PS 916-12:2010 IEC 60076-12:2008

C is the effective thermal capacity of winding, in watt-hours per K (Wh/K),

= (0,25 × mass of aluminium conductor in kilograms (kg)) + (0,408 × mass of epoxy and other winding insulation in kilograms (kg)), or

= (0,107 × mass of copper conductor in kilograms (kg)) + (0,408 × mass of epoxy and other winding insulation in kilograms (kg));

P_r is the winding total losses (resistive losses + eddy losses) at rated load and rated temperature rise, in watts (W);

$\Delta\vartheta_{HS,r}$ is the winding hot-spot temperature rise at rated load, in Kelvin (K);

ϑ_e is the core contribution to winding hot-spot temperature rise at no load. This value should be the value given below or the value measured by the manufacturer during the temperature rise test on the transformer.

= 5 K for outer winding (usually HV)
= 25 K for inner winding (usually LV less than 1 kV).

NOTE 1 The core contribution values above are based on manufacturers' experience.

NOTE 2 Other winding insulation material and kind of epoxy material can be used. For such transformers the correspondent specific heat values of 24,5 Wmin/K and /kg (or 0,408 Wh/K and per kg) can be replaced by the values based on the manufacturer's experience.

5.10.3 Time constant test method

Time constants may also be estimated from the hot resistance cooling curve obtained during thermal tests.

5.11 Determination of winding time constant according to empirical constant

When the temperature rise changes, the time constant varies according to the empirical constant m.

$$\tau_R = \frac{C(\Delta\vartheta_{HS,r} - \vartheta_e)}{P_r} \tag{17}$$

If m is equal to 1, Equation (17) is correct for any load and any starting temperature. If m is not equal to 1, the time constant for any load and for any starting temperature for either a heating cycle or a cooling cycle is given by Equation (18).

$$\tau = \tau_R \frac{\left(\frac{\Delta\vartheta_U}{\Delta\vartheta_{HS,r}}\right) - \left(\frac{\Delta\vartheta_i}{\Delta\vartheta_{HS,r}}\right)}{\left(\frac{\Delta\vartheta_U}{\Delta\vartheta_{HS,r}}\right)^{\frac{1}{m}} - \left(\frac{\Delta\vartheta_i}{\Delta\vartheta_{HS,r}}\right)^{\frac{1}{m}}} \tag{18}$$

5.12 Calculation of loading capability

Equations (10) through (18) should be used to determine hot-spot temperatures during a load cycle. They should also be used to determine the short-time or continuous loading, which results in the maximum temperatures given in Table 1 or any other limiting temperatures.

The initial hot-spot temperature rise for the initial loading factor I_i should be obtained from Equation (11) and is determined as follows:

$$\Delta\vartheta_i = \Delta\vartheta_{HS,r}[I_i]^{2m} \tag{19}$$

where