

1.

$$f := 50 \quad n1 := 3000 \quad P2 := 55000 \quad m := 3 \quad U1H := 220$$

$$p := 60 \cdot \frac{f}{n1} = 1$$

$$h := 0.225 \quad Da := 0.392 \quad Kd := 0.52$$

31. 4A225M2	55	380 (3,5)	3000
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$$D := Kd \cdot Da = 0.204 \quad (M)$$

$$\tau := \frac{\pi \cdot D}{2 \cdot p} = 0.32$$

$$ke := 0.98 \quad \eta := 0.90 \quad \cos \varphi := 0.91$$

$$P' := P2 \cdot \frac{ke}{\eta \cdot \cos \varphi} = 6.581 \cdot 10^4$$

$$A := 40000 \quad B\delta := 0.74$$

$$k\sigma61 := 0.95$$

$$kb := \frac{\pi}{2 \cdot \sqrt{2}} = 1.111$$

$$\Omega := \frac{2 \cdot \pi \cdot f}{p} = 314.159$$

$$l\delta := \frac{P'}{kb \cdot D^2 \cdot \Omega \cdot k\sigma61 \cdot A \cdot B\delta} = 0.161$$

$$\lambda := \frac{l\delta}{\tau} = 0.504$$

2.

$$t1max := 0.018 \quad t1min := 0.016$$

$$Z1min := \frac{\pi \cdot D}{t1max} = 35.577 \quad Z1max := \frac{\pi \cdot D}{t1min} = 40.024$$

$$Z1 := 36$$

$$q := \frac{Z1}{2 \cdot p \cdot m} = 6$$

$$t1 := \frac{\pi \cdot D}{2 \cdot p \cdot m \cdot q} = 0.018 \quad (M)$$

$$I_{1H} := \frac{P_2}{m \cdot U_{1H} \cdot \cos \varphi \cdot \eta} = 101.75$$

$$u' := \frac{\pi \cdot D \cdot A}{I_{1H} \cdot Z_1} = 6.993$$

$$u' := 7 \quad a := 2$$

$$u := a \cdot u' = 14$$

$$w_1 := \frac{u \cdot Z_1}{2 \cdot a \cdot m} = 42$$

$$A := \frac{2 \cdot I_{1H} \cdot w_1 \cdot m}{\pi \cdot D} = 4.004 \cdot 10^4$$

$$A := 40000$$

$$k_{об1} := 0.95$$

$$\Phi := \frac{k_e \cdot U_{1H}}{4 \cdot k_b \cdot w_1 \cdot k_{об1} \cdot f} = 0.024$$

$$B\delta := \frac{p \cdot \Phi}{D \cdot l\delta} = 0.739$$

$$B\delta := 0.74$$

$$AJ_1 := 185 \cdot 10^9$$

$$J_1 := \frac{AJ_1}{A} = 4.625 \cdot 10^6$$

предварительно

$$q_{эф} := \frac{I_{1H}}{a \cdot J_1} = 1.1 \cdot 10^{-5}$$

$$n_{эл} := 10$$

$$q_{эл} := \frac{q_{эф}}{n_{эл}} = 1.1 \cdot 10^{-6} \quad (M^2)$$

по таблице

$$q_{эл} := 1.094 \cdot 10^{-6} \quad d_{эл} := 1.18 \cdot 10^{-3} \quad du_3 := 1.26 \cdot 10^{-3}$$

$$q_{эф} := q_{эл} \cdot n_{эл} = 1.094 \cdot 10^{-5} \quad (M^2)$$

$$J_1 := \frac{I_{1H}}{a \cdot q_{эл} \cdot n_{эл}} = 4.65 \cdot 10^6$$

3.

$$kc := 0.97 \quad lcm1 := l\delta = 0.161 \quad Bz1 := 1.6 \quad Ba := 1.4$$

$$bz1 := \frac{B\delta \cdot t1 \cdot l\delta}{Bz1 \cdot lcm1 \cdot kc} = 0.008 \quad (m)$$

$$ha := \frac{\Phi}{2 \cdot Ba \cdot lcm1 \cdot kc} = 0.055 \quad (m)$$

$$buc := 4 \quad (mm)$$

$$huc := 1 \quad (mm)$$

$$hn := \frac{Da - D}{2} - ha = 0.039 \quad (m)$$

$$b1c := \frac{\pi \cdot (D + 2 \cdot hn)}{Z1} - bz1 = 0.016 \quad (m)$$

$$b2c := \frac{\pi \cdot (D \cdot 10^3 + 2 \cdot huc - buc) - Z1 \cdot bz1 \cdot 10^3}{Z1 - \pi} = 10.005 (mm)$$

$$h1c := hn \cdot 10^3 - \left(huc + \frac{b2c - buc}{2} \right) = 34.595 \quad (mm)$$

$$\Delta bn := 0.2 \quad \Delta hn := 0.2 \quad (mm)$$

$$b'1 := b1c \cdot 10^3 - \Delta bn = 15.843 \quad (mm)$$

$$b'2 := b2c - \Delta bn = 9.805 \quad (mm)$$

$$h'1 := h1c - \Delta hn = 34.395 \quad (mm)$$

$$buz := 0.4 \quad (mm)$$

$$Snp := 0 \quad Su3 := bu3 \cdot (2 \cdot hn \cdot 10^3 + b1c \cdot 10^3 + b2c) = 41.298 \quad (mm^2)$$

$$S'n := \frac{b'1 + b'2}{2} \cdot h'1 - Su3 - Snp = 399.796 \quad (mm^2)$$

$$k3 := \frac{(du3 \cdot 10^3)^2 \cdot u \cdot n_{эл}}{S'n} = 0.556$$

4.

