SELECTING ELECTRIC MOTOR PROTECTION FOR PLANT AND PROCESS OPTIMIZATION

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Abstract - In the past the basic function of motor protection was to detect the fault and due to failures of motor. If the motor protections occur then the motor working normal condition without failure when protection is not provided then the result was unplanned shut down and lost the production and unusable product. Using modern electronic motor protection, increased productivity and shut down the processes. By analyzing abnormal operating conditions having more data such as motor temperature, overloading, it is possible to minimize faults and downtime by taking preventive action. This paper discussed causes of motor failure and proper protection can be selected to secure the motor.

Key Words: *Induction motor, motor fault, relay, motor protection.*

1. INTRODUCTION

Three phase Induction motors (IMs) used as actuators in many industrial processes, in fact 90 to 95% motors used in industries are three phase Induction motors. Although IMs are reliable, they are subjected to some unwanted stresses such as thermal, ambient, causing faults resulting in failure monitoring of a IM is a fast emerging technology for the exploration of initial faults, elusion unexpected defeat of an industrial process. Protection of motor against possible problem such as unbalance supply voltage, increasing temperature, occurring in the progress of its operation is very intrinsic in plant as an actuator. IMs protected using some component such as timer, current and voltage sensing relays, sensor to avoid the major damage.

2. ABNORMAL OPERATING CONDITIONS AND CAUSES OF FAILURE IN IMs

Three phase IMs are very widely used for industrial use. The abnormal conditions are summarized below.

i) Prolonged overloading: It is caused by mechanical loading, short time cyclic overloading. Overloading results in temperature rise of winding and deterioration of insulation resulting in winding fault. Hence motor should be provided with overload protection.

ii) Single phasing: One of the supply lines gets disconnected due to blowing of fuse or circuit in one the three supply connections. In such cases the motor continues to run on single phase supply. If the motor is loaded to its rated full load, it will draw excessive currents single phasing. The winding get overheated and damage is caused. The single phasing causes unbalanced load resulting excessive heating of rotor due to negative sequence component of unbalance current. Static single phasing relays becoming very popular.

iii) Stalling: If the motor does not start due to excessive load, it draws heavy current. It should be immediately disconnected from supply.

iv) Stator earth faults: Faults in motor winding are mainly caused by failure of insulation due to temperature rise.

v) Phase to phase faults: These are relatively rare due to enough insulation due between phases. Earth faults are relatively more likely.

vi) Inter- turn faults: These grow into earth faults. No separate protection is generally provided against inter-turn faults.

vii) Rotor faults: These are likely to occur in wound rotor motors, due to insulation failure.

viii) Failure of bearing: These causes locking up of rotor. The motor should be disconnected. Bearing should be replaced.

ix) Unbalance supply voltage: these causes heating up of rotor due to negative sequence current in stator winding.

x) Supply under voltage: The under voltage supply cause increase in motor current for the same load.

3. PLANT MANAGEMENT AND MOTOR PROTECTION

In prescript to induce quality products at the desired expense, all aspects of manufacturing costs need to be analyzed. Investment costs, operational costs, maintenance costs and repair costs and lost production costs due to down time are the components of the operational costs. Investment costs and energy usage can be optimized by close coordination of the motor and burden, since lowest horsepower motor is selected and to bolt at a higher frequency level than if it were oversized. Appropriate selection and application of motor protective equipment can downstate the cost. Repairs can be kept to minimum by early finding of faults. A pre warning and initiate to prevent function can mitigate unplanned down time by allowing the operator to make adjustment or automatically switch off before damage actually occurs. Remedial maintenance can be performed, of costly repairs.

4. PURPOSE OF MOTOR PROTECTION

The most common causes of motor failure discusses above mention, protecting the motor winding from overheating is the main function of motor protection. Already bearing failures can also result in motor winding failure if not detected in time, motor protection can be divided in to a different ways or task with respect to requirements of plant management. These functions are shown in Table 1.

