**ALUMNO:.....STyME 25-06-2014**

2º.- Una máquina asíncrona de 380 V, 50 Hz, 1435 rpm, con el estator en estrella, se somete a ensayos en fábrica y se obtienen los siguientes resultados:

Ensayo de vacío: 380 V, 5 A, 900 W

Ensayo a rotor bloqueado 60 V, 16 A, 1000 W

Medida de la resistencia por fase del estator en caliente= 0,50 Ω. Pérdidas mecánicas consideradas constantes a las diferentes velocidades = 450 W.

Determinar:

a) Parámetros del circuito equivalente aproximado.

b) Corriente nominal, factor de potencia, par máximo, par de arranque, par nominal y par útil.

Si la máquina se acciona mediante una turbina hidráulica a la velocidad de 1540 rpm. Calcular:

c) Las potencias activa y reactiva enviadas a la red de 380 V y el par que suministra la turbina

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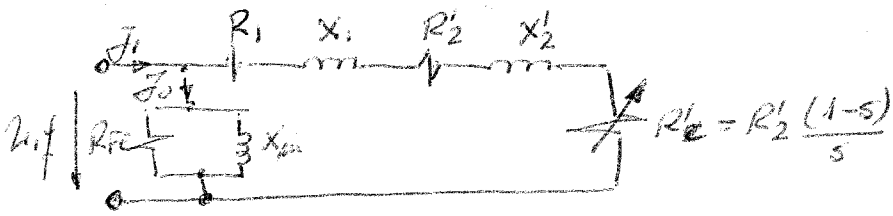
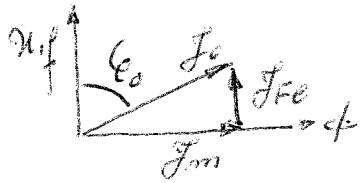



a) $P_{Fe} = P_0 - P_{mec} - 3R_1 I_0^2 = 900 - 450 - 3 \cdot 0{,}50 \cdot 5^2 = 412{,}50\ W$




$P_{Fe} = \sqrt{3} \cdot U_1 I_0 \cos\varphi_0$

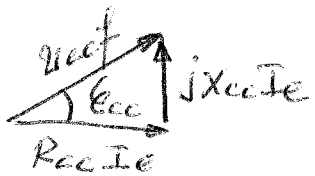
$\cos\varphi_0 = \dfrac{P_{Fe}}{\sqrt{3} \cdot U_1 I_0} = \dfrac{412{,}5}{\sqrt{3} \cdot 380 \cdot 5} = 0{,}1253 \Rightarrow \begin{cases} \varphi_0 = 82{,}80 \\ \operatorname{sen}\varphi_0 = 0{,}992 \end{cases}$

$I_m = I_0 \cdot \operatorname{sen}\varphi_0 = 5 \cdot 0{,}992 = 4{,}96\ A$

$I_{Fe} = I_0 \cdot \cos\varphi_0 = 5 \cdot 0{,}1253 = 0{,}6265\ A$

$\Rightarrow I_0 = 0{,}6265 + j4{,}96$

$R_{Fe} = \dfrac{U_1 f}{I_{Fe}} \overset{1-\lambda}{=} \dfrac{\frac{380}{\sqrt{3}}}{0{,}6265} = 351{,}16\ \Omega \qquad X_m = \dfrac{U_1 f}{I_m} = \dfrac{\frac{380}{\sqrt{3}}}{4{,}96} = 44{,}35\ \Omega$




$P_{cc} = \sqrt{3} \cdot U_{cc} I_e \cdot \cos\varphi_{cc}$

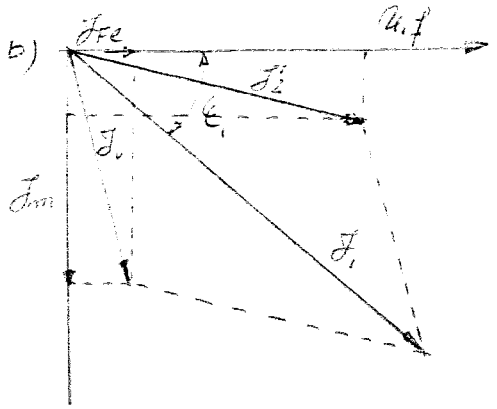
$\cos\varphi_{cc} = \dfrac{P_{cc}}{\sqrt{3}\, U_{cc} I_e} = \dfrac{1000}{\sqrt{3} \cdot 60 \cdot 16} = 0{,}6014 \Rightarrow \begin{cases} \varphi_{cc} = 53{,}03^\circ \\ \operatorname{sen}\varphi_{cc} = 0{,}7989 \end{cases}$

$U_{cf} \cdot \cos\varphi_{cc} = R_{cc} I_e \Rightarrow R_{cc} = \dfrac{U_{cf} \cdot \cos\varphi_{cc}}{I_e} \overset{1-\lambda}{=} \dfrac{\frac{60}{\sqrt{3}} \cdot 0{,}6014}{16} = 1{,}30\ \Omega$

$R_{cc} = R_1 + R'_2 \Rightarrow R'_2 = R_{cc} - R_1 = 1{,}30 - 0{,}50 = 0{,}80\ \Omega$