$$\delta := 1.2 \quad (mm)$$

$$Z2 := 28$$

$$\text{Внешний_диаметр} \quad D2 := D - 2 \cdot \delta \cdot 10^{-3} = 0.201 \quad (m)$$

$$L1 := l\delta = 0.161 \quad L2 := L1 = 0.161 \quad (м)$$

$$tz2 := \frac{\pi \cdot D2}{Z2} = 0.023 \quad (м)$$

$$k\vartheta := 0.23$$

$$Dj := k\vartheta \cdot Da = 0.09 \quad D\vartheta := Dj = 0.09 \quad (м)$$

$$vi := \frac{2 \cdot m \cdot w1 \cdot k061}{Z2} = 8.55$$

$$ki := 0.2 + 0.8 \cdot \cos\varphi = 0.928$$

$$I2 := ki \cdot I1H \cdot vi = 807.326$$

$$J2 := 3.3 \cdot 10^6$$

$$qc := \frac{I2}{J2} = 2.446 \cdot 10^{-4} \quad (м^2)$$

$$b\omega p := 1.5 \quad h\omega p := 0.7 \quad h'\omega p := 0.3 \quad (мм)$$

$$Bz2 := 1.8$$

$$lcm2 := l\delta = 0.161$$

$$bz2 := \frac{B\delta \cdot tz2 \cdot l\delta}{Bz2 \cdot lcm2 \cdot kc} = 0.01 \quad (м)$$

$$b1p := \frac{\pi \cdot (D2 \cdot 10^3 + 2 \cdot h\omega p - 2 \cdot h'\omega p) - Z2 \cdot bz2 \cdot 10^3}{Z2 + \pi} = 11.789 \quad (мм)$$

$$b2p := \sqrt{\frac{b1p^2 \cdot \left(\frac{Z2}{\pi} + \frac{\pi}{2} \right) - qc \cdot 10^6 \cdot 4}{\frac{Z2}{\pi} - \frac{\pi}{2}}} = 8.073 \quad (мм)$$

$$h1p := (b1p - b2p) \cdot \frac{Z2}{2 \cdot \pi} = 16.561 \quad (мм)$$

Принимаем $b1p := 12 \quad b2p := 8 \quad h1p := 17 \quad (мм)$

$$hn2 := h'\omega p + h\omega p + \frac{b1p}{2} + h1p + \frac{b2p}{2} = 28 \quad (мм)$$

Принимаем $hn2 := 28 \quad (мм)$

$$q_c := \left(\frac{\pi}{8} \right) \cdot (b_1 p^2 + b_2 p^2) + 0.5 \cdot (b_1 p + b_2 p) \cdot h_1 p = 251.681 \text{ (мм}^2\text{)}$$

$$J_2 := \frac{I_2}{q_c \cdot 10^{-6}} = 3.208 \cdot 10^6$$

$$\Delta := 2 \cdot \sin \left(\frac{\pi \cdot p}{Z_2} \right) = 0.224$$

$$I_{кл} := \frac{I_2}{\Delta} = 3.605 \cdot 10^3$$

$$J_{кл} := 0.85 \cdot J_2 = 2.727 \cdot 10^6$$

$$q_{кл} := \frac{I_{кл}}{J_{кл}} = 0.001 \quad (\text{м}^2)$$

$$b_{кл} := 1.25 \cdot h_{п2} = 35 \quad (\text{мм})$$

$$a_{кл} := \frac{q_{кл} \cdot 10^6}{b_{кл}} = 37.779 \quad (\text{мм})$$

$$q_{кл} := b_{кл} \cdot a_{кл} = 1.322 \cdot 10^3 \quad (\text{мм}^2)$$

$$D_{к.ср} := D_2 \cdot 10^3 - b_{кл} = 166.44 \quad (\text{мм}^3) \quad \text{мм}_2!!!!$$

5.

