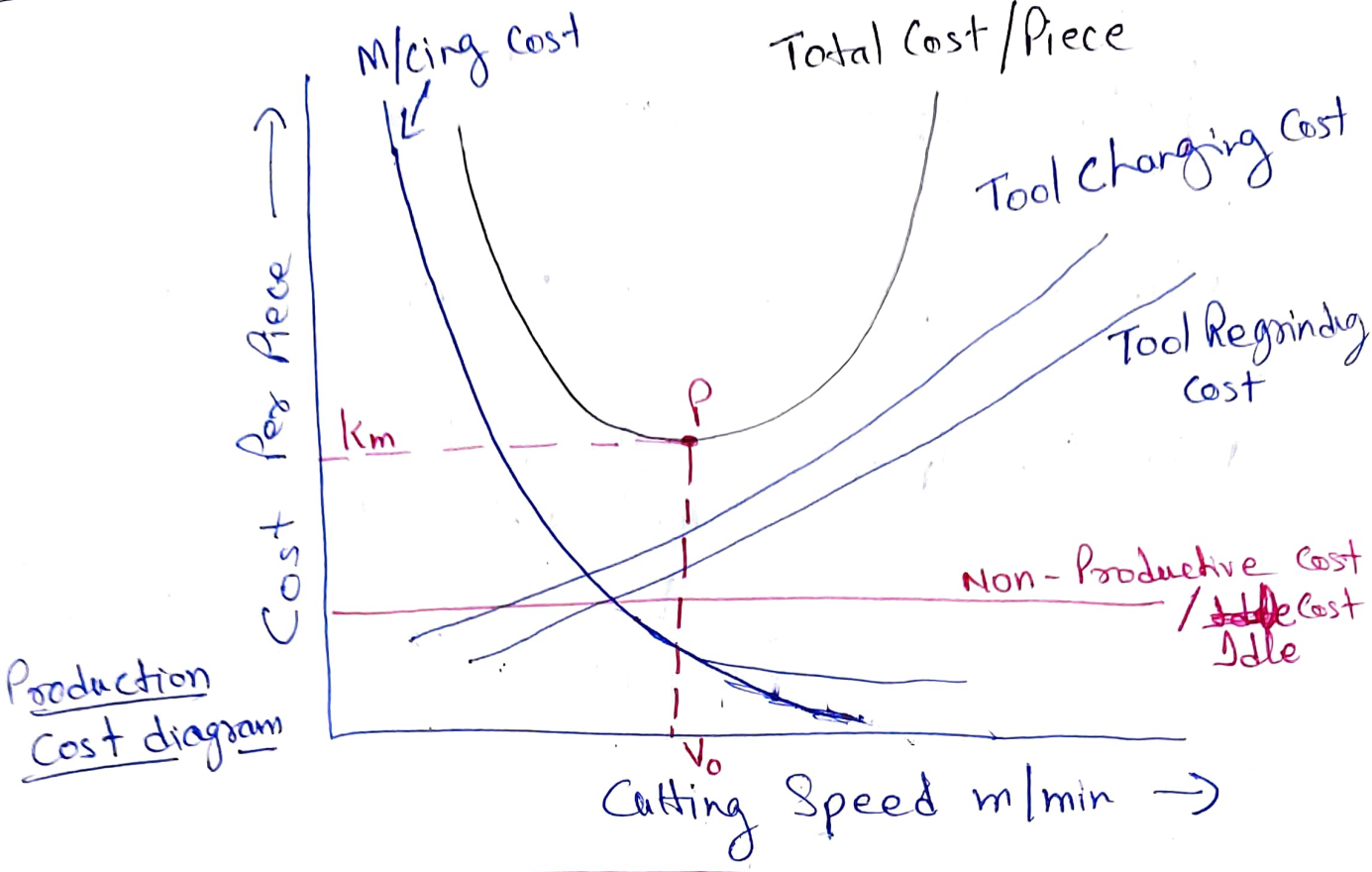
Economics Of Metal Machining



Cost/Piece = Idle Cost Per Piece + Cutting cost per Piece + Tool Changing cost Per Piece + Tool regrinding Cost per Piece.

K_1 = (Direct labour cost + overhead Charges) in Rs/min

K_2 = Cost of tool per grind in Rs.