$U_{cf} \cdot \operatorname{sen}\varphi_{cc} = X_{cc} I_e \Rightarrow X_{cc} = \dfrac{U_{cf} \cdot \operatorname{sen}\varphi_{cc}}{I_e} = \dfrac{\frac{60}{\sqrt{3}} \cdot 0{,}7989}{16} = 1{,}73$

b)




$$s_n = \frac{1500 - 1435}{1500} = 0,043$$

$$R'_2 = R'_2 \frac{(1-s)}{s} = \frac{1-0,043}{0,043} \cdot 0,8 = 17,66\ \Omega$$

$$\dot{Z}_1 = (0,50 + 0,80 + 17,66) + j\,1,73 = 18,96 + j\,1,73$$

$$= 19,04\ \angle 5,21°$$

$$\dot{I}'_{2n} = \frac{\dot{U}_1}{\dot{Z}_1} = \frac{220\ \angle 0°}{19,04\ \angle 5,21} = 11,55\ \angle -5,21$$

$$= 11,50 - j\,1,05$$

$$\dot{I}_{1fn} = \dot{I}_0 + \dot{I}'_{2n} = (0,6265 + 11,50) - j\,(4,96 + 1,05) =$$

$$= 12,1265 - j\,6,01 = 13,53\ \angle -26,36$$

$1-1 \rightarrow \dot{I}_{1n} = \dot{I}_{1fn} = 13,53\ A \qquad \cos\varphi_1 = \cos(-26,36) = 0,896$

$$s_m = \frac{R'_2}{\sqrt{R_1^2 + X_{cc}^2}} = \frac{0,80}{\sqrt{0,5^2 + 1,73^2}} = 0,444$$

$$M_{max} = \frac{3\,\frac{R'_2}{s_m} \cdot U_{1f}^2}{\frac{2\pi n_s}{60}\left[\left(R_1 + \frac{R'_2}{s_m}\right)^2 + X_{cc}^2\right]} = \frac{3 \cdot \frac{0,80}{0,444} \cdot \left(\frac{380}{\sqrt{3}}\right)^2}{\frac{2\pi \cdot 1500}{60}\left[\left(0,50 + \frac{0,80}{0,444}\right)^2 + 1,73^2\right]} = 199,91\ Nm$$

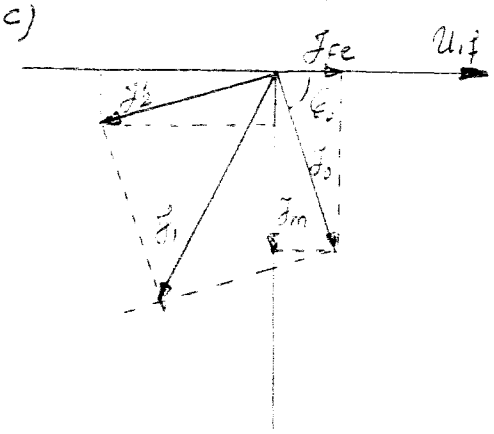
$$s=1 \Rightarrow M_a = \frac{3 \cdot \frac{0,80}{1} \cdot \left(\frac{380}{\sqrt{3}}\right)^2}{\frac{2\pi \cdot 1500}{60}\left[\left(0,50 + \frac{0,80}{1}\right)^2 + 1,73^2\right]} = 157,91\ Nm$$

$$M_{in} = \frac{3 \cdot \frac{R'_2}{s_n} \cdot I'^2_n}{\frac{2\pi n_s}{60}} = \frac{3 \cdot \frac{0,8}{0,043} \cdot 11,55^2}{\frac{2\pi \cdot 1500}{60}} = 49,17\ Nm$$

$$M_{perd} = \frac{\text{pierdere}}{\Omega_r} = \frac{450}{\frac{2\pi \cdot 1435}{60}} = 3\ Nm.$$

$$M_u = M_{in} - M_{perd} = 49,17 - 3 = 46,19\ Nm$$

c)




$$s_g = \frac{1500 - 1540}{1500} = 0,0267$$

$$R'_c = \frac{0,30\,[1-(-0,0267)]}{-0,0267} = -30,76\,\Omega$$

$$\underline{Z}_1 = (0,50 + 0,30 - 30,76) + j\,1,73 = -29,46 + j\,1,73 = 29,51\,\angle 176,64$$

$$\dot{I}'_{2f} = \frac{U_{1f}}{\underline{Z}_1} = \frac{220\,\angle 0}{29,51\,\angle 176,64} = 7,455\,\angle -176,64 = -7,44 - j\,0,437$$

$$\dot{I}_1 = \dot{I}_0 + \dot{I}'_2 = (-7,44 + 0,6265) - j\,(0,437 + 4,96) = -6,8135 - j\,5,394$$

$$\underline{S} = 3\,U_1 I_1^* = 3 \cdot 220\,(-6,8135 + j\,5,394) = -4.497 + j\,3562 = P + jQ$$

$$P_{mec} = 3\,R'_c \cdot I'^2_2 = 3 \cdot (-30,76) \cdot 7,455^2 = -5128,65\,W$$

$$P_{J1} = 3\,R_1 I'^2_2 = 3 \cdot 0,5 \cdot 7,455^2 = 83,36\,W$$

$$P_{J2} = 3\,R'_2 I'^2_2 = 3 \cdot 0,8 \cdot 7,455^2 = 133,8\,W$$

$$P_{Fe} = 3 \cdot 351,16 \cdot 0,6265^2 = 412,5\,W$$

$$P_u = 5.128,65 - 83,36 - 133,38 - 412,5 = 4.499,43\,W$$

$$\text{Diferencia} = 4.499,43 - 4.497 = 2,43\,W$$

$$M_T = \frac{-(5128,65 + 450)}{\frac{2\pi \cdot 1540}{60}} = -34,59\,Nm$$