Table 1: Protective Functions

Sr. No.	Task	Purpose	Example
1.	prevent starting	- Avoid damage - Avoid unsuccessful start	- Incorrect phase sequence - Insufficient thermal reserve - Defective insulation
2.	Disconnect rapidly	- Avoid damage - Keep damage low	- Short circuits - Ground faults on grounded System - High over temperatures - Stalling
3.	Pre warning	- Avoid stop by preventive measures - Switch off at convenient time	- Ground on isolated system - Failures in cooling system - Asymmetrical supply
4.	Availability of operational data	- Optimization of process	- motor temperature used to control loading

Operational requirement of motors or proper maintenance is not possible. But proper protective devices can help to exert motors to their fullest capabilities. Following protective measures can help to avoid the upcoming problem of motor.

A) THERMAL PROTECTION WITH CURRENT SENSING

The most common method of protecting motor is to use current sensing overload relays. Electromagnetic and electronic relays are the two types of over current sensing relays. The electromagnetic devices can be either eutectic alloy or bimetal overload relays. These are very popular. In case of three phase motors triple pole bimetal relays are generally employed. Bending of one or more bimetal strips causes movement of common lever which in turn operates the trip contact in case of overload. The bimetal strips are either heated directly by current flowing through them or by special heater coil through which motor current flows. In case of bigger motors, they are connected in the secondary circuit of CTs (current transformer) bimetal relays can usually be set in a certain range. Most of them are provided with additional bimetal strips to enable ambient temperature compensation. Further bimetal strip can be self setting type or hand resetting type. In the latter, the trip mechanism locks itself in operated condition until reset mechanically. Electronic overload relays are a relatively new technology. They provide more flexibility with regard to the quality of the thermal simulation and trip characteristic. Electronic overload can perform additional functions for extra cost.

B) PROTECTION AGAINST SINGLE PHASING AND SUPPLY UNBALANCE

It is standard for modern electronic relays to have at least single phasing protection in bloom to usual overload protection; protection against single phasing is a normal feature of modern electronic protection relays. In the past, specific single phase relays has to be added to the system, if protection over and above that installed by overload relays is required. It is best to disunite a motor rapidly with the loss of a phase, since the majority of cases the motor would stall due to the reduced torque. This would unnecessarily heat the motor if only thermal function was available. Motor also required the protection against unbalance supply. Formulas subsist to count the additional losses fed into the rotor, which are good estimated of real stipulation. With an unbalance of as little as 3% the motor must be dreaded by approximately 10%. And motor manufacturers state that operation of the motor when the unbalance is more than 5% is not recommended. I addition supply unbalance does not normally just affect just one motor, but all the plant or section of a plant, then central supervisory relay should alert personal to the fact that certain limits are exceeded and permitting them to take corrective measures before motor overheating occurs.

C) GROUND FAULT PROTECTION

When insulation breakdown occur, many result in ground fault currents. Before finding keeps damage to minimum due to this it's require less repair time and minimizing repair cost. In isolated supply systems, a first ground fault could even only start alarm. But applicable codes require followed. The plant could continue to sustain until a convenient time to shut down such as the end of the shift, day or week. Due to current transformer saturation at the start of a ground fault, tripping normally occurs after a short delay. This deferment is also intrinsic in order to differentiate between ground fault and short circuit. This allows the fuses or circuit breaker to clear the short circuit instead a conductor. Protection against ground fault can be applied as individual protective equipment. But this protection is also standard with high level digital protection.

D) MODERN PROTECTION INCREASES PRODUCTIVITY

Avoiding unplanned shut down is other way modern protection techniques can help to increase productivity. In this sense, they help to uninterrupted operation and mitigate costly down times. With electronic circuitry additional functions mainly aimed at supporting unplanned shutdown or maximum motor output are possible. In many cases, a warning signal indicating that thermal trip is pending can increase productivity. By calling attention to the overload condition prise to tripping, an operator has time to clear the overload without shutting down the motor. With microprocessor relays and assuming a stable load even the time left before trip indicate as shown in figure 1.

