제 8 장

문제 1 풀이

$$\underbrace{M \cdot t_{ct}}_{\text{tool changing cost/edge}} + \underbrace{C_t}_{\text{tool cost/edge}}$$

$$= 0.2 + \left(\underbrace{\frac{0.8}{4}}_{\text{insert cost/edge}} + \underbrace{\frac{0.08}{4}}_{\text{holder cost/edge}}\right) = \$0.42$$

(1) $\underbrace{M}_{\text{total machine and operate rate}} = \frac{\$20000}{5\text{years} \times 50\text{weeks/year} \times 40(\text{hr})/\text{week} \times 3600\text{sec}/(\text{hr})} + \frac{6\$(\text{hr})}{3600\text{sec}/(\text{hr})}$

$$= 2.22 \times 10^{-3}\ \$/\text{sec}$$

식 (8.11) 에서

$$t_c = \left(\frac{1}{n} - 1\right)\left(\frac{C_t + M \cdot t_{ct}}{M}\right)$$

$$= \left(\frac{1}{0.25} - 1\right)\left(\frac{0.42}{2.22 \times 10^{-3}}\right)$$

$$= 3 \times \frac{0.42}{2.22 \times 10^{-3}} = 567\ \text{sec}$$

$$V_c = \left(\frac{t_r}{t_c}\right)^n \cdot V_r = \left(\frac{60}{567}\right)^{0.25} \times 17.6 = 4.33\ m/\text{sec}$$

(2) $M = \frac{20000}{5 \times 50 \times \underbrace{(2 \times 40)}_{\text{two shifts}} \times 3600} + \frac{6}{3600} = 1.94 \times 10^{-3}\ \$/\text{sec}$

$$\therefore t_c = \left(\frac{1}{n} - 1\right)\left(\frac{C_t + M \cdot t_{ct}}{M}\right) = \frac{3 \times 0.42}{1.94 \times 10^{-3}} = 649.5\ \text{sec}$$

$$V_c = \left(\frac{t_r}{t_c}\right)^n \cdot V_r = \left(\frac{60}{649.5}\right)^{0.25} \times 17.6 = 4.19\ m/\text{sec}$$

[답] (1) 공구수명 $t_c = 567\ \text{sec}$

(2) 절삭속도 $V_c = 4.19\ m/\text{sec}$

문제 2 풀이

$M \cdot t_{ct} + C_t = 0.5\,\$$. $M = 8\,\$/hr = 8\,\$/3600\,sec$

(1) $t_c = \left(\frac{1}{n} - 1\right)\left(\frac{C_t + M \cdot t_{ct}}{M}\right)$

$= \left(\frac{1}{0.25} - 1\right)\left(\frac{0.5}{8/3600}\right) = 675\,sec$

(2) $V_c = \left(\frac{t_r}{t_c}\right)^m \cdot V_r = \left(\frac{1}{675}\right)^{0.25} \times 28 = 5.49\,m/sec$

$(* \; V \cdot t^{0.25} = 28 \rightarrow t = 1$ 일때 $V = 28)$

(3) 식 (8.5) $t_m = \frac{K}{V}$ 에서

그런데 $K = \frac{\pi \cdot d_w \cdot l_w}{f} = \pi \times \frac{80}{1000} \times \frac{3000}{1000} / 0.25 / 1000$

$= \pi \times \frac{80}{1000} \times \frac{3000}{1000} \times \frac{1000}{0.25} = 301.6\,m$

$\therefore t_m = \frac{K}{V_c} = \frac{301.6}{5.49} = 54.93\,sec$

$\frac{t_c}{t_m} = \frac{675}{54.93} \fallingdotseq 12$

$\therefore t_{pr} = t_l + t_m + \frac{t_m}{t_c} \cdot t_{ct}$.

