Electrical Machine

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GATE EE 2018 AIR 1

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Chapter 1: Basic Introduction

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INTRODUCTION

→ Electrical Material

i) Conducting Material
ii) Magnetic Material
iii) Insulating Material

* Electrically Conducting Material

These materials carry current in elect. machine.

i) Highly Conducting Material
ii) Highly Resistive Material.

Cu, Al, Au, Ag ⇒ HCM
Alloys ⇒ HRM

⇒ Heating element માટે highly Resistive material use થાય. ઓવન, ઈસ્ત્રી વગેરે.
⇒ હીટર માટે Alloy (મિશ્ર ધાતુ) વપરાય છે.
⇒ Alloy નું temperature co-efficient is low.
⇒ Resistance Alloy નું ઓક્સિડેશન ઓછું હોય.

Property of Highly Conducting Material

⇒ Highest possible conductivity.
⇒ less temp co-efficient of Resistance.
⇒ Addiquete of Mechanical strength and absens of brittleness.
⇒ Rollability and drawability should good.

σ = Conductivity

$\sigma Au > \sigma Ag > \sigma Cu > \sigma Al$ {સૌથી વધુ condctive Au એટલે કે સોનુ}

$\alpha Cu = 0.00393 / °C$

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⟹ Good weldebility & sholderability to ensure low resistance of Joints

⟹ Addiquet Resistance to corrosion.

<1.> Copper

⟹ Machine winding માં વપરાય.

⟹ Copper is resistant to oxidation and corrosion.

⟹ Hard drawn copper wires are used in electrical machine because there mechanical strength is high.

$$\alpha Cu = 0.00393 / °C$$

↑ Temp co-efficient of copper

<2.> Aluminium

⟹ Since copper is getting depleted Alumi. is the next best choice for conducting material.

⟹ As it is ~~abedently~~ abundantly available

⟹ Aluminium can not be drawn into thin wire but it can be use for form thin plates

For Same Resistance The cross Section of Al is more than Cu

__/__/__

Parameter	Cu	Al
Cost	1	0.49
Cross Section	1	1.62
Diameter	1	1.27
Volume	1	2.04
Weight	1	0.49
Strength	1	0.64

σ = resistivity

we know, $\sigma_{Cu} > \sigma_{Al}$

$$R = \rho l/A = \frac{l}{\sigma A} \qquad (\rho = 1/\sigma)$$

$$R_{Cu} = R_{Al}$$

$$\frac{l}{(A\sigma)_{Cu}} = \frac{l}{(A\sigma)_{Al}}$$

$$(A)_{Al} = \frac{(A)_{Cu}(\sigma)_{Cu}}{(\sigma)_{Al}}$$

as the $\sigma_{Al} < \sigma_{Cu}$

we get $(A)_{Al} > A_{Cu}$

Interview

Q Why cross sectional Area is more than copper

⟹ કેમ કે, cu જેટલો loss રાખવા Area વધારવો પડે કેમકે Al ઓછું conductive છે.

⟹ For aluminium wire the size of slot require is higher as compare to cu.

⟹ For induction motor above 100kW o/p Al can be used for cage rotor.

⟹ Al can be used to form foil type low voltage winding in transformer.

⟹ Al can be used to construct the tank of transformer to reduce stray losses.

⟹ Al is easily gets oxidised to form Al_2O_3 layer which prevent further oxidation.

<3> Electrical Carbon

⟹ This material is made up of graphite or other form of carbon.

⟹ Conductivity of carbon is less than of cu & Al. but its surface is smoother so it is used to make brushes in an electrical machines.

Graphite has -ve temp co-efficient.

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⇒ Carbon brushes are graphited or heat treated to increase condctivity and increase smoothness.

⇒ Graphite has -ve temp co-efficient

So $T \uparrow \Rightarrow R \downarrow$

So $V_{BD} = IR \Rightarrow$ Brush drop is constunt.

Cu ⇒ Winding वाले

Al ⇒ Trans. Tank वाले

Carbon ⇒ Brush वाले

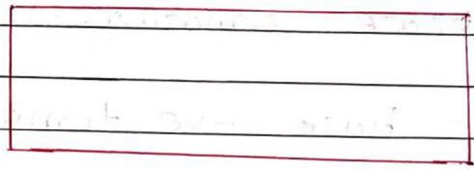
Magnetic Materials

⇒ The material which allows flows of magnetic field through them are called as magnetic material.

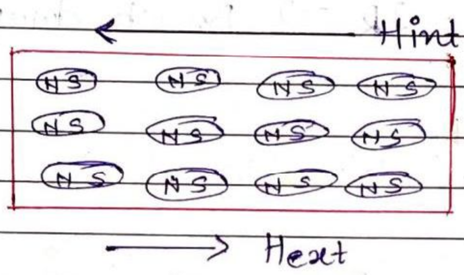
i) Dia magnetic Material
ii) Para magnetic Material
iii) Ferro magnetic Material

_/_/_

(ii) Diamagnetic



no dipoles in absense of magnetic field.



⇒ In diamagnetic material there is no magnetism in absence of external field.

⇒ When magnetic field is applied dipoles are induced and they orient in direction opposite to external mag. field.

magnetization (M)
↓
ability of dipoles to align when mag. field is applied.

$\vec{M} = X_m \vec{H}$ ($\vec{H}$ = ext. mag field)
(Xm = mag. susceptibility)

↓
~~SIEP~~ Pr
Pronounce as
SIEP

What is Susceptibility
What is Permeability

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Susceptibility shows that for same value of magnetic field how strong material get magnetize.

Susceptibility is a measure of material to get magnetize when external mag. field is applied.

in diamagnetic material

$\vec{M}$ & $\vec{H}$ are opposite to -

So $\chi_m < 0$

$\mu = \mu_0 \mu_r$

μ_0 = Permeability of free space/vacuume
$= 4\pi \times 10^{-7}$ H/m

μ_r = relative permeability.

$\mu_r = 1 + \chi_m < 1$ in diamagnetic.

So $\mu < \mu_0$

$\Rightarrow$ Permeability of material is related to ability of material to allow magnetic field lines to pass through it.

$\Rightarrow$ Magnetic flux density (B) represents the closeness of magnetic field line to each other in unit surface area.