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VIBRATION-BASED CONDITION MONITORING OF INDUCTION MOTOR

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ABSTRACT

The induction machines are widely used for their simplicity, robustness and their low cost. Induction motors are a critical component of many industrial processes and are frequently integrated in commercially available equipment and industrial processes. 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. Furthermore, these machines can be subjected to different operating conditions that can produce electrical or mechanical damages on the stator and/or the rotor and bearings too. It is well known that the bearing faults constitute a significant.

2.LITRETURE SURVEY

1. Saikat Kumar Shome, Uma Datta, S.k.Vadali.

The present work compares three signal averaging based filtering techniques for the purpose of analysis. The filters have been implemented in Field Programmable Gate Arrays (FPGA) which are characterized by reduced power consumption and high operational speed for real time applications. CM by vibration analysis a technique of growing importance .It is felt that available spectral vibration analysis are not highly reliable in noisy scenario .FPGA is better diagnostic than FFT based vibration analysis. FPGA produced latency problem this is limitation.

2. Mariana Iorgulesc, Robert Beloiu.

In this paper, the vibration and current of an induction motor are analyzed in order to obtain information for the detection of bearing faults. Significant vibration and current spectrum differences between healthy motor and motors with fault bearing are observed. The high frequency spectral analysis of vibration and current provides a method to detect bearing faults. The effectiveness of the diagnosis system is demonstrated through staged motor faults of electrical and mechanical origin.

3. Condition monitoring technology

The following list includes the main condition monitoring techniques applied in the industrial and transportation sectors:

- Vibration condition monitoring and diagnostics
- Thermal monitoring
- Torque monitoring
- Noise monitoring
- Electrical monitoring

1. Current signature analysis
2. Wavelet analysis

Vibration condition monitoring

Vibration control and vibration diagnostics are different practical problems. For diagnostics, often both the vibration-acceleration and the vibration-velocity are measured in restricted low frequency ranges.

Note that only one current transducer is required for this method, and it can be in any one of the three phases. The motor current signature analysis method can detect these problems at an early stage and thus avoid secondary damage and complete failure of the motor. Another advantage of this method is that it can be also applied online. Experiments were conducted on defective bearings with scratches on the outer races and bearing balls an cage defects. It has been claimed that all defective measurements were correctly classified as defective However; the detection procedure required extensive training for feature extraction.

4 Failures in induction motors

In general, faults in electrical machines are dominated by failures in bearings and stator coils. Focused on asynchronous motors with squirrel cage rotor failure statistics are the following (Fig. 4.2) (Thomson & Fencer, 2001):[12]

- Bearings fault related: 41%
- Stator faults related: 37%
- Rotor faults related: 10%
- Other problems: 12%

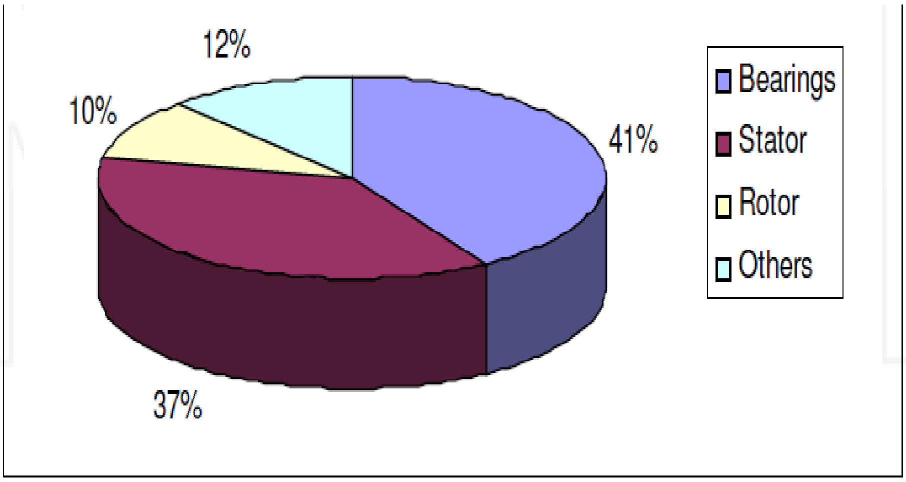

Fig. 4.1- Failures statistics in induction motors.

