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Innovation technology for detection of Tangible & Intangible failure modes through Condition Base Monitoring (CBM) System

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Abstract
Problem - At present, all automobiles original equipment manufacturing plants have been testing and screening with sophisticated test ring at end of line before dispatches to end customers in all plants level
After testing, in some industries, special Quality gate have been instituted to detect the defects, which are skipping and not capturing during testing on test rig.
These test rigs have been embedded, instituted and installed with enormous mechanical, electrical and electronic elements like power drivers, gears, motors, sensors and with electronic gadgets
Why it's an interesting problem - For to test each machines like alternators, starter motors and wiper motors, major expenses contributing with power (Through main power supply from electricity board & through Diesel Genset , man power , methodology etc
Solutions achieves - During failure occurring in the field, the above said sophisticated test rigs and gadgets are not available instantaneously to recheck and confirm whether the machine is OK OR NOT OK (Defective OR NO Defective). Hence, we have started researching simple method of checking the OK electrical machine components and defective machine components through handy device like multimeter to achieve the innovation through low cost technology
What follows from solution - "Innovation technology for detection of Tangible & Intangible failure modes through Condition Base Monitoring (CBM) System"

Introduction

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The focus of this paper is an investigation and detecting of tangible and intangible failures modes of electrical and electronic machines in automobiles industry through conceptual method with Multimeter advanced technologies under condition base monitoring systems (CBM)
Normally, digital multimeters were widely used to detect the short circuit, Open circuit , continuity, Ohms, Hz, Ampere, Voltage and earthing in the field in macro level.
With an innovated advance checking method, defects detected in micro level to identify the child parts level through digital numerical values

Existing techniques

We would consider traditional techniques, most of which can broadly be classified in following groups /types in CBM systems

- Performance monitoring
- Visual ,optical , tactile and aural monitoring
- Temperature Monitoring
- Vibration Monitoring
- Lubricant Monitoring
- Leakage Monitoring
- Crack Monitoring
- Thickness Monitoring
- Corrosion Monitoring
- Noise/sound monitoring , Acoustic Emission; Ultrasound /ultrasonic monitoring
- Smell /odour monitoring
- Motor current signature analysis
- Partial discharge monitoring
- Radiographic monitoring etc other monitoring /diagnostics methods, commonly used, Off-course, some of these may be considered in performance monitoring.
- Pressure monitoring g-through bourdon tubes, diaphragms, bellow, piezoresistance , strain-gauge etc
- Flow monitoring –through orifice plate, venture tube, conductance probe, ultrasonic echo, optical refraction, nucleonic etc
- Level monitoring –through float, capacity probe, conductance probe, ultrasonic echo, optical refraction, nucleonic etc

- Physical monitoring –through load, force, displacement , consistency , density ,humidity etc,
- Analytical monitoring –through pH meter, selective ion electrodes, electrolytic conductance, magnetic susceptibility, chromatography etc.

3.0 Contributions

What is a digital multimeter?

A **digital multimeter (DMM)** is a device / test tool used to measure two or more electrical values—principally voltage (volts), current (amps) and resistance (ohms). It is a standard diagnostic tool for technicians in the electrical/electronic industries.

Digital multimeters long ago replaced needle-based analog meters due to their ability to measure with greater accuracy, reliability and increased impedance. Fluke introduced its first digital multimeter in 1977.

Digital multimeters combine the testing capabilities of single-task meters—the voltmeter (for measuring volts), ammeter (amps) and ohmmeter (ohms). Often they include a number of additional specialized features or advanced options. Technicians with specific needs, therefore, can seek out a model targeted for particular tasks.

Safety

Each application with a digital multimeter presents potential safety hazards that must be considered when taking electrical measurements. Before using any electrical test equipment, people should always first refer to the user's manual for proper operating procedures, safety precautions, and limits.

