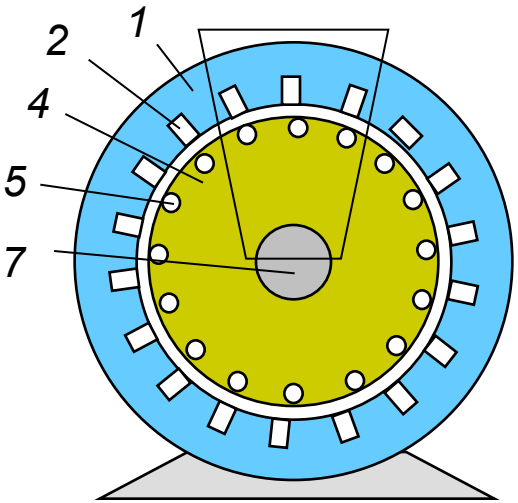
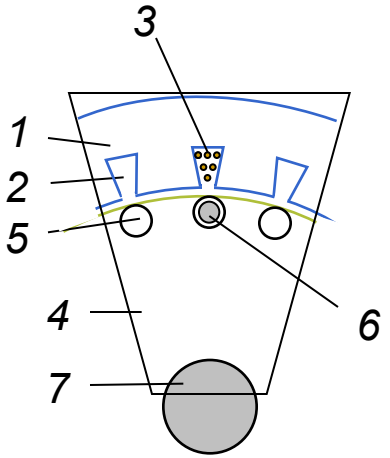
ÀÜ¸Ð²Üàôð ¾È°Îîð²î°ÊÜÆÎ²

²êÆÜøðàÜ Ø°ø°Ü²Ü°ð

ºé³ý³½ ³ëÇÝùñáÝ Ù»ù»Ý³ÛÇ Ï³éáõóí³ÍùÁ 1



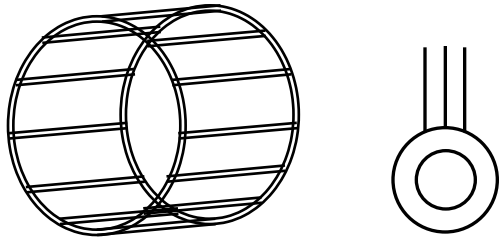
1 - ëï³ïáñÇ ÙÇçáõÏ
2 - ëï³ïáñÇ ÷áñ³ÏÝ»ñ
4 - éáïáñÇ ÙÇçáõÏ
5 - éáïáñÇ ÷áñ³ÏÝ»ñ
7 - ÉÇë»é:



3 -ëï³ïáñÇ ÷áÃáõÛÃ

6 - éáïáñÇ Ï³ñ× ÙÇ³óí³Í ÷³ÃáõÛÃÇ (§ëÏÛáõéÇ ³ÝÇíÇ¦) ÓáÕ»ñ

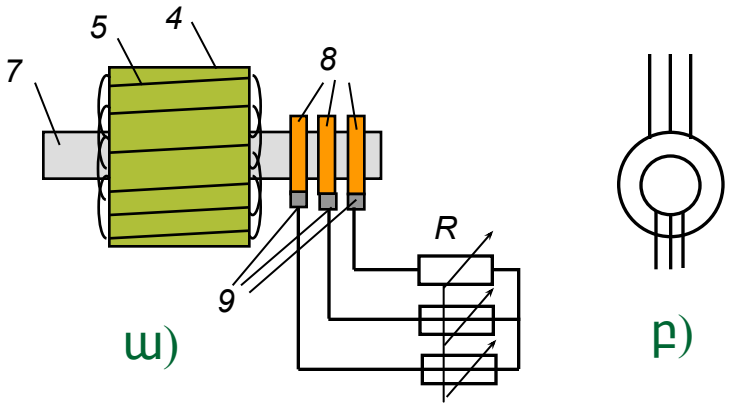
º é³ý³½ ³ëÇÝùñáÝ Ù»ù»Ý³ÛÇ Ï³éáõóí³ÍùÁ 2



ա) բ)

Î³ñ× ÙÇ³óí³Í éáïáñáí ³ëÇÝùñáÝ ß³ñÅÇãÇ éáïáñÇ ÃÙµáõÏ³Ó¨ ÷³ÃáõÛÃÁ (§uÏÛáõéÇ ³ÝÇíÁ¦) (ա) ¨ å³ÛÙ³Ý³Ï³Ý Ýß³ÝÁ (բ)