4.1 Set up:

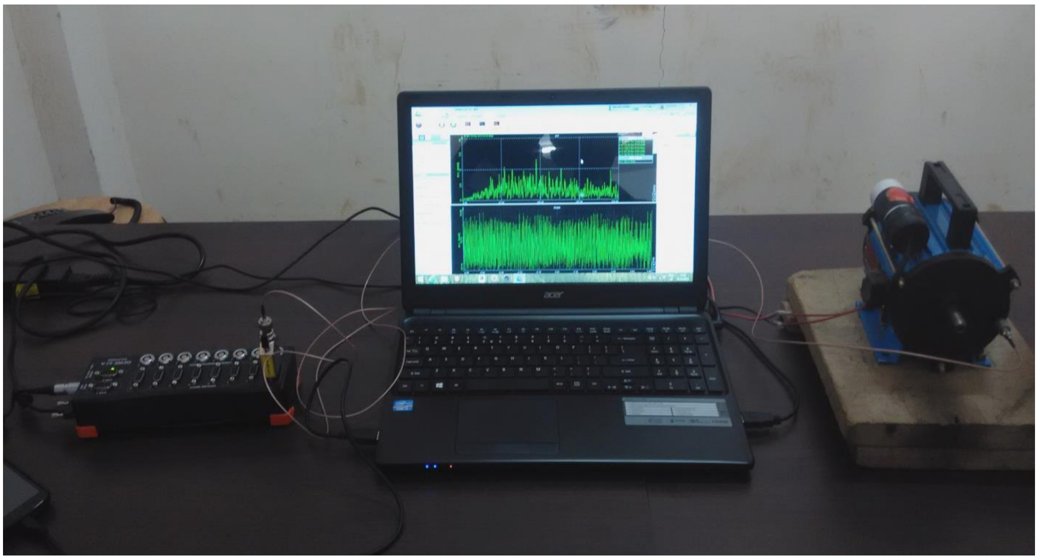

Fig 6.5 - Experimental setup

In order to diagnose the fault of induction motor with high accuracy, a modern laboratory test bench was set up as in figure. It consists of an electrical machine, piezoelectric accelerometer, FFT, computer (PC), Induction motor, wooden foundation.

Ball bearing 6202-Z specifications:

- Number of ball element: 8
- Pitch diameter: 29.75 mm
- Ball diameter: 6.35 mm

4.2 System representation using DEWE soft programming:

The purpose of experimental set up is to measure the induction motor stator vibration by using FFT analyzer and to analyse these data determining the fault frequencies on the bearing. The vibrations that flow in the induction motor are sensed by piezoelectric accelerometer. This vibration is supplied to piezoelectric accelerometer. Piezoelectric accelerometer is connected to 8 channel FFT analyzer which sense the vibration and send to personnel computer. The digitalized vibration signal is applied to the low pass current filter to remove the undesirable high frequency components. The 'DEWE Soft programme' converts the sampled signal to the FFT representation. The FFT representation is generated using advanced signal processing module of DEWE Software. DEWE Software for FFT analyzer Approach is shown in figure.

