International Journal of Electrical and Computer Engineering.
ISSN 0974-2190 Volume 8, Number 1 (2016), pp. 13-18

http://www.irphouse.com

Fault Diagnosis of Induction Motor using MCSA

Neelam Turk
Department of Electronics Engineering
YMCA University of Science and Technology,
Faridabad-121006 (Haryana), India.

Abstract

In this paper, the effects of induction motor rotor faults on the current and voltage of motor are studied through motor current signature analysis. This technique utilizes the results of spectral analysis of the stator current. The distortion of current waveform is generally very minute due to fault of induction motor so it is very difficult. In this paper, power spectrum of motor is taken to investigate frequency signature of rotor bar fault. The virtual instrument is developed to obtain the Power spectrum. The Virtual Instrument was build up by programming in LabVIEW 8.2. A three phase 0.5 hp, 415V induction motor is used for experiment in which rotor faults are replicated. The experiment conducted on motor show that Motor current signature analysis is reliable technique to diagnose the faults of induction motor.

Introduction

Preventive maintenance of electric derive systems with induction motors involves monitoring of their operation for detection of abnormal electrical and mechanical conditions that indicate, or may lead to, a failure of the system. The monitoring of the electrical machines can significantly reduce the costs of maintenance by allowing the early detection of faults, which would be expensive to repair. Effective online condition monitoring of Induction motors is critical to improving the productivity, reliability and safety to avoid unexpected downtime and expensive repair cost. Therefore, the diagnosing of the health condition of induction motors is receiving more and more attention from industry in the past decades since it can detect an incipient fault at an early stage. Because of natural aging processes and other factors in practical applications, induction motors are subject to various faults. These faults disturb the safe operation of motors, threaten normal manufacturing, and can result in substantial cost penalties. The field of motor condition monitoring recognizes those problems, and more and more relative research is being devoted to it by industry and academia. With condition monitoring, an incipient fault can be detected at an early stage [1]. Appropriate maintenance can then be scheduled at a planned downtime, avoiding a costly emergency. This reduces downtime expense and reduces the occurrence of catastrophic failures. Broken rotor bars can be a serious problem with certain induction motors due to arduous duty cycles. Although broken rotor bars do not initially cause an induction motor to fail, there can be serious secondary effects. The fault mechanism can result in broken parts of the bar hitting the end winding or stator core of a high voltage motor at a high velocity. This can cause serious mechanical damage to the insulation and a consequential winding failure may follow, resulting in a costly repair and lost production. There are many condition monitoring methods, including vibration monitoring, temperature monitoring, chemical monitoring, acoustic emission monitoring, current monitoring, etc. Except for current monitoring, all these monitoring methods require expensive sensors or specialized tools and are usually intrusive. In current monitoring, no additional sensors are necessary [2]. This is because the basic electrical quantities associated with electromechanical plants such as currents and voltages are readily measured by tapping into the existing voltage and current transformers that are always installed as part of the protection system. As a result, current monitoring is non-intrusive and may even be implemented in the motor control center remotely from the motors being monitored. Therefore, current monitoring offers significant implementation and economic benefits.

Analysis For Broken Rotor Bar Fault

Modern measurement techniques in combination with advanced computerized data processing and acquisition show new ways in the field of rotor bar analysis monitored by the use of spectral analysis. The success of these techniques depends upon locating by spectrum analysis with specific harmonic components caused by faults. One of the most frequently used fault detection methods is Fast Fourier transform (FFT). This technique utilizes the spectral analysis of motor current.

The lower sideband is specifically due to broken bar while the upper sideband is due to consequent speed oscillation. In fact, researchers show that broken bars actually give rise to a sequence of such sidebands given by [6, 7, 8]:

$$f_b = (1 \pm 2ks)f_1, \qquad k = 1, 2,3 \tag{1}$$

Data Acquisition and Experimental Set Up

In order to diagnose the fault of induction motor with high accuracy, a modern laboratory test bench was set up. It consists of an electrical machine coupled with rope brake dynamometer, transformer, NI data acquisition card PCI-6251, data acquisition board ELVIS and Pentium-IV Personnel Computer with software Lab VIEW 8.2. The rated data of the tested three-phase squirrel cage induction machine were: 0.5 hp, 415V, 1.05 A and 1380(FL) r/min.

