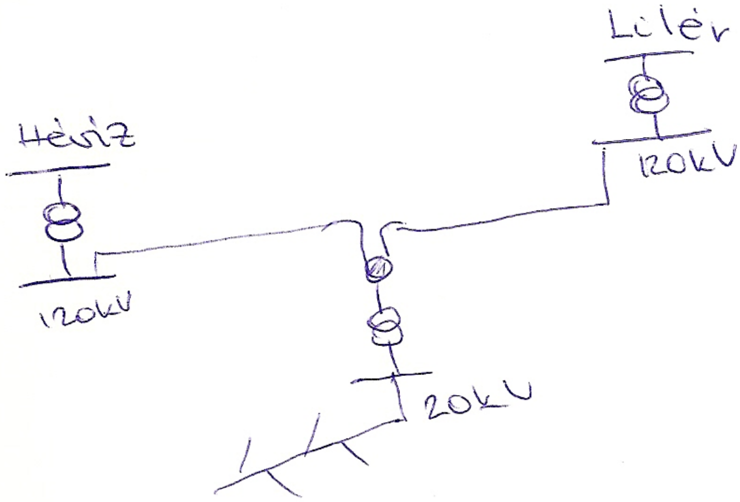
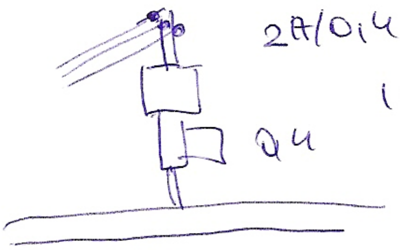
2009. 03. 03. Villamos[illegible] áll./gyak[illegible]

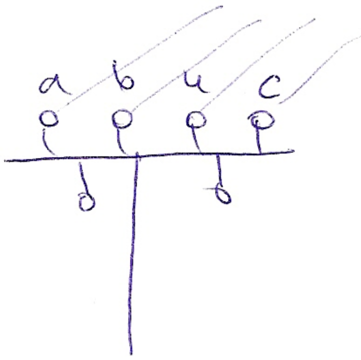


Kisdörgicse



2A/0,4 kV/kV

160kVA



(I)

P W kW pl ⊗ 40, 60, 100W
fűtőtest 2000W
ventillátor

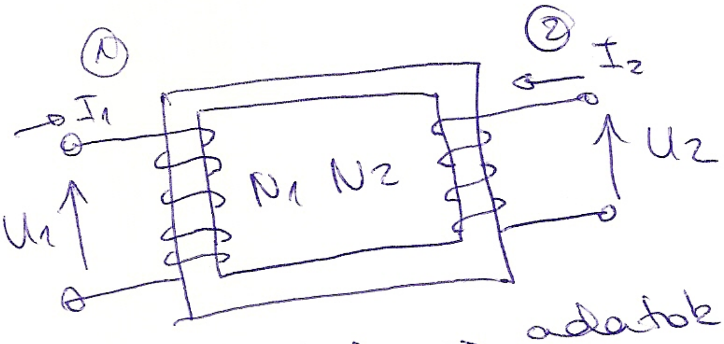
W Wh kWh
44Ft/kWh 1 óra fűtés 88 Ft
6 óra 100W 26,4 Ft

Fogyasztásmérő:
1f 231V 16 A max 3,7kW
25A 5,8kW

nap 417W → 10kWh → 30nap
13200Ft

év: 160.000Ft

Tr. elv



$e = \frac{N_1}{N_1} = \frac{U_2}{N_2}$

$a = \frac{U_1}{U_2} = \frac{N_1}{N_2}$

névleges adatok U_{1n}, U_{2n}

I_{1n}, I_{2n}

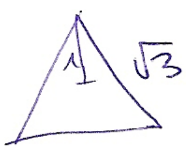
terhelés mérték

$$\frac{I_1}{I_{1n}} = \frac{I_2}{I_{2n}}$$

$$S_{tr\,1f} = U_{1n} I_{1n} = U_{2n} I_{2n}$$

3f, 3°
U_{1n} fázis

U_{1n} vonali



$$S_{tr}^{3f} = \sqrt{3}\, U_{1n}\, I_{1n} = \sqrt{3}\, U_{2n}\, I_{2n}$$

mérés:

ü.j. mérés

U_1 ~ $I_2 = \phi$

$I_{üj}$ → mágnesező áram

$P_{üj}$ → üj. veszteség
(vas, hiszterézis)