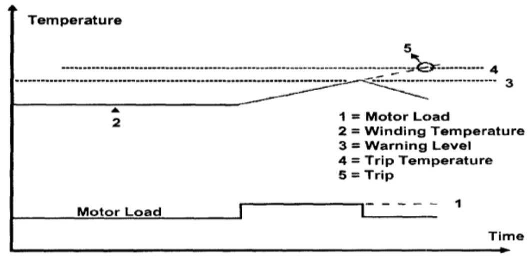

Fig.1: Pre-Trip Warning and Load Control

Rather production a process where the load can be varied, a motor temperature output has proven to very useful. By controlling the load either manually or automatically, the motor loading can be optimized at a point where the temperature rise on the motor is within its limits. When stalled rotor stipulation it is beneficial to disjoin the motor rapidly and not to wait till the motor becomes heated. Likewise a high level overload which would inevitably lead to a thermal trip occurs while running should also as a motor to be shut down fast. This minimizes motor stress and can even protect machinery. This feature which is also known as "jam" protection can be realized when a motor current signal is accessible in the relay (Figure 2).

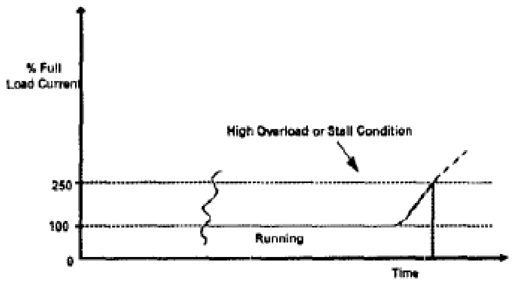

Fig. 2: Stall Protection

The temperature output can be used for inhibiting essay to start a motor if the thermal reserve of the motor is not adequate for the restart. Preventing a motor from starting does no voice like a way to develop productivity. But the time lost waiting for a motor to cool down later on aborted to begin is longer than preventing to start till the thermal reserve is plenty to allow a successful beginning. With a good thermal with microprocessor based relays, even an indication of the remaining waiting time, as shown in figure 3 could be provided to operators.

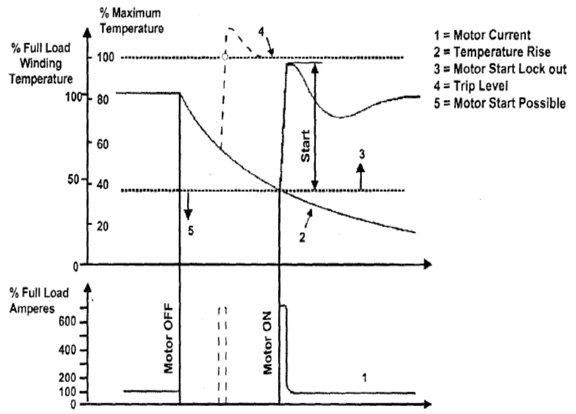

Fig. 3: Start Prevention

Under load protection is something which is not normally discussed, when motor protection is normally required when overload occur. But in cases where the motor is cooled by the medium it drives, such as fans, a lack this medium due to barrier of air blow would result simultaneously in a reduced motor load and limitless motor heating. Under load can also be an indicator that there is a trouble with the process. For this reason a warning signal or a trip before product is lost or damage occurs is useful scrutiny of the motor current can indicate failure such as broken bars in the cage, a rubbing of the rotor against stator, other similar periodic loading originating from failures on the load side, or even bearing failures. Generally, the exploration of these failures is limited to a little percentage of applications. To show, visual indicators or even acoustical signals to give extraction regarding operational terms and failure are relatively easy to provide with electronic motor protection. The display and visual indicators also assist in making setting and doing functional tests. Through a simulation model, the shortest waiting times can be achieved. And communication bus connection, remote controlling and connection to other automation appliances is also possible, these features again help to minimize start up and maintenance costs. Down time can be minimized when more detailed data about failure which has occurred is available.

5. CONCLUSION

There are many variables that can lead to premature electric motor failures. Reliability operators at any plant cannot easily predict future operational issues particularly in new appliances where little operational information has been acquired. The cost for unplanned outage and repairs raise many questions. Therefore the proposed paper investigates different motor protection such as ground fault protection etc. which initiate different fault and there remedies this helps to maximize productivity, efficiency.

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