$(* \; t_l + t_m + \frac{N_t}{N_d} \cdot t_{ct} = t_l + t_m + \frac{t_m}{\frac{1}{N_t} \times t_c} = t_l + t_m + \frac{t_m}{t_c} \cdot t_{ct})$

$\therefore t_{pr} = 60 + 54.93 + \frac{1}{12} \times 30 = 117.43\,sec$

$\therefore$ 1 batch 의 가공시간 $= 1\,hour + N \times t_{pr} = 3600 + 1000 \times 117.43)$

$= 121\,Ksec$.

(나) 총가공비 $= N \times C_{pr} = N \times M \cdot (t_c + t_m + \frac{t_m}{t_c} \cdot t_{ct}) + (\frac{t_m}{t_c}) \cdot C_t$

$= \frac{\$8}{3600\,sec} \times (121 \times 10^3)\,sec + \frac{1}{12} \times 0.5\$ = 269\$$

[답]

(1) 공구수명 $t_c = 675\,sec$

(2) 절삭속도 $V_c = 5.49\,m/sec$

(3) 총생산시간 $= 121\,Ksec$

(4) 총생산비 $S = 269\$$

문제 3 풀이

(1) $C_t = \frac{10\$}{10} + 1\$ = 2\$$: 공구비/grinding

$$M = W_o + \left(\frac{\text{persent operator overheads}^{100}}{100}\right) \cdot W_o + M_t + \left(\frac{\text{persent machine overheads}^{100}}{100}\right) \cdot M_t$$

$= 2W_o + 2M_t$

$= 2 \times \frac{5\$}{3600\,sec} + 2 \cdot \frac{20000}{10\,years \times 50\,weeks/year \times 5\,days/week \times 8\,hr/day \times 3600\,sec/hr}$

$= 3.33 \times 10^{-3}\,\$/sec.$

$t_c = (\frac{1}{m} - 1)(\frac{C_t}{M} + t_{ct})$

$= (\frac{1}{0.25} - 1)(\frac{2}{3.33 \times 10^{-3}} + 4 \times 60) = 2520\,sec$

$\therefore V_c = (\frac{t_r}{t_c})^n \cdot V_r = (\frac{1}{2520})^{0.25} \times 7 = 0.988\,m/sec.$

($V_r \cdot t_r^{0.25} = 7$ 에서 $t_r = 1$ 일때 $V_r = 7$)

$\therefore t_m = \frac{K}{V_c} = \frac{200}{0.988} = 202\ sec$

$\therefore \frac{t_c}{t_m} = \frac{2520}{202} \fallingdotseq 12.$

∴ 최소 가공비는 A(8.2)와 (8.4)에서.

$C_{pr} = M \cdot t_e + M \cdot t_m + \frac{t_m}{t_c}(C_t + M \cdot t_{ct})$

$= (3.33 \times 10^{-3}) \times (5 \times 60) + (3.33 \times 10^{-3}) \cdot (202)$

$+ \frac{1}{12}\{(2 + 3.33 \times 10^{-3}) \times (4 \times 60)\}$

$\fallingdotseq 1.9$ ₩.

(2) $t_p = (\frac{1}{m} - 1) \cdot t_{ct} = (\frac{1}{0.25} - 1) \times (4 \times 60) = 720\ sec.$

$\therefore V_p = (\frac{t_r}{t_c})^m \cdot V_r = (\frac{1}{720})^{0.25} \times 7 = 1.35\ m/sec.$

$(V_r \cdot t_r^{0.25} = 7$ 에서 $t_r = 1$ 일때 $V_r = 7)$

$\therefore t_m = \frac{K}{V_p} = \frac{200}{1.35} = 148\ sec$

$\therefore \frac{t_m}{t_p} = \frac{148}{720} \fallingdotseq \frac{1}{5}$

∴ 최소 가공 A간 $t_{pr} = t_e + t_m + \frac{t_m}{t_p} \cdot t_{ct}$

$= (5 \times 60) + 148 + \frac{1}{5} \times (4 \times 60)$

$= 496\ sec$

[답]