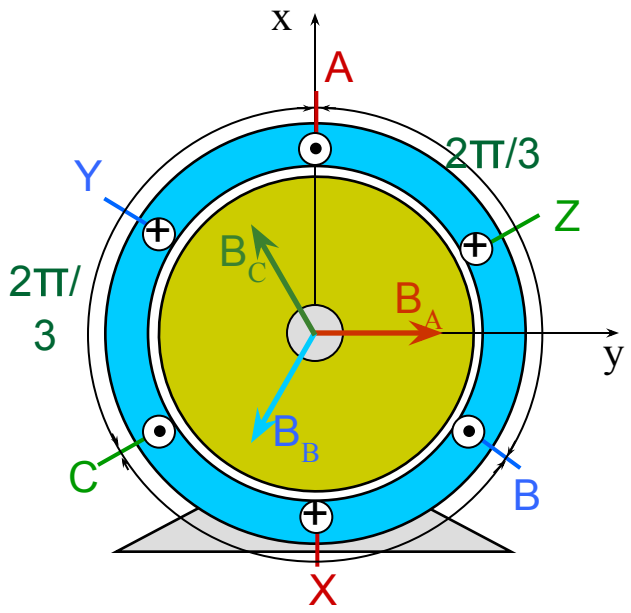
ü³½³ÛÇÝ éáïáñáí ³ëÇÝùñáÝ ß³ñÅÇãÇ éáïáñÇ Ï³éáõóí³ÍùÁ (ա) ¨ å³ÛÙ³Ý³Ï³Ý Ýß³ÝÁ (բ)



ա) բ)

4 - éáïáñÇ ÙÇçáõÏ
5 - éáïáñÇ ÷áñ³ÏÝ»ñ
7 - ÉÇë»é
8 – åÕÝÓ» ûÕ³ÏÝ»ñ
9 - ·ñ³ýÇï» (³ÍË» ûÕ³ÏÝ»ñ)

äïïíáÕ Ù³·ÝÇë³Ï³Ý ¹³ßïÇ ëï³óáõÙÁ 1



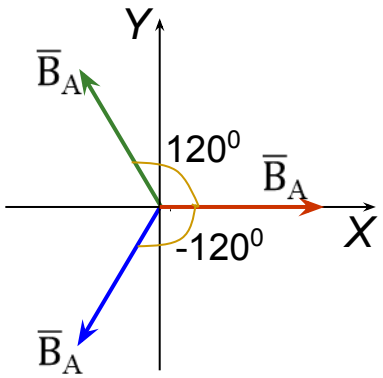
$B_A = B_m \sin\omega t \quad (\psi_A = 0)$

$B_B = B_m \sin(\omega t - 2\pi/3)$

$B_C = B_m \sin(\omega t - 4\pi/3)$

$$\vec{B} = \vec{B}_A + \vec{B}_B + \vec{B}_C$$

äïïíáÕ Ù³·ÝÇë³Ï³Ý ¹³ßïÇ ëï³óáõÙÁ 2



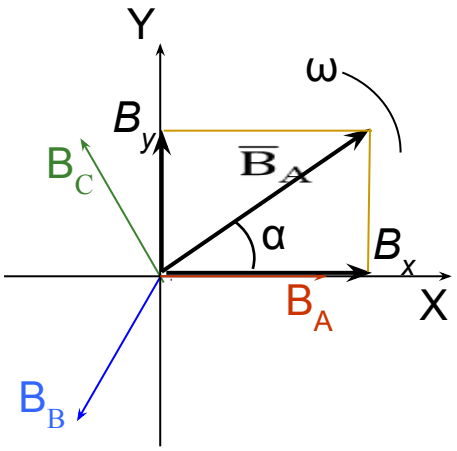
$$B_x = B_A + B_B\cos(-120^0) + B_C\cos 120^0 = B_A + B_B(-\frac{1}{2}) + B_C(-\frac{1}{2})$$

$$B_x = B_m\left[\sin\omega t - \frac{1}{2}\sin(\omega t - \frac{2\pi}{3}) - \frac{1}{2}\sin(\omega t - \frac{4\pi}{3})\right] = 1.5B_m\cos\omega t$$

$$B_y = B_A\sin 0^0 + B_B\sin(-120^0) + B_C\sin 120^0 = B_B(-\frac{\sqrt{3}}{2}) + B_C\frac{\sqrt{3}}{2}$$

$$B_y = B_m\left[-\frac{\sqrt{3}}{2}\sin(\omega t - \frac{2\pi}{3}) + \frac{\sqrt{3}}{2}\sin(\omega t - \frac{4\pi}{3})\right] = 1.5B_m\sin\omega t$$

