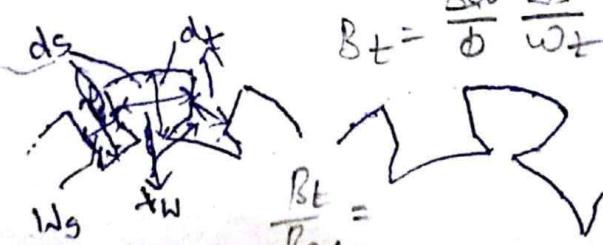


Choice of Specific Electric Loading: → (a)

- The main limiting factor in choice of specific electric loading is the temp rise.

1. Temperature Rise: → The copper losses in the m/c is proportional to the squared value of the current density in its conductor. The choice of conductor current density is therefore limited by permissible temp rise. The maximum allowable temperature rise of a m/c is determined by type of insulating material used. For example, Class A organic material such as cotton can withstand a temperature of up to about 105°C, while Class H inorganic material such as Polyester films may operate at higher temp (about 180°C). Hence a better quality insulating material can withstand high temp. rise and we can use increased value of specific electric loading (Also the size of m/c would also be reduced).

2. Size of Machine: → Increasing the no. of conductors, Z , in a m/c → increases slot area so that all the conductors may be accommodated. The slot area may be increased by using deep slot, wide slot or a combination of both. Using deep slot results in increased slot leakage inductance and higher tooth mmf. On the other hand using wide slot, results in narrow teeth, for a given frame size. This reduces the slot leakage resistance but increase flux density-to-specific magnetic loading ratio (B_t/B_{av}) from (2).



Therefore for selecting the choice of specific electric loading we have to taking into consideration the dimension of slot/tooth width, depth by keeping ~~on the~~ the value of leakage inductance in mind.

As per standard design.

- ③ Voltage: → how we choose the specific electric loading taking pt of view of voltage / operating voltage
- For a high voltage m/c (several kilovolts), insulating materials in a slot occupy more space. Compared to a low voltage m/c → this results in the slot space factor for a high voltage m/c is less than that of low voltage m/c.
- ∴ therefore the specific electric loading of m/c high voltage m/c would generally be less than that of lower voltage one of the ~~the~~ same rating. [~~as~~ with same size → inner dia, outer dia, slot dimensions, teeth arm, stack length → can we get diff output voltage → yes → it depends on ac → specific electric loading. as discussed above.]

* Separation of D^2L : → $\Phi = C D^2 L n_s$ (20)
 The value of D^2L can be calculated by using output equation for D.C. and A.C. m/c and the product D^2L has to split into two components $D \& L$.

Separation of $D \& L$ for

D.C. $M_L M_C$

(a) $M_L M_C$ proportion

$$\frac{L}{T} = 0.7 \text{ to } 0.9$$

Induction m/c

$$\frac{L}{T} = 1.5 \text{ to } 2$$

$$\frac{L}{T} = 1.0 \text{ to } 1.25 \text{ for good pf.}$$

$G_m = 1$ for good overall design

actually large value of L/T applies to high voltage m/c due to longer core length thereby no. of cond. is reduced $b.c. L_{red} \Rightarrow D_{red} \Rightarrow n_o \cdot 7$ slots \Rightarrow cond. dec. \Rightarrow gaussh will reduced.

20-30 m/sec

Synch. m/c

(a)

$$\frac{L}{T} = 0.8 \text{ to } 1.2$$

$$K_{RA} = h \cdot p \times 0.746$$

$$K_W = h \cdot p \times 0.746$$

(b) Peripheral speed

$$V_A = \pi Dn$$

not exceed 30 m/s

(b) peripheral speed may reach 175 m/s for turbo-alternator and 60 m/s for slow speed salient pole m/c

Example:- A 350kW, 500V, 450 r.p.m.,

6-pole d.c. generator is built with an armature diameter of 0.87m and a core length of 0.32m.

The wound armature has 660 conductors.

Calculate the specific electric & mag. loading.