$$Bz_1 := \frac{B\delta \cdot t_1 \cdot l\delta}{bz_1 \cdot lcm_1 \cdot kc} = 1.6$$

$$t_2 := tz_2 = 0.023$$

$$Bz_2 := \frac{B\delta \cdot t_2 \cdot l\delta}{bz_2 \cdot lcm_2 \cdot kc} = 1.8$$

$$Ba := \frac{\Phi}{2 \cdot ha \cdot lcm_1 \cdot kc} = 1.4$$

$$mk_2 := 0 \quad dk_2 := 0 \quad \text{Так_как_нет_аксиальных_каналов}$$

$$h'j := \frac{2+p}{3.2 \cdot p} \cdot \left(\frac{D_2 \cdot 10^3}{2} - h_{п2} \right) - \frac{2}{3} \cdot dk_2 \cdot mk_2 = 68.175 \quad (\text{мм})$$

$$Bj := \frac{\Phi}{2 \cdot h'j \cdot 10^{-3} \cdot lcm_2 \cdot kc} = 1.139$$

$$b_{ш1} := b_{шp} = 1.5 \quad (\text{мм})$$

$$\gamma := \frac{\left(\frac{buc}{\delta}\right)^2}{5 + \frac{buc}{\delta}} = 1.333$$

$$k\delta := \frac{t1 \cdot 10^3}{t1 \cdot 10^3 - \gamma \cdot \delta} = 1.099$$

$$F\delta := 1.59 \cdot 10^6 \cdot B\delta \cdot k\delta \cdot \delta \cdot 10^{-3} = 1.551 \cdot 10^3$$

$$Hz1 := 850 \quad Hz2 := 1520$$

$$hz1 := hn = 0.039 \quad (m)$$

$$hz2 := hn2 \cdot 10^{-3} - 0.1 \cdot b2p \cdot 10^{-3} = 0.027 \quad (m)$$

$$Fz1 := 2 \cdot hz1 \cdot Hz1 = 65.616$$

$$Fz2 := 2 \cdot hz2 \cdot Hz2 = 82.688$$

$$kz := 1 + \frac{Fz1 + Fz2}{F\delta} = 1.096$$

$$Ha := 400 \quad Hj := 1290$$

$$La := \frac{\pi \cdot (Da - ha)}{2 \cdot p} = 0.529 \quad (m)$$

$$hj := \left(\frac{D2 - Dj}{2} - hn2 \cdot 10^{-3} \right) = 0.028 \quad (m)$$

$$Lj := \frac{\pi \cdot (Dj + hj)}{2 \cdot p} = 0.185 \quad (m)$$

$$Fa := La \cdot Ha = 211.44$$

$$Fj := Lj \cdot Hj = 238.701$$

$$Fu := F\delta + Fz1 + Fz2 + Fa + Fj = 2.15 \cdot 10^3$$

$$k\mu := \frac{Fu}{F\delta} = 1.386$$

$$I\mu := \frac{p \cdot Fu}{0.9 \cdot m \cdot w1 \cdot k\sigma1} = 19.957$$

$$I''\mu := \frac{I\mu}{I1H} = 0.196$$

6.

$$\rho_{115} := \frac{10^{-6}}{41}$$

$$l_{n1} := l\delta = 0.161 \quad (м)$$

$$B := 0.01 \quad (м)$$

$$K_{л} := 1.2$$

$$h_{n1} := h_n = 0.039 \quad (м)$$

$$\beta_1 := 1$$

$$b_{км} := \frac{\pi \cdot (D + h_{n1})}{2 \cdot p} \cdot \beta_1 = 0.381 \quad (м)$$

$$l_{л1} := K_{л} \cdot b_{км} + 2 \cdot B = 0.477 \quad (м)$$

$$l_{cp1} := 2 \cdot (l_{n1} + l_{л1}) = 1.277 \quad (м)$$

$$L_1 := l_{cp1} \cdot w_1 = 53.626 \quad (м)$$

$$r_1 := \rho_{115} \cdot \frac{L_1}{q_{эф} \cdot a} = 0.06$$

$$K_{выл} := 0.26$$

$$l_{выл} := K_{выл} \cdot b_{км} + B = 0.109 \quad (м)$$

$$r''_1 := r_1 \cdot \frac{I_{1H}}{U_{1H}} = 0.028$$

$$\rho_{115} := \frac{10^{-6}}{20.5} \quad \text{Примечание_таблицы_5.1}$$

$$l_2 := l\delta = 0.161 \quad (м)$$

$$r_c := \rho_{115} \cdot \frac{l_2}{q_c \cdot 10^{-6}} = 3.129 \cdot 10^{-5}$$

$$h_{кл} := 1.2 \cdot h_{n2} = 33.6 \quad (мм)$$

$$D_{клср} := D_2 - h_{кл} \cdot 10^{-3} = 0.168 \quad (м)$$

$$r_{кл} := \rho_{115} \cdot \frac{\pi \cdot D_{клср}}{Z_2 \cdot q_{кл} \cdot 10^{-6}} = 6.947 \cdot 10^{-7}$$

$$r_2 := r_c + \frac{2 \cdot r_{\kappa\lambda}}{\Delta^2} = 5.9 \cdot 10^{-5}$$

$$r'_2 := r_2 \cdot \frac{4 \cdot m \cdot (w_1 \cdot k_{об1})^2}{Z_2} = 0.04$$

$$r''_2 := r'_2 \cdot \frac{I_{1H}}{U_{1H}} = 0.019$$

$$r'_2 := r_2 \cdot \frac{4 \cdot m \cdot (w_1 \cdot k_{об1})^2}{Z_2} = 0.04$$

$$\text{Относит.} \quad r''_2 := r'_2 \cdot \frac{I_{1H}}{U_{1H}} = 0.019$$

$$f_1 := f = 50 \quad l'\delta := l\delta = 0.161 \quad (\text{м})$$

$$h_3 := h_{1c} = 34.595 \quad (\text{мм}) \quad b_{1c} := 13 \quad (\text{мм}) \quad h_2 := 0$$