$a = U_2/U_1$

rz. mérés

U_1 @ $U_2 = \phi$

$U_{1rz} \rightarrow I_1 = I_{1n}$; $I_2 = I_{2n}$

$\frac{U_{1rz}}{U_{1n}} = \varepsilon$ (drop) pl.: 0,05 5%

$P_{rz} \rightarrow R$

$Q_{rz} \rightarrow X$

pl.: 3f

$P_{veszt} = 3 I_1^2 R = \left(\frac{I_1}{I_{1n}}\right)^2 P_{rz}$

$Q_{veszt} = 3 I_1^2 X = \left(\frac{I_1}{I_{1n}}\right)^2 Q_{rz}$

$Z = \sqrt{R^2 + X^2}$

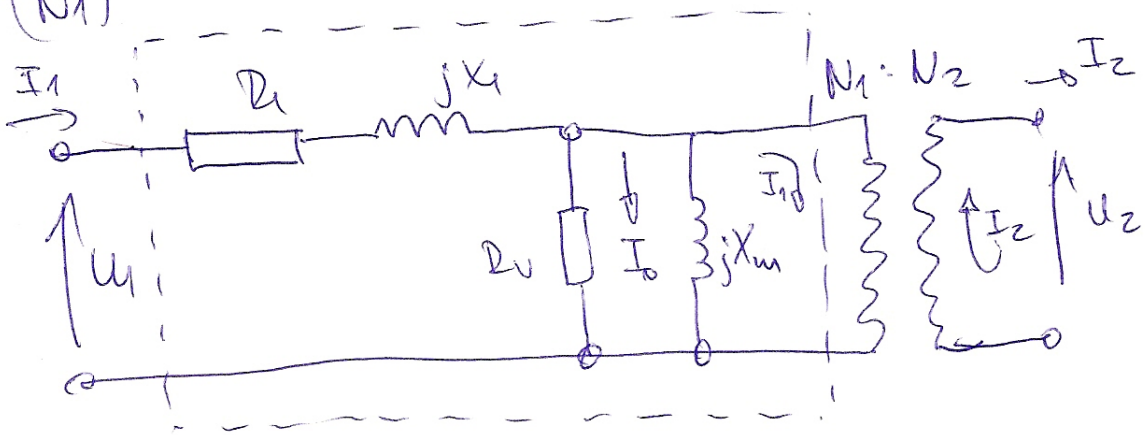
$U_{rz} < \varepsilon_r, \varepsilon_x$ $\xrightarrow{3f}$ $R_1 = \varepsilon_r \frac{U_{1n}^2}{S_{tr}}$ vonali / 3f

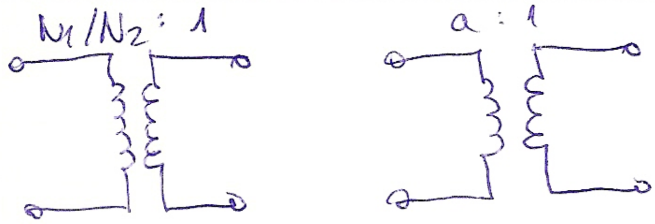
$X_1 = \varepsilon_x \frac{(U_{1n})^2}{S_{tr}}$

$\varepsilon = \sqrt{\varepsilon_r^2 + \varepsilon_x^2}$

$R_2 = \left(\frac{N_2}{N_1}\right)^2 R_1$

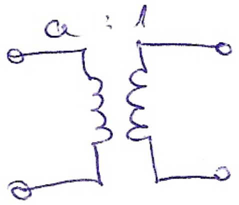
$X_2 = \left(\frac{N_2}{N_1}\right)^2 X_1$