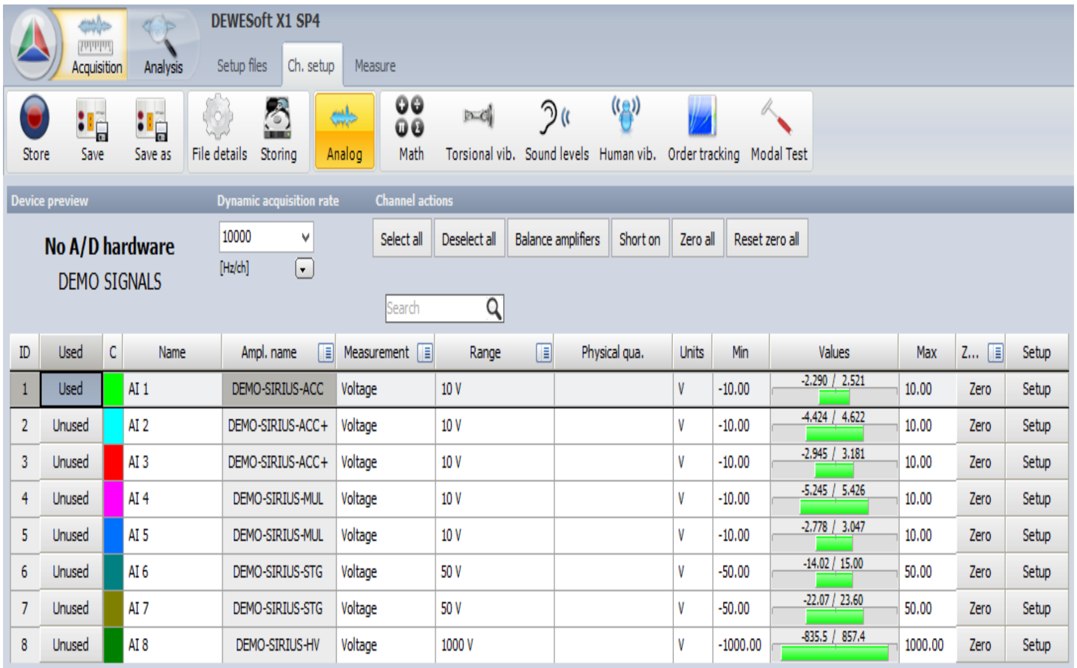

Fig 4.2- Channel FFT set up

5.EXPERIMENTAL OBSERVATIONS AND DISCUSSION:

The FFT approach is a relatively effective technique which has been successfully applied in the steady state diagnosis of bearing faults. The analysis of the signal-phase induction motor can be simplified using the piezoelectric accelerometer. The method is based on the visualization of the motor vibration representation. If this is a perfect constant wave nature the machine can be considered as healthy. If an un-regular wave pattern is observed for this representation, the machine is faulty. From the characteristics of the wave the fault's type can be established.

5.1 Position no 1:-

By placing the piezoelectric accelerometer is to upper most position of shaft on casing.

5.1.1 Time-Response Observation:-

1. Table for Average Acceleration

Sr No	Time	good	Faulty
	S	m/s2	m/s2
1	0	0.012737	0.018506
2	2	-0.00331	-0.00934
3	4	-0.00545	-0.004
4	6	0.000766	-0.00014
5	8	-0.00148	0.003917
6	10	0.001211	-0.00591
7	12	0.001763	0.005223
8	14	-0.00912	0.000385
9	16	0.005795	-0.01131
10	18	-0.00372	0.006349
11	20	0.006812	-0.00531
12	22	-0.0077	0.005143
13	24	0.007935	0.001118
14	26	0.002188	0.007985
15	28	-0.00685	-0.00374
16	30	0.004732	0.003328
17	32	-0.00746	-0.00697
18	34	0.006944	0.003104
19	36	0.00741	0.002605
20	38	-0.0092	-0.00412

1. Table for RMS Acceleration-

Sr No	Time	good	faulty
	S	m/s2	m/s2
1	0	0.829179	4.574765

2	2	0.827235	4.371129
3	4	0.826993	4.620824
4	6	0.827287	4.416219
5	8	0.833093	4.639552
6	10	0.832715	4.371032
7	12	0.83282	4.543715
8	14	0.835475	4.145731
9	16	0.841893	4.225352
10	18	0.841432	4.080285
11	20	0.840394	4.139463
12	22	0.842224	4.135309
13	24	0.837231	4.156354
14	26	0.836577	4.228223
15	28	0.833043	4.119766
16	30	0.831554	4.180441
17	32	0.839018	3.961032
18	34	0.84307	4.14881
19	36	0.848396	3.881987
20	38	0.820347	4.106289

5.1.1.2 Graphical representation between good and faulty motor (position 1):-

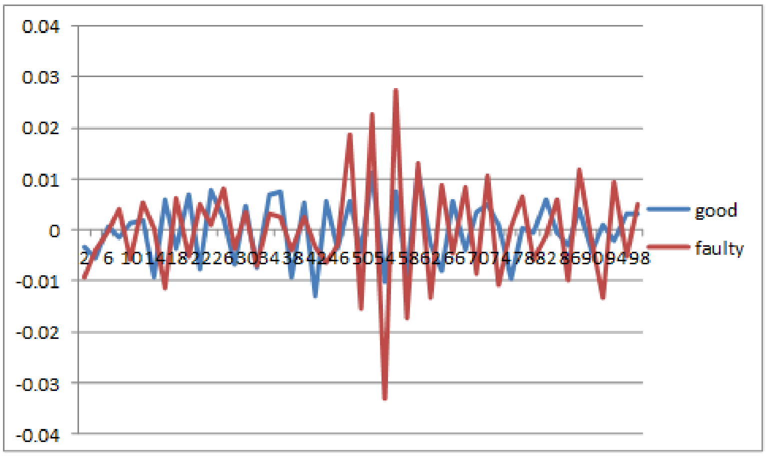

Fig 7.1- Average graph of response vs. time.