$$h_1 := 0.5 \cdot (b_{1c} - b_{шc}) = 4.5 \quad (\text{мм})$$

$$k\beta := 1 \quad k'\beta := 1$$

$$\lambda_n := \frac{h_3}{3 \cdot b_{1c}} \cdot k\beta + \left(\frac{h_2}{b_{1c}} + \frac{3 \cdot h_1}{b_{1c} + 2 \cdot b_{шc}} + \frac{h_{шc}}{b_{шc}} \right) \cdot k'\beta = 1.78$$

$$l_l := l_{l1} = 0.477 \quad (\text{м}) \quad \beta := \beta_1 = 1$$

$$\lambda_{l1} := 0.34 \cdot \frac{q}{l'\delta} \cdot (l_l - 0.64 \cdot \beta \cdot \tau) = 3.438$$

$$\beta_{ск} := 0 \quad k'_{ск} := 1 \quad \text{для} \quad \frac{t_2}{t_1} = 1.271$$

$$\xi := 2 \cdot k'_{ск} \cdot k\beta - k_{об1}^2 \cdot \left(\frac{t_2}{t_1} \right)^2 \cdot (1 + \beta_{ск}^2) = 0.543$$

$$\lambda_{\partial 1} := \frac{t_1 \cdot 10^3}{12 \cdot \delta \cdot k\delta} \cdot \xi = 0.61$$

$$x_1 := 15.8 \cdot \frac{f_1}{100} \cdot \left(\frac{w_1}{100} \right)^2 \cdot \frac{l'\delta}{p \cdot q} \cdot (\lambda_n + \lambda_{l1} + \lambda_{\partial 1}) = 0.219 \quad (\text{Ом})$$

$$\text{относит.} \quad x_1'' := x_1 \cdot \frac{I_{1H}}{U_{1H}} = 0.101$$

$$h_1 := h_{n2} - 0.5 \cdot b_{1p} = 22 \quad (\text{мм})$$

$$k\partial := 1$$

$$\lambda n2 := \left(\frac{h1}{3 \cdot b1p} \cdot \left(1 - \frac{\pi \cdot b1p^2}{8 \cdot qc} \right)^2 + 0.66 - \frac{bwp}{2 \cdot b1p} \right) \cdot k\partial + \frac{hwp}{bwp} + 1.12 \cdot \frac{h'wp \cdot 10^{-3} \cdot 10^6}{I2} = 1.848$$

$$\lambda l2 := \frac{2.3 \cdot D\kappa \cdot cp \cdot 10^{-3}}{Z2 \cdot l' \delta \cdot \Delta^2} \cdot \log \left(\frac{4.7 \cdot D\kappa \cdot cp \cdot 10^{-3}}{a\kappa l \cdot 10^{-3} + 2 \cdot b\kappa l \cdot 10^{-3}} \right) = 1.454$$

$$\xi := 1$$

$$\lambda \partial 2 := \frac{t2 \cdot 10^3}{12 \cdot \delta \cdot k\delta} \cdot \xi = 1.428$$

$$x2 := 7.9 \cdot f1 \cdot l\delta \cdot (\lambda n2 + \lambda l2 + \lambda \partial 2) \cdot 10^{-6} = 3.016 \cdot 10^{-4} \quad (OM)$$

$$\Sigma \lambda 2 := \lambda n2 + \lambda l2 + \lambda \partial 2 = 4.73$$

$$x'2 := x2 \cdot \frac{4 \cdot m \cdot (w1 \cdot k\partial b1)^2}{Z2} = 0.206 \quad (OM)$$

$$\text{Относит.} \quad x''2 := x'2 \cdot \frac{I1H}{U1H} = 0.095$$

7.

$$p1.5 := 2.55 \quad \beta := 1.5 \quad \gamma c := 7.8 \cdot 10^3$$

$$ha := 0.5 \cdot (Da - D) - hn1 = 0.055 \quad (M)$$

$$ma := \pi \cdot (Da - ha) \cdot ha \cdot lcm1 \cdot kc \cdot \gamma c = 71.637 \quad (\kappa 2)$$

$$bz1cp := bz1 = 0.008 \quad (M)$$

$$mz1 := hz1 \cdot bz1cp \cdot Z1 \cdot lcm1 \cdot kc \cdot \gamma c = 14.393 \quad (\kappa 2)$$

$$k\partial a := 1.6 \quad k\partial z := 1.8$$

$$P_{ст.осн} := p1.5 \cdot \left(\frac{f1}{50} \right)^\beta \cdot (k\partial a \cdot Ba^2 \cdot ma + k\partial z \cdot Bz1^2 \cdot mz1) = 741.992$$

