Chapter 20

Online Condition Monitoring of Traction Motor

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ABSTRACT

Squirrel Cage Induction Motors (SCIMs) are major workhorse of Indian Railways. Continuous online condition monitoring of the SCIMs like Traction Motor (TM) are essential to prevent unnecessary stoppage time in case of a complete failure. Before a complete failure, the TMs generally develop incipient or weak faults. Weak faults have minute influence on the motor performance but eventually leads to complete failure of the motor. If these weak faults are identified at the earliest then, a scheduled maintenance can be planned which will prevent any unplanned stoppage. The signals used for SCIM fault detection are motor current, voltage, vibration, temperature, voltage induced in search coil, etc. The most popular fault detection technology is based on Motor Current Signature Analysis (MCSA). MCSA based online and onboard TM condition monitoring system can be very useful for Indian railways to reduce the cost of operation and unplanned delay by shifting from unnecessary scheduled maintenance to condition-based maintenance of TM and other auxiliary SCIMs.

INTRODUCTION

Indian Railway uses both electric and diesel locomotives that derive their tractive power, as well as power for maintaining auxiliary activities in the locomotives from electricity. Power for most of the auxiliary activities in locomotives is mostly generated from the induction motors. Auxiliary activities in locomotives are mostly related to cooling of different sub-systems and equipment of the locomotive. Earlier tractive power was generated by D.C. motors. The advantages offered by A.C. drives and induction motors have
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changed the scenario with Indian Railways adopting A.C. induction motors in a big way for generating their tractive power as well. Advantages of A.C. drives have led to the induction of WAP5, WAP7 and WAG9 class of electric locomotives and WDP4 and WDG5 class of diesel locomotives. These locomotives also provide higher tractive power compared to DC traction motor based locomotives due to their higher torque to weight ratio.

The maintenance practice of these locomotives is entirely periodic wherein different equipment and motors are checked after a defined period. Shift to induction motors has been able to increase time interval between successive maintenance calls for a locomotive. The practice includes carrying certain replacement activities that may not be necessary as per their condition at that time. Periodic maintenance results in unnecessary expenses and running equipment and components for suboptimal periods. A way out to obviate this drawback is by shifting to condition based maintenance that would require residual life assessment of equipment.

Due to restricted availability of space in the locomotives redundancies are nonexistent. Because of this any outage of any of the machine, drastically reduces the capability of the locomotive and can even completely disable it. The cooling mechanisms like the different blower fans come with no redundancies that makes their functioning extremely critical in the working of the locomotive. While a locomotive comes with four or six traction motors depending on the class of locomotive, yet, outage of any traction motor affects the reliability of the locomotive. Faults in the bearings, mechanical defects in fans, electrical faults like shorting in windings, rotor bar and end ring breakages all occur in the motors in the locomotive and affect its performance.

It, therefore, becomes necessary to have monitoring systems of the motors available in a locomotive that would be able to diagnose the health and fault levels of the motors. In this chapter our focus will be on fault detection of Squirrel Cage Induction Motors (SCIMs) with application to Traction Motor(TM) of A.C. electric locomotives.

BACKGROUND

Fault detection of Inductor motor requires extensive study about the different types of faults and how they are detected. To provide a better understanding, two sections have been dedicated about the faults that occurs and how they are detected. This chapter summarizes the existing techniques and gives an insight into recent technologies that are available for fault detection and diagnosis of SCIMs.

1. Induction Motor Faults and It's Classification

Fault is defined as unpermitted deviation of at least one characteristic property of the system from the acceptable, usual, standard condition, Isermann (2006). Faults are incipient in nature, so even if there is a fault in the system, the system may operate as a normal system with subtle deviation in its states. Fault diagnosis consists of three different steps, 1. Fault detection, 2. Fault Isolation - localization or classification of the fault, and 3. Fault identification - determination of type, magnitude and cause of the fault. Failure is defined as permanent interruption of the system’s ability to perform the required functions, Isermann (2006). If faults are not detected and proper maintenance has not been taken, the faulty system leads to complete failure resulting in loss of productivity. Failure prognosis consists of early detection of incipient faults and predicting the remaining useful life before failure and is required