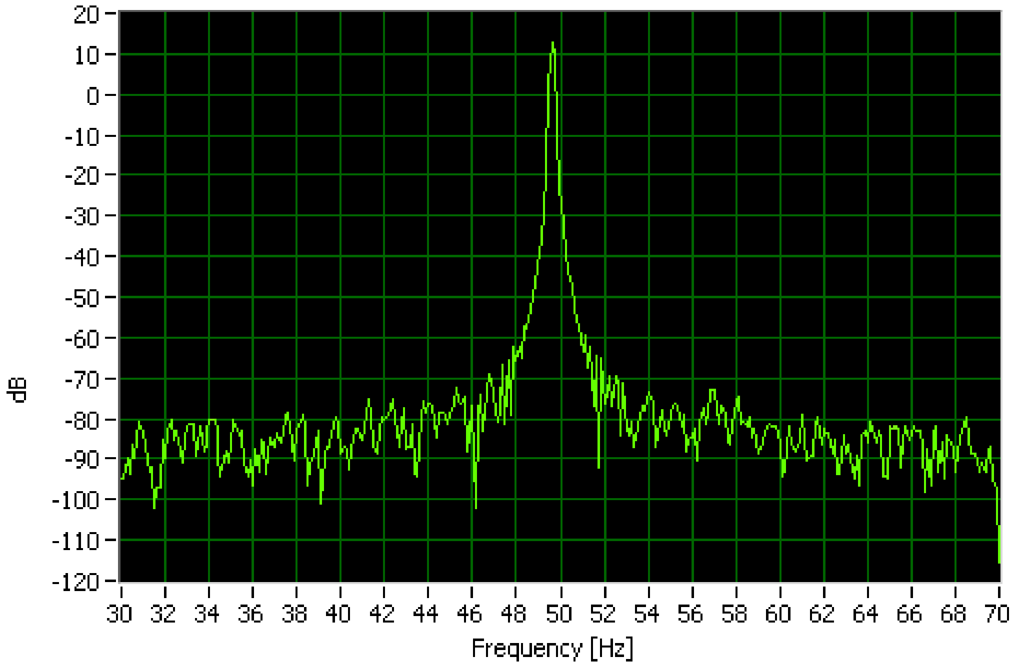

Figure 1: Power spectrum of healthy motor

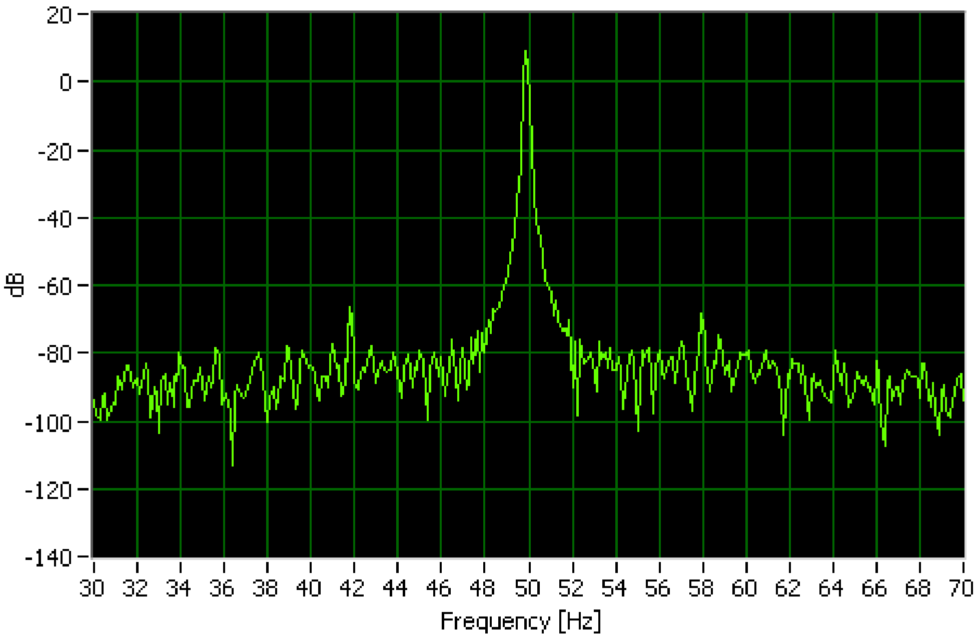

Figure 2: Power spectrum of faulty motor with 1 broken bar under full load

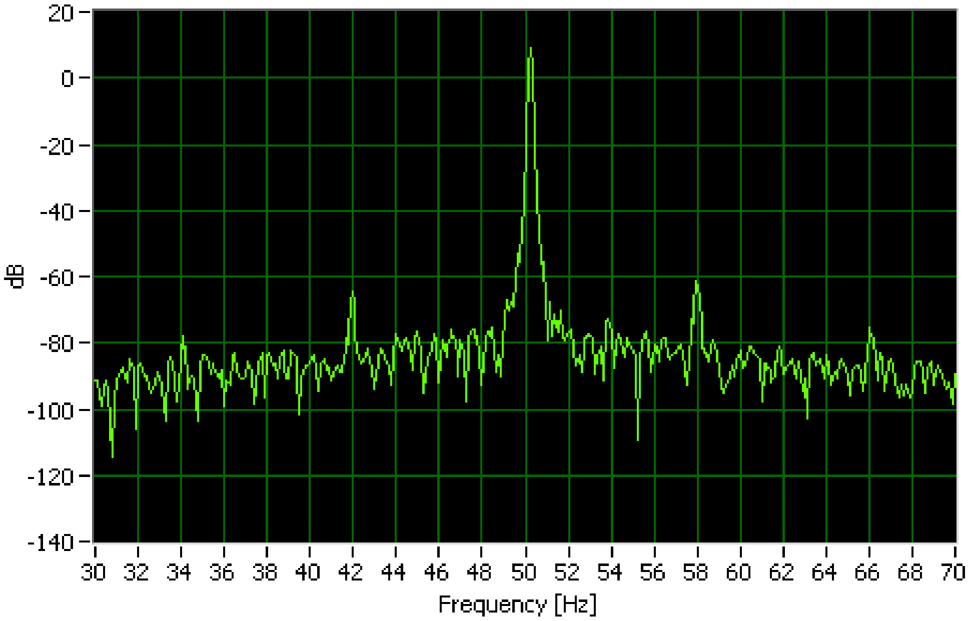

Figure 3: Power spectrum of faulty motor with 5 broken bars under full load

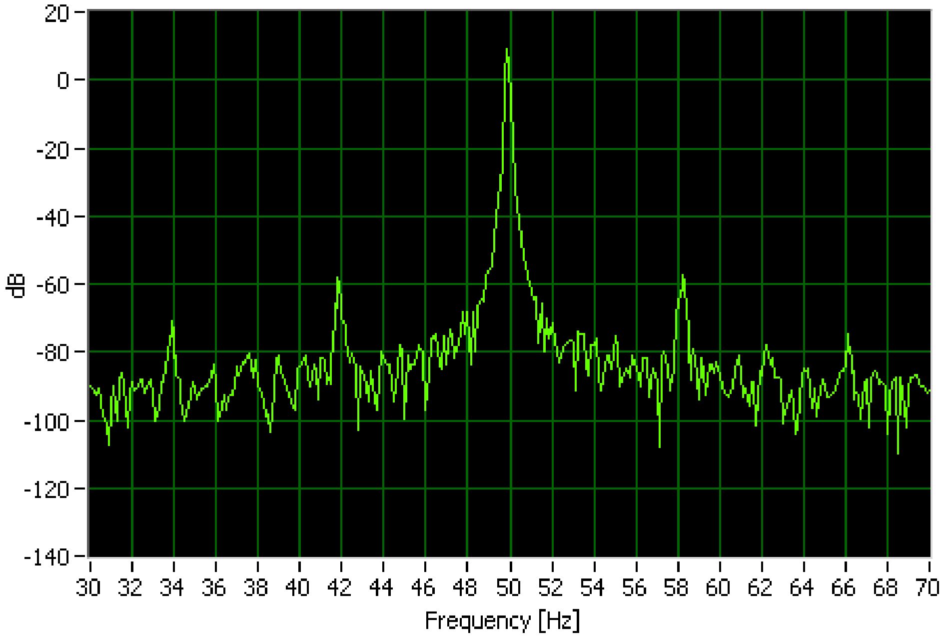

Figure 4: Power spectrum of faulty motor with 12 broken bars under full load

A system for fault detection was designed to detect the broken rotor bar fault. Current measurements were performed for a healthy rotor and also for the same motor having different number of broken rotor bar. Initially, Test was conducted on healthy motor. Then, tests were carried out for full loads with faulty motors having up to 12 broken rotor bars. The rotor faults were provoked interrupting the rotor bars by drilling into the rotor. The slip was 0.01, 0.04 and 0.08 at no load, 50% load and full load respectively. The power spectrum of the measured phase currents was plotted. The results obtained for the healthy motor and those having rotor faults were compared, especially looking for the sideband components having frequencies given by equation (8).

Results and Discussion

