction motor different parameters of induction motor and supply system is being measured and varies.

In this paper we represent the effect of low voltage and frequency on the torque and speed of induction motor.

These parameters directly affected to the torque and speed of induction motor.

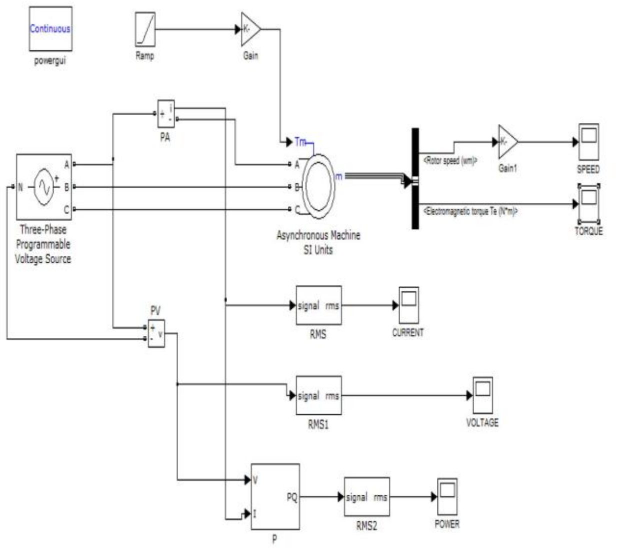

Fig. 6.1 Induction motor model

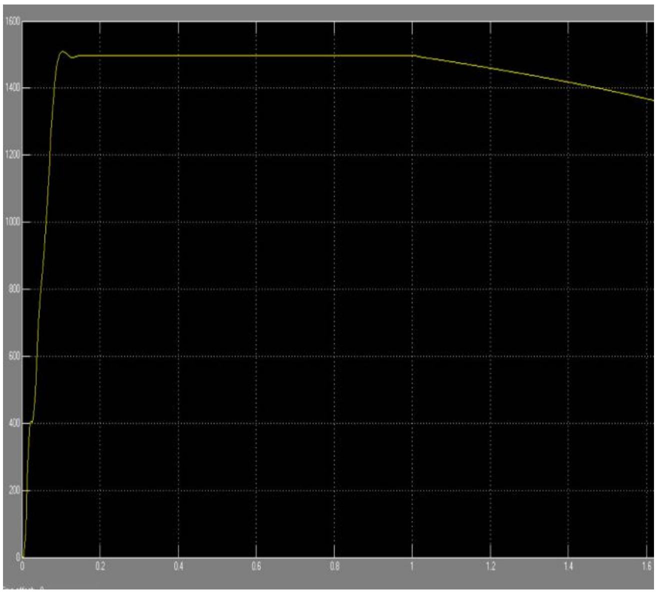

Fig.6.4 Speed vs. Time graph due to low voltage

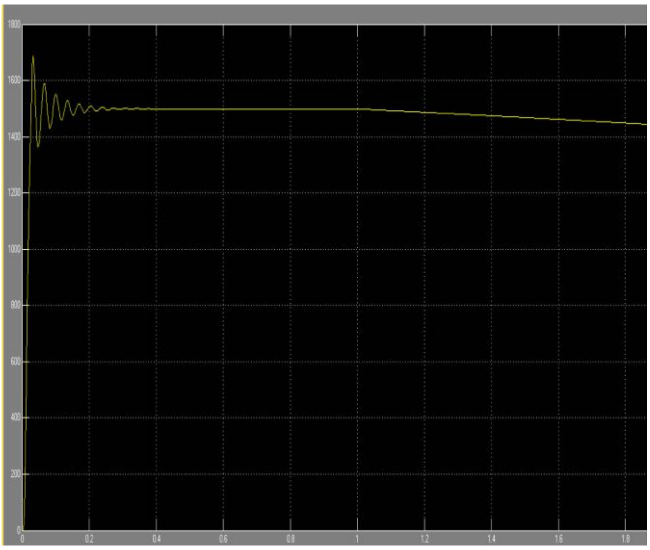

Fig.6.2 Speed vs. Time graph in Healthy condition

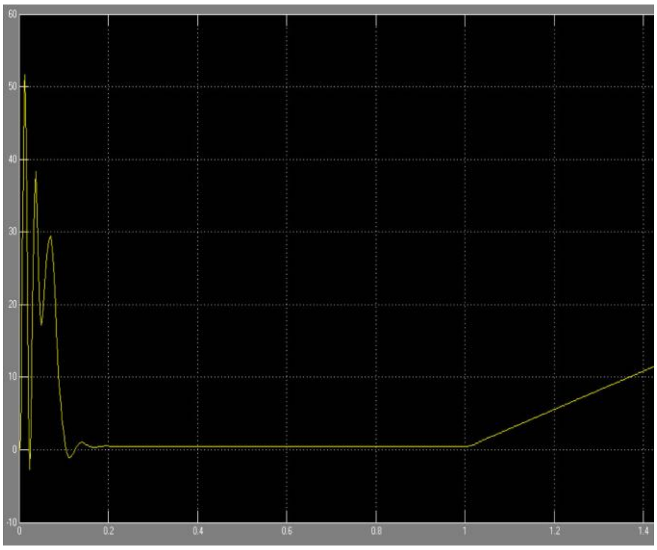

Fig.6.5 Torque vs. Time graph due to low voltage

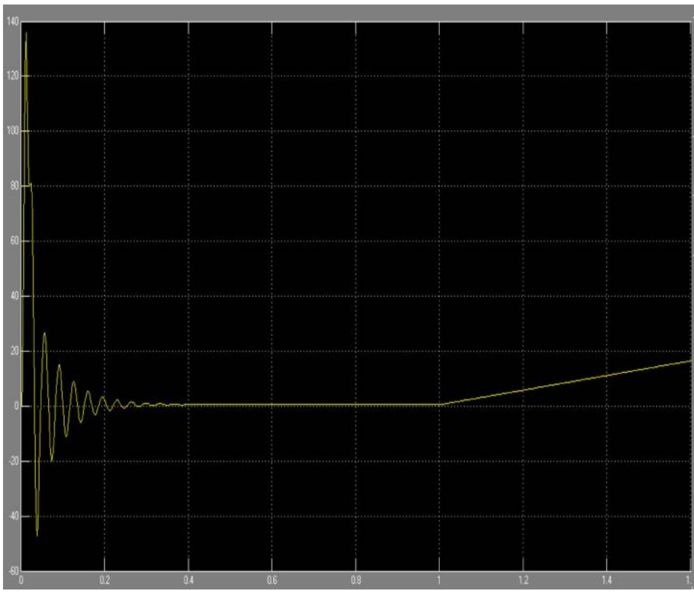

Fig.6.3 Torque vs. Time in Healthy condition

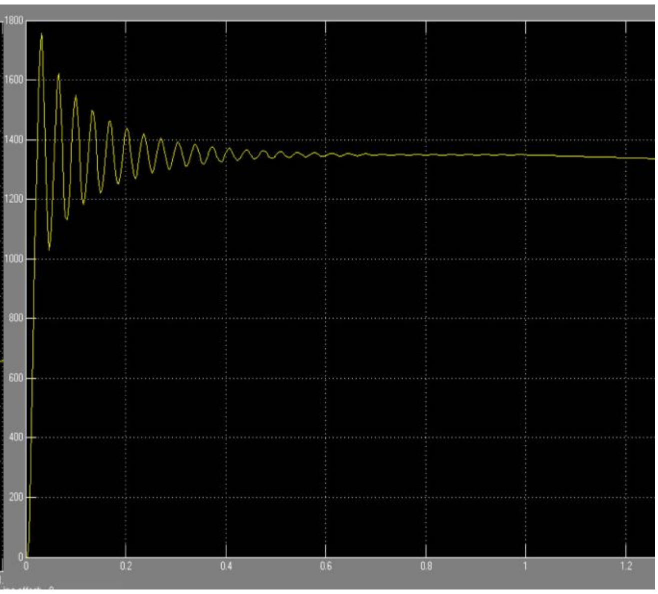

Fig.6.6 Speed vs. Time graph due to low frequency

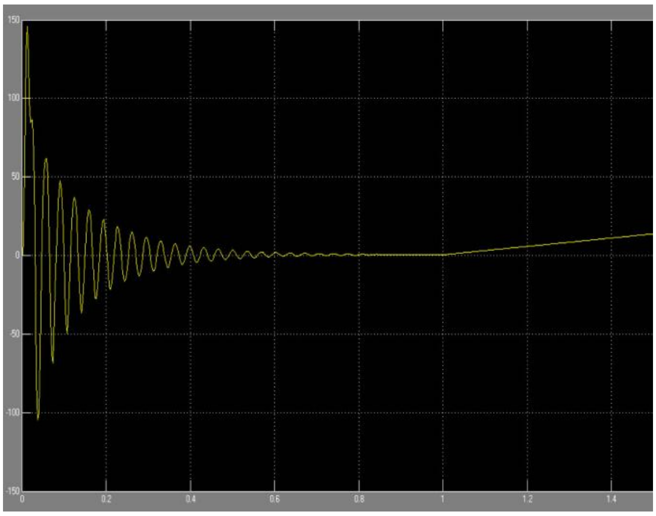

Fig.6.7 Speed vs. Time graph due to low voltage

In the figure 6.2 and figure 6.3 showed the speed and torque of induction motor as in balanced power supply system. As the imbalanced power supply system that is due to absence of one phase the voltage being low. Than due to low voltage the affected speed and torque graph showed in figure 6.4 and 6.5 respectively.

As the low frequency the speed and torque of induction motor have also varied which show in graph figure 6.5 and 6.7 respectively.

VII. CONCLUSION

The results in this paper have clearly demonstrated that due to being effected in the parameters of induction motor due to any causes suffered in abnormal working condition. In this paper we represent practical analysis due to help of MATLAB / SIMULINK. The results is being clear the concept about the abnormal condition of induction motor and its different characteristics. Behalf of the modeling and simulation of induction motor each parameters of induction motor and supply system masked as for variable results.

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VIII. REFERENCE

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