Soln:-

(a) specific electric loading (a_e) $\leq \frac{I_2 Z}{\pi D}$

$$\therefore I_2 = \frac{700}{6} = 116.6A$$

$$\left[\text{for } A = p \right] \quad I_2 = \frac{T_q}{a} \quad a_e = \frac{116.6 \times 660}{\pi \times 0.87} = 28200 \text{ amp cond. per m.}$$

(b) specific magnetic loading $\Rightarrow B_{av} = \frac{P\phi}{\pi D}$

$$\Rightarrow \phi = \frac{500 \times 6}{\left(\frac{450}{60} \right) \times 6 \times 660} = 0.101 \text{ wb.}$$

$$\Rightarrow B_{av} = \frac{6 \times 0.101}{\pi \times 0.87 \times 0.32} = 0.693 \text{ wb/m}^2$$

$$\begin{aligned} \phi &= ? \\ E &= \frac{n_p \phi}{a} \\ \phi &= \frac{E}{n_p} \\ \text{Ans} &= ? \end{aligned}$$

(ii) Rotor Design:-

Example :- find the main dimensions, no. of stator turns, size of conductor and no. of Rotor slots of a 5 h.p., 400V, 3-ph, 50Hz, 1500 synch. r.p.m. SQR.T.N.L. star-Delta starting is used.

Use foll. data

$$\text{Avg. flux den. in air gap} = 0.46 \text{ wb/m}^2 \quad \text{Bar}$$

$$\text{Ampere cond. per met. of arm. periphery} = 22000 \quad \text{AC}$$

$$\text{full load est.} (\eta) = 0.83 / 83\% \rightarrow 0.82 - 0.93$$

$$\text{" " P.F.} = 0.84 \text{ Lagging} \quad 0.82 - 0.92$$

Appropriate ~~data~~ values for additional data required may be assumed

Soln:-

$$\text{KVA} = \frac{H.P. \times 0.746}{2 \times \cos \phi} = \frac{5 \times 0.746}{0.83 \times 0.84} = 5.35 \text{ kVA}$$

$$\text{KW} = \text{H.P.} \times 0.476$$

$$\Phi = C_0 D^2 L n_s \Rightarrow D^2 L = \frac{\Phi}{C_0 n_s}$$

$$n_s = \frac{1500}{60} = 25, \quad C_0 = 11 \cdot \text{Bar AC KW} \times 10^{-3}$$

$$= 11 \times 0.46 \times 22000 \times 0.95 \times 10^{-3}$$

$$= 105.88$$

$$D^2 L = \frac{5.35}{105.88 \times 25} = 0.00202115 \text{ m}^3$$

$$= 2.02115 \times 10^{-3} \text{ m}^3 \quad - \textcircled{1}$$

To separate D & L

$$\frac{L}{2} = 1$$

$$\frac{L}{\frac{\pi D}{4}} = 1 \Rightarrow \frac{4L}{\pi D} = 1 \Rightarrow 4L = 3.14D \Rightarrow L = \frac{3.14D}{4} \Rightarrow L = 0.785D$$

$$\text{put in } \textcircled{1} \quad D^2 L = 2.02115 \times 10^{-3}$$

$$D^2 (0.785D) = 2.02115 \times 10^{-3}$$

$$D^3 = 2.5747133 \times 10^{-3}$$

$$D = \sqrt[3]{2.5747133 \times 10^{-3}}$$

$$= 0.15222 \approx 0.15 \text{ m}$$

$$\therefore L = 0.785 \times 0.15$$

$$= 0.1194$$

$$\approx 0.12 \text{ m}$$

Net iron length

$$= 0.9 \times 0.12 = 0.1075 \text{ m}$$

check for peripheral velocity

$$V = \pi D n$$

$$= 3.14 \times 0.15 \times 25 = 11.775$$

$$P = W.T$$

(21)

Example 2:

Prove that in a d-c m/c, the volume of active parts is proportional to torque of the m/c.

