march 2018

5. The area of an indicator diagram taken off one cylinder of a four-cylinder, four-stroke internal combustion engine is 374 mm^2 and the length is 68 mm. The bore of the engine is 225 mm, the stroke is 325 mm and the speed is 300 rev/min. All of the cylinders develop equal power.

Calculate EACH of the following:

(a) The mean indicated pressure; (3)

(b) The indicated power of the engine. (6)

Note: spring constant is 1 mm = 1 bar

july 2015

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Calculate EACH of the following:

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dec 2014

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Calculate EACH of the following:

(a) the cylinder diameter; (7)

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dec 2014

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Calculate EACH of the following:

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july 2017

3. A six cylinder two-stroke single acting diesel engine has a bore of 920 mm, a stroke of 1250 mm and runs at 120 rev/min. The effective brake torque is 714 kNm, the mechanical efficiency is 88% and the brake specific fuel consumption is 0.24 kg/kWh.
Calculate EACH of the following:

(a) the brake power; (3)

(b) the indicated power; (3)

(c) the indicated mean effective pressure in bar. (4)

dec 2016

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july 2016

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Calculate EACH of the following:

(a) the indicated mean effective pressure in bar; (5)

(b) the brake thermal efficiency; (3)

(c) the brake specific fuel consumption. (2)

Note: calorific value of the oil = 42 MJ/kg

march 2018

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Calculate EACH of the following:

(a) The mean indicated pressure; (3)

(b) The indicated power of the engine. (6)

Note: spring constant is 1 mm = 1 bar

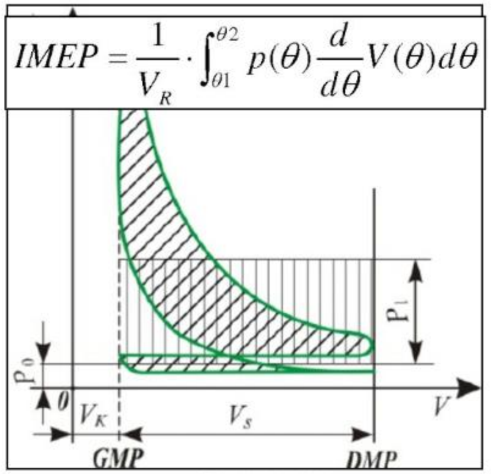
a) Mean indicate Pressure $= \dfrac{\text{Area} \times \text{Spring constant}}{\text{length}}$