äïïíáÕ Ù³·ÝÇë³Ï³Ý ¹³ßïÇ ëï³óáõÙÁ 3



$$B = \sqrt{B_x^2 + B_y^2} = 1.5B_m \qquad \mathrm{tg}\alpha = \frac{B_x}{B_y} = \frac{\sin \omega t}{\cos \omega t} = \mathrm{tg}\omega t$$

$$\alpha = \omega t$$

$$n_1 = \frac{60 f_1}{p} \text{ (åï/ñ)}$$

P – ½áõÛ· µ¨»éÝ»ñÇ ÃÇí

êÇÝËñáÝ ³ñ³·áõÃÛáõÝÝ»ñÇ ë³Ý¹Õ³ÏÁ

$P = 1; 2; 3; 4$

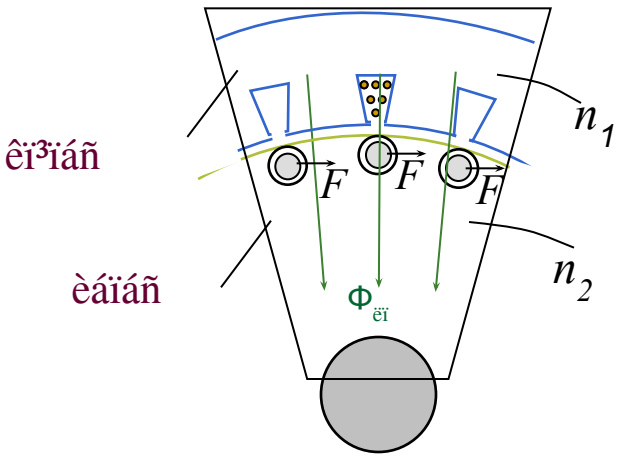
$P = 1,\ \mathrm{n}_1 = 3000$ (åï/ñ),

$P = 2,\ \mathrm{n}_1 = 1500$ (åï/ñ),

$P = 3,\ \mathrm{n}_1 = 1000$ (åï/ñ),

$P = 4,\ \mathrm{n}_1 = 7500$ (åï/ñ):

²ëÇÝùñáÝ ß³ñÅÇãÇ ³ßË³ï³ÝùÇ ëÏ½µáõÝùÁ



$$\Delta\Phi_{ëï} \rightarrow e_2 \rightarrow i_2 \rightarrow F \rightarrow M$$

$$n_2 = \text{const} < n_1$$

$$s = \frac{n_1 - n_2}{n_1}$$ - ë³ÑùÇ ·áñÍ³ÏÇó

$$n_2 = n_1(1-s) = \frac{60f}{p}(1-s)$$

²Ýí³Ý³Ï³Ý µ»éÝí³ÍùÝ»ñÇ ¹»åùáõÙ` $s_э$ = 0,02…0,06 .

»Ã» n_1 = 3000 åï/ñ, $n_{2э}$ = (2820 … 2940) åï/ñ

n_1 = 1500 åï/ñ, $n_{2э}$ = (1410 … 1470) åï/ñ

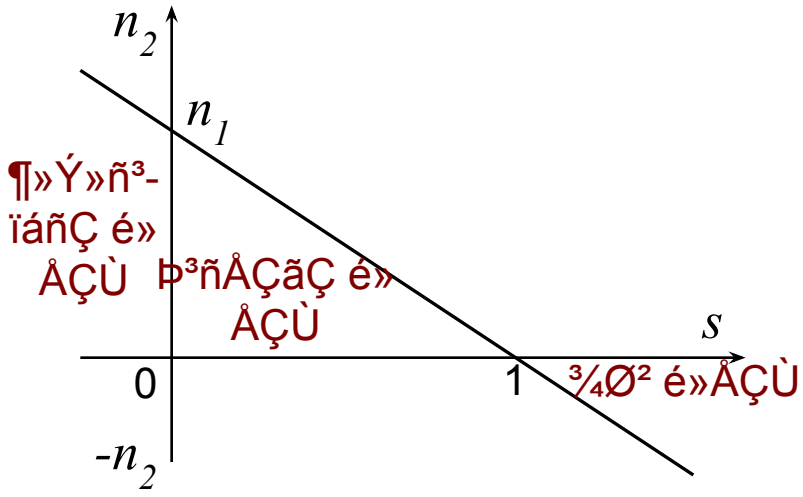
n_1 = 1000 åï/ñ, $n_{2э}$ = (940 … 980) åï/ñ

n_1 = 750 åï/ñ, $n_{2э}$ = (705 … 735) åï/ñ

ä³ñ³å ÁÝÃ³óùÇ ¹»åùáõÙ` s_0 = 0,005…0,01:

²ëÇÝùñáÝ Ù»ù»Ý³ÛÇ ³ßË³ï³Ýù³ÛÇÝ é» ÅÇÙÝ»ñÁ

- ºñµ 0 < *s* < 1, *ß³ñÅÇãÇ é»ÅÇÙª* ó³ÝóÇó í» ñóñ³Í ¿É»Ïïñ³Ï³Ý ¿Ý»ñ·Ç³Ý ÉÇë»éÇ íñ³ ÷áË³ñÏíáõÙ ¿ Ù»Ë³ÝÇÏ³Ï³Ý ¿Ý»ñ·Ç³ÛÇ: Þ³ñÅÇãÇ éáïáñÁ åïïíáõÙ ¿ ëï³ïáñÇ ¹³ßïÇ åïïÙ³Ý áõÕÕáõÃÛ³Ùµ, $n_2 < n_1$ ³ñ³·áõÃÛ³Ùµ:
- ºñµ *s* < 0, *·»Ý»ñ³ïáñÇ é»ÅÇÙª`* ÉÇë»éÇÝ Ñ³Õáñ¹í³Í Ù»Ë³ÝÇÏ³Ï³Ý ¿Ý»ñ·Ç³Ý ÷áË³ñÏíáõÙ ¿ ¿É»Ïïñ³Ï³Ý ¿Ý»ñ·Ç³ÛÇ: Ù»ù»Ý³ÛÇ éáïáñÁ åïïÙ³Ý Ù»ç ¿ ¹ñíáõÙ ëï³ïáñÇ ¹³ßïÇ åïïÙ³Ý áõÕÕáõÃÛ³Ùµ $n_2 > n_1$ ³ñ³·áõÃÛ³Ùµ:



- ºñµ *s* > 1, *¿É»Ïïñ³Ù³·ÝÇë³Ï³Ý ³ñ·»É³ÏÇ é»ÅÇÙ`* éáïáñÁ åïïíáõÙ ¿ ëï³ïáñÇ Ù³·ÝÇë³Ï³Ý ¹³ßïÇÝ åïïÙ³ÝÁ Ñ³Ï³é³Ï:

²ëÇÝùñáÝ ß³ñÅÇãÇ ³ßË³ï³ÝùÁ µÝáõÃ³·ñáÕ ³Ýí³Ý³Ï³Ý å³ñ³Ù»ïñ»ñÁ 1

$P_з$ - ²ëÇÝùñáÝ ß³ñÅÇãÇ ³Ýí³Ý³Ï³Ý Ñ½áñáõÃÛáõÝÁ ÉÇë»éÇ íñ³ ½³ñ·³óñ³Í Ù»Ë³ÝÇÏ³Ï³Ý Ñ½áñáõÃÛáõÝÝ ¿ ³Ýí³Ý³Ï³Ý µ»éÝí³ÍùÇ ¹»åùáõÙ: $P_з$ ³Ýí³Ý³Ï³Ý Ñ½áñáõÃÛ³Ùµ »ñÏ³ñ³ï¨ ³ßË³ï»ÉÇë ß³ñÅÇãÇ ç»ñÙ³ëïÇ×³ÝÁ ãÇ ·»ñ³½³ÝóáõÙ ÃáõÛÉ³ïñ»ÉÇ ë³ÑÙ³Ý³ÛÇÝ ³ñÅ»ùÁ:

$P_{¿..з} = \sqrt{3}U_з\ I_з\ \cos\varphi_з$ - ²ëÇÝùñáÝ ß³ñÅÇãÇ ëå³éÙ³Ý Ñ½áñáõÃÛáõÝÁ` ß³ñÅÇãÇ í»ñóñ³Í ¿É»Ïïñ³Ï³Ý Ñ½áñáõÃÛáõÝÁ ³Ýí³Ý³Ï³Ý µ»éÝí³ÍùÇ ¹»åùáõÙ;

$\eta_з = \dfrac{P_з}{P_{¿.з}} = 0{,}8 - 0{,}95$ -²ëÇÝùñáÝ ß³ñÅÇãÇ û·ï³Ï³ñ ·áñÍáÕáõÃÛ³Ý ·áñÍ³ÏÇóÁ ³Ýí³Ý³Ï³Ý µ»éÝí³ÍùÇ ¹»åùáõÙ;

$\Delta P_з = P_{¿.з} - P_з$ - ²ëÇÝùñáÝ ß³ñÅÇãÇ Ñ½áñáõÃÛ³Ý ÏáñáõëïÝ»ñÁ ³Ýí³Ý³Ï³Ý µ»éÝí³ÍùÇ ¹»åùáõÙ:

²ëÇÝùñáÝ ß³ñÅÇãÇ ³ßË³ï³ÝùÁ µÝáõÃ³·ñáÕ ³Ýí³Ý³Ï³Ý å³ñ³Ù»ïñ»ñÁ 2

ºé³ý³½ ß³ñÅÇãÁ Ï³ñáÕ ¿ ³ßË³ï»É »ñÏáõ ï³ñµ»ñ ·Í³ÛÇÝ ³Ýí³Ý³Ï³Ý É³ñáõÙÝ»ñáí.

