Table 1 page 42 Pulkabrek (1)

First column.

$B = 2.00$

$S = 2.04$

$\bar{U}_p = 2S\frac{N}{60}$

$= 2 \times \frac{2.04}{100} \times \frac{13000}{60} \frac{m}{s}$

$= \underline{\underline{8.84\ m/s}}.$

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3. A four-cylinder 2.4L engine operates on a four-stroke cycle at 3200 ~~rpm~~ RPM. The compression ratio is 9.4:1, the connecting rod length $r = 18$ cm, and the bore and stroke are related as $S = 1.06B$. At this speed, combustion ends at 20° aTDC.

Calculate:

(a) clearance volume ~~or~~ of one cylinder in cm^3.

(b) Bore and stroke in cm.

(c) Average piston speed in m/s.

(d) Piston speed at end of combustion.

(e) distance the piston has travelled from TDC at the end of combustion.

(f) volume in the combustion chamber at the end of combustion.

Ans: Displacement Volume of each cylinder $= \frac{2.4}{4} L = 0.6L$

$\therefore \frac{\pi}{4}B^2 S = \frac{\pi}{4}B^2 \times 1.06B = 0.6 \times 10^3\ cm^3$

$B^3 = \frac{0.6 \times 10^3 \times 4}{\pi \times 1.06} = 720.7\ cm^3$

$\therefore B = 8.96$ cm. $\therefore S = 9.5$ cm.

r_c = compression ratio $= \frac{V_d + V_c}{V_c}$ where V_d = displacement volume, V_c = clearance volume.

$9.4 = \frac{0.6 \times 10^3}{V_c} + 1$

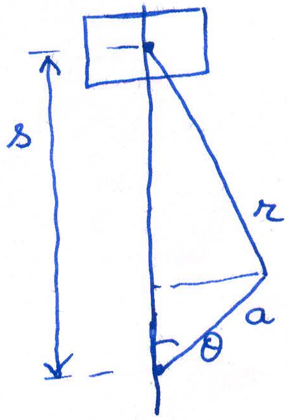
or, $\frac{0.6 \times 10^3}{V_c} = 9.4 - 1 = 8.4$,

or, $V_c = \frac{0.6 \times 10^3}{8.4} = 71.4\ cm^3$

Average piston speed $= \frac{2SN}{60}$ where S = stroke length, N = RPM

$= \frac{2 \times 9.5 \times 10^{-2} \times 3200}{60}$ m/s

$= \cancel{1.01 \text{ m/s}}$ 10.1 m/s



$s = a\cos\theta + \sqrt{r^2 - a^2\sin^2\theta}$

$= a\left[\cos\theta + \sqrt{R^2 - \sin^2\theta}\right]$ where $R = \frac{r}{a}$.

$U_p =$ Piston speed $= \cancel{d\theta} \frac{ds}{dt}$

$U_p = \frac{ds}{dt} = a\left[-\sin\theta - \frac{1}{\cancel{2}} \cdot \frac{1}{\sqrt{R^2 - \sin^2\theta}} \cdot \cancel{2}\sin\theta\cos\theta\right]\frac{d\theta}{dt}$

$= \cancel{(-a\sin\theta)\omega}$

$= -a\omega\sin\theta\left[1 + \frac{\cos\theta}{\sqrt{R^2 - \sin^2\theta}}\right]$

$\bar{U}_p = \frac{2SN}{60} = \frac{S}{\pi} \cdot \frac{2\pi N}{60} = \frac{S\omega}{\pi} = \frac{2a\omega}{\pi}$

$R = \frac{r}{a} = \frac{r}{\frac{S}{2}} = \frac{2r}{S} = \frac{2 \times 18}{9.5} = 3.79$

$\therefore \frac{U_p}{\bar{U}_p} = \frac{-\cancel{a}\cancel{\omega}\sin\theta \times \pi\left[1 + \frac{\cos\theta}{\sqrt{R^2 - \sin^2\theta}}\right]}{2\cancel{a}\cancel{\omega}}$

$= -\frac{\pi}{2}\sin\theta\left[1 + \frac{\cos\theta}{\sqrt{R^2 - \sin^2\theta}}\right]$

$= -\frac{\pi}{2} \times \sin 20 \times \left[1 + \frac{\cos 20}{\sqrt{3.79^2 - \sin^2 20}}\right]$

$= -\frac{\pi}{2} \times 0.342 \times 1.249$

$= \cancel{0.134}$ 0.671 Taking absolute value.

$\therefore U_p = \cancel{1.35 \text{ m/s}}$ 6.78 m/s

~~&~~ $s = \cancel{r+a}\ a\left[\cos\theta + \sqrt{R^2 - \sin^2\theta}\right]$

$= \frac{9.5}{2}\left[\cos 20 + \sqrt{3.79^2 - \sin^2 20}\right]$

$= 22.39$ cm

$x = r + a - s = 18 + \frac{9.5}{2} - 22.39 = 0.36$ cm.

Volume in the combustion chamber

$$= V_c + \frac{\pi}{4} B^2 . x$$

$$= 71.4 + \frac{\pi}{4} \times 8.96^2 \times 0.36 \text{ cm}^3$$

$$= 94 \text{ cm}^3$$