Tool Life

During m/cing, the cutting edge of the tool gradually wears out and its does not perform satisfactory. When the wear reaches a certain stage it is said that the tool has lost its utility and its life is over. The period during which a tool cuts satisfactory is called its tool life.

The common method for the measurement of tool life quantitatively are:-

- Machine Time
- Actual Cutting time
- Average length of cut per tool edge.
- Average number of identical components m/ced per tool edge
- Average volume of metal removed per cutting edge
- Cutting speed.

F.W. Taylor developed the relationship b/w tool life and cutting speed –

$$\boxed{VT^n = C} \quad \text{——— (1)}$$

↳ Taylor's tool life equation

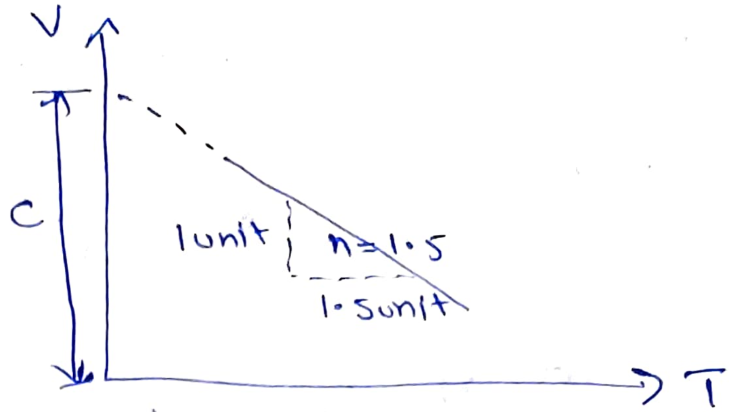
V = cutting speed, m/m

T = Tool life, m

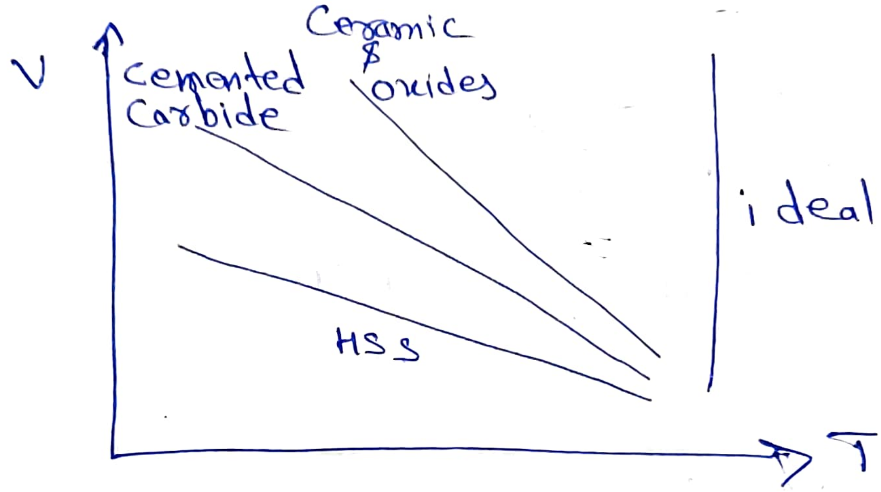
n = ~~exe~~ exponent

C = Constant depend upon the cutting condition and work meterial, known as M/cing Constant

- m/cing at high cutting speed leads to much earlier failure of the tool.
- At low speed low production rate.



Tool life plot (log-log scale)



Log-log tool plots for various cutting tool material.

In log-log representation of eq (i) -

$$\log VT^n = \log C$$

$$\log V = \log C - n \log T$$

$$n = \frac{\log C - \log V}{\log T}$$

At $T = 1$,

$\log T = 0$

$\therefore \log V = \log C$

Q) In m/cing test with two tools A & B, the exponent n and constant C were found to be 0.45 and 90 for tool A and 0.3 and 60 for tool B. Determine the cutting speed above which tool A will have higher tool life than tool B.

Sol) Let

V = Cutting speed above which tool A will have higher tool life than tool B.

at V, $T_A = T_B$

$$V T_A^{0.45} = 90$$

$$V T_B^{0.3} = 60$$

Taking log both side.

$$\ln V + 0.45 \ln T_A = \ln 90 \quad \text{—— (i)}$$

$$\ln V + 0.3 \ln T_B = \ln 60 \quad \text{—— (ii)}$$

Divided (i) & (ii)

$$\ln T_A - \ln T_B = \frac{\ln 90 - \ln V}{0.45} - \frac{\ln 60 - \ln V}{0.30}$$

As $T_A = T_B$, at cutting speed of V, we get

$$0 = \frac{0.3 \ln 90 - 0.3 \ln V - 0.45 \ln 60 + 0.45 \ln V}{0.45 \times 0.3}$$

$$0.15 \ln V = 0.4925$$

$$V = 26.67 \text{ m/min.}$$

Modified Taylor's Constant C_v

Tool life also affected by feed & depth of cut.

$$T = \frac{C_1}{v^m}$$ ——— (~~Tool li~~ speed Cutting)

$$T = \frac{C_2}{t^q}$$ ——— Depth of cut

$$T = \frac{C_3}{s^p}$$ ——— feed.

Combining all above three ~~eq~~ eq.,

$$T = \frac{C_4}{v^m t^q s^p}$$

$$\boxed{V = \frac{C_v}{T^{\frac{1}{m}} s^{y_v} t^{x_v}}}$$ — Taylor's Generalized tool life ~~eqn~~ eq.

$\frac{1}{m} = n$ — Taylor's tool life exponent

$x_v = \frac{q}{m}$ — exponent of depth of cut

$y_v = \frac{p}{m}$ ——— exponent of feed

C_v = modified taylor's Constant

Max. impact on tool life is that ~~cu~~ of cutting speed followed by feed & depth of cut in the given order, $m > p > q$, therefor $y_v > x_v$. The value of x_v & y_v depand on the type of cutting tool, work material and m/cing conditions.

5) The following tool life equation was obtained for HSS tool, $VT^{0.13}S^{0.6}t^{0.3} = C$. Tool life of 60min was obtained at $V = 40$ m/min, $S = 0.25$ mm/rev and $t = 2$ mm. Calculate the effect of tool life if V, S and t are together increased by 25 percent.

Sol Given Data.

$$VT^{0.13}S^{0.6}t^{0.3} = C$$

$V = 40$ m/min

$S = 0.25$ mm/rev

$t = 2$ mm

$T = 60$ min

$$40 \times 60^{0.13} \times 0.25^{0.6} \times 2^{0.3} = C$$

$$C = 36.5$$

With increase of 25%.

$V = 1.25 \times 40 = 50$ m/min, $S = 1.25 \times 0.25 = 0.3125$ mm/rev

$t = 1.25 \times 2 = 2.5$ mm

$$T = \frac{36.5}{50(0.3125)^{0.6}(2.5)^{0.3}}$$

$T = 2.30$ min.

Effect of Cutting Fluid on Tool Life. ⟶