(1) 최소 생산가 $C_{pr} \fallingdotseq 1.9$₩

(2) 최소 생산시간 $t_{pr} = 496\ sec$

문제 4 풀이

$$t_{ef} = \left(\frac{1-m}{m}\right)\left(t_{qt} + \frac{t_e \cdot C_t}{s}\right) + \frac{C_t \cdot K}{m \cdot s \cdot V_r}\left(\frac{t_{ef}}{t_r}\right)^m$$

$$= \left(\frac{1-0.25}{0.25}\right)\left(4\times 60 + \frac{5\times 60\times 2}{4}\right) + \frac{2\times 200}{0.25\times 4\times 7}\left(\frac{t_{ef}}{1}\right)^m$$

$$= 1170 + 57.14 \times t_{ef}^{\,m}$$

$t_{ef}^{\,m} = 6.5s^m$ 라 놓으면

$$t_{ef} = 1170 + 57.14 \times 6.5s^m = 1170 + 57.14 \times 6.5 \times 4^{0.25}$$

$$= 1433 \text{ sec}$$

$$\therefore V_{ef} = \left(\frac{t_r}{t_{ef}}\right)^m \cdot V_r = \left(\frac{1}{1433}\right)^{0.25} \times 7 = 1.14 \text{ m/sec}$$

($V_r \cdot t_r^{0.25} = 7$ 에서 $t_r = 1$ 일때 $V_r = 7$)

$$\therefore t_m = \frac{K}{V_{ef}} = \frac{200}{1.14} = 175.4 \text{ sec}$$

$$\therefore \frac{t_{ef}}{t_m} = \frac{1433}{175.4} = 8.17$$

$\therefore$ A (8.8) 에서.

$$t_{pr} = t_e + t_m + \frac{t_m}{t_{ef}} \cdot t_{ct}$$

$$= 5\times 60 + 175.4 + \frac{1}{8.17}(4\times 60) = 504.8 \text{ sec}.$$

$$\therefore C_{pr} = M \cdot t_e + M \cdot t_m + M \cdot \frac{N_t}{N_b} \cdot t_{ct} + \frac{N_t}{N_b} \cdot C_t$$

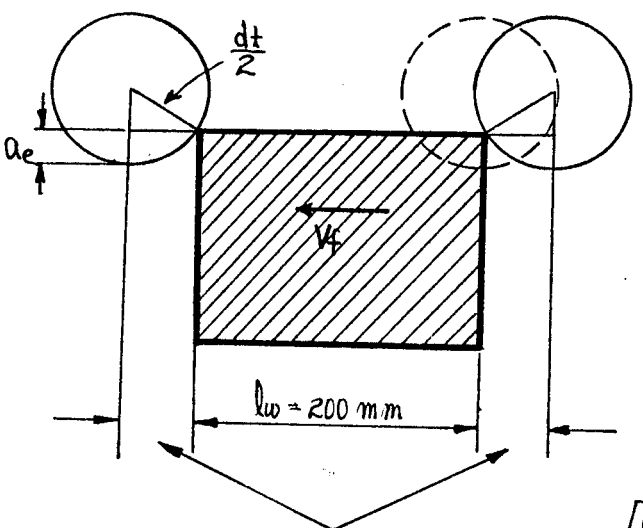
$$= M\underbrace{\left(t_e + t_m + \frac{t_m}{t} \cdot t_{ct}\right)}_{\uparrow t_{pr}} + \frac{t_m}{t} \cdot C_t$$

$= (3.33 \times 10^{-3}) \times 504.8 + \frac{1}{8.17} \times 2 = 1.926$ 개

[답] 공구수명 $t_{ef} = 1433$ sec , 절삭속도 $V_{ef} = 1.14$ m/sec

생산비 $t_{pr} = 504.8$ sec , 생산시간 $C_{pr} = 1.926$ 개

문제 5 풀이



$\sqrt{(\frac{dt}{2})^2 - (\frac{dt}{2} - ae)^2} = \sqrt{ae(dt - ae)}$

$C_t = (\frac{2 \times 80\text{개}}{20} + 2 \times 10\text{개}) + (\frac{2 \times 100\text{개}}{20} + 2 \times 12\text{개}) = 62$ 개