$$ko2 := 1.5$$

$$\frac{buc}{\delta} = 3.333 \quad \beta o2 := 0.24$$

$$Bo2 := \beta o2 \cdot k\delta \cdot B\delta = 0.195 \quad (Tл)$$

$$pнов2 := 0.5 \cdot ko2 \cdot \left(\frac{Z1 \cdot n1}{10000} \right)^{1.5} \cdot (Bo2 \cdot t1 \cdot 10^3)^2 = 320.791 \quad (Bm)$$

$$t2 := 0.012 \quad (M)$$

$$Pнов2 := pнов2 \cdot (t2 - bwp \cdot 10^{-3}) \cdot Z2 \cdot lcm2 = 15.224 \quad (Bm)$$

$$Bz2cp := Bz2 = 1.8 \quad (Tл)$$

$$Bnyл2 := \frac{\gamma \cdot \delta \cdot 10^{-3}}{2 \cdot t2} \cdot Bz2cp = 0.12 \quad (Tл)$$

$$bz2cp := bz2 = 0.01 \quad (м) \quad hz2 := hn2 = 28 \quad (мм)$$

$$kc2 := kc \cdot 7800 = 7.566 \cdot 10^3$$

$$mz2 := Z2 \cdot hz2 \cdot 10^{-3} \cdot bz2cp \cdot lcm2 \cdot kc2 = 9.172 \quad (кг)$$

$$Pnyл2 := 0.11 \cdot \left(\frac{Z1 \cdot n1}{1000} \cdot Bnyл2 \right)^2 \cdot mz2 = 169.46 \quad (Bм)$$

$$Pcm.доб := Pнов2 + Pnyл2 = 184.683 \quad (Bм)$$

$$Pcm := Pcm.осн + Pcm.доб = 926.675 \quad (Bм)$$

$$Kt := 1$$

$$Pмex := Kt \cdot \left(\frac{n1}{10} \right)^2 \cdot Da^4 = 2.125 \cdot 10^3 \quad (Bм)$$

$$Pдоб.н := 0.005 \cdot \frac{P2}{\eta} = 305.556 \quad (Bм)$$

$$Pэ1xx := 3 \cdot I\mu^2 \cdot r1 = 71.422 \quad (Bм)$$

$$Ixxa := \frac{Pcm + Pмex + Pэ1xx}{m \cdot U1н} = 4.732 \quad (A)$$

$$Ixx := \sqrt{Ixxa^2 + I\mu^2} = 20.51 \quad (A)$$

$$\cos\varphi_{xx} := \frac{Ixxa}{Ixx} = 0.231$$

8.

$$r12 := \frac{Pcm.осн}{m \cdot I\mu^2} = 0.621 \quad (Ом)$$

$$x12 := \frac{U1н}{I\mu} - x1 = 10.805 \quad (Ом)$$

$$c1 := 1 + \frac{x1}{x12} = 1.02 \quad \text{Так_как_}\gamma' < 1^\circ$$

$$\gamma' := \operatorname{atan}\left(\frac{r1 \cdot x12 - r12 \cdot x1}{r12 \cdot (r1 + r12) + x12 \cdot (x1 + x12)}\right) = 0.004$$

$$I0a := \frac{P_{cm.оч} + 3 \cdot I\mu^2 \cdot r1}{3 \cdot U1H} = 1.232 \quad (A)$$

$$a' := c1^2 = 1.041$$

$$b' := 0$$

$$a := c1 \cdot r1 = 0.061 \quad (Ом)$$

$$b := c1 \cdot (x1 + c1 \cdot x'2) = 0.437 \quad (Ом)$$

$$P_{cm} + P_{mex} = 3.052 \cdot 10^3 \quad (Вт)$$

$$sH := r''2 = 0.019$$

РАСЧЁТЫ_ДЛЯ_ТАБЛИЦЫ_1

$$P_H := 55 \quad (кВт) \qquad 2 \cdot p = 2 \qquad U1H = 220 \quad (В)$$

$$I0a = 1.232 \quad (A) \qquad I0p := I\mu = 19.957(A)$$

$$P_{cm} + P_{mex} = 3.052 \cdot 10^3 \quad (Вт) \qquad r1 = 0.06 \quad (Ом)$$

$$r'2 = 0.04 \quad (Ом) \qquad c1 = 1.02$$

$$a' = 1.041 \qquad a = 0.061 \quad (Ом)$$

$$b' = 0 \quad (Ом) \qquad b = 0.437 \quad (Ом)$$

Принимаем $s := sH$

$$a' \cdot \frac{r'2}{s} = 2.25 \quad (Ом)$$

$$b' \cdot \frac{r'2}{s} = 0 \quad (Ом)$$

$$R := a + a' \cdot \frac{r'2}{s} = 2.311 \quad (Ом)$$

$$X := b + b' \cdot \frac{r'2}{s} = 0.437 \quad (Ом)$$

$$Z := \sqrt{R^2 + X^2} = 2.352 \quad (OM)$$

$$I''2 := \frac{U_{1H}}{Z} = 93.519 \quad (A)$$

$$\cos\varphi'2 := \frac{R}{Z} = 0.983$$

$$\sin\varphi'2 := \frac{X}{Z} = 0.186$$

$$I_{1a} := I_{0a} + I''2 \cdot \cos\varphi'2 = 93.123 \quad (A)$$

$$I_{1p} := I_{0p} + I''2 \cdot \sin\varphi'2 = 37.334 \quad (A)$$

$$I_1 := \sqrt{I_{1a}^2 + I_{1p}^2} = 100.328 \quad (A)$$

$$I'2 := c_1 \cdot I''2 = 95.411 \quad (A)$$

$$P_1 := 3 \cdot U_{1H} \cdot I_{1a} \cdot 10^{-3} = 61.461 \quad (\kappa Bm)$$

$$P_{\exists 1} := 3 \cdot I_1^2 \cdot r_1 \cdot 10^{-3} = 1.805 \quad (\kappa Bm)$$

