Ground Fault Detection & Protection For Motors

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Almost 80 % of the electrical faults in low voltage distribution systems are line to ground faults. In a solidly grounded distribution system the fault current is very high and if there is an arcing type fault then the fault energy causes catastrophic damage. In industrial power systems the bulk of the load consists of motors. In order to avoid severe damage the faults need to be detected before they evolve in to major problems.

Ground fault relays, when applied to monitor each motor, can be set to trip at 5-10 A. They can be mounted in the starter bucket in the motor control center and the relay trip contact wired to operate the shunt trip to open the breaker or the contactor. In this case the relay should be time coordinated so that in the event of a large magnitude fault it does not open the contactor beyond its interrupting ability.

Converting to high resistance grounding will lower the fault current and thus the fault will not cause damage and the motor with the ground fault need not be tripped. The fault current can remain in the ground return path continuously. The fault needs to be detected and an alarm needs to be provided. It is most useful to know which motor has the fault.

The relay set at 500 ma to 2.5 A. can provide an alarm and energize a pilot light on the MCC bucket door indicating a fault in the motor while the load keeps running. The process or batch is not interrupted and no production loss occurs. A maintenance shutdown can now be scheduled to repair the motor.

When the motor control center has a large number of starters an alternative method of detection is to use a multi-circuit alarm system (Type DSA), which can handle up to 192 motor circuits. Zero sequence sensors are mounted in the MCC, one per motor circuit, with all three-phase load conductors passing through the window. The DSA unit indicates which motor has a ground fault.

Yet another approach is to use an integrated high resistance ground with pulsing system on the main supply transformer to detect, indicate and alarm, when the system has a ground fault. The fault can then easily be located by initiating the pulsing function. A flex core sensor is wrapped around load cables of the feeders to find the one that has the fault. The faulty motor is identified at the MCC when the flex sensor, wrapped around the load conductors of the motor, indicates pulsing.

Monitoring leakage to ground is a

predictor of an impending ground fault.

Most faults start with leakage to ground. IPC type GM indicators are an effective means to show when these leakage currents begin to increase which eventually will lead to a ground fault. Early detection keeps the damage at the fault point very low and therefore the repair cost and time to repair the equipment is also significantly reduced. These indicators can be group mounted in a compartment of the MCC or individually mounted in starter buckets. After a ground fault alarm is indicated by the substation ground fault detection system then a simple visual inspection at the MCC identifies which motor has the ground fault by noting the indicator with the maximum deflection.

Most motor failures occur in the motor terminal box and are caused by moisture, aging, vibration, etc. These faults are normally of low impedance and the GM indicator shows full scale deflection.

Internal faults in the motor winding are rare but they do occur. For a delta connected winding the smallest amount of ground current will occur for faults at the mid point of the winding and for a solid fault it will indicate 50 % or higher deflection on the indicator.

The current will be higher for fault locations closer to the ends of the winding.

For star connected motor windings the fault current reduces as the fault location gets closer to the star point. If the fault is at the star point then there is no fault current and the fault cannot be detected by zero sequence current or phase to ground voltage measurement. The insulation impedance of the winding to the grounded steel core needs to be measured.

Periodically noting the deflection shown by the ground current indicator is a recommended practice that will show a trend. An increasing trend noted on a motor is a definite indicator that the insulation is going to break down and a fault is going to happen. This advance warning is tremendously useful in planning preventive maintenance and scheduling an outage for the motor.

Application With Drives

Ground fault sensing is normally applied on the line side of the drive. Ground faults on the load side of the sensor location are detected. Isolation transformers, if used, prevent detection of ground faults on the load side of the secondary winding. Ground faults inside the drive on the DC bus will cause a non sinusoidal DC current flow which will not be detected by the AC zero sequence sensing circuit. Ground faults on the AC side of the drive, including the motor winding, will be seen

Application On Wound Rotor Motors

A wound rotor motor behaves like a transformer and ground faults in the rotor winding and circuit are isolated and not seen by the ground fault relay protecting the motor.

This same comment applies to synchronous motors. The ground faults in the DC excitation circuit are not seen by the motor ground fault relay.

Application On Large MV Motors

Quite frequently the MV systems are low resistance grounded and the ground fault relays applied for motor protection must trip on the occurrence of a ground fault. A sensitive ground differential scheme is often conveniently possible when all winding terminations are available in the motor terminal box, so that all conductors pass through a zero sequence current sensor providing ground differential sensing. All other comments noted above apply.apply.

Summary

Converting to high resistance grounding will control and reduce the ground fault current. It will allow you to maintain manufacturing process continuity even if an insulation failure and a ground fault occurs on the distribution system operating the process load. The fault damage will be limited. The fault can be easily located and repairs can be scheduled. Periodic monitoring of ground leakage current can be a predictor of an incipient failure and can be used effectively in a preventive maintenance program. Ω

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