SURGE TESTING

Educational Series: Why Test?

Why Do Motors Fail?

Motors fail both mechanically and electrically. Electrical failure occurs due to shorting which is caused by a breakdown of winding insulation. There are three types of insulation failure that can occur:

- Ground wall insulation (the primary insulation between the copper winding and steel core)
- Phase-to-phase insulation (the secondary insulation between the end turns of a random wound motor)
- Turn-to-turn insulation (the secondary insulation applied to the surface of the copper winding)

Stresses that cause electrical motor failure include differential thermal stress, different coefficients of expansion, varnish weakening at high temperatures, magnetic force due to winding currents, environmental contaminants, and moisture. These stresses cause looseness, motion, and wear of the insulation.

Why Perform Surge Testing?

Insulation deterioration is one of the first signs that a motor is going to fail electrically. Since secondary insulation is least able to sustain wear, shorting usually occurs here before the thicker, ground wall insulation is affected. Surge testing is a non-destructive test and detects the early stages of secondary insulation deterioration.

The cost of motor failure is measured by interruption of plant output as well as extent of repair or replacement. Surge testing greatly decreases both. It detects failure early enough so that repair or replacement can be scheduled during a normal shutdown rather than an emergency outage. In addition, damage to the motor is minimized.

How is Surge Testing Performed?

The test can be performed on the motor winding without actually connecting to the motor itself. The test equipment can be connected to the load side of the motor starter. During the test a voltage pulse is placed across two of the three windings while the third is grounded. The magnitude of the pulse is approximately twice the operating voltage plus 1000 volts. Therefore, low voltage starters operating at 460 volts, are tested at approximately 2000 volts and medium voltage starters, operating at 2400 volts, are tested at approximately 6000 volts. Pulses are produced at a frequency of 60 times per second and dissipate in approximately 100 microseconds.

The output, which is a dampened sign wave, is then monitored on an oscilloscope. Since all three windings should have the same surge patterns, the two patterns being monitored should appear as a single overlapping wave. This procedure is repeated for all three pairs of windings.

In some cases if the two waves separate as the test voltage is increased, this indicates weakened insulation which in time will lead to electrical failure.

Surge Scope Patterns of Two Coils

Good Insulation ***Deteriorating Insulation***

When Should Surge Testing be Performed?

Surge testing is a part of a comprehensive maintenance program. Without maintenance and repair all motors will eventually fail either electrically or mechanically. A complete maintenance program will reduce any unexpected occurrences. Surge testing will predict motor burn-out due to turn-to-turn or phase-to-phase shorting.

Surge testing should be added to a regular predictive maintenance program. It should be used in conjunction with high potential or insulation resistance testing of the primary insulation as well as mechanical evaluation such as vibration analysis.