Soln.

$$\text{Torque, } T = \frac{\text{Power developed by arm}}{\text{Angular velocity}} = \frac{EI_a}{2\pi n} \quad \left\{ \begin{array}{l} P = W.T \\ \omega = 2\pi n \end{array} \right.$$

$$= \frac{\eta P \phi Z}{2\pi f} \cdot I_a = \frac{1}{2\pi} \phi \frac{P}{\alpha} I_a Z$$

$$B_{av} = \frac{P \phi}{\pi D L} \Rightarrow \phi = \frac{B_{av} \pi D L}{P} \text{ and } \alpha_c = \frac{I_z Z}{\pi D} \Rightarrow$$

$$\Rightarrow I_z Z = \pi D \alpha_c$$

$$I_z = \left(\frac{I_a}{\alpha} \right) \Rightarrow \frac{I_a}{\alpha} Z = \pi D \alpha_c$$

$$I_a Z = \alpha \pi D \alpha_c$$

$$T = \frac{1}{2\pi} \left(\frac{B_{av} \pi D L}{P} \right) \left(\frac{P}{\alpha} \right) [\alpha \pi D \alpha_c]$$

$$= \frac{1}{2\pi} \left[\frac{B_{av} \pi D L}{P} \right] [P] [\pi D \alpha_c]$$

$$= \frac{1}{2\pi} = \frac{\pi}{2} B_{av} \alpha_c D^2 L$$

$$D^2 L = \frac{2T}{\pi B_{av} \alpha_c}$$

Volume of active part of m/c

$$\frac{D^2 L}{2} = \frac{T}{\pi B_{av} \alpha_c}$$

$$\frac{\pi}{4} D^2 L = \frac{T}{\alpha B_{av} \alpha_c} \quad \checkmark$$

$$kW = h \cdot p \times 0.746$$

$$kVA = \frac{h \cdot p \times 0.746}{n \times \cos \phi}$$

B_{av} and α_c are const, the volume of active part is proportional to ~~the~~ torque.

8(b)

General Concepts & Constraints in Design of rotating

SECTION A OR B part. Electrical MIC Chapter No. 6th of A K Sawhney

* Relation b/w Rating & Dimensions of Rotating MIC:

→ How we have to relate the rating of rotating mic to their main dimensions. A few general equations are developed which are applicable to all type of rotating mic - dc mic, induction, synch/mic. But design is a complex process and many factors which affects design of different type of mic can't be incorporated into a set of few general equations. [There are some difference in each set of equations for different-different mic]. → but the general manner is almost same i.e., how the size and shape of mic are related to its rating.

* Symbols: →

D = Armature Diam, or Stator bore, m

L = Stator core length, m n = speed r.p.s. ; n_s = Synch-speed r.p.

p = no. of poles, a = No of parallel paths, \underline{z} = pole pitch, m

$Z = \frac{\underline{z} \cdot p}{2}$ Total no. of armature or stator conductors

T_{ph} = turns per phase, I_2 = Current in each conductor, A

K_W = winding factor, I_a = Armature current, A; I_{ph} = current per ph

E = back emf, V; E_{ph} = induced e.m.f per phase, V;

P = Rating of mic, KW; P_a = power developed by arm, KW

$\checkmark D = kVA$ rating of mic

* Main Dimensions: →

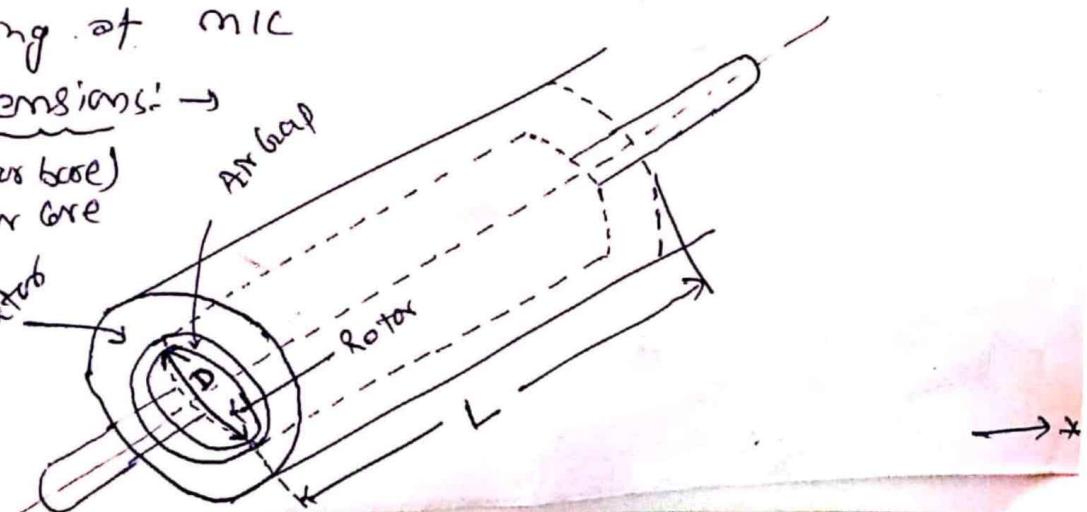
The arm Dia (stator bore)

