INSULATION AND TEMPERATURE RATINGS OF MACHINE

For convenient reference insulating materials are grouped in classes according to their *nature* and the *working temperature* for which they are suitable.

Classes O, A, B and C have been in general use for many years, but *O will in future* be known as *Y* and three classes E, F and H have recently been added to legislated for some of the new material and processes in this filed.

CLASSIFICATIONS OF INSULATIONS

Class Y
Insulation consists of material or combinations of materials such as *cotton, silk and paper without impregnation*.

Class A (105 ^{O}C)
Insulation consists of materials such as *cotton, silk, and paper* when suitably *impregnation* or *coated* or when *immersed in dielectric liquid* as oil.

Class E
Insulation consists of materials or combinations of material which experience or test can be shown to be capable of operation at the class E temperature.

Class B (130 ^{O}C)
Insulation consists of materials or combinations of materials such as *mica, fiber, asbestos*, etc *with suitable bonding*, *impregnation* or *coating* substance.

Class F…

Class F (155 ^{O}C)

Insulation consists of materials or combinations of materials such as *mica, fiber, asbestos*, etc *with suitable bonding*, *impregnation* or *coating* substance as well as other materials or combinations of material.

Class H (180 ^{O}C)

Insulation consists of materials or combinations of materials such as *mica, fiber, asbestos*, etc *with suitable bonding*, *impregnation* or *coating* substance such as appropriate silicone resins.

Class C (220 ^{O}C)

Insulation consists of materials or combinations of materials such as *mica, porcelain, glass quartz and asbestos without or with* an *inorganic binder*.

In each class, a proportional of materials of a *lower temperature class* may be included for *structural proposes only*, provided that adequate *electrical and mechanical properties* are maintained during the applications of the *maximum permitted temperature*.

An Insulating material is considered to be "***suitably impregnated***" when suitable substance such as *varnish* ***penetrates the interstices*** **between fibers, film**, etc to a *sufficient degree adequately to bond components* of the insulations structure and to *provide a surface film* which adequately *excludes moisture, dirt* and *other contaminations*.

For…

For some applications, compounds and resins without solvents may be used which substantially *replace all the air in the interstices*.

An insulating material is considered to be "***suitably coated***" when it is ***covered*** with a suitable substance such as *varnish* which *excludes moisture, dirt and other contaminations* to a degree sufficient to provide adequate performance in service.

The endurance of insulation is affected by many factors such as *temperature, electrical and mechanical stresses, vibrations, exposure to deleterious atmosphere, and chemicals, moisture and dirt*. For example, some varnish tend to harden with age to such an extend that cracks are formed and moisture is then admitted.

HOT – SPOT TEMPERATURE

When considering suitable operating temperature is the temperature at the hottest point that is important, and this is referred to as "*Hot spot*" temperature.

In field coil, for instance, *the hot spot* is somewhere *near the center of winding* and there is temperature gradient from there to the surface, so that temperature *is not uniform throughout the coil*.

The only means available in practice therefore is to determine the temperature either by *the change in resistance of the winding*, or by *measuring the surface temperature by thermometer*.

Temperature…

TEMPERATURE RISE

A continuously rated machine will eventually reach a steady temperature at which *the heat in windings* and *magnetized cores* and *the heat arising from frictional losses* will be dissipated at the same rate as they are generated.

The difference between this *steady temperature* and that of the *incoming cooling air* is the *temperature rise*. For all practical purposes, other thing being equal, *this rise is always the same regardless of the temperature of the cooling air*.

Examples:
Accordingly if a machine is tested in an ambient temperature or cooling air temperature of 20 ^{O}C, and a machine temperature of 55 ^{O}C is recorded, the rise is 35 ^{O}C. When the same machine is in tropics and the air-cooling at 45 ^{O}C, the rise will still be 35 ^{O}C, giving total machine temperature of 80 ^{O}C.

Having determined *the appropriated hot-spot temperature* for a given class of insulations, and from that *the surface temperature*, *the permissible temperature rise* is arrived at by *deducting the maximum ambient temperature* under which machine will be called upon to operate.

Permissible…

PERMISSIBLE TEMPERATURE RISE

During the normal operation of electrical machinery, its temperature rises above that of the surrounding air. Because the internal temperature is greater than the external value, the thermometer measurement is always less than that obtained by embedded detector or resistance measurement.

Furthermore, owing to variations in the thickness of insulation, no uniformity of cooling, inaccessibility of the hottest spot, etc, the observable temperature rise may be less than actual value.

The accumulation of dirt on the surface of insulation and in the ventilating duct reduces the dissipation of heat, raises the temperature and causes thermal degrading of the insulation.

Because the useful life expectancy of electrical machinery is approximately halved with each 10 ^{O}C increase in operating temperature, good preventive maintenance require that periodic check be made on the operating temperature machine, particularly those operating on a continuous basis.

Although the temperature life curve helps to estimate the life expectancy of machine, the mode of operation is an important determining factor. Vibration, over voltage, and other adverse operating condition also decrease the useful life by weakening the insulation.