- $U_з$ ·Í³ÛÇÝ É³ñáõÙáí` »Ã» ß³ñÅÇãÇ ëï³ïáñÇ ÷³ÃáõÛÃÁ ÙÇ³óí³Í ¿ ³ëïÕ³Ó,
- ·Í³ÛÇÝ É³ñáõÙáí` »Ã» ß³ñÅÇãÇ ëï³ïáñÇ ÷³ÃáõÛÃÁ ÙÇ³óí³Í ¿ »é³ÝïÛáõÝ³Ó¨: $\frac{U_з}{\sqrt{3}}$

$\cos\varphi_з = 0{,}8 - 0{,}9$ - ß³ñÅÇãÇ Ñ½áñáõÃÛ³Ý ·áñÍ³ÏÇóÁ ³Ýí³Ý³Ï³Ý µ»éÝí³ÍùÇ ¹»åùáõÙ

$\cos\varphi_0 = 0{,}1 - 0{,}2$ - ß³ñÅÇãÇ Ñ½áñáõÃÛ³Ý ·áñÍ³ÏÇóÁ å³ñ³å ÁÝÃ³óùÇ é»ÅÇÙáõÙ

²ëÇÝùñáÝ ß³ñÅÇãÇ ³ßË³ï³ÝùÁ µÝáõÃ³·ñáÕ ³Ýí³Ý³Ï³Ý å³ñ³Ù»ïñ»ñÁ 3

ºé³ý³½ ³ëÇÝùñáÝ ß³ñÅÇãÇ ³Ýí³Ý³Ï³Ý Ñáë³ÝùÁ

$$I_з = \frac{P_{¿.³}}{\sqrt{3}U_з \cos\varphi_з} = \frac{P_з}{\sqrt{3}\cdot U_з \ \eta_з \ \cos\varphi_з}$$

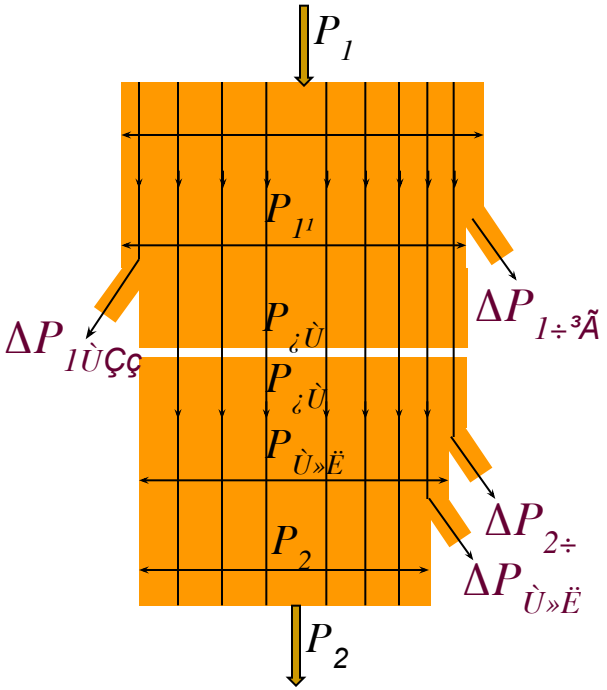
²ëÇÝùñáÝ ß³ñÅÇãÇ éáïáñÇ ³Ýí³Ý³Ï³Ý ³ñ³·áõÃÛáõÝÁ ¨ ë³ÑùÁ