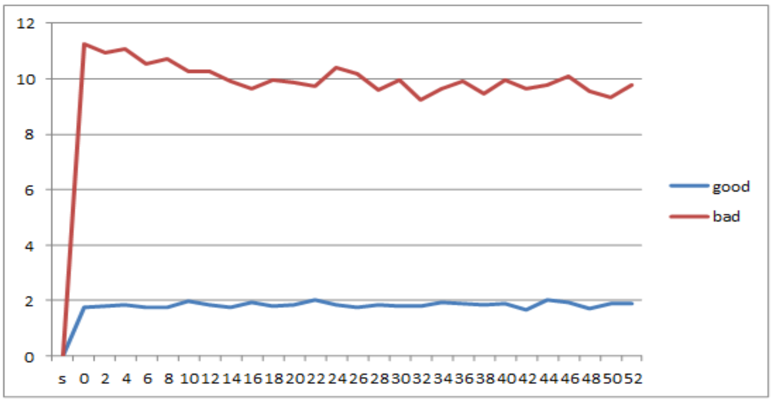

Fig 7.2- RMS graph of response vs. time.

5.1.2 Frequency response:-

1. for healthy signal:-

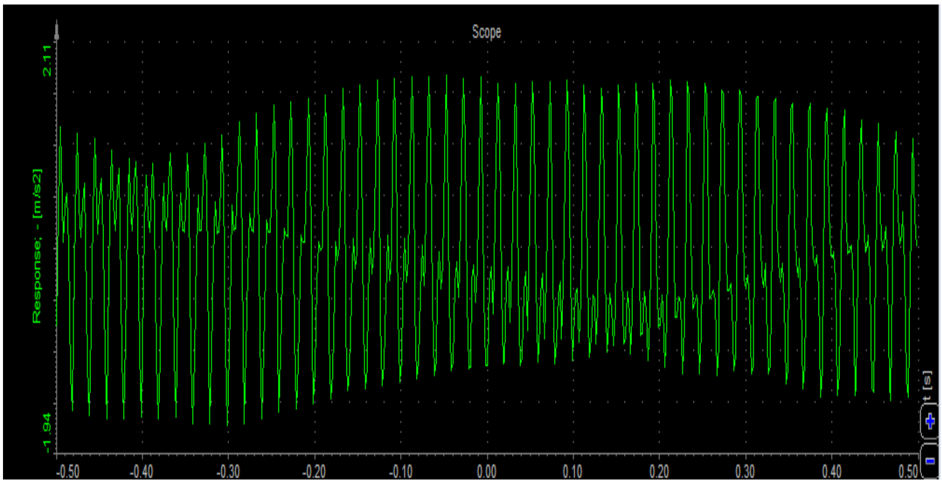

Fig 7.3-Vibration of scope.

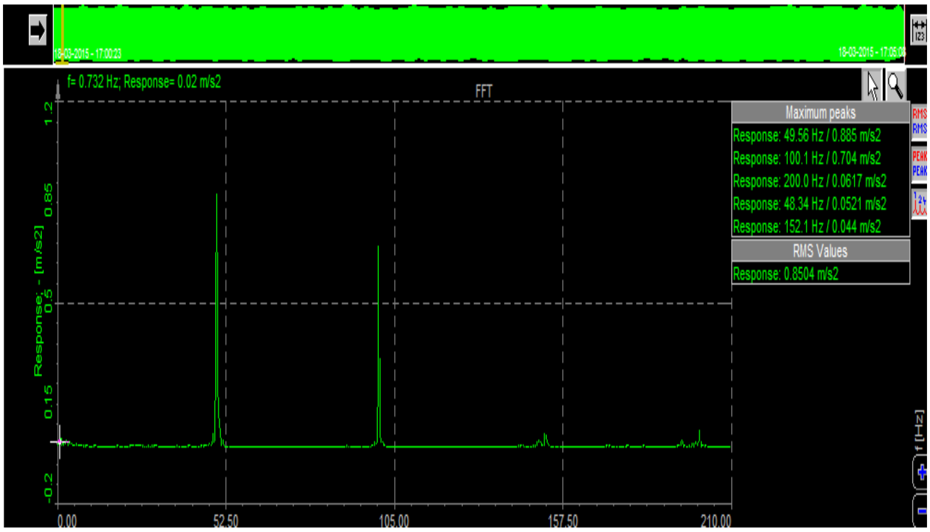

Fig. 7.4-FFT signal of vibration of Induction motor.

