طراحی اجزای دو — تکلیف شماره ۲

(حل سئوال ۱)

$$N = |N_j + N_b - 2N_f|$$

$$N = |50 + 0 - (-2\times 25)| = 100 \ \text{rps}$$

$$P = \frac{W}{2rl} = \frac{800}{2\times 1\times 2} = 200 \ \text{psi}$$

$$S = \left(\frac{r}{c}\right)^2 \left(\frac{\mu N}{P}\right)$$

Figure 12-12 $\longrightarrow$ $\mu = 0.26\,(\mu)$ SAE-10 at 300 °F

$\mu = 0.85\,(\mu)$ SAE-70 at 300 °F

$$\Rightarrow S = \left(\frac{1}{0.001}\right)^2 \times \frac{\mu \times 100}{200} \begin{cases} S = 0.13 & \text{SAE-10} \\ S = 0.43 & \text{SAE-70} \end{cases}$$

Figure 12-16 $\left(\frac{l}{d} = \frac{2}{2} = 1\right)$

$\frac{h_0}{c} = 0.42$ $\quad \varepsilon = 0.62$ $\quad$ SAE-10 $\quad$ (Min.f - Max.W) در محدوده است!

$\frac{h_0}{c} = 0.71$ $\quad \varepsilon = 0.31$ $\quad$ SAE-70 $\quad$ خارج از محدوده مطلوب است!

$$\Rightarrow \begin{cases} h_0 = 0.42 \times 0.001 = 42\times 10^{-5} \ (\text{inch}) \ \text{SAE-10} \\ h_0 = 0.71 \times 0.001 = 71\times 10^{-5} \ (\text{inch}) \ \text{SAE-70} \end{cases}$$

$$\Rightarrow \begin{cases} \varepsilon = \frac{e}{c} \Rightarrow e = 0.62 \times 0.001 = 62\times 10^{-5} \ (\text{inch}) \ \text{SAE-10} \\ \varepsilon = \frac{e}{c} \Rightarrow e = 0.31 \times 0.001 = 31\times 10^{-5} \ (\text{inch}) \ \text{SAE-70} \end{cases}$$

پس از لحاظ کمینه ضریب اصطکاک و بیشینه بار، روغن SAE-10 مناسب‌تر می‌باشد!

Figure 12-18

$$\frac{r}{c} f = 0.32 \Rightarrow f = 0.32 \times \frac{0.001}{1} = 32\times 10^{-5} \ \text{SAE-10}$$

$$\frac{r}{c} f = 5.8 \Rightarrow f = 5.8 \times \frac{0.001}{1} = 58\times 10^{-4} \ \text{SAE-70}$$

$$T = fWr \longrightarrow H_{loss} = \frac{TN}{1050} = \frac{fWrN}{1050}$$

$$\Rightarrow \begin{cases} H_{loss} = \dfrac{32\times 10^{-5} \times 800 \times 1 \times 100}{1050} = 0.024 \ \text{hp} \ \text{SAE-10} \\ H_{loss} = \dfrac{58\times 10^{-4} \times 800 \times 1 \times 100}{1050} = 0.442 \ \text{hp} \ \text{SAE-70} \end{cases}$$

(2)

Figure 12-17 → SAE-10 : $\phi = 52^\circ$

→ SAE-70 : $\phi = 70^\circ$

Figure 12-19 → SAE-10 : $\frac{Q}{rcNl} = 4.3 \Rightarrow Q = 4.3 \times 1 \times 0.001 \times 100 \times 2 = 0.86 \ in^3/s$

→ SAE-70 : $\frac{Q}{rcNl} = 3.7 \Rightarrow Q = 3.7 \times 1 \times 0.001 \times 100 \times 2 = 0.60 \ in^3/s$

Figure 12-20 → SAE-10 : $\frac{Q_s}{Q} = 0.68 \Rightarrow Q_s = 0.58 \ in^3/s$

→ SAE-70 : $\frac{Q_s}{Q} = 0.38 \Rightarrow Q_s = 0.23 \ in^3/s$

Figure 12-21 → SAE-10 : $\frac{P}{P_{max}} = 0.42 \rightarrow P_{max} = \frac{200}{0.42} = 476.2 \ psi$

→ SAE-70 : $\frac{P}{P_{max}} = 0.51 \rightarrow P_{max} = \frac{200}{0.51} = 392.2 \ psi$

Figure 12-22 → SAE-10 : $\theta_{P_o} = 74^\circ$, $\theta_{P_{max}} = 74^\circ$

→ SAE-70 : $\theta_{P_o} = 100^\circ$, $\theta_{P_{max}} = 16^\circ$

Figure 12-24

$\frac{l}{d} = 1 \rightarrow \frac{9.7\,\Delta T}{P} = 0.349109 + 6.00940\,S + 0.047465\,S^2$

$\rightarrow$ SAE-10 : $\frac{9.7\,\Delta T}{P} = 1.131$

SAE-70 : $\frac{9.7\,\Delta T}{P} = 2.942$

$\rightarrow$ $\Delta T = 1.131 \times \frac{200}{9.7} = 23.3 \ ^\circ F$

$\Delta T = 2.942 \times \frac{200}{9.7} = 60.7 \ ^\circ F$

③ (ادامه سوال)

$$d = \frac{N}{P_t} \longrightarrow N_p = \frac{2k\cos\psi}{3\sin^2\phi_t}\left(1+\sqrt{1+3\sin^2\phi_t}\right)$$