$$P_{\exists 2} := 3 \cdot I'2^2 \cdot r'2 \cdot 10^{-3} = 1.099 \quad (\kappa Bm)$$

$$P_{\partial o6} := P_{\partial o6.H} \cdot 10^{-3} \cdot \left(\frac{I_1}{I_{1H}} \right)^2 = 0.297 \quad (\kappa Bm)$$

$$\Sigma P := (P_{cm} + P_{Mex}) \cdot 10^{-3} + P_{\exists 1} + P_{\exists 2} + P_{\partial o6} \cdot 10^{-3} = 5.957$$

$$P_2 := P_1 - \Sigma P = 55.505 \quad (\kappa Bm)$$

$$\eta := 1 - \frac{\Sigma P}{P_1} = 0.903$$

$$\cos\varphi := \frac{I_{1a}}{I_1} = 0.928$$

$$\nu_{pac4} := 115$$

$$hc := h\nu_2 - (h\nu_p - h'\nu_p) = 27.6 \quad (mm)$$

$$s := 1$$

$$\xi := 63.61 \cdot hc \cdot 10^{-3} \cdot \sqrt{s} = 1.756$$

$$\varphi := 0.55$$

$$\varphi' := 0.85$$

$$\varphi_{089} := 0.89 \cdot \xi^4 = 8.455$$

$$hr := \frac{hc \cdot 10^{-3}}{1 + \varphi} = 0.018 \quad (M)$$

$$b1p = 12$$

$$b2p = 8$$

$$h1p = 17$$

$$k\partial := \varphi' = 0.85$$

$$\frac{b1p}{2} = 6 \quad (MM) \quad \frac{b1p}{2} + h1p = 23 \quad (MM)$$

$$3.8 < 17 < 19$$

$$br := b1p - \frac{b1p - b2p}{h1p} \cdot \left(hr \cdot 10^3 - \frac{b1p}{2} \right) = 9.222 \quad (MM)$$

$$qr := \frac{\pi \cdot b1p^2}{8} + \frac{b1p + br}{2} \cdot \left(hr \cdot 10^3 - \frac{b1p}{2} \right) = 181.827 \quad (MM^2)$$

$$kr := \frac{qc}{qr} = 1.384$$

$$qc = 251.681$$

$$rc = 3.129 \cdot 10^{-5}$$

$$KR := 1 + \frac{rc}{r2} \cdot (kr - 1) = 1.204$$

$$r2 = 5.9 \cdot 10^{-5}$$

$$r'2 = 0.04$$

$$r'2\xi := KR \cdot r'2 = 0.048 \quad (OM)$$

$$\lambda n2\xi := \left(\frac{h1}{3 \cdot b1p} \cdot \left(1 - \frac{\pi \cdot b1p^2}{8 \cdot qc} \right)^2 + 0.66 - \frac{bwp}{2 \cdot b1p} \right) \cdot k\partial + \frac{bwp}{hwp} + 1.12 \cdot \frac{h'wp \cdot 10^3}{6.5 \cdot I2} = 3.027$$

$$Kx := \frac{\lambda n2\xi + \lambda n2 + \lambda \partial 2}{\lambda n2 + \lambda n2 + \lambda \partial 2} = 1.249$$

$$x'2 = 0.206$$

$$x'2\xi := x'2 \cdot Kx = 0.257 \quad (OM)$$

$$I'2 := \frac{U1H}{\sqrt{\left(r1 + \frac{r'2\xi}{s} \right)^2 + (x1 + x'2\xi)^2}} = 451.04 \quad (A)$$

$$kHac := 1.35$$

$$I1 := I'2 = 451.04 \quad (A)$$

$$a := 2$$

$$ky := 1$$

$$Fn.cp := 0.7 \cdot \frac{kHac \cdot I1 \cdot u}{a} \cdot \left(k'\beta + ky \cdot ko61 \cdot \frac{Z1}{Z2} \right) = 6.628 \cdot 10^3$$

$$Cn := 0.64 + 2.5 \cdot \sqrt{\frac{\delta \cdot 10^{-3}}{t1 + t2}} = 1.142$$

$$B\phi\delta := \frac{Fn.cp}{1.6 \cdot \delta \cdot 10^{-3} \cdot Cn} \cdot 10^{-6} = 3.023 \quad (Tл)$$

$$\kappa\delta := 0.75$$

$$c1 := (t1 \cdot 10^3 - b\omega c) \cdot (1 - \kappa\delta) = 3.447 \quad (мм)$$