(No. of regrindings)

$t_c = (\frac{1}{\eta} - 1)(t_{ct} + \frac{C_t}{M}) = (\frac{1}{0.125} - 1)(5 \times 60 + \frac{62}{24/3600})$

$= 7(\frac{62}{24/3600} + 300) = 67200$ sec

$t_m = \frac{l_w + 2\sqrt{ae(d_t - ae)}}{V_f} = \frac{200 + 2\sqrt{14(150 - 14)}}{2} = 143.6$ sec

$\therefore \frac{t_c}{t_m} = \frac{67200}{143.6} = 468.$

$$t_{pr} = t_\ell + t_m + \frac{N_t}{N_b}\cdot t_{ct} = t_\ell + t_m + \frac{t_m}{t_c}\cdot t_{ct}$$

$$= 3\times 60 + 143.6 + \frac{1}{468}(5\times 60) = 324\,sec$$

$$C_{pr} = M\cdot t_\ell + M\cdot t_m + M\cdot\frac{N_t}{N_b}\cdot t_{ct} + \frac{N_t}{N_b}\cdot C_t$$

$$= M\underbrace{\left(t_\ell + t_m + \frac{t_m}{t_c}\cdot t_{ct}\right)}_{\uparrow t_{pr}} + \frac{t_m}{t_c}\cdot C_t$$

$$= M\cdot t_{pr} + \frac{t_m}{t_c}\cdot C_t = \frac{24\,¢}{3600}\times 324 + \frac{1}{468}\times 62¢ = 2.29\,¢$$

회전 Vise 에서.

$$t_{pr} = t_\ell + t_m + \frac{t_m}{t_c}\cdot t_{ct} = 30 + 143.6 + \frac{1}{468}\times(5\times 60) = 174\,sec$$

$$C_{pr} = M\cdot t_{pr} + \frac{t_m}{t_c}\cdot C_t = \frac{24}{3600}\times 174 + \frac{1}{468}\times 62 = 1.29\,¢$$

[답] 생산시간 $t_{pr} = 324\,sec$, 최소생산비 $C_{pr} = 2.29¢$

회전Vise 생산시간 $t_{pr} = 174\,sec$, 최소생산비 $C_{pr} = 1.29¢$

문제 6 풀이

$\frac{T}{t_m}$ ← T: tool life, t_m: machining time $= 6$ ← No. of holes.

그런데 $t_m = 6\times 60 = 360\,sec$

$\therefore T = 6\times t_m = 6\times 360 = 2160\,sec$

$$M = W_o + \left(\frac{operator\ overhead}{100}\right)\cdot W_o + M_t + \left(\frac{machine\ over\ head}{100}\right)\cdot M_t$$

$$= \left(\frac{14\text{¢}}{3600} + \frac{10\text{¢}}{3600}\right) + \left(\frac{100000}{50000\times 3600} + \frac{100000\times 0.7}{50000\times 3600}\right)$$

$$= \frac{14}{3600} + \frac{100000\times 1.7}{50000\times 3600} = 4.83\times 10^{-3}\text{¢/sec}$$

$$C_t = \frac{30\text{¢}}{10} + 2\text{¢} = 7\text{¢}.$$

(1) $C_{pr} = M\left(\underset{\uparrow 0}{t_c} + t_m + \frac{t_m}{t}\right) + \frac{t_m}{t}\cdot C_t$

$$= 4.83\times 10^{-3}\left(6\times 60 + \frac{360}{6}\right) + \frac{1}{6}\times 7 = 3.20\text{¢}$$

(2) $t_c = \left(\frac{1}{n} - 1\right)\left(t_{ct} + \frac{C_t}{M}\right)$

$$= \left(\frac{1}{0.25} - 1\right)\left(6\times 60 + \frac{7}{4.83\times 10^{-3}}\right) = 5428\ \text{sec}$$

$V_c = \left(\frac{t}{t_c}\right)^n \cdot V$ 且 $V = \pi \cdot d_t \cdot n_t$ 成立.