که در: $k = 1$: full-depth teeth

$$\phi_t = \tan^{-1}\left(\frac{\tan\phi_n}{\cos\psi}\right) = \tan^{-1}\left(\frac{\tan 15}{\cos 30}\right) = \tan^{-1}(0.309) = 17.2^\circ$$

$$\Rightarrow N_p = \frac{2\times 1\times\cos 30}{3\sin^2(17.2)}\left(1+\sqrt{1+3\sin^2(17.2)}\right)$$

$$\Rightarrow N_p = 7.4 \longrightarrow N_p = 8 \quad \surd \text{ (الف)}$$

$$d = \frac{N}{P_t} \begin{cases} \text{Coarse}: & d = \frac{8}{10} = 0.8 \quad \text{inch} \\ \text{Fine}: & d = \frac{8}{40} = 0.2 \quad \text{inch} \end{cases}$$

$$P_t = \frac{\pi}{P_t} \begin{cases} \text{Coarse}: & P_t = \frac{\pi}{10} = 0.3 \quad \text{inch} \\ \text{Fine}: & P_t = \frac{\pi}{40} = 0.1 \quad \text{inch} \end{cases}$$

$$P_n = P_t\cos\psi \begin{cases} \text{Coarse}: & P_n = 0.3\times\cos 30 = 0.3 \quad \text{inch} \\ \text{Fine}: & P_n = 0.1\times\cos 30 = 0.1 \quad \text{inch} \end{cases}$$

$$P_n = \frac{P_t}{\tan\psi} \begin{cases} \text{Coarse}: & P_x = \frac{0.5}{\tan 30} = 0.5 \quad \text{inch} \\ \text{Fine}: & P_n = \frac{0.1}{\tan 30} = 0.2 \quad \text{inch} \end{cases}$$

$$\text{(Normal)}\ P_n = \frac{P_t}{\cos\psi} \begin{cases} \text{Coarse}: & P_n = \frac{10}{\cos 30} = 11.5 \quad \text{teeth/inch} \\ \text{Fine}: & P_n = \frac{40}{\cos 30} = 46.2 \quad \text{teeth/inch} \end{cases}$$

Table 13-4

$$a = \frac{1}{P_n} \begin{cases} \text{Coarse}: & a = \frac{1}{11.5} = 0.087 \quad \text{inch} \\ \text{Fine}: & a = \frac{1}{46.2} = 0.022 \quad \text{inch} \end{cases}$$

$$b = \frac{1.25}{P_n} \begin{cases} \text{Coarse}: & b = \frac{1.25}{11.5} = 0.109 \quad \text{inch} \\ \text{Fine}: & b = \frac{1.25}{46.2} = 0.027 \quad \text{inch} \end{cases}$$

$$d_b = d\cos\phi_t \begin{cases} \text{Coarse}: & d_b = 0.8\times\cos 17.2 = 0.764 \quad \text{inch} \\ \text{Fine}: & d_b = 0.2\times\cos 17.2 = 0.191 \quad \text{inch} \end{cases}$$

$$\psi_b = \tan^{-1}(\tan\psi\cdot\cos\phi_t) = \tan^{-1}(\tan 30\times\cos 17.2) = \tan^{-1}(0.552) = 29^\circ$$

④

$$W_t = 33000\frac{H}{V}$$

$$V = \frac{\pi dn}{12} \begin{cases} \text{Coarse}: & V = \dfrac{\pi \times 0.8 \times 2000}{12} = 418.7 \quad ft/min \\ \text{Fine}: & V = \dfrac{\pi \times 0.2 \times 2000}{12} = 104.7 \quad ft/min \end{cases}$$

$$W_t = \frac{33000 \times 2}{V} \begin{cases} \text{Coarse}: & W_t = 157.6 \quad lb \\ \text{Fine}: & W_t = 630.4 \quad lb \end{cases}$$

$$W_r = W \sin\phi_n$$

$$W_t = W \cos\phi_n \cos\psi \rightarrow W = \frac{W_t}{\cos\phi_n \cos\psi}$$

$$W_a = W \cos\phi_n \sin\psi$$

$W \rightarrow$ Coarse: $W = \dfrac{157.6}{\cos 15 \times \cos 30} = 188.3 \quad lb$

Fine: $W = \dfrac{630.4}{\cos 15 \times \cos 30} = 753.2 \quad lb$

$W_r \rightarrow$ Coarse: $W_r = 188.3 \times \sin 15 = 48.7 \quad lb$

Fine: $W_r = 753.2 \times \sin 15 = 194.9 \quad lb$

$W_a \rightarrow$ Coarse: $W_a = 188.3 \times \cos 15 \times \sin 30 = 90.9 \quad lb$

Fine: $W_a = 753.2 \times \cos 15 \times \sin 30 = 363.8 \quad lb$

براساس نیروی انتقالی بیشتر، چرخ دنده کوچک (Fine) مناسب است.

براساس نیروی مماسی کمتر، چرخ دنده بزرگ (Coarse) مناسب است.