$$d_1 \geq 4045 \sqrt[3]{\frac{P_1}{\varphi_d \cdot n_1} \cdot \frac{i_2+1}{i_2} \cdot K_A \cdot K_{H\alpha} \cdot K_{H\beta} \cdot \left(\frac{S_{H\min}}{\sigma_{H\lim}}\right)^2}$$

$\varphi_d = 1$

$S_{H\min} = 1{,}3$ $\quad P_1 = 14\,kW$

$\sigma_{H\lim}$ 22Ć360 (ČSN 42 0745) $= 460\ N/mm^2$ $\quad n_1 = \frac{1100}{60}$

$i = 4$

$K_{H\alpha} = 2$

$K_{H\nu} = 1$

$K_{A\alpha} = 1$

$K_{H\beta} = 1$

$$d_1 \geq 4045 \cdot \sqrt[3]{\frac{14 \cdot 60}{1100} \cdot \frac{5}{4} \cdot 2 \cdot \left(\frac{1{,}3}{460}\right)^2}$$

$$d_1 \geq 109{,}3\ mm$$

$$\omega = \frac{2\pi n}{60} = \frac{2\pi \cdot 1100}{60} = 115{,}12\ rad/s$$

$$v = \frac{d_1 \omega}{2} = \frac{109{,}3 \cdot 115{,}12}{2}$$

$$v = 5776{,}86\ m$$

$$v = 5{,}77\ m/s \Rightarrow z_1 = 20 \ldots 25 \quad (21)$$

$$z_2 = 21 \cdot i_2$$
$$= 21 \cdot 4$$
$$z_2 = 21 \cdot 4$$
$$= 84$$

$$m_n = \frac{d_1}{z_1} = \frac{109{,}3}{21} = 4{,}472619 \Rightarrow m_n = 5$$

$$a = \frac{m_n}{2}(z_1 + z_2)$$

$$a = \frac{5}{2}(21+84) = 262{,}5\ mm$$

$$d_1 = m_n \cdot z_1 = 5 \cdot 21 = 105\ mm$$

$$b_2 = \psi_d \cdot d_1 = 105\ mm$$

$$b_1 = b_2 + 5\ mm = 110\ mm$$

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$d_2 = m_n \cdot z_2$

$= 5 \cdot 84$

$d_2 = 420\ mm$

$c = c^* \cdot m_n$

$c = 0{,}25 \cdot 5 = 1{,}25$

$h_f = m + c \quad (m_n \cdot 1{,}25)$

$= 5 + 1{,}25 = 6{,}25$

$d_{f1} = d_1 - 2h_f$

$= 105 - 12{,}5$

$d_{f1} = 92{,}5\ mm$

$d_{f2} = d_2 - 12{,}5$

$d_{f2} = 420 - 12{,}5$

$d_{f2} = 407{,}5\ mm$

} Promjer preko korijena zuba

$d_{a1} = 2 \cdot 262{,}5 - 92{,}5 - 2 \cdot 12{,}5$

$d_{a1} = 115\ mm$

$d_{a2} = 2 \cdot 262{,}5 - 92{,}5 - 25$

$d_{a2} = 430\ mm$

} Promjer preko glave zupčanika

Momenti i snage

$T_1 = \frac{P_1}{\omega_1} = \frac{14 \cdot 10^3 \cdot 60}{2 \cdot \pi \cdot 1100} = 121{,}53\ Nm$

$P_2 = \sum_{a=1}^{n} \eta_a \cdot P_1$

$= (0{,}99 \cdot 0{,}98 \cdot 0{,}98) \cdot 14\ kW$

$P_2 = 0{,}950796 \cdot 14\ kW$

$P_2 = 13311{,}14\ W$

$n_2 = \frac{n_1}{i} = \frac{1100}{4} = 275\ min^{-1}$

$T_2 = \frac{P_2}{\omega_2} = \frac{13311{,}14 \cdot 60}{2\pi \cdot 275}$

$T_2 = 462{,}2\ Nm$

$$F_t = \frac{2 \cdot T_1}{d_1} = \frac{2 \cdot 121{,}53}{0{,}105} =$$

$$F_t = 2314{,}85\ N$$

$$F = \sqrt{F_t^2 + F_r^2}$$

$$= \sqrt{2315^2 + 243^2}$$

$$F = 2327{,}72\ N$$

$$F_{A1} = F_{B1} = \frac{F}{2} = 1164\ N$$

$$F_r = F_t \cdot \tan\alpha$$

$$= 2315 \cdot \tan(20)$$

$$F_r = 2425{,}3 \Rightarrow 243\ N$$

Proračun vratila – Poganjko

$$d_{PR} \geq \sqrt[3]{\frac{16 \cdot T_{ekv}}{\pi \cdot \tau_{tdop}}}$$

$$R_{dto} = 260\ N/mm^2$$

$$d \geq \sqrt[3]{\frac{16 \cdot T_n \cdot k_A \cdot S}{\pi \cdot R_{dto}}}$$

$$d \geq \sqrt[3]{\frac{16 \cdot 121{,}2 \cdot 12 \cdot 10^3}{\pi \cdot 260}}$$

$$d \geq 38{,}45\ mm \Rightarrow \text{PO DIN 748}\ \ d_1 = 40 \times 110\ \text{DIN 748},$$