$$n_{2³} = n_1(1 - s_з) \qquad s_з = \frac{n_1 - n_{2³}}{n_1}100\% = (2-6)\%$$

ÈÇë»éÇ íñ³ ³ëÇÝùñáÝ ß³ñÅÇãÇ ½³ñ·³óñ³Í ³Ýí³Ý³Ï³Ý ÙáÙ»ÝïÁ

$$M_з = \frac{P_з}{\omega_{2³}} = \frac{60P_з}{2\pi n_{2³}}$$

²ëÇÝËñáÝ ß³ñÅÇãÇ Ñ½áñáõÃÛáõÝÝ»ñÇ Ñ³Ûï»ÏßÇéÁ



$$P_1 = \sqrt{3}UI\cos\varphi$$

$$P_{¿Ù} = P_{1'} - \Delta P_{1ÙÇç}$$

$$P_{Ù} = P_{¿Ù} - \Delta P_{2÷} =$$

$$= P_1 - \Delta P_{1÷} - \Delta P_{1ÙÇç} - \Delta P_{2÷³Ã}$$

$$P_2 = P_{Ù»Ë} - P_{ß÷}$$

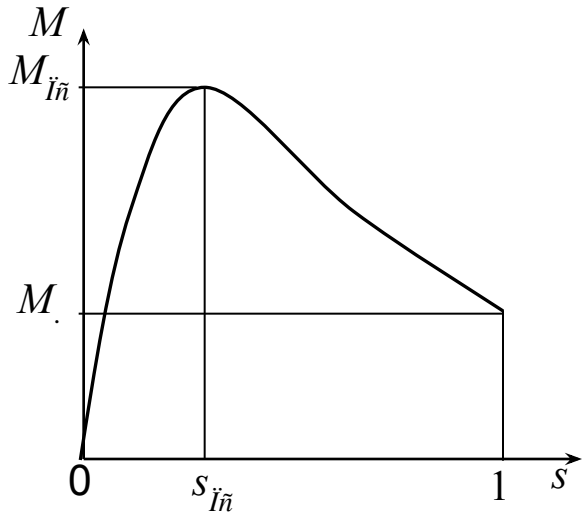
$$\eta = \frac{P_2}{P_1}$$

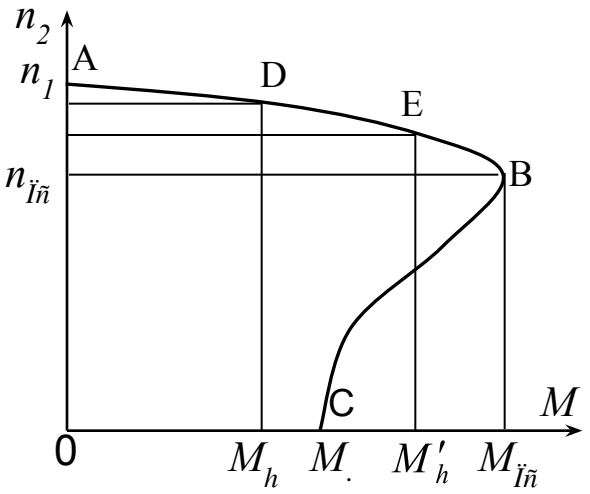
$$P_1 - P_2 = \Delta P_{ß} = \Delta P_{1÷³Ã} + \Delta P_{1ÙÇç} + \Delta P_{2÷³Ã} + \Delta P_{Ù»Ë}$$

²ëÇÝùñáÝ ß³ñÅÇãÇ Ù»Ë³ÝÇÏ³Ï³Ý µÝáõÃ³·ÇÍÁ

$$s_{ïñ} = \frac{n_1 - n_{2ïñ}}{n_1} \cdot 100\% = (10-15)\%$$

$$M = \frac{2M_з}{s / s_{ïñ} + s_{ïñ} / s}$$

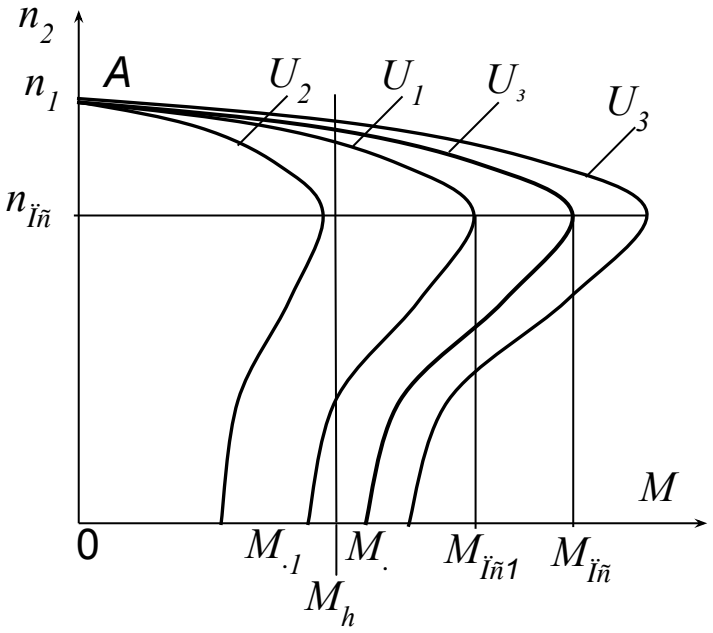




$$\lambda = \frac{M_{ïñ}}{M_з} = 2-3$$

$$k_{.} = \frac{M_{.}}{M_з} = 1{,}1-1{,}8$$

êÝáÕ ó³ÝóÇ É³ñÙ³Ý ³½¹»óáõÃÛáõÝÁ ³ëÇÝùáÝ ß³ñÅÇãÇ ³ßË³ï³ÝùÇ íñ³



$M = f(U)$, $n_{Ïñ} \neq f(U)$

$U_1 = (0{,}8 - 0{,}9)U_з$

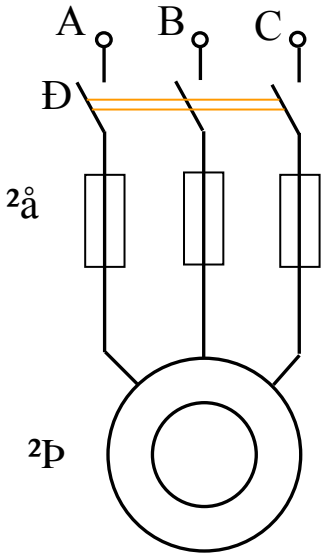
$U_2 = (0{,}6 - 0{,}7)U_з$

$U_3 = (1{,}1 - 1{,}2)U_з$

êÝáÕ ó³ÝóÇ É³ñÙ³Ý ß»ÕÙ³Ý ÃáõÛÉ³ïñ»ÉÇ ë³ÑÙ³ÝÝ»ñÁ ³ëÇÝùáÝ ß³ñÅÇãÇ ÝáñÙ³É ³ßË³ï³ÝùÇ Ñ³Ù³ñ