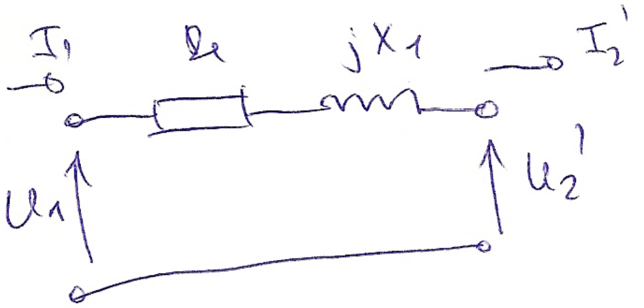


Közös | menetszámra vonatkozó | modell
| feszültségre redukált |

3f tr. szimm. üzemre modell



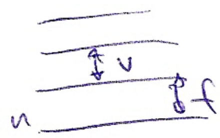
$\bar{a} = a e^{j\alpha}$



(Pl.) Típus NA 21 kV ± 3%

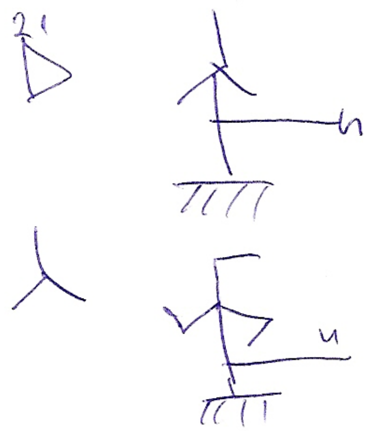
21/0,4 kV/kV

160 kVA



U_1/U_2 400(231)
vonali fázis

Yz5



$P_{üj}$ 0,55kW

I_0 3%

P_{tz} 3,9kW

ε_r 2,4%

ε_x 4,5%

súly 1000kg

ebből olaj 310kg

21/0,4

$$I_{1n} = \frac{S_{tr}}{\sqrt{3}\, U_{1n}} = \frac{160 \cdot 10^3}{\sqrt{3}\, 21 \cdot 10^3} = 4{,}4\ A$$

$$I_{2n} = \frac{S_{tr}}{\sqrt{3}\, U_{2n}} = \frac{160 \cdot 10^3}{\sqrt{3} \cdot 94 \cdot 10^3} = 231\ A$$ /fázis

$$a = \frac{U_{1n}}{U_{2n}} = \frac{I_{2n}}{I_{1n}}$$

1év 8760 óra

Veszteségteljesítmény: $P_{üj} = 0{,}55\ kW$

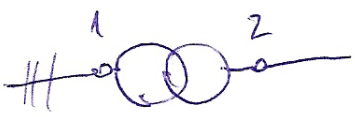
1 kWh 44 Ft/kWh

≈ 192.000 Ft

~~1220~~
16
25
40
60
100
160
250
⋮

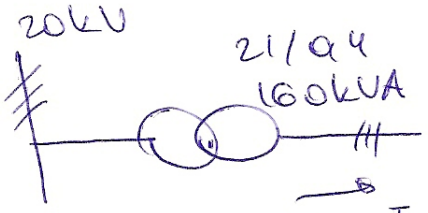
$\sqrt[10]{10} = R$

ΔU_{tr}



$$\frac{U_1 - U_2'}{U_{1névl}} \cdot 100$$

$$\frac{U_1' - U_2}{U_{2névl}} \cdot 100$$

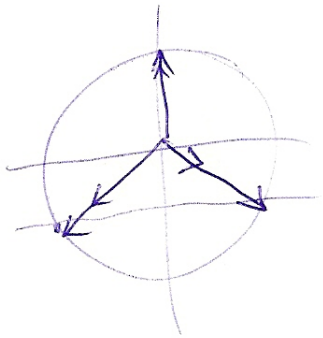


$\varepsilon_r = 4,5\%$

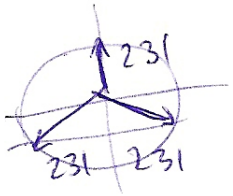
$\varepsilon_\cdot = 2,4\%$

$I_t = I_{névl}$ fázis

$\varepsilon_x = \sqrt{\varepsilon^2 - \varepsilon_r^2} = 3,8\%$



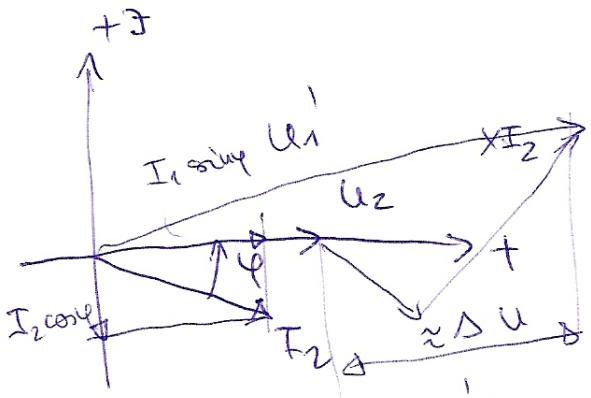
$I_{2névl} = 231\ A$ fázis



$R_{tr} = \frac{\varepsilon_r}{100} \frac{(U_{2\ell})^2}{S_{tr}} =$

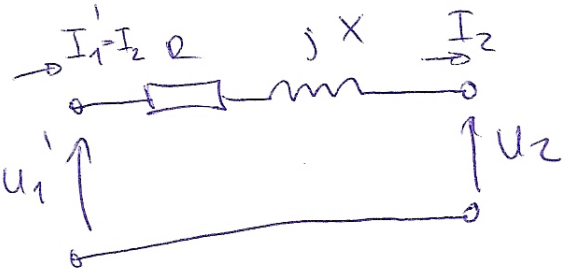
$= \frac{2,4}{100} \frac{(0,4 \cdot 10^3)^2}{160 \cdot 10^3} = 0,024\,\Omega$

