4) $B.P_{(1)} = T_1 \cdot \omega = 177 \times \frac{2\pi}{60} \times 2000 = 37.07 \text{ Kw}$

$B.P_{(2)} = T_2 \cdot \omega = 170 \times \frac{2\pi}{60} \times 2000 = 35.6 \text{ Kw}$

$B.P_{(3)} = T_3 \cdot \omega = 168 \times \frac{2\pi}{60} \times 2000 = 35.2 \text{ Kw}$

$B.P_{(4)} = T_4 \cdot \omega = 174 \times \frac{2\pi}{60} \times 2000 = 36.4 \text{ Kw}$

$I.P_{(1)} = B.P_{tot} - B.P_{(1)} = 52 - 37.07 = 14.93 \text{ Kw}$

$I.P_{(2)} = 52 - 35.6 = 16.4 \text{ Kw}$

$I.P_{(3)} = 52 - 35.2 = 16.8 \text{ Kw}$

$I.P_{(4)} = 52 - 36.4 = 15.6 \text{ Kw}$

$\Rightarrow I.P_{tot.} = 63.71 \text{ Kw}$

$\eta_m = \frac{B.P}{I.P} = \frac{52}{63.71} = 81.6\%$

$\eta_{thermal} = \frac{B.P}{\dot{m}_f \times CV} = 22.4\%$

8) $\eta_{th} = \frac{B.P}{\dot{m}_f \times C.V} \rightarrow \dot{m}_f = \frac{B.P}{\eta_{th} \times C.V} = \frac{186.5}{0.32 \times 44200} = 0.01318\ kg/s$

$\frac{\dot{m}_a}{\dot{m}_f} = 12 \rightarrow \dot{m}_a = 12 \times 0.01318 = 0.1582\ kg/s$

$\dot{V}_a = \frac{\dot{m}_a RT}{P} = \frac{0.1582 \times 287 \times 288}{1.01 \times 10^5} = 0.129\ m^3/s$

$\eta_{volumetric} = \frac{\dot{V}_a}{V_s \times N \times n} = \frac{\dot{V}_a}{\frac{\pi}{4} D^2 L \times N \times n}$

$= \frac{\dot{V}_a}{\frac{\pi}{4} D^2 \times 0.8D \times N \times n} = \frac{\dot{V}_a}{0.2\pi D^2 \times N \times n}$

$\Rightarrow D^2 = \frac{\dot{V}_a}{\eta_{vol} \times N \times 0.2\pi \times n} = \frac{0.129}{0.9 \times 0.2\pi \times \frac{44200}{2 \times 60} \times 8}$

$=$

$\Rightarrow D = 0.1\ m$

$L = 0.08\ m$

6) $\dot{m}_a = C_d A \sqrt{2gh \rho_w \rho_{air}}$

$= 0.6 \times \frac{\pi}{4} (0.04165)^2 \sqrt{2 \times 9 \times 1000 \times h \times 1.215}$

$= 0.126 \sqrt{h}$

h [mm]	$\dot{m}_a$ [kg/s]	$\dot{m}_f$ [kg/s] $\times 10^{-3}$	A/F	B.P
33.5	0.0231	1.5	0.0153	14.09
33.5	0.0231	1.48	0.0156	18.5
33.5	0.0231	1.57	0.0147	18.89
33.8	0.0232	1.81	0.0125	19
33.8	0.0232	2.056	0.0112	18.89
34.25	0.0234	2.458	0.0095	18.12
34.8	0.0235	2.577	0.0091	17.78

$(A/F)_{max}$ at $B.P_{max} = 0.0128 = 12/1$

$(A/F)_{max\ economy} = 0.0156 = 15/1$

5 $V_S = \frac{\pi}{4} b^2 L = \frac{\pi}{4} (0.063)^2 (0.076) = 2.76 \times 10^{-4}\ m^3$

$b.mep = \frac{Brake.Power}{V_S \times N \times n}$, $N = \frac{3000}{2 \times 60} = 25$

$n = 4$

$s.f.c = \frac{\dot{m}_f}{b.p} = \frac{Fc \times 5.9}{b.p} = \frac{0.7924 \times Fc}{b.p}$

brake load [N]	Fc (mL/s)	b.p [kw]	b.mep [kPa]	$\dot{m}_f$ [kg/s] $\times 10^{-3}$	s.f.c (kg/kwh) $\times 10^{-7}$
126	2.08	14.09	594.97	1.506	384.8
165.5	2.04	18.5	781.46	1.48	287.9
169	2.17	18.89	797.34	1.57	299.89
170	2.5	19	802.07	1.81	342.9
169	2.84	18.89	797.34	2.05	391.7
162	3.4	18.11	764.3	2.45	488.5
159	3.56	17.78	750.17	2.57	521.8

max power = 802.07 kPa

max. fuel economy = 287×10^{-3} kg / kwh.