$-5\% < \delta U < +5\%\ (+10\%)$

Î³ñ× ÙÇ³óí³Í éáïáñáí ³ëÇÝùñáÝ ß³ñÅÇãÇ ·áñÍ³ñÏáõÙÁ

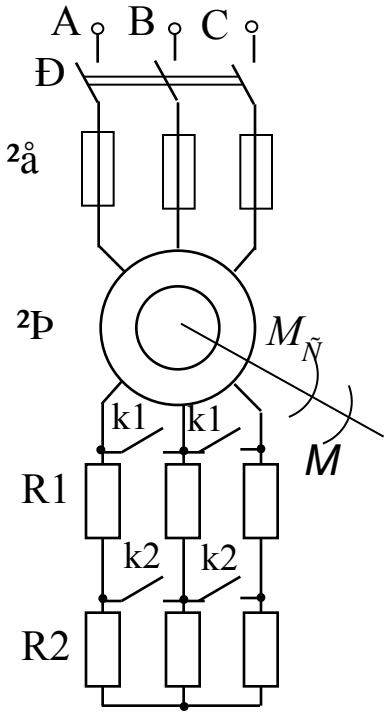


$P_з \le 100$ Ïìï

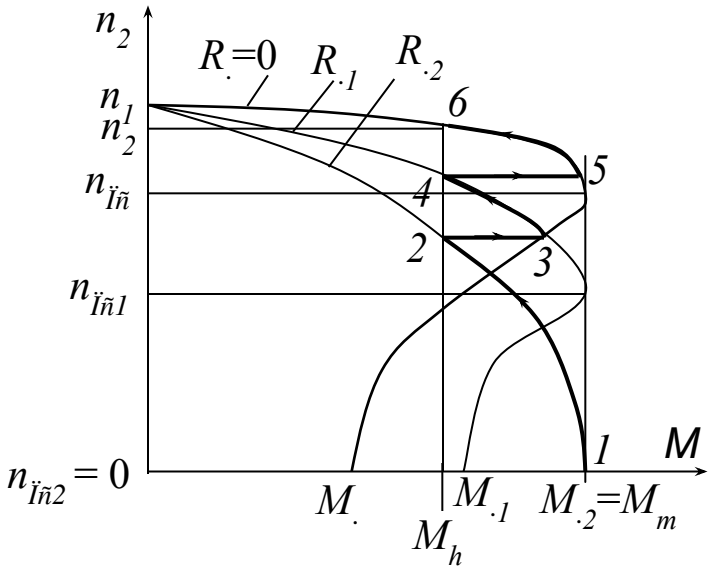
$I_{.} = (5\ldots7) \cdot I_з$

$$\begin{cases} I_{зå} \ge I_з \\ I_{зå} \ge \dfrac{I_g}{2{,}5} \end{cases}$$

ü³½³ÛÇÝ éáïáñáí ³ëÇÝËñáÝ ß³ñÅÇãÝ»ñÇ ·áñÍ³ñÏáõÙÁ



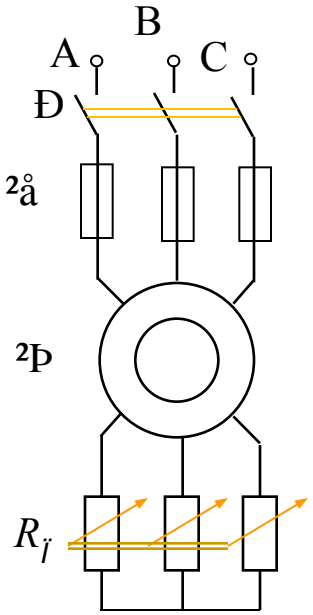
$M_m \neq f(R)$, $n_{ïñ} = f(R)$

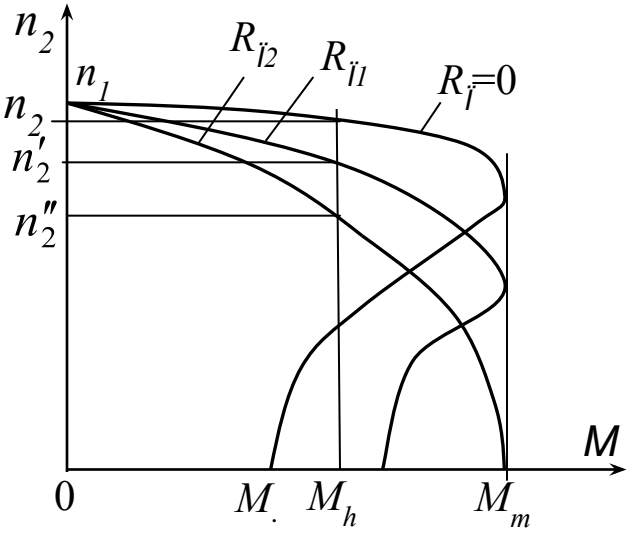


²ëÇÝùñáÝ ß³ñÅÇãÝ»ñÇ ³ñ³·áõÃÛ³Ý Ï³ñ·³íáñáõÙÁ

$$n_2 = n_1(1-s) = \frac{60 f_1}{p}(1-s)$$