$n_{tc} = \left(\frac{t}{t_c}\right)^n \cdot n_t$

$\therefore n_{tc} = \left(\frac{t}{t_c}\right)^n \cdot n_t = \left(\frac{2160}{5428}\right)^{0.25}\times 25 = 19.86\ S^{-1}$

(3) $t_m \propto \frac{1}{n_t}$

$\therefore t_{m_2} = \frac{n_{t_1}}{n_{t_2}} \cdot t_m = \frac{25}{19.86}\times 360 = 453\ \text{sec}$

$\therefore \frac{t_c}{t_{m_2}} = \frac{5428}{453} \doteq 12.$

$$\therefore C_{pr_2} = M\left(t_c + t_m + \frac{t_m}{t}\cdot t_{ct}\right) + \frac{t_m}{t}\cdot C_t$$

(t_c: $t_c \to 0$, t_m: t_m 그대로, $\frac{t_m}{t}$: $t \to t_c$, $\frac{t_m}{t}$: $t_m \to t_m$, $\frac{t_m}{t}$: $t \to t_c$)

$$= 4.83 \times 10^{-3} \times \left(453 + \frac{1}{12} \times 360\right) \times \frac{1}{12} \times 7 = 2.92\,\$$$

[답]

(1) 구멍당 비용 $C_{pr} = 3.20\,\$$

(2) drill 속도 $n_{tc} = 19.86$ sec^{-1}

(3) 최소생산비 에서 구멍당비용 $C_{pr_2} = 2.92\,\$$

문제 7 풀이

$$M = \frac{1}{3 \times 0.9}\left(\frac{25000 \times 1.7}{50000 \times 3600} + \frac{14}{3600}\right) = 2.315 \times 10^{-3}\,\$/\text{sec}$$

$$t_{ct} = 2 \times 60 = 120\ \text{sec}$$

(1) $C_{pr} = M\left(t_c + t_m + \frac{t_m}{t}\cdot t_{ct}\right) + \frac{t_m}{t}\cdot C_t$ ($t_c \to 0$)

$$= 2.315 \times 10^{-3} \times (6 \times 60 + \frac{1}{6} \times 120) + \frac{1}{6} \times 7 = 2.05\,\$.$$

(2) $t_c = \left(\frac{1-n}{n}\right)\left(t_{ct} + \frac{C_t}{M}\right)$

$$\left(\frac{1-0.25}{0.25}\right)\left(120 + \frac{7}{2.315 \times 10^{-3}}\right) = 9431\ \text{sec}$$

$V_c = \left(\frac{t}{t_c}\right)^m \cdot V$ 와 $V = \pi \cdot d_t \cdot n_t$ 에서

$n_{tc} = \left(\frac{t}{t_c}\right)^n \cdot n_t.$

$$\therefore n_{tc} = \left(\frac{t}{t_c}\right)^m \cdot n_t = \left(\frac{2160}{9431}\right)^{0.25} \times 25 = 17.3\ S^{-1}$$

(3) $$t_{m_2} = \frac{n_{t_1}}{n_{t_2}} \cdot t_{m_1} = \frac{25}{17.3} \times 360 = 520\ sec$$

$$\therefore \frac{t_c}{t_{m_2}} = \frac{9431}{520} = 18$$

$$\therefore C_{pr} = M\left(\underset{\uparrow}{t_c} + t_m + \frac{t_m}{t} \cdot t_{ct}\right) + \frac{t_m}{t} \cdot C_t$$

$$= 2.315 \times 10^{-3}\left(520 + \frac{1}{18} \times 120\right) + \frac{1}{18} \times 7$$

$$= 1.61\ ₩ .$$

[답]

(1) drill의 속도가 25sec^{-1} 일때 구멍 1개당의 총생산비 $C_{pr} = 2.05$ ₩

(2) 구멍 1개당의 최소 생산비에 대한 drill의 속도 $n_{tc} = 17.3\ sec^{-1}$

(3) 개당의 총생산비 $C_{pr} = 1.61$ ₩