$$h' := 0.5 \cdot (b1p - b2p) = 2$$

$$\Delta\lambda n1_{\text{нас}} := \frac{h\omega c + 0.58 \cdot h'}{b\omega c} \cdot \frac{c1}{c1 + b\omega c} = 0.25$$

$$\lambda n1 := \lambda n = 1.78$$

$$\lambda n1_{\text{нас}} := \lambda n1 - \Delta\lambda n1_{\text{нас}} = 1.53$$

$$\lambda\partial 1_{\text{нас}} := \lambda\partial 1 \cdot \kappa\delta = 0.458$$

$$\Sigma\lambda 1_{\text{нас}} := \lambda n1_{\text{нас}} + \lambda\partial 1_{\text{нас}} + \lambda l1 = 5.426$$

$$\Sigma\lambda 1 := \lambda n1 + \lambda\partial 1 + \lambda l1 = 5.829$$

$$x1_{\text{нас}} := x1 \cdot \frac{\Sigma\lambda 1_{\text{нас}}}{\Sigma\lambda 1} = 0.203$$

$$c2 := (t2 \cdot 10^3 - b\omega p) \cdot (1 - \kappa\delta) = 2.625 \quad (мм)$$

$$\Delta\lambda n2_{\text{нас}} := \frac{h\omega p}{b\omega p} \cdot \frac{c2}{c2 + b\omega p} = 0.297$$

$$\lambda n2_{\text{нас}} := \lambda n2\xi - \Delta\lambda n2_{\text{нас}} = 2.73$$

$$\lambda\partial 2_{\text{нас}} := \lambda\partial 2 \cdot \kappa\delta = 1.071$$

$$\lambda 2\xi_{\text{нас}} := \lambda n2_{\text{нас}} = 2.73$$

$$\Sigma\lambda 2\xi_{\text{нас}} := \lambda 2\xi_{\text{нас}} + \lambda\partial 2_{\text{нас}} + \lambda l2 = 5.255$$

$$x'2\xi_{\text{нас}} := x'2 \cdot \frac{\Sigma\lambda 2\xi_{\text{нас}}}{\Sigma\lambda 2} = 0.229 \quad (Ом)$$

$$x12n := x12 \cdot \frac{F\varphi}{F\delta} = 14.973$$

$$c1n_{\text{нас}} := 1 + \frac{x1_{\text{нас}}}{x12n} = 1.014$$

$$a_n := r_1 + c_{1n} \cdot \frac{r'^2 \xi}{s} = 0.109$$

$$b_n := c_{1n} \cdot x'^2 \xi_{нас} + x_{1нас} = 0.435$$

$$I'^2 := \frac{U_{1H}}{\sqrt{a_n^2 + b_n^2}} = 490.439 \quad (A)$$

$$I_1 := I'^2 \cdot \frac{\sqrt{a_n^2 + (b_n + x_{12n})^2}}{c_{1n} \cdot x_{12n}} = 497.94 \quad (A)$$

Относительные значения

$$I_{1n} := I_1 = 497.94$$

$$I'_{2n} := I'^2 = 490.439$$

$$I''_n := \frac{I_{1n}}{I_{1H}} = 4.894$$

$$s = 1 \quad s_H := r''^2 = 0.019$$

$$I'_{2H} := 51.585 \quad (A) \quad \text{по_таблице_1_при_} s_H \text{ (вместо } s \text{)}$$

$$M''_n := \left(\frac{I'_{2n}}{I'_{2H}} \right)^2 \cdot KR \cdot \frac{s_H}{s} = 2.026$$

9.

$$K := 0.19$$

$$P_{\Sigma 1} := 1796 \quad (Bm) \quad \text{по_таблице_1_при_} s_H$$

$$\alpha_1 := 170$$

$$l_{cp1} = 1.277$$

$$k_p := 1.07 \quad \text{для_изоляции_класса_} F$$

$$l_1 := l\delta = 0.161 \quad (m) \quad P_{ст.осн} = 741.992$$

$$P'_{\Sigma.n1} := k_p \cdot P_{\Sigma 1} \cdot \frac{2 \cdot l_1}{l_{cp1}} = 485.904 \quad (Bm) \quad D = 0.204$$

$$\Delta \zeta_{нов1} := K \cdot \frac{P'_{\Sigma.n1} + P_{ст.осн}}{\pi \cdot D \cdot l_1 \cdot \alpha_1} = 13.276 \quad (^\circ C) \quad l_1 = 0.161$$

$$\Pi_{n1} := 2 \cdot h_n + b_{1c} \cdot 10^{-3} + b_{2c} \cdot 10^{-3} = 0.1 \quad (m)$$