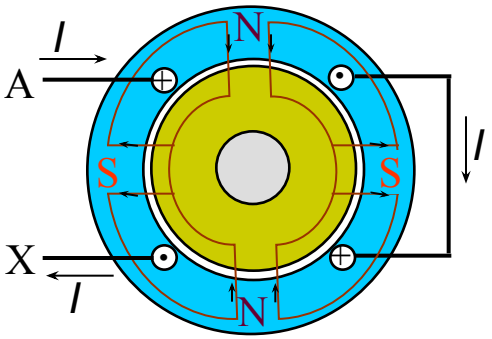
1. è»áëï³ï³ÛÇÝ Ï³ñ·³íáñáõÙ

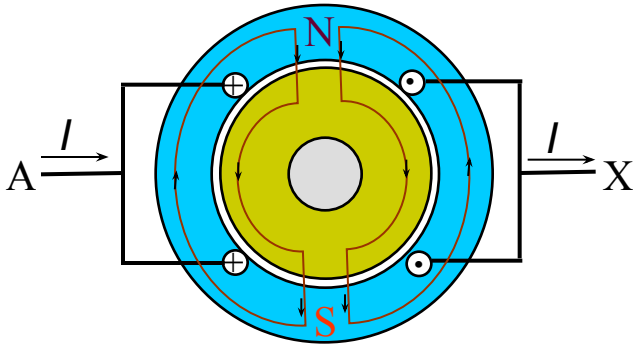




²ëÇÝùñáÝ ß³ñÅÇãÝ»ñÇ ³ñ³·áõÃÛ³Ý Ï³ñ·³íáñáõÙÁ

2. ´¨»é³ÛÇÝ Ï³ñ·³íáñáõÙ



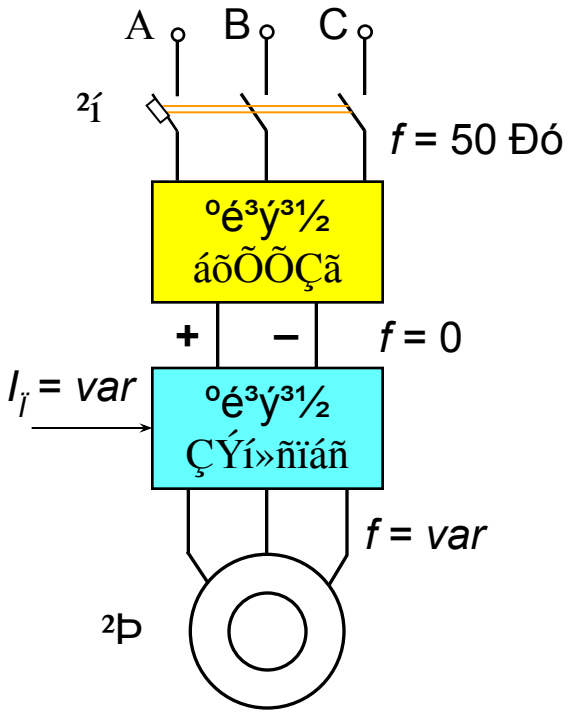


$P = 2,\ n_1 = 1500$ åï/ñ

$P = 1,\ n_1 = 3000$ åï/ñ

²ëÇÝùñáÝ ß³ñÅÇãÝ»ñÇ ³ñ³·áõÃÛ³Ý Ï³ñ·³íáñáõÙÁ

3. Ð³×³Ë³Ï³Ý³ÛÇÝ Ï³ñ·³íáñáõÙ



- °é³ý³½ áõÕÕÇãÁ »é³ý³½ Ñáë³ÝùÁ Ó¨³÷áËáõÙ ¿ Ñ³ëï³ïáõÝ Ñáë³ÝùÇ
- °é³ý³½ ÇÝí»ñïáñÁ Ñ³ëï³ïáõÝ Ñáë³ÝùÁ Ó¨³÷áËáõÙ ¿ »é³ý³½ Ñáë³ÝùÇ
- öá÷áË»ÉáíÁ $I_ï$ Ï³é³í³ñÙ³Ý Ñáë³ÝùÁ` ÷á÷áËíáõÙ ¿ »é³ý³½ Ñáë³ÝùÇ Ñ³×³ËáõÃÛáõÝÁ ¨, Ñ»ï¨³µ³ñ, ß³ñÅÇãÇ ³ñ³·áõÃÛáõÝÁ