Motor temperature ratings

Business, Industries

A frequently misunderstood subject related to electric motors is insulation class and temperature ratings. This paper tries to describe, in basic terms, the temperature relationships that are meaningful in standard AC induction motors. Some of the same information can be applied to DC motors but DC motors are more specialized and some of the ratings are slightly different. Perhaps the best way to start is to define the commonly used terms.

MOTOR SURFACE TEMPERATURES

Motor surface temperature is frequently of concern. The motor surface temperature will never exceed the internal temperature of the motor. However, depending upon the design and cooling arrangements in the motor, motor surface temperature in modern motors can be high enough to be very uncomfortable to the touch. Surface temperatures of 75° to 95° C can be found on T frame motor designs. These temperatures do not necessarily indicate overload or impending motorfailure.

OTHER FACTORS

Insulation life is affected by many factors aside from temperature. Moisture, chemicals, oil, vibration, fungus growth, abrasive particles, and mechanical abrasion created by frequent starts, all work to shorten insulation life. On some applications if the operatingenvironmentand motor load conditions can be properly defined, suitable means of winding protection can be provided to obtain reasonable motor life in spite of external disturbing factors.

OLD AND CURRENT STANDARDS

U frame 184 through 445U frames, were designed based on using Class A insulation. Temperature rise was not precisely defined by the resistance method. Temperature rise by thermometer for Class A, open drip proof motors was 40° C. This was generally thought to be equivalent to approximately 50° C by resistance. U frame motors were the industry standard from 1954 to 1965 and are still preferred in some industries and plants. T frame, 143T through 449T motors are generally designed based on using Class B insulation with temperature rises by resistance of approximately 80° C. Production of T frame motors started in the mid-sixties and they continue to be the industry standard at this time.

SUMMARY

A key ingredient in motor life is the insulation system used in the motor. Aside from vibration, moisture, chemicals, and other non-temperature related life-shortening items, the key to insulation and motor life is the maximum temperature that the insulation system experiences and the temperature capabilities of the system components. Table 1 shows the temperature ratings, temperature rise allowances and hot spot allowances for various enclosures and service factors of standard motors. Table 2 shows a listing of temperature related life-shortening factors along with symptoms and cures. You may find this table useful.

TABLE1

Insulation System Class

ABFH

Temperature Rating in Degrees Centigrade105°130°155°180° Temperature Rise Allowance by Resistance (Based on 40° C Ambient Temperature) All

Motors with 1. 15 Service Factor (Hot Spot Allowance)70 *90 *115 *— Totally Enclosed Fan Cooled Motors (Hot Spot Allowance)60 (5)80 (10)105 (10)125 (15) Totally Enclosed Non-Ventilated Motors (Hot Spot Allowance)65 (0)85 (5)110 (5)135 (5) Motors other than those listed above (Hot Spot Allowance)60 (5)80 (10)105 (10)125 (15) * When operating at service factor loading the hot spot temperatures can actually exceed the insulation rating resulting in shortened motor life.

TABLE 2

Temperature Related Life-Shortening Factors

PROBLEMS SYMPTOMS CURES

Low VoltageOverload Tripping High current Short motor lifeCorrect power supply or match motor to actual power supply voltage rating. High VoltageOverload Tripping High current Short motor lifeCorrect power supply or match motor to actual power supply voltage rating. Unbalanced VoltageUnbalanced phase currents Overload trippingDetermine why voltages are unbalanced and correct. OverloadOverload Tripping High current Short motor lifeDetermine reason for overload. Increase motor size or decrease load speed. High Ambient TemperaturesShort motor life* Rewind motor to higher class of insulation.

Oversize motor to reduce temperature rise. Ventilate area to reduce ambient temperature. Blocked VentilationShort motor life Runs hot Amperage o. k. Clean lint and debris from air passageways or use proper motor enclosure for application. Frequent StartsShort motor life** Use a reduced voltage starting method. Upgrade class of insulation. High Inertia LoadsShort motor life Overload tripping during startingOversize motor frame. Use higher class of insulation * Use a reduced voltage starting method. * Bearing lubrication must also be matched to high operating temperature. **Reduced voltage starting method and motor characteristics must be matched to the load requirement.

APPENDIX

Temperature Rise by Resistance Method Degrees C Rise = Rh – Rc/ Rc (234. 5 + T) Where Rc = Cold Winding Resistance in Ohms R h = Hot Winding Resistance in Ohms T = Cold (ambient) Temperature in Degrees Centigrade Note: This formula assumes that the ambient temperature does not change during the test. Example: A small motor has a cold temperature of 3. ohms at 25° C (77° F) ambient temperature. After operating at full load for several hours, the resistance measures 4. 1 ohms and the ambient has increased to 28° C.

Calculate the temperature rise: Apparent rise = 4. 1 – 3. 2/3. 2 (234. 5 + 25) = 73° C Correcting for 3° C increase in ambient: Actual rise = 73° – 3° = 70° C Centigrade Fahrenheit Conversions Actual Temperatures To change Fahrenheit to Centigrade: C° = (F° – 32) 5/9 To change Centigrade to Fahrenheit: F° = (C° x 9/5) + 32 Rise Values Only Degrees “ C” Rise = °F (Rise) x . 56 Degrees “ F” Rise = °C (Rise) x 1. 8