Losses in Transformers

- Iron losses (P_i)
- Cu losses (P_{cu})

P_i are also known as core losses or permanent losses

P_{cu} → are also known as winding loss or temporary losses.

Cu loss is the I^2R loss that takes place in the primary and secondary winding because of the winding resistance.

Total Cu losses = Primary winding Cu loss + secondary winding Cu loss.

$$P_{cu} = I_p^2 R_p + I_s^2 R_s$$

Because: $I_p T_p = I_s T_s$

or $I_p = I_s \frac{T_s}{T_p}$; so:

$$P_{cu} = I_s^2 \left(\frac{T_s}{T_p}\right)^2 R_p + I_s^2 R_s$$

$$= I_s^2 \left[R_s + \left(\frac{T_s}{T_p}\right)^2 R_p \right]$$

$$\boxed{P_{cu} = I_s^2 R_{es}}$$

similarly; $I_s = \frac{I_p T_p}{T_s}$; so:

$$P_{cu} = I_p^2 R_p + \left(\frac{I_p T_p}{T_s}\right)^2 R_s$$

$$P_{cu} = I_p^2 \left[R_p + \left(\frac{T_p}{T_s}\right)^2 R_s \right] = I_p^2 R_{ep}$$

$$\boxed{P_{cu} = I_p^2 R_{ep} = I_s^2 R_{es}}$$

Core losses (P_i)

$P_i = P_h + P_e$

P_h = hysteresis loss

P_e = eddy current "

$P_h = K_h f B_m^x$ $\quad P_e = K_e f^2 B_m^2$

K_h = a factor which depends upon the volume quality of core material and the units used.

K_e = a factor whose ~~values~~ value depends upon the volume and resistivity of the core material, thickness of laminations and units used

B_m = max. flux density in the core

f = frequency of alternating flux.

Stray Loss

- The occurrence of these stray losses is due to the presence of leakage field.
- The percentage of these losses are very small as compared to the iron and copper losses so they can be neglected.

Dielectric Loss

- Dielectric loss occurs in the insulating material of the transformer that is in the oil of the transformer, or in the solid insulations.
- When the oil gets deteriorated or the solid insulation gets damaged, or its quality decreases, and because of this, the efficiency of the transformer gets affected.