1.1. Alternator

Alternator is a machine which converts mechanical energy into electrical energy. This machine initial produce Alternate current and converts into Direct current through electronic device – Rectifier and control the regulating voltage through electronic device – Regulator (Mono function OR Multifunction regulator)

In this machine, child parts comprises of rotor, rectifier, regulator, stator winding, slip ring, Drive end bracket, Slip ring bracket, Pulley and fasteners

This machine widely used in Automobile industry like manufacturing of cars, LCV, HCV, Tractors, DG Genset, to charge the batteries and to provide electrical loads

How to detect and monitor the Alternator defects with a digital multimeter through innovated new methodology

In an alternator machine, four terminals incorporated for input and out put

WL- Warning Lamp terminal is used for to provide initial excitation current to rotor to induce the electromagnetic

W- Phase tap terminal is used for to receive the AC out put

Positive Terminal – is used for to receive the DC out put and connected parallel with battery

Negative Terminal – is used for to connect the negative terminal cable for proper polarity to close the circuit

To check any machine, two probes given in the multimeter – One in RED colour and another in Black colour

Red is consider as Positive mode and Black is in Negative mode

To check the forward bias –

1. Red probe has to be kept over WL terminal and Black probe has to be kept over positive terminal – value indicated in the multimeter
2. Red probe has to be kept over W terminal and black probe has to be kept over positive terminal – Value indicated in the multimeter

2. Forward Bias and Reverse Bias checking method with Digital Multimeter

2.1. Forward Biased P-N Junction

When we connect p-type region of a junction with the positive terminal of a voltage source and n-type region with the negative terminal of the voltage source, then the junction is said to be forward biased.

WL to Positive Terminal	Numerical Value
W to Positive terminal	Numerical Value
WL to Ground	Numerical Value
W to Ground	Numerical Value

To check the forward bias –

1. Black probe has to be kept over WL terminal and Red probe has to be kept over positive terminal – value indicated in the multimeter
2. Black probe has to be kept over W terminal and Red probe has to be kept over positive terminal – Value indicated in the multimeter

2.2. Reverse Biased P-N Junction

When positive terminal of a voltage source is connected to the n-type region and the negative terminal of the source is connected to the p-type region then the p n junction is said to be in reverse biased condition.

WL to positive terminal	Numerical Value
W to Positive terminal	Numerical Value
WL to Ground	Numerical Value
W to Ground	Numerical Value

Illustration of an alternator checking – Application – Indica / Indigo Passenger Car

Forward Bias

WL to Positive Terminal	1.999
W to Positive terminal	0.498
WL to Ground	Open Circuit
W to Ground	1.279

Reverse Bias

WL to Positive Terminal	Open Circuit
W to Positive terminal	Open Circuit
WL to Ground	0.575
W to Ground	0.501

Results

Investigation report on 3SA28-12V- 90 A Alternators, which had removed from TML-INDIGO TCIC vehicle at M/S FIAT- Ranjangoan – Pune

Reference – Customer Complaint - 24 SEP 2015

Customer complaint

- ***Battery indicator NOT OFF in the telltale cluster***
- ***LTVS- p.no- 26021786 / TML- p.no- 2775 1540 0107***
- ***Batch code – 34/2015***

Observations and worthwhile noting are as follows

Case study – I

- **In multimeter checking –In forward Bias Short circuit between W to Positive terminal and In Reverse Bias short circuit between W to Ground in the alternator**

Forward Bias

WL to Positive Terminal	1.999
W to Positive terminal	1.476
WL to Ground	Open Circuit
W to Ground	1.279

Reverse Bias

WL to Positive Terminal	Open Circuit
W to Positive terminal	Open Circuit
WL to Ground	0.575
W to Ground	0.606

- ***In strip analysis –Rectifier , Rotor , Stator , Regulator - Found intact***
- ***Main diodes (Positive and Negative Main diodes found intact)***

  Defect identified
- ***Regulator fixing screw with SRE bracket assembly found in loosened and not tightened properly – Pl refer attached photos***

Conclusion

The study is undertaken with the following outcomes:-

- **Sophisticated test rigs is not required in the field to check OR verify the tangible and intangible defects**
- **Multimeter is sufficient to analysis the defects in the field and to find out the potential failures modes**
- **Expenses reduces and Time , Power Energy saved**
- **Results declaration instantaneously to take the actions**
- **Instead of checking the machines on sophisticated test rigs in dynamic running conditions to find out the tangible and in tangible defects**
- **With help of multimeter, tangible and in tangible defects have been identified through sensing method**
- **By identifying the symbols and other inappropriate numerical values – tangible and intangible defects confirmed for further course of action , correction and implementation**

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