DARMSTADT UNIVERSITY OF TECHNOLOGY

Department of Electrical Energy Conversion

Motor Development For Electric Drive Systems

Tutorial 3

Linear motors: generation and characteristics of moving magnetic fields

1) Perform a qualitative comparison of the field excitation (m.m.f.) curve *V(x,t)* of both a linear moving and a rotating magnetic field with the following data: q = 1, m = 3, unchorded two-layer winding, sinusoidal three-phase system at time t with $i_U = 0$, $i_V = -i_W = \sqrt{3}/2 \cdot \hat{I}$. Check the compliance with the third *MAXWELL* equation ($div\vec{B} = 0$)!
   a) Draw 2 poles of the rotating field.
   b) Generate the linear moving field by "cutting" a four-pole rotating field winding, so that the end poles only consist of upper or lower layer conductors. How many poles does this moving field winding span? What do the end-pole m.m.f. curves look like, compared to the interior field curves?

2) Fundamental harmonic analysis for task 1): Assume the electric loading *A(x,t)* to be sinusoidally distributed and calculate, neglecting iron saturation and slot opening effects
   a) the rotating air gap field $B_\delta(x,t)$,
   b) the linear moving air gap field $B_\delta(x,t)$. Take into account that the electric loading is reduced to its half at the end of the winding. Divide the winding zone into the end sections I and III and the middle section II. What special characteristic occurs in the field of the end zones I and III ?

3) Plot the rotating and the linear moving air gap flux density from 2) for three different times $\omega t = 0$, $\omega t = \pi/2$, $\omega t = \pi$.

4) Assume the secondary to be a linear squirrel-cage armature (linear induction machine), moving with v_m, whereas the primary, carrying the linear winding, stands still. Is there any tangential force on the armature if slip $s = 0$? If so, why is that and how does this force act?

5) Like 4), but with a permanent magnet synchronous armature. Does the armature experience any tangential force? If so, why and which way does this force act?