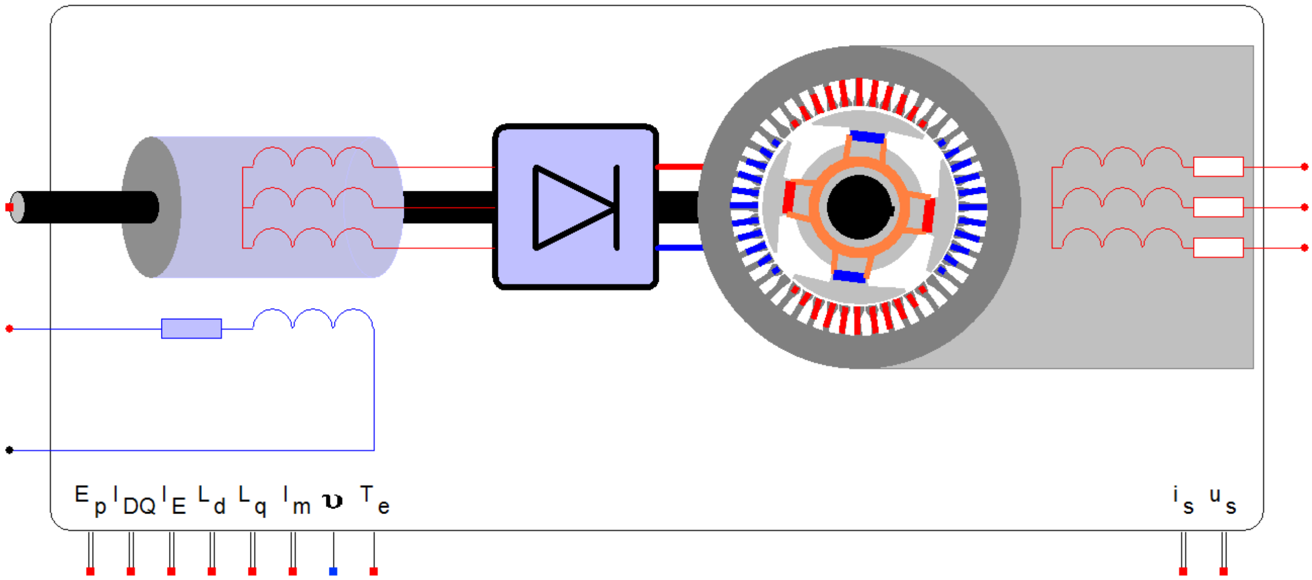
Synchrone machine



S	6	Power in [KVA]
pp	2	Number of pole-paires
U	398.37168574084	Grid voltage Line-Line RMS
Us	230	Grid voltage Line-Neutral RMS
T	30	Load torque
I	0	Excitation current [A], enter 0 to use the nominal value

Calculate

Xd	26.450[ohm]
Lm	84.193[mH]
Pmech	4712.389[Watt]
v	0.903[Rad]
lasthoek	25.879[Degrees]
Ie	12.298[A]
Epx	-255.466[V]
Epy	201.339[V]
Exx	255.466[V]
Exy	123.931[V]
Isx	4.685[A]
Isy	-9.658[A]
Is^{rms}	7.591[A]
cos(phi)	0.900[.]
Pcalculated	4712.389[Watt]

Synchronous Machine

S[VA]=6000[kVA]
Sb[VA]=S/3=2000[kVA] per phase

Line and neutral voltage:
U[V]=230[Vrms Line-Neutral] * sqrt(3)= 398[Vrms Line-Line]

Mechanical power:
Tm=30[Nm] and n=3000/pp=>ω=157.1[Rad/s]
P[Watt]=Tm*ω=30*157=4712[Watt]

Calculate base impedance:
Zb[V]=U^2/Sb=230*230/2000=52900/2000=26.45

Assume 1pu for the synchronous impedance/inductance:
Xd[ohm]=Zb*1p.u.=26[ohm]
Ld[mH]=Xd/314.15927=26.45/314.15927=84[mH]

Calculate load angle from power equation:
sin(υ)=(Xd*Pm)/(Us*Up*3)=(26.45*4712)/(230*230*3)=0.785
υ=arcsin(0.785)=0.9[Rad electric]=26[degrees mechanical]

Calculate Ie in case of nominal operation, so Ep=Us
IeNom=U*sqrt(2)/Xd=1.414*230/26.45=325/26.45=12.3[A]

Calculate the induced back emf from the rotorfield:
Epx[v]=-sqrt(2)*Up*sin(υ)=-sqrt(2)*230*sin(0.9)=-255[v]
Epy[v]= sqrt(2)*Up*cos(υ)= sqrt(2)*230*cos(0.9)=201[v]
Note that we are using the maximum amplitude of the voltage, while calculating voltages and currents!

Calculate the voltage Ux between the induced back emf and the grid voltage:
Ux(x)[v]=0 - Epx= 0 -(-255)=255[v]
Ux(y)[v]=sqrt(2)*Us - Epy= 325-201=124[v]
I=Ux/Xd

Stator current lags Ux with 90 degrees:
with xy components Ix=Ux(y)/Xd and Ix=-Ux(x)/Xd
Ix=Ux(y)/Xd = 124/26.45=4.7
Iy=-Ux(x)/Xd = -255/26.45=-9.7

RMS value of the stator current:
Is = sqrt(Ix^2+Iy^2)/sqrt(2)=sqrt(22+93)/1.414=7.59
and the cos(ϕ)
cos(ϕ)=-cos(atan2(Ix,Iy))=-cos(atan2(4.7,-9.7))=0.9

from which we can recalculate and check the real power:
P=3*Us*Is*cos(ϕ)=230*7.59*0.9=4712
S=3*Us*Is*cos(ϕ)=230*7.59*0.9=5238