2. for faulty (Bearing failure):-

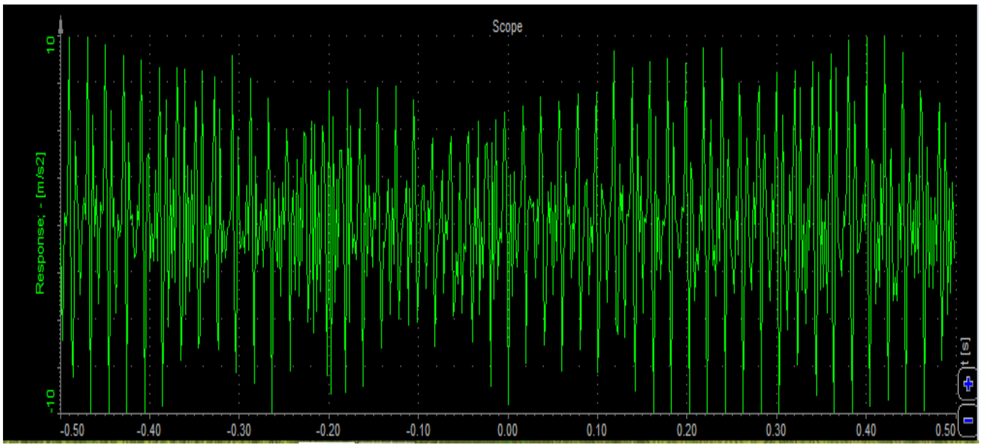

Fig 7.5-Vibration of scope for faulty condition.

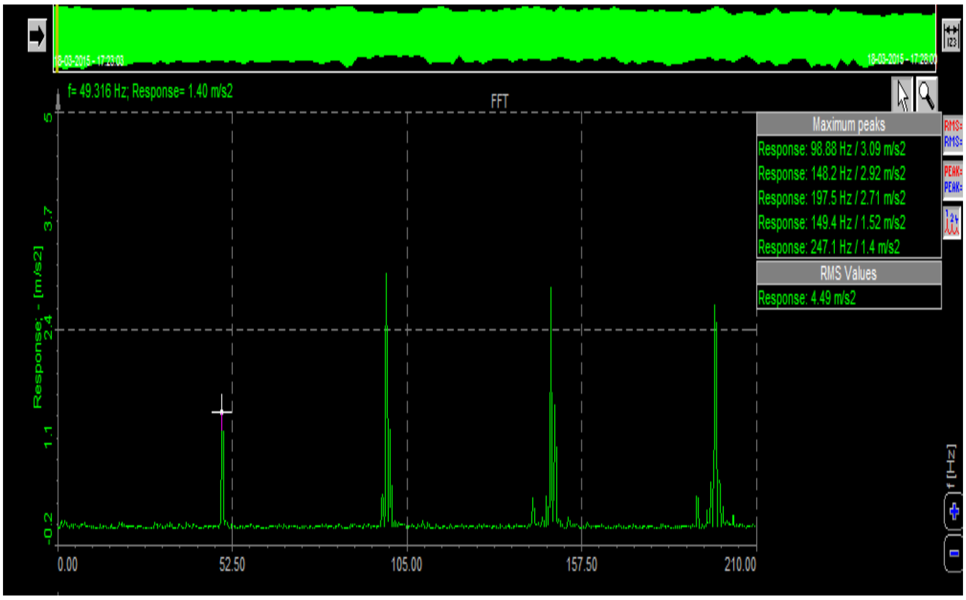

Fig 7.6-FFT signal of vibration of Induction motor for faulty condition.

6. CONCLUSION

The signal processing technique (FFT) was applied to detect the bearing fault for motor. Experimental results showed that the characteristic frequencies could not see in the power spectrum if fault is small in size. As severity of fault increases, the characteristic frequencies become visible. FFT shows better result than any other CM techniques like Park's vector method. The major benefit includes the prevention of lost downtime, avoid the major motor repair, or replacement costs.