Torque Topics WE

TEMPERATURE AND THERMAL PROTECTION - A Brief Guide

METHODS

There are several methods to protect an electric motor from overheating.
***External devices**, such as circuit breakers and thermal overloads, in general measure the current to the motor and assume that the measure the current to the temperature is proportional to the current. They can be selected and set to shut the motor down if the current exceeds the nominal full load. This can allow a motor to overheat without registering a problem, e.g. if the fan cowl inlet gets blocked, (even by a plastic bag lying around), or by an excessively high ambient temperature, the current will not increase, but the temperature will. However, this form of protection will protect against a locked rotor situation better than most.

***Internal devices**, such as RTD's of thermistors, are much more effective as they measure the actual temperature of the winding which is what we want to protect. Briefly the 3 most common internal devices are as follows:

PTC Thermistors. Positive Temperature Coefficient Thermistors can be fitted into the windings of a motor during manufacture of retrofietted after manufacture. Usually 3 are fitted in series, 1 in each phase of the winding. They can be purchased with trip temperatures from 90 deg. C to 180 deg. C in 5 deg. steps. They need to be connected to a Thermistor Relay, (preferably one with a latching trip), which detects the rapid increase in resistance of the thermistor when it reaches it's trip temperature. These devices are non-linear. At ambient temperatures the resistance of a set of 3 will be about 200 ohms, and this will increase rapidly to 3000 ohms, (1000 ohms each), and, if the temperature increases further, to several thousand ohms. The thermistor relays are usually set to trip at 3000 ohms. Recommended thermistors for Class F motors with Class B rise are 140 deg. C.

Microtherms and Thermostats. These are small bi-metallic switches that switch due to temperature. They can be obtained with a wide range of trip temperatures and normally -open and normally-closed types are available, but the normally-closed are more common. Three, (n/c), in series, are usually fitted in the windings like thermistors and can be connected directly into the circuit of the main contactor coil, thus saving the cost of a relay. Because this form of protection is cheaper that thermistors it is commonly used in motors for 'white goods' and in single phase motors. They are not commonly used in industrial 3 phase motors. The switch contacts sometimes do not reset after they have tripped and the motor has cooled down.

RTD's. Resistant Temperature Detectors, Platinum Resistance Thermometers, (PT100). The resistance varies in direct proportion to temperature so that an accurate temperature reading can be obtained. The monitoring device usually displays the actual temperature and can be programmed for alarm and trip points. PT100's are available in 2, 3, and 4 wire configurations, depending on the accuracy required, with 3 wire being the more common. One monitoring device is required for each PT100, and usually there is 1 in each phase of the winding and 2 to monitor bearing temperature. As this system is quite expensive it is usually only used on high voltage motors.

TIME CONSTANTS

All of the devices mentioned above have a certain amount of time delay or "temperature overrun" mainly because they have to be electrically insulated from the winding, which also acts as thermal insulation. If the winding heats up quickly, which happens during starting or locked rotor situations, these devices may not operate quickly enough to save the motor.

We recommend the use of thermistors with a thermistor relay to protect a motor against excessive

temperatures which increase slowly, and circuit breakers of thermal overloads to protect against rapid temperature rise caused by heavy overload.

AMBIENT TEMPERATURE ADJUSTMENTS

If motors are to be operated in a high ambient temperature environment they should be derated to ensure that the winding temperature rise is similar to the design temperature rise. Motors that are operated in high ambients or high altitudes may need thermistors of microtherms with a higher trip temperature to prevent nuisance tripping as the actual winding temperature rise is normal. Standard Western Electric Motors can be operated in higher ambient temperatures than 40 deg. C. and at altitudes above 1000 metres, but they should be derated as below:

Derating For Ambients Above 40 Deg.C. and below 1000M	
Ambient tempDeg.C.	Recommended Output Power
40	100%
45	95%
50	90%
55	84%
60	77%

Derating For Altitudes Above 1000 Meters At 40 Deg.C.		
Altitude	Output At Ambient of 40 Deg. C.	100% Output For M Ten
Up to 1000M	100%	40 De
1000M to 2000M	90%	32 De
2000M to 3000M	80%	25 De
3000M to 4000M	70%	15 De