# Chapter 1

1. **A Copper bar with a diameter of 1.2cm and length 20cm is insulated with micanite which fits tightly around the bar and into the rotor slot of induction motor. Thickness of the micanite tube is 1.5mm and thermal resistivity is . Calculate the loss that will pass from copper bar to iron for a temperature difference of C maintained between them.**

**Solution:**

Diameter of Copper Bar, D = 12mm = 12\*m

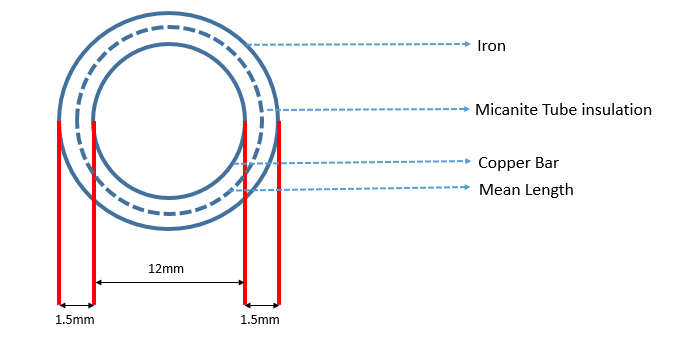
Thickness of Micanite Tube, t = 1.5mm = 1.5\*m

Thermal Resistivity () =

Temperature difference, () = C

Length of Copper bar, L = 0.2m

Loss that will pass from copper bar to iron, = ()/



Thermal Resistance, =   
Surface area of insulation s = π\*(D + t)\*L = π\*(12+1.5)\*\*0.2 = 8.4823\*

=  = 11.4147

= = 17.6715 W

1. **A 230V, 2.5KW single element resistor is made of a cylindrical nichrome wire. The temperature rise of strip should not exceed C over the ambient temperature of C Determine the length and diameter of strip assuming coefficient of emissivity() 0.9, radiating efficiency = 1 and resistivity of nichrome wire() as 0.424 .**

**Solution:**

Voltage = 230V; Power() = 2.5KW

Temperature of nichrome wire, = 1200 + 20 = C (Converted to absolute temperature as 1493K)

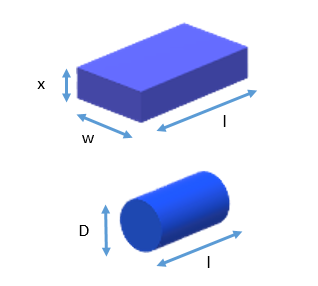
Temperature of Ambient medium, = C (Converted to absolute temperature as 293K)

Coefficient of emissivity () = 0.9

Radiating Efficiency () = 1

Stefan's Boltzmann constant,

Heat dissipated from material,



Resistance of nichrome wire, R = ()

R = 21.16

R = ()/A

A = (

------------------------------------------------------------------------------------------------- (1)

Total heat radiated,

= 3.1266\* ----------------------------------------------------------------------------------------- (2)

Solve eq. (1) and eq. (2),

D = 0.0726m;L = 0.0430m

1. **The inner dimensions of the former field coil of a DC Generator are 150mm \* 250mm. The former is 2.5mm thick. Calculate the heat conducted across the former from winding to core if there is an air space 1mm wide between the former and the pole core. The thermal conductivities of former and air are 0.166 and 0.05W/m- , respectively. The winding height is 200mm and the temperature rise is 40 .**

**Solution:**

Thickness of field coil, = 2.5mm

Thickness of air space, = 1mm

Winding height = 200mm

Thermal conductivity of the field coil, = 0.166W/m-

Thermal conductivity of the air, =0.05W/m-

Temperature rise, = 40

Heat conducted across the field coil, = (

Thermal resistance, = + (i.e., sum of thermal resistance of field coil and air coil)

=

=

=

= (2.5\*/ (0.166\*0.16)

= 0.094

= (1\*/ (0.05\*0.16)

= 0.125

= 0.094 + 0.125 = 0.219

= (40/0.219) = 182.6484

1. **Calculate the heating time constant of 10KVA transformer during a heat run test, if the temperature rise after one hour and two hours is found to be 35 and 47.5, respectively.**

**Solution:**

Temperature rise of transformer after one hour = 35

Temperature rise of transformer after two hour = 47.5

Temperature Rise,

At t=1, 35 = ---------------------------------------------------------------------------------------- (1)

At t=2, 47.5 = -------------------------------------------------------------------------------------- (2)

Div eq(2) and eq(1)

1. **During a heat run test of a 100KVA transformer, the temperature rise after one hour and two hours are found to be 24 and 34, respectively. Calculate the heating time constant and final steady state temperature rise. If the cooling is improved by using an external fan so that the rate of heat dissipation is increased by 18%, find the new KVA rating for the same final temperature rise. Assume the maximum efficiency occurs at 80% of full load and unity p.f.**

**Solution:**

Transformer power output = 100KVA

Maximum efficiency, = 80 %( efficiency at full load,)

Temperature rise after one hour = 24

Temperature rise after two hour = 34

Increase in rate of heat dissipation when cooling is employed by external fan = 18%

Temperature Rise,

After one hour:

24 = ---------------------------------------------------------------------------------------------------- (1)

After two hours:

34 = ---------------------------------------------------------------------------------------------------- (2)

= - 0.87562

Substitute T

34 =

= (34/0.827) = 41.1125

Allowable losses = 1.18 \* (Total losses at full load)

Total losses at full load =

, we know

= 1.5625

Allowable losses = 1.18\*(1.5625+) = 3.02375

Allowable copper loss = 3.02375 - = 2.02375

Allowable copper losses = 2.02375\*

Copper losses at this output, 1.2952 =

= 1.2952

x = 1.1380

New output = x (100KVA) = 1.1380\*100KVA = 113.80KVA