L = Length of m/cing in mm

D = M/ced dia of workpiece (mm)

V = Cutting speed, in m/min

f = feed rate (mm/rev)

T_i = Idle time per piece, (min)

T_c = Tool changing time (min)

Idle cost/piece = (Direct labour cost + Overhead) x Idle Time

$$\text{Idle cost/piece} = K_1 \times T_i$$

Cutting cost/piece = K_1 x (Machining time/piece)

$$\text{M/cing Time/piece} = \frac{\text{Length of M/cing}}{\text{Feed rate} \times \text{r.p.m}}$$

$$= \frac{L}{f \times N} \quad \left[V = \frac{\pi D N}{1000} \text{ or } N = \frac{V \times 1000}{\pi D} \right]$$

$$= \frac{L}{f \times \frac{V \times 1000}{\pi D}}$$

$$\text{M/cing time/piece} = \frac{\pi D L}{f . V . 1000}$$

$$\text{Cutting Cost/piece} = K_1 \frac{\pi D L}{f . V . 1000}$$

Tool Changing cost/piece = (Direct cost x overheads)
x Tool failures per workpiece
x Tool Changing time for each failure

Taylor's tool life.

$$VT^n = C$$

$$T = \frac{C^{1/n}}{V^{1/n}}$$

Total number of tool failures (T_x) per workpiece

$$T_x = \frac{\text{M/cing time per piece}}{\text{Tool life.}}$$

$$T_x = \frac{\pi DL/1000 f.V.}{C^{1/n}/V^{1/n}}$$

$$T_x = \frac{\pi DL V^{\frac{1}{n}-1}}{1000 f V. C^{1/n}}$$

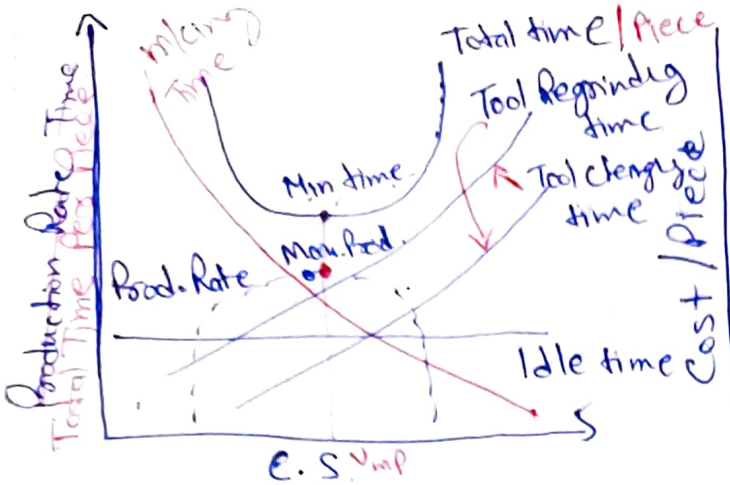
$$\text{Tool charging cost/piece} = K_1 \frac{\pi DL (V)^{\frac{1}{n}-1}}{1000 f V (C)^{1/n}} T_c$$

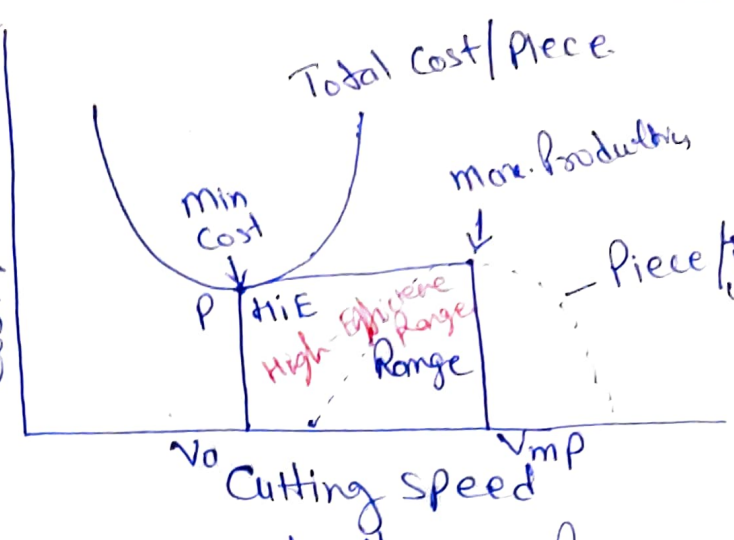
Tool Regrinding cost/piece (T_R) = Cost of tool per grind x Total number of tool failure per workpiece