D and armature stator core

length L are known

as Main dimensions of rotating

mic



~~3 PHASE INDUCTION MOTOR~~

Specifications: →

The main specifications for a three phase

induction motor are

1. Rated output in KW or H.P.
2. No. of phases (3phase, 1phase)
3. frequency in Hz = f
4. Voltage in volts (V)
5. Connections - star or Delta (Y or Δ)
6. Speed in r.p.m. = N
7. Type of Duty
8. Power factor
9. Efficiency
10. Class of insulation
11. Temperature rise.
12. full load current
13. pullout torque.

* →

→ Total Loading: → two types:-

1. Total Magnetic Loading: → The total flux around the armature (or stator) periphery at the air gap is called the total magnetic loading.

$$\text{Total magnetic loading} = \rho \phi$$

2. Total Electric Loading: → The total no. of ampere conductors around the armature (stator) periphery is called total electrical loading.

$$\text{Total electric loading} = I_2 Z.$$

Last Lect.
Design factors, Limt,
Reln b/w Dim & rating
Main Dimensions
Total Loadings

* Specific Loading: \rightarrow

There are two types of specific loading which are the starting point in design of rotating electric machines.

$$\phi = B \cdot A$$

$$B = \frac{\phi}{A}$$

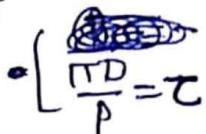
1. Specific magnetic loading: \rightarrow

The average flux density over the air-gap of a machine is known as specific magnetic loading.

Specific magnetic loading

$$B_{av} = \frac{\text{total flux around the airgap}}{\text{area of flux path at the airgap}} = \frac{\Phi}{\pi D L}$$

$$= \frac{\Phi}{\pi L}$$



$$\left[\frac{\pi D}{L} \right] = C$$

2. Specific electric loading: \rightarrow

The no. of armature (stator) ampere conductors per meter of armature (or stator) periphery at the air gap is known as specific electric loading.



Specific Electric

$$\text{loading}, a_c = \frac{\text{total armature ampere cond's}}{\text{armature periphery at air gap}} = \frac{I_z Z}{\pi D}$$

* OUTPUT EQUATION: \rightarrow have to relate the output of m/c with its main dimensions.

Consider an m phase machine having one circuit (parallel path) per phase. The KVA rating of machine

$$Q = \text{No. of phase} \times \text{o/p voltage per phase} \times \text{current per phase} \times 10^{-3}$$

$$= m \times E_{ph} I_{ph} \times 10^{-3}$$

where E_{ph} = induced e.m.f. per phase in volts.

(Ind. e.m.f per phase \approx Applied voltage per ph)

$$\Phi = m E_{ph} \times I_{ph} \times 10^{-3}$$

- ⑦

Induced e.m.f per phase, $E_{ph} = 4.44 f \phi T_{ph} k_w$

$$\therefore \Phi = m \times 4.44 f \phi T_{ph} k_w \times I_{ph} \times 10^{-3}$$

$$\text{Also } f = \frac{P n_s}{2}$$

$$N_S = \frac{120f}{P} \quad (1)$$

$$\Rightarrow 120f = N_S \cdot P \cdot \frac{\text{opm}}{60}$$

$$f = \frac{N_S \cdot P}{120} \Rightarrow f = \frac{N_S \cdot P}{120} / \frac{60}{60}$$

$$\therefore \Phi = m \times 4.44 \cancel{f} \left(\frac{P n_s}{2} \right) \phi T_{ph} k_w \times I_{ph} \times 10^{-3} \Rightarrow f = \frac{n_s \cdot P \times 60}{120} / \frac{60}{60}$$