$r_{max} = 1\ mm$ (Ø40k6)

PROMJER LEŽAJA – UNUTARNJI

$$d_L = d_V + 5\ mm$$

$$d_L = 40 + 5$$

$$d_L = 45\ mm$$

ULOŽNO PERO:

DIN6885 – A 12 x 8 x 100 – E295

utor – $t_1 = 5\ mm$ – u vratilu

utor u glavini – $t_2 = 3{,}3\ mm$

d_a – BOČNI OSLONAC LEŽAJA za 6009 (SKF)

$$44{,}6\ mm \leq d_a \leq 49{,}25\ mm \Rightarrow d_a = 48\ mm$$

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GONJENO VRATILO

$$d_2 \geq \sqrt[3]{\frac{16 \cdot T_{m_2} \cdot K_A \cdot S}{\pi \cdot R_{d60}}}$$

$$d_2 \geq \sqrt[3]{\frac{16 \cdot 462 \cdot 10^3 \cdot 2 \cdot 1,4}{\pi \cdot 260}}$$

~~$d_2 \geq 60,11$ mm~~

$d_2 \geq 58,39$ mm $\Rightarrow$ $d_2 = 60 \times 140$ DIN 748 ($\varnothing 60$ m6)

ULOŽNO PERO:

DIN 6885 - A 18 x 11 x 130 - E295

$t_1 = 7$ mm - utor u vratilu

$t_2 = 4,4$ mm - utor u glavini

ODABIR LEŽAJEVA $v < 150°C \Rightarrow f_t = 1$

POGONSKO VRATILO

~~$L_{10h} = 60000$~~

$$L_{10h} = \left(\frac{C}{F} \cdot f_t\right)^p \cdot \frac{10^6}{60 n} \Rightarrow C = \frac{F}{f_t} \sqrt[p]{\frac{L_{10h} \cdot 60 \cdot n}{10^6}}$$

Za pogonska vratila: kuglični ležajevi $\Rightarrow p = 3$

$$C \geq \frac{1164}{1} \cdot \sqrt[3]{\frac{19000 \cdot 60 \cdot 1100}{10^6}}$$

$C \geq 12552,17$ N

$C \geq 12,5$ kN $\Rightarrow$ iz SKF kataloga 6008 $\therefore C = 17,8$ kN

~~$d = 44,6$ mm~~ $d_a \leq d_1 = 49,25$ mm

$D = 68$ mm

$B = 15$ mm

$$L_{10h} = \left(\frac{C}{F} \cdot f_t\right)^p \cdot \frac{10^6}{60 n}$$

$$= \left(\frac{17,8 \cdot 10^3}{1164}\right)^3 \cdot \frac{10^6}{60 \cdot 1100}$$

$L_{10h} = 54182$ sati

~~GONJENO:~~

LUMENART

LEŽAJEVI CILINDRIČNI VALJCI $\Rightarrow k = \frac{10}{3}$

GONJENO VRATILO

$$F_\epsilon = \frac{2 \cdot T_2}{d_2} = \frac{2 \cdot 462{,}2}{0{,}42}$$

$$F_\epsilon = 2201\,N$$

$$F = \sqrt{2201^2 + 801^2}$$

$$F = 2342\,N$$

$$F_{A2} = F_{B2} = \frac{F}{2} = 1171\,N$$

$$F_r = F_\epsilon \cdot \tan\alpha$$

$$= 2201 \cdot \tan 20°$$

$$F_r = 801\,N$$

$$C \geq 1171 \cdot \sqrt[\frac{10}{3}]{\frac{19000 \cdot 60 \cdot 275}{10^6}}$$

$$C \geq 6568\,N \Rightarrow SRF\ 32912 \therefore C = 53{,}2\,kN$$

$$L_{10h} = \left(\frac{53{,}2 \cdot 10^3}{1171}\right)^{\frac{10}{3}} \cdot \frac{10^6}{60 \cdot 275}$$

$$L_{10h} = 20278314\,h \Rightarrow ZA\ VIJEK\ ???$$