Motor was tested for healthy working condition and for broken rotor bars. The current measurements were made for one phase at full load. Due to similarity of the 3 phases, the results for only one of them are presented. Cases were considered where rotor has 1, 5, and 12 broken bars. The figure 1 to figure 4 presents the practical results for these cases. The frequency components related to broken bar could be clearly recognized in the current spectrum as shown in figures 2, 3 and 4. These components are marked as FF (Fault frequency). It can also be observed that the magnitude of the frequency components increase when the number of broken bars increases. Based on the results obtained with the systems it can be stated that this method proven to be adequate for the cases and load conditions considered, as the system was capable to detect the broken bar fault.

Conclusion

In this paper, broken rotor bar fault is diagnosed Motor current signature analysis. To diagnose the rotor fault, Power spectrum is obtained using LabVIEW software. Several experiments were performed on motor under no load condition and with load coupled to shaft of motor. In this experimental study, the severity of fault was increased from one broken bar to twelve broken bar. It can be seen that the magnitude of fault frequencies increases with increase the severity of rotor fault. Based on the results obtained from the experiments, it can be concluded that FFT based power spectrum can be effectively used for diagnosis of rotor faults of induction motor.

References

[1] W. T. Thompson, “A review of on-line condition monitoring techniques for three phase squirrel induction motors – Past, present and future,” in *Proc. IEEE Int. Symp. Diagnostics Electrical Machines, Power Electronics Drives*, pp. 3–18, 1999.

[2] P. C. Krause, “*Analysis of Electric Machinery*.” New York: McGraw-Hill, 1986.

[3] Peter Vas, “Parameter estimation, condition monitoring, and diagnosis of electrical machines”, Clarendon Press Oxford., 1993.

[4] P. J. Tavner and J. Penman, "Condition Monitoring of Electrical Machines. Hertfordshire", England: *Research Studies Press Ltd,* ISBN: 0863800610, 1987.

[5] A.H. Bonnett and G.C. Soukup, "Rotor failures in squirrel cage induction motors", IEEE Trans. Ind. Apllication. . Vol. IA-22, pp 1165-1173, Nov. Dec. 1986.

[6] W.T. Thomson and R.J. Gilmore, "Motor current signature analysis to detect faults in induction motor derives-Fundamentals, Data interpretation, and industrial case histories', proceedings of 32nd Turbo-machinery symposium, Texas, A&M university, USA, 2003.