$$= 2.22 m P n_s \phi T_{ph} k_w \times I_{ph} \times 10^{-3}$$

Since $I_{ph} = I_2$ (As there is only one coil per phase)
one phase/coil

Total no. of
Armature conductors

$$Z = \text{no. of phases} \times (2 \times \text{turn per phase})$$

$$= m \times (2 \times T_{ph}) = 2mT_{ph}$$

: Total Electrical
loading

$$I_2 Z = I_{ph} \times 2mT_{ph} \quad [I_2 \approx I_{ph}]$$

$$I_{ph} = \frac{I_2 Z}{2mT_{ph}} \quad - ④ \quad - ⑤$$

Put in Equation (x) (4)

$$\therefore Q = 2.22 m P n_s \phi T_{ph} k_w \times \left(\frac{I_2 Z}{2mT_{ph}} \right) \times 10^{-3}$$

$$= 1.11 (P\phi) (I_2 Z) n_s \times k_w \times 10^{-3}$$

$$= 1.11 k_w (P\phi) (I_2 Z) n_s \times 10^{-3}$$

$$= 1.11 k_w (\pi D L B_{av}) (\pi D ac) n_s \times 10^{-3}$$

$$= (1.11 \pi^2 B_{av} ac k_w \times 10^{-3}) D^2 L n_s$$

$$= [11 B_{av} ac k_w \times 10^{-3}] \times D^2 L n_s$$

$$= C_o D^2 L n_s$$

Where $C_o = 11 B_{av} ac k_w \times 10^{-3}$

$$f = \frac{N_S \cdot P}{120} \times 60 = \frac{N_S \cdot P}{2} \rightarrow \text{opm}$$

$$f = \frac{P n_s}{2}$$

is output equation of a.c.
mic it is known as α/p
coefficient.

$$B_{av} = 0.30 - 0.65$$

$$q_L = 5000 - 2300$$

Effect of Size & Ventilation / Factors Affecting Size of rotating Machines:-

$$Q = C_0 D^2 L n_s$$

Examining output equation of (d.c. & a.c) m/c we observe that product $D^2 L$ will decrease with increase of speed and/or increase of output coefficient. Hence the volume or cost of m/c will decrease with increase in speed / output coefficient.

① SPEED:-

$$Q = C_0 D^2 L n_s \rightarrow D^2 L = \frac{Q}{C_0 n_s}$$

As it is clear that the volume of active part varies inversely as the speed. Thus for the same output a m/c designed with greater speed will have smaller size and hence lesser cost as compared to m/c designed with smaller speed.

- Ist one factor ~~is active part or main part~~ (is speed that affects size) → for speed is size (volume of active part) → 2nd one - whenever choice has to be made - when speed is not specified and is left for the designer to decide - then the highest practical speed rating should be selected - but the ~~maximum~~/max speed may be limited by mechanical stress in the armature materials.

- ### ② Output Coefficient:-
- It is clear from output equation that volume of active part is inversely proportional to value of output coefficient C_0 . Thus an increase in value of C_0 results in reduction in size and cost of m/c and so looking from the economics pt-of view the value of output coeff C_0 should be as high as possible.

$$\text{As } C_0 = 11 \text{ Bar ac kw} \times 10^{-3} \text{ (for a.c. m/c)}$$

$$C_0 = \pi^2 \text{ Bar ac} \times 10^{-3} \text{ (for d.c. m/c)}$$

The specific magnetic & electric loading is directly proportional to output coeff. and it is also cleared that the output coeff. should be high as much high therefore the specific elec & mag loading should also be as much high as possible to reduce dimension of

of m/c but how much high it should be pushed is decided by the designer by analysing the effect of increased loading on performance characteristics of m/c as the cost of m/c is not the only important aspect of m/c design.

If high value of loading are used, some performance characteristics like temperature rise, efficiency, power factor (in case of I.M) and commutation condition (in d.c.) are adversely affected and this pt. cannot be lost sight of. In fact such value of specific loading should be selected which give a design that complies with specifications relating to performance required and at the same time gives a m/c having maximum reliability and efficiency together with minimum cost.