$$\lambda_{экв} := 0.16 \quad \text{для_изоляции_класса_} F$$

$$\lambda'_{экв} := 1.1$$

$При$	$Z1 = 36$	$l1 = 0.161$
$\frac{d\lambda}{du3} = 0.937$	$Пn1 = 0.1$	
$буз.n1 := буз = 0.4$		
$\Delta\zeta_{уз.n1} := \frac{P'_{\lambda}.n1}{Z1 \cdot Пn1 \cdot l1} \cdot \left(\frac{буз.n1 \cdot 10^{-3}}{\lambda_{\lambda\kappa\theta}} + \frac{(b1c + b2c) \cdot 10^{-3}}{16 \cdot \lambda'_{\lambda\kappa\theta}} \right) = 3.177$		$(^{\circ}C)$
$P'_{\lambda}.l1 := kp \cdot P_{\lambda}1 \cdot 2 \cdot \frac{l1}{lcp1} = 1.436 \cdot 10^3$	(Bm)	$\lambda_{\lambda\kappa\theta} = 0.16$
$P_{\lambda}1 = 1.796 \cdot 10^3$	$l1 = 0.477$	$lcp1 = 1.277$
$Пl1 := Пn1 = 0.1$	$(м)$	$hn1 = 0.039$
		$\lambda'_{\lambda\kappa\theta} = 1.1$
$буз.l1 := 0$	$l_{\text{выл}} = 0.109$	$\alpha1 = 170$
$\Delta\zeta_{уз.l1} := \frac{P'_{\lambda}.l1}{2 \cdot Z1 \cdot Пl1 \cdot l1} \cdot \left(\frac{буз.l1}{\lambda_{\lambda\kappa\theta}} + \frac{hn1}{12 \cdot \lambda'_{\lambda\kappa\theta}} \right) = 1.22$		$(^{\circ}C)$
$\Delta\zeta_{нов1} = 13.276$	$\Delta\zeta_{нов.l1} := \frac{K \cdot P'_{\lambda}.n1}{2 \cdot \pi \cdot D \cdot l_{\text{выл}} \cdot \alpha1} = 3.89$	$(^{\circ}C)$
$\Delta\zeta_{уз.n1} = 3.177$		$P'_{\lambda}.n1 = 485.904$
$lcp1 = 1.277$		$K = 0.19$
$l1 = 0.161$		$D = 0.204$
$\Delta\zeta_{нов.l1} = 3.89$	$\Delta\zeta'1 := \frac{(\Delta\zeta_{нов1} + \Delta\zeta_{уз.n1}) \cdot 2 \cdot l1}{lcp1} + \frac{(\Delta\zeta_{нов.l1} + \Delta\zeta_{уз.l1}) \cdot 2 \cdot l1}{lcp1} = 7.978$	
$\Delta\zeta_{уз.l1} = 1.22$		
$l1 = 0.477$	$P_{\lambda}2 := 1174 (Bm)$	$\Sigma P := 6019 (Bm)$
		$по_таблице_1_при_сн$
	$\Sigma P' := \Sigma P + (kp - 1) \cdot (P_{\lambda}1 + P_{\lambda}2) = 6.227 \cdot 10^3$	(Bm)
	$\Sigma P'_{\theta} := \Sigma P' - (1 - K) \cdot (P'_{\lambda}.n1 + P_{\text{см.осн}}) - 0.9 \cdot P_{\text{мех}} = 3.32 \cdot 10^3$	(Bm)
		$P'_{\lambda}.n1 = 485.904$
$Пp := 0.56$	$(м)$	$K = 0.19$
		$P_{\text{см.осн}} = 741.992$
		$P_{\text{мех}} = 2.125 \cdot 10^3$
$Skop := (\pi \cdot Da + 8 \cdot Пp) \cdot (l1 + 2 \cdot l_{\text{выл}}) = 2.167$		$(м^2)$
$\alpha_{\theta} := 26$	$Da = 0.392$	$Пp = 0.56$
		$\Sigma P = 6.019 \cdot 10^3$
$\Delta\zeta_{\theta} := \frac{\Sigma P'_{\theta}}{Skop \cdot \alpha_{\theta}} = 58.915$	$(^{\circ}C)$	$l_{\text{выл}} = 0.109$
		$kp = 1.07$
		$P_{\lambda}1 = 1.796 \cdot 10^3$
$\Delta\zeta'1 := \Delta\zeta'1 + \Delta\zeta_{\theta} = 66.892$	$(^{\circ}C)$	$\Delta\zeta'1 = 7.978$
$km := m \cdot \sqrt{\frac{n1}{100} \cdot Da} = 10.288$		$\Sigma P'_{\theta} = 3.32 \cdot 10^3$
$Q_{\theta} := \frac{km \cdot \Sigma P'_{\theta}}{1100 \cdot \Delta\zeta_{\theta}} = 0.527$	$\left(\frac{м^3}{c} \right)$	$n1 = 3 \cdot 10^3$
		$Da = 0.392$
$Q'_{\theta} := 0.6 \cdot Da^3 \cdot \frac{n1}{100} = 1.084$	$\left(\frac{м^3}{c} \right)$	

$$Q'_{\text{в}} > Q_{\text{в}}$$

вывод

$$Ca := \frac{l\delta \cdot D^2 \cdot w1}{P'} = 4.28 \cdot 10^{-6}$$

$$P' = 6.581 \cdot 10^4$$

$$D = 0.204$$

$$w1 = 42$$

$$l\delta = 0.161$$