Temperature Rise

The temperature rise within a motor is dependant on the load on its output. With motors connected to fans the load will vary with different air performance duty points.

With increased or reduce system resistance the fan will produce increased or reduce pressure development and reduced or increased volume flow. Whether this increases or reduces the load on the motor depends on the type of impeller, but it will change the load and so the temperature rise within the motor will change. This change could be greater then the rise allowed for the motor insulation, see insulation class, and will result in the motor being thermally overloaded and premature failure.

The temperature rise can be check with the fan installed to determine the motor temperature rise. This should be added to the maximum ambient temperature the fan and motor are likely to experience and the sum should not be greater then the maximum for the class of motor insulation used. The following explains how to undertake such a test. It can only be applied to AC induction motors and not DC or EC motors.

Method

1. Position the fan in the application for a suitable period of time so that the winding temperature stabilizes at the same temperature as the general surroundings.

   Before starting the motor, measure and record the following;

   A) Ambient temperature
   B) Resistance of the windings

2. Run motor for a length of time to stabilize the motor temperatures (45-90 minutes)

3. Switch off the motor, noting the time, and bring the fan immediately to a stop.

   Record the following measurements:

   A) Record the resistance of the windings at periodic time intervals, e.g every 10 seconds. Ideally the first measurement should be taken in the first 10 seconds.
   B) Ambient temperature at the end of the test

Results

Plot a graph of winding resistance (Y axis), against time (X axis), for all windings.
Extrapolate the .Best fit. line back to 0 seconds, this gives the .R2. figure.
Use the following equation to determine the temperature rise.

$$\Delta t = \frac{R2 - R1}{R1} (234.5 + t1) - (t2 - t1)$$

∆t - Temperature rise
R1 - Resistance at beginning of test
R2 - Resistance at end of test
T1 - Ambient temperature at beginning of test
T2 - Ambient temperature at end of test

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Interpretation of results

Add the temperature rise test result to the maximum temperature the fan and motor is likely to experience to obtain the total temperature.   Refer to Clause 19 of EN60335-1 for permissible motor temperatures of insulation class of the motor.

Example for a Three phase fan

Test results

Ambient temperature at start	19.9 °C
Resistance of U winding (Cold)	51.5 Ø
Resistance of V winding (Cold)	52.5 Ø
Resistance of V winding (Cold)	51.7 Ø
Ambient temperature at finish	20.7 °C

Resistance of U winding

Time Seconds	Resistance Ø
5	62.6
20	61.9
40	61.3
60	60.8
80	60.4
100	59.9
120	59.5

Resistance of V winding

Time Seconds	Resistance Ø
5	61.9
20	61.5
40	61.3
60	61.0
80	60.8
100	60.4
120	60.2

Resistance of W winding

Time Seconds	Resistance Ø
5	63.9
20	63.1
40	62.5
60	61.9
80	61.4
100	61.0
120	59.6

Running Time

Start	08:50 am
Stop	09:57 am

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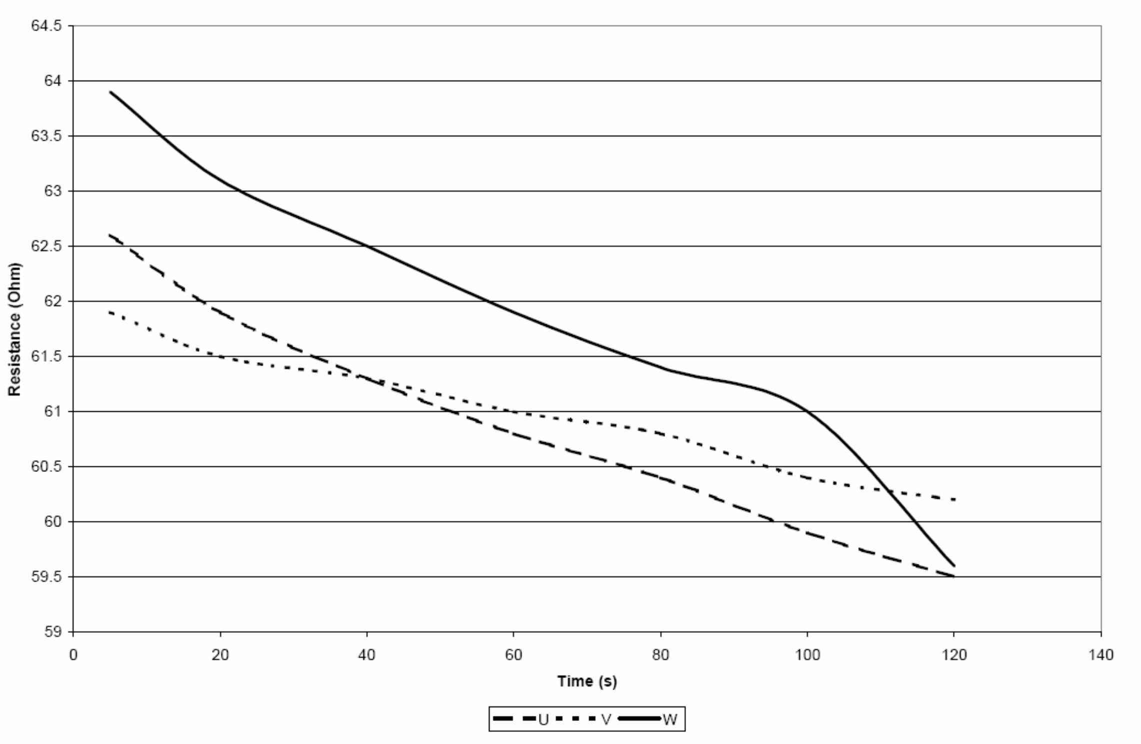

Extrapolated Resistance at 0 seconds

U	=	63.0 Ohms
V	=	62.3 Ohms
W	=	64.5 Ohms

Calculation

$$\Delta t = \frac{R2 - R1}{R1} \times (234.5 + t1) - (t2 - t1)$$

U Winding

$$\Delta t = \frac{63.0 - 51.5}{51.5} \times (234.5 + 19.9) - (20.7 - 19.9) \quad \underline{= 56.0\ K}$$

V Winding

$$\Delta t = \frac{62.3 - 52.5}{52.5} \times (234.5 + 19.9) - (20.7 - 19.9) \quad \underline{= 46.7\ K}$$

W Winding

$$\Delta t = \frac{64.5 - 51.7}{51.7} \times (234.5 + 19.9) - (20.7 - 19.9) \quad \underline{= 62.2\ K}$$

Therefore temperature rise 62.2 K (worst case).

If the maximum ambient temperature was 70°C then 70 + 62.2 = 132.2 which is less than the maximum 140°C allowed for a class F insulation.

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