* choice/ Select of specific magnetic Loading : $\rightarrow (B_{av})$

Basically the specific magnetic loading (B_{av}) is determined by :

- (1) Maximum flux density in iron part of m/c
 - (2) Power Factor
 - (3) Magnetising current and Core loss. (③)
- The choice of B_{av} directly influences the core losses and magn. current and has an important effect on p.f. and also the efficiency.
- (5) Over load capacity:-

X X X X 18/02/2020
 $\Phi = BA$

① Maximum flux density in iron part of m/c: \rightarrow

mag. ckt of the max flux density in iron part of m/c must be definitely below a certain limiting value depending on material used. The flux density in iron part ~~max~~ is directly proportional to average flux density in air gap. In a well designed m/c the "max" flux density occurs in teeth of a m/c and that's why we relate the flux density in teeth with flux density in air gap.

Relation b/w flux density in teeth and average flux density in air-gap:

Flux density in air-gap:

Consider a non-salient

pole m/c having 8 armature slots

$$\text{flux over one slot pitch} = \frac{P\phi}{S} \quad [\because B_{av} = \frac{P\phi}{\pi D L}]$$

$$= P \cdot \frac{B_{av} \pi D L}{P} \cdot \frac{1}{S} \phi$$

$$= B_{av} \frac{\pi D}{S} L = B_{av} y_s L$$

Where, y_s = slot pitch = $\pi D / S$ $\left[\tau = \frac{\pi D}{P} = \text{pole pitch} \right]$

If we neglect saturation, the entire flux over a slot pitch is carried by the tooth.

Area of flux path in each tooth = Width of tooth \times length

$$= W_t L$$

$$\therefore \text{Flux density in each tooth } B_t = \frac{\text{flux in each tooth}}{\text{area of each tooth}}$$

$$= \frac{B_{av} y_s L}{W_t L} = \frac{B_{av} y_s}{W_t} \quad \dots \quad (20) \rightarrow \phi = B \cdot A$$

The same flux will cover over the complete pole arc/ therefore the teeth will occupied/covered by the same flux

$$(20) \Rightarrow \therefore B_t = \frac{B_{av}}{\phi} \cdot \frac{y_s}{W_t} \quad \dots \quad (21)$$

$$\text{Also } B_t = B_g \cdot \frac{y_s}{W_t} \quad \text{where } B_g \rightarrow \text{max. flux density in airgap}$$

\rightarrow It is clear from Eqn (21) that the flux density in teeth is directly proportional to specific magnetic loading.

* Let us consider the case of salient pole m/c

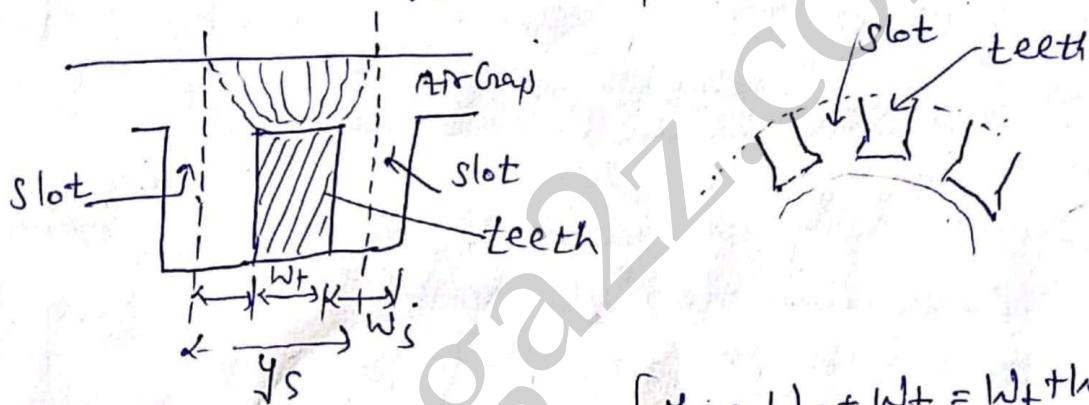
(15)

$$\therefore (21) \Rightarrow B_T = \frac{B_{av}}{\phi} \cdot \frac{y_s}{W_t}$$

$$\frac{B_T}{B_{av}} = \frac{y_s}{\phi W_t} \quad (22) \text{ the value of } B_T \text{ always lies b/w } 2.0 \text{ to } 2.2 \text{ Wb/m}^2 \text{ (for D.C. M/C)}$$