4) at full load ⇒ Imep = working map − Pumping map

= 6.2 − 0.35 = 5.85 bar

= 585 kPa.

full load ⇒ I.P = I.mep × V_s × N × n

= 585 × $\frac{\pi}{4}$ × (0.178)² (0.33) × $\left(\frac{400}{60}\right)$

= 16 kW

at no load ⇒ I.mep = $\frac{(I_{mep})_{*}(\text{firing/min}) - (\text{Dead man point})(N_D)}{\frac{N_P}{2}}$

N_D = Power stroke − firing/min = $\frac{400}{2}$ − 47 = 153 Cycle

$(I_{mep})_{no\ load}$ = $\frac{585 * 47 - 62 * 153}{\frac{400}{2}}$ = 90.045 kPa = friction losses.

$(I.P)_{no\ load}$ = friction losses × $I_{mep_{no\ load}}$ × V_s × N^2

= 90.045 × $\frac{\pi}{4}$ (0.178)² (0.33) $\left(\frac{400}{2\times60}\right)$ = 2.46 kW

brake power = Ip − friction losses

= 16 − 2.46 = 17.54 kW

η_{mech} = $\frac{B.P}{I.P}$ = $\frac{13.54}{16}$ = 84.6%

[3] bore = 212 mm
Stroke = 292 mm
N = 720 rev/min
b.mep = 5.93 bar

S.F.C = 0.226
A/F = 25/1
C.V = 44200 kJ/kg

$$\text{brake power} = \frac{b.mep \times 10^5 \times \pi \times b^2 \times L \times N_{rev}}{4 \times 2 \times 1000 \times 60} =$$

$$= \frac{5.93 \times 10^5 \times \pi \times (0.212)^2 \times (0.292) \times 720 \times 2}{2 \times 4 \times 1000 \times 2}$$

$$= 27.49 \text{ kW}$$

$$S.F.C = \frac{FC}{\text{brake power}} \Rightarrow 0.226 = \frac{FC}{27.49} \Rightarrow FC = 6.21$$

$$\Rightarrow \eta_{th} = \frac{\text{brake Power}}{\text{fuel power}} = \frac{b.P(3600)}{FC \times CV} = \frac{27.49 \times 3600}{6.21 \times 44200}$$

$$= 36\%$$

$$\Rightarrow \frac{\dot{m}_a}{m_f} = A/f = 25 \Rightarrow \dot{m}_a = 25 \times 9.2 \times 10^{-3} = 0.23 \text{ kg/s}$$

$$\dot{V}_a = \frac{\dot{m}_a RT}{P} = \frac{0.23 \times 287 \times (288)}{1.01 \times 10^5} = 0.188 \text{ m}^3/\text{s}$$

$$\eta_V = \frac{\dot{V}_a}{V_s * N} = \frac{0.188}{\pi/4 (0.212)^2 (.292) \left(\frac{720}{60}\right) \frac{4}{2}} = 76.4\%$$

(2) indicated power (i.p) = $\frac{\text{indicated pressure} \times A \times L \times N}{2}$, $N = \frac{495}{60} = 7.5416$ rev/sec

indicated pressure (P.i) = $\frac{578 \times 10^{-6} \times 815}{70 \times 10^{-3}} = 6.73$ bar.

$A = \frac{\pi}{4} d^2 = \frac{\pi}{4} (0.146)^2 = 0.0167 \ m^2$

indicated power = $\frac{6.73 \times 105 \times 0.0167 \times 0.25 \times 7.192}{2} = 12.48$ kW

$T = W * R = 433 \times 0.45 = 194.85$ Nm.

brake power = $2\pi T N = 2 \times \pi \times 194.85 \times 7.5416$

$= 9.691$ kW

$\eta_{mech} = \frac{\text{Brake power}}{\text{indicated power}} = \frac{9.691}{12.48} = 77.6\%$

(1) two cylinder

four stroke

b = 380 mm

L = 585 mm

speed = 240 rpm

T = 5.16 kN.m

Omar Nesleh

H.w # 3

1090918

① brake power (b.p) = $\frac{2\pi \times T \times N}{60} = \frac{2\pi \times 5.16 \times 240}{60} = 129.6$ kw

② 4-stroke speed (m/s) = 2 × stroke × speed

$= 2 \times \frac{0.585 \times 240}{60} = 4.68$ m/s

③ brake power, BP = $\frac{b.mep \times 10^5 \times \pi \times b^2 \times L \times N \times n}{4 \times 2 \times 1000 \times 60}$

$= \frac{b.mep \times 10^5 \times \pi \times (0.38)^2 \times 0.585 \times 240 \times 2}{4 \times 2 \times 1000 \times 60}$

$= 26.538$ B.mep

$\rightarrow$ b.mep = $\frac{129.6}{26.538} = 4.88$ bar

④ $\eta_v = \frac{\dot{V}_a}{V_s \times N}$, $\dot{V}_a = V_s \times N \times \eta$

$= 0.0663 \times \frac{240}{60} \times 0.85 = 0.225$ m³/s

$\frac{\dot{V}_a}{\dot{V}_f} = 7 \Rightarrow \dot{V}_f = 0.0322$ m³/s

$\eta_{thermal} = \frac{b.p}{\dot{V}_f . C_v} = \frac{129.7}{0.0322 \times 16200} = 0.24 = 24\%$