$X_{tr} = \ldots = 0,038\,\Omega$



$\cos\varphi = 0,98$

$tg\varphi = 0,2$



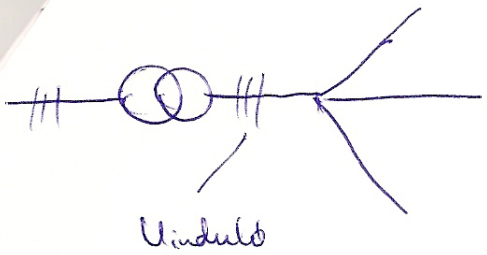
$\Delta U_{tr} \approx \Delta U = R\,I\cos\varphi + X\,I\sin\varphi =$

$= (R + X\,tg\varphi)\,I\cos\varphi = 7,15\,V$ fázisonként

$\Delta U_{tr} = \frac{\Delta U_{tr}}{U_{2\text{fázis}}} 100 = \frac{7,15}{231} = 3,1\%$

$= 10^{-3}(24 + \underbrace{38 \cdot 0,2}_{7,6})\,231 \cdot 0,98$

$31,6$



Unevleges ± 7,5 %

tr. veszteség

$I_t = I_{névleges}$

$P_{veszt} = P_{rz} + P_{üj}$

$Q_{veszt} = Q_{rz} + P_{üj}$

$P_{rz} = 3,9 kW$

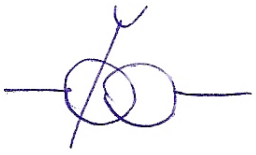
$P_{üj} = 0,55 kW$

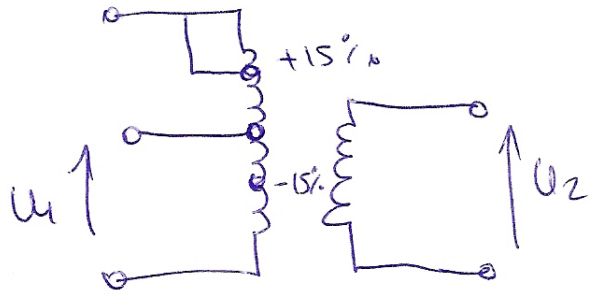
Ha $I_t = 1/2 I_u$:

$P_ü = \frac{1}{4} P_{rz}$

Tr. szabályozás

Elvi rajz





$U_2 = N_2 e$

$e = \frac{U_1}{N_1 + \Delta U}$

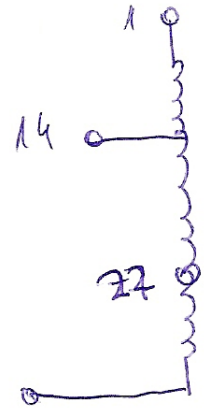
↑ közép

± 15 %

Lépés { 15%/9 = 1,67 ; 15%/13 = 1,1

+ 9 lépés
− 9 lépés
− e_1 közép

+ 13 lépés
− 13 lépés
+ közép



+13
-13 lépés

(F)

DHSV 40000/120 típus

120kV ± 15% / 11kV

40MVA

N: 120kV

K: 11kV

N = 1

k = 2

névleges áram (középállás)

$I_{1n} = \frac{S_{tr}}{\sqrt{3}\, U_{1n}} = 193\,A$

$I_{kn} = \ldots = 2100\,A$

100% a terhelés, ha

$\frac{I_1}{I_{1n}} \leq 1$ vagy $\frac{I_2}{I_{2n}} \leq 1$

középállás $U_2 = U_n$

$I_1 = I_{1n}$

$I_2 = I_{2n} \rightarrow 40MVA$

+15% $U_2 = U_n$ $(U_1 > U_{1n})$

$I_2 = I_{2n}$ → 40MVA

$I_1 < I_{1n}$

-15% $U_1 < U_{1n}$ $(0{,}85\,U_{1n})$

$U_2 = U_n$

$I_1 = I_{1n}$

$I_2 < I_{2n}$

$0{,}85 \cdot 40 = 34\,MVA$

túlterhelés (névleges ≙ 100)

ha $I_1 > I_{1n}$

vagy $I_2 > I_{2n}$

tr. (túl) terhelhetőség

ha előtte $I_{névl}$

akkor 2 óra 1,2 $I_{névl}$

pl. 250kV 2 óráig 300kVA

21/0,4