$$T_R = K_2 \frac{\pi DL (V)^{\frac{1}{n}-1}}{1000 f V (C)^{1/n}}$$

Total Cost per piece (K)

$$K = (K_1 + T_i) + K_1 \frac{\pi DL}{1000 f V} + K_1 \frac{\pi DL (V)^{\frac{1}{n}-1}}{1000 f V (C)^{1/n}} \cdot T_c + K_2 \frac{\pi DL (V)^{\frac{1}{n}-1}}{1000 f V (C)^{1/n}} T$$





Total time in m/cing

Gilbert's HiE - High Efficiency Range
(Combination of total cost/piece & max. production time)

For min. Cost

$$\text{Cutting Speed } (V_o) = \frac{C}{\left[\left(\frac{1}{n}-1\right)\left(\frac{K_1 \times T_c + K_2}{K_1}\right)\right]^n}$$

$$\text{Tool life } (T_{mc}) = \left(\frac{1}{n}-1\right)\left(\frac{K_1 \times T_c + K_2}{K_1}\right)$$

For Max. Production

$$\text{Cutting speed } (V_{mp}) = \frac{C}{\left[\left(\frac{1}{n}-1\right)T_c\right]^n}$$

$$\text{Tool Life } (T_{mp}) = \left(\frac{1}{n}-1\right)T_c$$

8) During m/cing of a component on Lathe the data obtained and those available otherwise are: M/cing Costant (C) = 80, Tool changing time = 5 min, Tool regrinding time = 3 min, Tool depreciation cost = Rs. 1·20 per grind, operating cost = 25 paise/min, Labour + overheads per min. = 20 paise, work loading and unloading = 30 sec., Feed = 0·25 mm/rev exponent (n) = 0·25, Job Length = 500 mm, m/ced all over in 4 passes, Cutting speed = 30 m/min, Work dia. = 60 mm, Idle time/workpiece = 4 min., tool grinding cost = Rs. 1 per grind.

Calculate: i) Optimum Cutting speed

ii) Tool life (min. ~~cost~~ optimum cutting speed)

iii) Cutting speed (Max. production)

iv) Tool life (Max. production)

v) M/cing cost

vi) Tool Changing cost

vii) Tool life

viii) Idle cost

ix) Tool regrinding cost

x) Total cost of production 1000 components.

Sol) i) Cutting speed (min. cost)

$$V_0 = \frac{C}{\left[\left(\frac{1}{n}-1\right)\left(\frac{k_1 \cdot T_c + k_2}{k_1}\right)\right]^n}$$

$$= 50.5 \text{ m/min.}$$

ii) $VT^n = C$

$$T = \left(\frac{C}{V}\right)^{1/0.25} = 6.35 \text{ min.}$$

iii) $V_{mp} = \dfrac{C}{\left[\left(\frac{1}{n}-1\right)T_c\right]^n}$

$= 47.6 \text{ m/min}$

iv) $T_{mp} = \left(\frac{1}{n}-1\right)T_c = 15 \text{ min.}$

v) $\text{M/cing } \cancel{\text{cost}} \text{ time} / \text{piece} = \dfrac{\pi DL}{1000 f V} = 50 \text{ min.}$

M/cing Cost / piece (Rs) $= 1 \times 50$

$= \text{Rs. } 10 / \text{piece}$

vi) $T = \left(\frac{C}{V}\right)^{1/n} = \left(\frac{80}{30}\right)^{\frac{1}{0.25}} = 1.28 \text{ min.}$

vii) $T_{CT} = k_1 \times \text{Tool failure per workpiece} \times T_c$

$= k_1 \times \dfrac{\text{M/cing time}}{\text{Tool life}} \times T_c$

$= 20 \times \dfrac{50}{1.28} \times 5$

$= \text{Rs. } 39.06 / \text{piece.}$

viii) Idle cost $= k_1 \times T_1$

$= 0.80 \text{ P} / \text{piece}$

ix) T_R = Cost / grind x No. of tool failure / piece

$= k_2 \times \dfrac{\text{M/cing time}}{T}$

$= \text{Rs. } 39.06 \text{ per piece}$