Let us take the core of D.C. M/C with tooth width equal to slot width and $\phi = 0.66$

$$W_t = W_s \Rightarrow y_s = \text{slot pitch} =$$



$$(22) \Rightarrow B_T = \left(\frac{y_s}{\phi W_t} \right) B_{av} \Rightarrow \left[\frac{y_s}{\phi y_s} \right] B_{av} \quad \begin{cases} y_s = W_s + W_t = W_t + K \\ y_s = 2 W_t \Rightarrow W_t = \frac{y_s}{2} \end{cases} \quad (\phi = 0.66 \text{ Wb})$$

$$= \left(\frac{2}{0.66} \right) B_{av} \Rightarrow B_T = \left[\frac{2}{0.66} \right] B_{av} \Rightarrow B_T = 3 B_{av}$$

As $B_T \rightarrow 2.0 - 2.2 \text{ Wb/m}^2$

$$\therefore I_1 = 3 B_{av} \Rightarrow [B_{av} = 0.7 \text{ Wb/m}^2]$$

(2) POWER FACTOR: → for selecting the choice of specific magnetic heading, we have to consider the power factor p.t. of view also. Higher value of B_{av} means higher value of flux → and large magnetising current. Since magnetising current is in quadrature with applied voltage → The resulting p.f. become very poor. Therefore for a good p.f. lower value of B_{av} should be selected.

[Therefore by taking p.f. p.t. of view into consideration → B_{av} should be such that, there is no sat' in any part of mag. ckt. Sat' demands large mag. current and consept. poor p.f.]

③ The Magnetising Current: →

The magnetising current of M.I.C. is directly proportional to mmf required to produce the flux in the air-gap and iron part. The mmf required to pass flux in the ~~core~~ iron section of M.I.C. is negligible compared with that of air-gap. (provided that ~~iron~~ is not saturated) The air gap mmf is directly proportional to specific magnetic loading. Therefore the magnetising current is proportional to specific magnetic loading.

- The value of magnetising current is not usually a serious design consideration in a d.c. M.I.C. and synch. M.I.C. This is bcz, these M.I.C. generally have two electrical inputs; one for the field and other for the armature [this enables independent control of field windings design parameter and current]
- The consideration of magnetising current is very important in case of I.M. motor. Large or Increased value of magnetising current resulting in low operating p.f. therefore value of specific magnetic loading for I.M.L. is lower than that in D.C. M.I.C.
- In case of Synchronous M.I.C., the magnetising current is not so critical and the value of specific magnetic loading intermediate b/w d.c. and induction M.I.C. may be used.

④ CORE LOSSES: → for selecting the choice of specific magnetic loading → the core losses are also taken into account.

→ The core (iron) losses may be considered to consist of two components eddy current and hysteresis losses. The eddy current is proportional to flux density and square of freq. The hysteresis losses varies directly with freq and square of flux density (B^2)

$$P_e = k_e f^2 B_m^2 \eta_{\%}$$

- The flux density in iron part of M.I.C. is directly proportional to specific magnetic loading. Therefore a high value of B_{av} means increased amount of core loss affecting the efficiency. [Therefore a reasonable or small value of B_{av} should be chosen for best/high/optimum economy & efficiency.]
- (5) Overload capacity:-

From the above pts / discussion \rightarrow high value of B_{av} means large value of flux per pole \rightarrow means Large magnetising current \downarrow red amnt. of core loss \rightarrow reduced I_2 reduced p.f. [but good overload capacity] Similarly the I_2 is reduced by high value of $B_{av} \rightarrow$ increased amount of core loss, but is this case good overload capacity].

Taking into considerations all above factors:-

- * Small $B_{av} \rightarrow$ gives good p.f. and reduced core loss but a small overload capacity.
- * On the other hand high $B_{av} \rightarrow$ gives poor p.f. and Large amount of core losses \Rightarrow but a good overload capacity. \Rightarrow Therefore a moderate value of B_{av} is to be selected. The limit under which B_{av} is to be selected as below:-

General purpose 0.3 to 0.55 ~~Wb/m²~~ Wb/m²

or Large overload capacity 0.6 to 0.65 ~~Wb/m²~~ [M.I.C used in oreney rolling mills etc]

Large capacity high speed 0.45 to 0.55 ~~Wb/m²~~ Wb/m²

[The material used for stator and rotor core lam's is Lohys or special Lohys 0.5 mm thick.