Ambient…

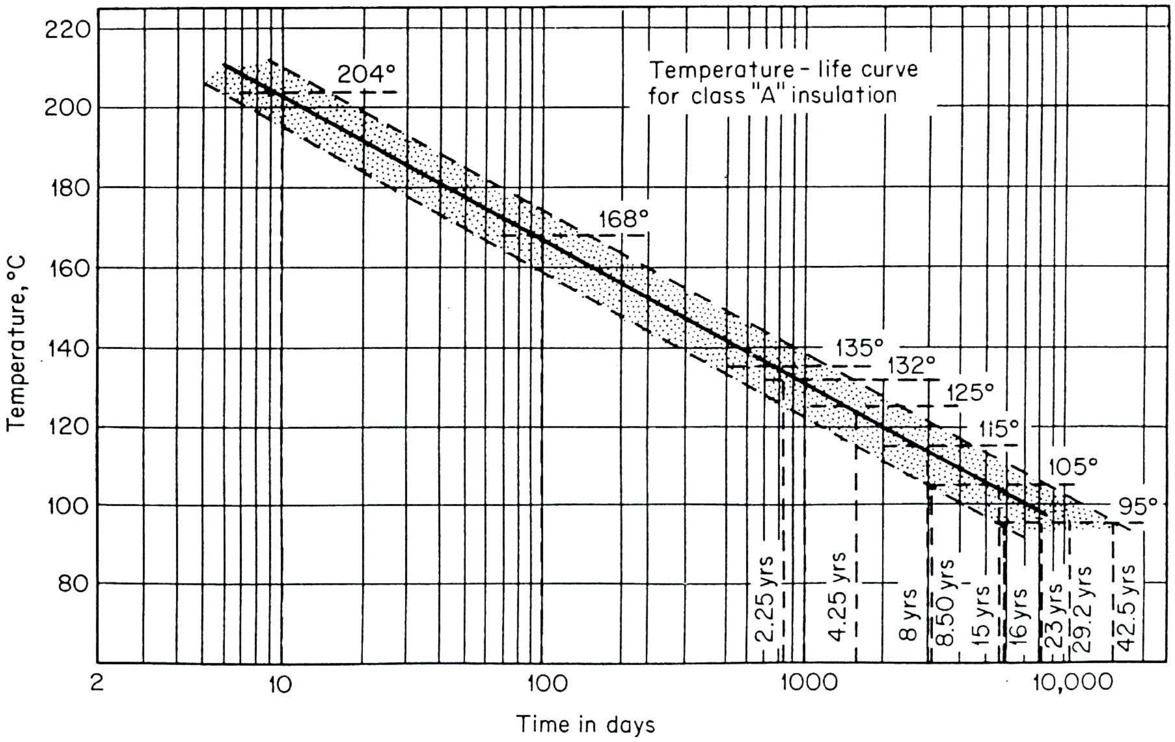

FIG. 2-1 Life expectancy versus operating temperature for class 105 (class A) insulation. *(Allis-Chalmers Mfg. Co.)*

AMBIENT AIR TEMPERATURE

Certain types of ship such as coaster, harbor craft, train ferries, etc *built primarily for service* in temperature climates will normally never required to operates in *the tropics*. However, for *ocean going ships* it is required that *temperature rises* should be based on *tropical conditions*.

Basis…

BASIS OF MACHINE RATINGS

Hitherto, there have been two method of assessing the rating of motor and generator, viz.

a. Continuous rating permitting overload
b. Continuous maximum rating

Momentary overload (for which, for test purpose, 15 second is recognized) of 50 % in current for generator and of varying amount in torque for motor according to type, size and duty are recognized. In fact, electric motor and generator have an inherent capacity sufficient for average requirement.

For exceptional application where overload are anticipated in normal service the purchaser should seek the advice of the manufacture or select a standard motor or higher rating. Such cases might arise with motor coupled to oil pump where the load may be increased for short period while pumping cold oil.

INSULATION RESISTANCE

The insulation resistance is affected by moisture and dirt and therefore a good indicator of deterioration from such cause.

The insulation resistance may be measured by non-destructive test applied between the conductor and the framework of the apparatus. The resistance value may be read directly from mega ohmmeter or indirectly by calculation, using voltmeter-ammeter method, or from voltmeter reading alone.

The insulation resistance values of DC machine are generally more sensitive to change in humidity than are those of AC winding, this due to the greater number of leakage paths in the armature and fields of DC machines.

METHOD OF MEASUREMENT OF TEMPERATURE RISE BY RESISTANCE

The hot temperature is determined from the following formula:

$T2 = R2 / R1\ (T1 + 234.5) – 234.5$

R1 = resistance of winding cold
R2 = resistance of winding hot
T1 = temperature of winding cold ^{O}C
T2 = temperature of winding hot ^{O}C

When it is intended to use embedded temperature detectors they must be built in the machine during construction. They may take form of either thermo-couples or resistance thermometer.

MEASUREMENT OF AMBIENT AIR TEMPERATURE

The thermometer should indicate the temperature of the air flowing toward the machine and should be protected from heat radiation and stray draughts.

The value…

The value to be adopted to determine temperature rise is the average of these temperatures from reading taken at the beginning and end of the last half-hour of the test.

If the air is admitted into the machine through a define inlet opening or openings, the temperature of the cooling air should be measured in the current of air near its entrance into the machine.

Selesai…

Kembali ke Menu Utama