



Motor Development For Electric Drive Systems

Tutorial 6

Effects of high order harmonics on the grid connected induction motor

An induction motor has the following dimensions:

Rated voltage $U_N = 690$ V Y, rated current $I_N = 60$ A, rated speed $n_N = 960$ /min, rated frequency $f_N = 50$ Hz, efficiency $\eta = 0.9$, power factor $\cos \varphi_N = 0.87$.
Measured no-load current: $I_0 = 20$ A.

Winding data:

Number of turns per coil $N_c = 5$, chorded two-layer winding $w/\tau_p = 7/9$
Series connection of all coils per phase: $a = 1$, number of pole pairs $2p = 6$.

Dimensions:

Stator inner diameter: $D_i = 250$ mm, length of laminated core $l_{Fe} = 250$ mm
Number of Stator / Rotor slots $Q_s/Q_r = 54/42$, air gap $\delta = 1$ mm

Calculate

- 1) the rated motor power P_N , the rated slip s_N , the number of turns per phase N_{Ph} , the pole pitch τ_p , the number of stator slots per pole and phase q , the synchronous rotational speed n_{syn} and the synchronous speed of the fundamental harmonic v_{syn} .
- 2) the ordinal numbers under no-load conditions of the field waves up to the first slot harmonics pair, the corresponding chording-, distribution- and winding-factors and the magnitudes of the field waves, if saturation of iron is neglected.
- 3) the slip s_v of the v^{th} -harmonic with respect the rotating armature in general and for the 5th harmonic.
- 4) the slip s of the rotor with respect to the synchronous speed, if the rotor runs synchronously with the v^{th} harmonic, in general and for the 5th harmonic.
- 5) the slip condition for the generation of synchronous harmonic torque. Which are the major synchronous harmonic torque slips for this non-saturated induction machine?
- 6) the ordinal numbers of the force wave and the excited frequencies generated by the sinusoidally distributed forces around the surface that are generated by the air gap harmonics and by the magnetic pull.
- 7) the ordinal numbers of the force wave and the excited frequencies for the induction motor described above, assuming no eccentricity and draw the corresponding deformation of the stator lamination.