Řešení operátorovým počtem

Pro případ zkratu na svorkách:

$$u_d = -L_d \frac{di_d}{dt} - M_{af}\frac{di_f}{dt} - L_q \omega i_q$$

$$u_q = -L_q \frac{di_q}{dt} + (L_d i_d + M_{af} i_f)\omega$$

$$u_0 = -L_0 \frac{di_0}{dt}$$

$$u_f = L_f \frac{di_f}{dt} + \frac{3}{2} M_{af}\frac{di_d}{dt}$$

$$-L_d \frac{di_d}{dt} - M_{af}\frac{di_f}{dt} - L_q \omega i_q = 0$$

$$-L_q \frac{di_q}{dt} + (L_d i_d + M_{af} i_f)\omega = 0$$

$$-L_0 \frac{di_0}{dt} = 0$$

$$L_f \frac{di_f}{dt} + \frac{3}{2} M_{af}\frac{di_d}{dt} = 0$$

Po Laplaceově transformaci:

$$-L_d p\, i_d - M_{af}(p\, i_f - i_{f0}) - \omega L_q i_q = 0$$

$$-L_q p\, i_q + (L_d i_d + M_{af} i_f)\omega = 0$$

$$L_f (p\, i_f - i_{f0}) + \frac{3}{2} M_{af} p\, i_d = 0$$

Řešení v Laplaceově prostoru:

$$i_d(p) = -\frac{M_{af}\, i_{f0}}{L'_d}\cdot\frac{\omega^2}{p(p^2+\omega^2)} = -\frac{X_{af}\, i_{f0}}{X'_d}\cdot\frac{\omega^2}{p(p^2+\omega^2)} = -\frac{E\sqrt{2}}{X'_d}\cdot\frac{\omega^2}{p(p^2+\omega^2)}$$

$$i_q(p) = \frac{M_{af}\, i_{f0}}{L_q}\cdot\frac{\omega}{p^2+\omega^2} = \frac{X_{af}\, i_{f0}}{X_q}\cdot\frac{\omega}{p^2+\omega^2} = \frac{E\cdot\sqrt{2}}{X_q}\cdot\frac{\omega}{p^2+\omega^2}$$

$$i_f(p) = \frac{i_{f0}}{p} + \frac{3}{2}\frac{M_{af}^2}{L_f}\cdot\frac{1}{L'_d}\cdot i_{f0}\,\frac{\omega^2}{p(p^2+\omega^2)} = \frac{i_{f0}}{p} + \frac{L_d - L'_d}{L'_d}\,\frac{\omega^2}{p(p^2+\omega^2)}\cdot i_{f0} =$$

$$= \frac{i_{f0}}{p} + \frac{X_d - X'_d}{X'_d}\cdot\frac{\omega^2}{p(p^2+\omega^2)}\, i_{f0}$$

Po zpětné transformaci Laplaceově:

$$i_d(t) = -\frac{\sqrt{2}E}{X'_d}\,(1-\cos\omega t)$$

$$i_q(t) = \frac{\sqrt{2}E}{X_q}\,\sin\omega t$$

$$i_f(t) = i_{f0} + \frac{X_d - X'_d}{X'_d}\,(1-\cos\omega t)\, i_{f0}$$

Po zpětné transformaci Parkově:

$$i_a(t) = -\frac{\sqrt{2}E}{X'_d}\cos(\omega t + \alpha_0) + \frac{\sqrt{2}E}{2}\left(\frac{1}{X'_d} + \frac{1}{X_q}\right)\cos\alpha_0 + \frac{\sqrt{2}E}{2}\left(\frac{1}{X'_d} - \frac{1}{X_q}\right)\cos(2\omega t + \alpha_0)$$