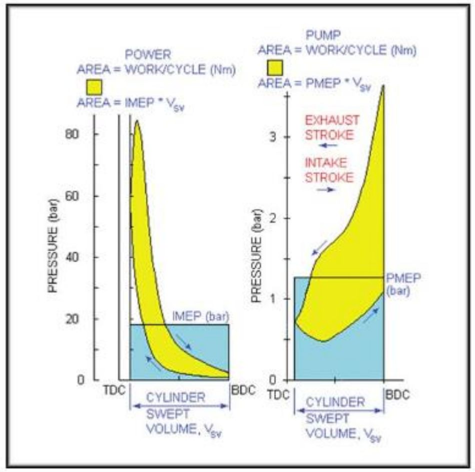
Cylinde

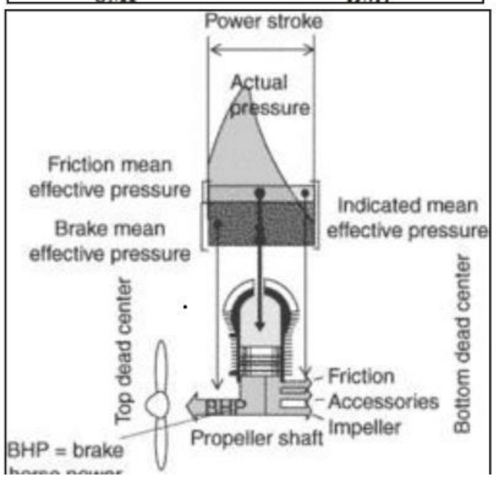
Area = 374 mm^2

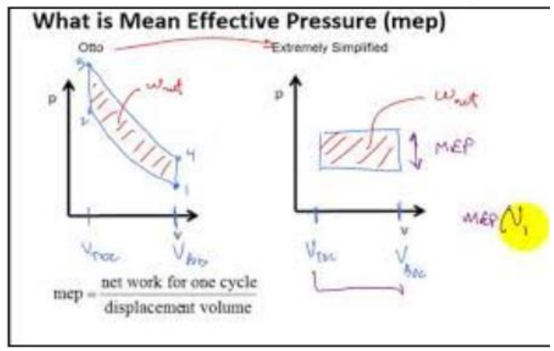
length = 68 mm

$$\text{Mip} = \frac{374 \times 1}{68} = 5.5 \text{ bar}$$


$$IMEP = \frac{1}{V_R} \cdot \int_{\theta 1}^{\theta 2} p(\theta) \frac{d}{d\theta} V(\theta) d\theta$$
P_1
P_0
0
V_K
V_s
V
GMP
DMP


POWER
AREA = WORK/CYCLE (Nm)
AREA = IMEP * V_{sv}
PUMP
AREA = WORK/CYCLE (Nm)
AREA = PMEP * V_{sv}
EXHAUST STROKE
INTAKE STROKE
PRESSURE (bar)
IMEP (bar)
PMEP (bar)
TDC
BDC
CYLINDER SWEPT VOLUME, V_{sv}


Power stroke
Actual pressure
Friction mean effective pressure
Brake mean effective pressure
Indicated mean effective pressure
Top dead center
Bottom dead center
Friction
Accessories
Impeller
BHP
Propeller shaft
BHP = brake


What is Mean Effective Pressure (mep)
Otto
Extremely Simplified
MEP
$\text{mep} = \frac{\text{net work for one cycle}}{\text{displacement volume}}$

b)

$IP = x\,p\,a\,l\,n$

x = No. cylin = 4

p = Pressure = 550,000 (Pa)

a = area (bore)

l = stroke length

n = strokes per sec

area = πr^2

diameter = 0.225 m = 0.1125 m

a = bore area = $(0.1125)^2 \pi$ = 0.03976078202 m^2

l = 0.325 m

p = 550,000

x = 4

$\frac{300 \text{ Rev}}{1 \text{ min}} = \frac{300}{60} = 5 \text{ Rev/sec}$

4 stroke ÷ 2

$IP = 4 \times 550{,}000 \times 0.03976078202 \times 0.325 \times \frac{5}{2}$

IP = 71072 W

71 KW

july 2015

6. The area of an indicator diagram taken off one cylinder of a four-cylinder, four-stroke internal combustion engine is 385 mm^2 and the length is 70 mm. The bore of the engine is 250 mm, the stroke is 300 mm and the speed is 300 rev/min. All of the cylinders develop equal power.

Calculate EACH of the following:

(a) the mean indicated pressure; (3)

(b) the indicated power of the engine. (6)

Note: the spring constant is 1 mm = 1 bar

a) Mean indicated Pressure = $\frac{\text{Area } (mm^2) \times \text{Spring Constant (bar)}}{\text{length}}$

$\frac{385}{70} = 5.5$ bar $= 550{,}000$ (Pa)

b) IP = xplan

$x = 4$

$p = 550{,}000$ (Pa)

$L = 0.3$m

$a = 0.04908738521$ m^2

$n = 5/2$

$a = \pi r^2$

$a = (0.125)^2 \pi = 0.04908738521$ m^2

$n = \frac{300 \text{ Rev}}{1 \text{ min}} = \frac{300}{60} = 5$ Rev/sec

4 stroke $= \frac{1}{2}$

$$IP = 4 \times 550{,}000 \times 0.3 \times 0.0490873852 1 \times 2.5$$

$$= 80994.1856 \text{ W}$$

$$80.994 \text{ kW}$$

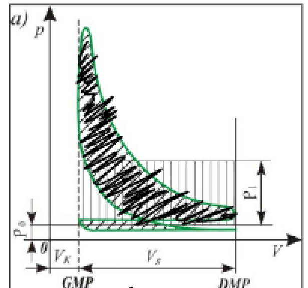
march 2018

5. The area of an indicator diagram taken off one cylinder of a four-cylinder, four-stroke internal combustion engine is 374 mm² and the length is 68 mm. The bore of the engine is 225 mm, the stroke is 325 mm and the speed is 300 rev/min. All of the cylinders develop equal power.
Calculate EACH of the following:

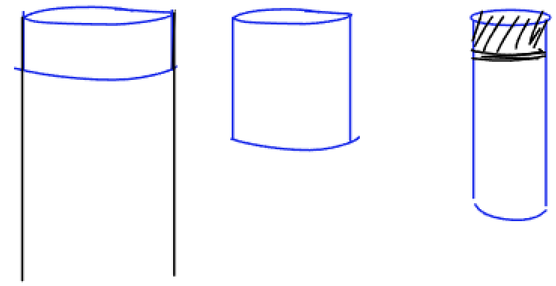
(a) The mean indicated pressure; (3)

(b) The indicated power of the engine. (6)

Note: spring constant is 1 mm = 1 bar



length



$$\text{Imep} = \frac{\text{Area} \times \text{spring}}{\text{Length}} = \frac{374}{68}\ \text{bar}$$

5.5 bar

IP = x p l a n

Power

$x = 4$

$p = 550{,}000$

$l = 325 = 0.325$

$d = 225 = 0.225$

$n = \frac{300 \text{ rev}}{\text{min}}$

$a = (0.1125)^2 \pi$

$n = \frac{300}{60} = \frac{5}{2}$

$$IP = 4 \times 550{,}000 \times .325 \times (0.1125)^2 \pi \times 2.5 = 710 \text{ watt}$$

715 000

dec 2014

5. A six-cylinder, single acting, two-stroke diesel engine develops a brake power of 1147.5 kW at a speed of 120 rev/min. The indicated mean effective pressure is 5 bar, the mechanical efficiency is 85% and the length of the stroke is 25% greater than the bore.

All of the cylinders develop equal power.

Calculate EACH of the following:

(a) the cylinder diameter; $= x$ (7)

(b) the stroke length. (2)

$$Eff = \frac{B.P}{I.P}$$

$$0.85 = \frac{1147.5\ kW}{I.P.}$$

$$I.P = \frac{1147.5}{0.85} = 1350\ kW$$

$$IP = x\,p\,l\,a\,n$$

$x = 6$

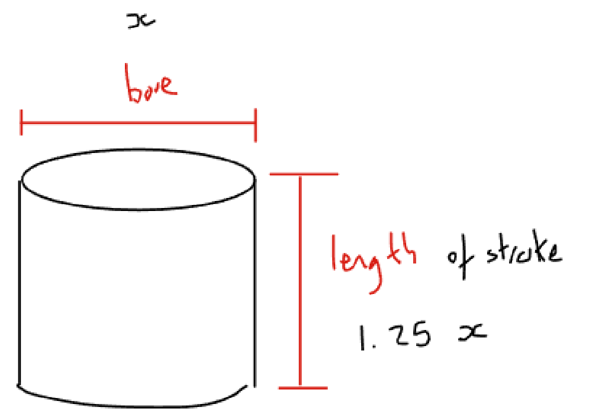
$p = 5\ bar = 500{,}000$

$a = \frac{x^2}{4}\pi$

$l = \frac{5}{4}x$

$n = 2$

$I.P = 1{,}350{,}000$



$$Area = \left(\frac{x}{2}\right)^2 \pi$$

$$l = 1.25x$$

$$l = \frac{5}{4}x$$

$$Area = \frac{x^2}{4}\pi$$

$$n = \frac{120\ Rev}{60\ sec} = 2$$

$$1{,}350{,}000 = (6)(500{,}000)\left(\frac{5}{4}x\right)\left(\frac{x^2}{4}\pi\right)2$$

$$1{,}350{,}000 = 3750000 \; x \frac{x^2}{4} \pi \; 2$$

$$1{,}350{,}000 = 1875000 \; x^3 \pi$$

$$\frac{1{,}350{,}000}{1875000\pi} = x^3$$

$$0.2291831181 = x^3$$

$$x = 0.611966 \text{ m}$$

$$\boxed{D = 0.611966 \text{ m}}$$

length = 0.76495m

july 2017

3. A six cylinder two-stroke single acting diesel engine has a bore of 920 mm, a stroke of 1250 mm and runs at 120 rev/min. The effective brake torque is 714 kNm, the mechanical efficiency is 88% and the brake specific fuel consumption is 0.24 kg/kWh.
Calculate EACH of the following:

(a) the brake power; (3)

(b) the indicated power; (3)

(c) the indicated mean effective pressure in bar. (4)

$T = 714{,}000$

$N = \frac{120 \text{ Rev}}{60 \text{ sec}} = 2$

$$B.P = \frac{Workdoneperminute}{60} = \frac{T \times 2\pi N}{60} = \frac{Wl \times 2\pi N}{60} \ watts$$

a) $Eff = \frac{BP}{IP}$

$BP = \frac{T \ 2\pi \ 120}{60}$

$0.88 = \frac{BP}{IP}$

$BP = 714\,000 \times 2\pi \times 2 = 8{,}972{,}388.619$

8 972 kW

b) $0.88 = \frac{8972388}{IP}$

$IP = 10196$ kW

c) $IP = xplan$

$p = Imep = x$

$x = 6$

$L = 1250\,mm = 1.25\,m$

$a = 0.6647610$

$n = 2$

$IP = 10{,}196{,}000$

bore = 920 = 0.920 m

r = 0.46

$area = \pi(0.46)^2 = 0.6647610$

$10{,}196{,}000 = 6x(1.25)(0.6647610)(2)$

$$\frac{10{,}196{,}000}{6(1.25)(0.6647610)(2)} = x$$

$Imep = 1{,}022{,}522.873\ (Pa)$

$(10.22\ )$

dec 2016

3. A six cylinder two-stroke single acting diesel engine has a bore of 900 mm, a stroke of 1300 mm and runs at 120 rev/min. The effective brake torque is 700 kNm, the mechanical efficiency is 94% and the brake specific fuel consumption is 0.24 kg/kWh.

Calculate EACH of the following:

(a) the brake power; (3)

(b) the indicated power; (3)

(c) the indicated mean effective pressure in bar. (4)

$N = \frac{120\ Rev}{min} = \frac{2\ Rev}{sec}$

a) $B.P = T\, 2\pi\, N$

$B.P = 700 \times 2\pi \times 2$

$B.P = 8796.459\ kW$

b) $Eff = \frac{BP}{IP}$

$0.94 = \frac{8796.459}{IP}$

$IP = 9{,}357{,}935$ Watts

c) $IP = x\ plan$

$IP = 9{,}357{,}935$

$I_{mep} = p$

$x = 6$

$l = 1.3\ m$

$a = 0.3617\ m^2$

$n = 2$

bore = 900 mm

0.9 m

radius 0.45 m

$a = 0.45^2\pi = 0.6361725$

$9{,}357{,}935 = 6\,(I_{mep})\,1.3\,(0.6361\,7)\times 2$

$\frac{9{,}357{,}935}{6 \times 1.3\,(0.6361\,7) \times 2} = I_{mep} = 942{,}932.3282\ (pa)$

9.4 bar

july 2016

3. A four cylinder, four-stroke engine has a bore of 76 mm and a stroke of 125 mm. The brake power is 14.8 kW at 1500 rev/min. The mechanical efficiency is 85% and the fuel consumption is 4.36 kg of oil per hour.
Calculate EACH of the following:

(a) the indicated mean effective pressure in bar; (5)

(b) the brake thermal efficiency; (3)

(c) the brake specific fuel consumption. (2)

Note: calorific value of the oil = 42 MJ/kg

$BP = T 2\pi N$

bore = 0.076 m

area = $4.53645979 \times 10^{-3}\ m^2$

$\frac{n}{2} = \frac{1500 \text{ rev}}{\frac{60}{2}} = \frac{25}{2} = 12.5$

a) $Eff = \frac{BP}{IP}$

$0.85 = \frac{14.8}{IP}$

$IP = \frac{14.8}{0.85} = 17.411764\ kW$

$IP = xplan$

$x = 4$

$p = Imep$

$L = 0.125\ m$

area = $4.53645979 \times 10^{-3}\ m^2$

$n = 12.5$

$17{,}411.764 = 4\,(Imep)\,0.125\,(4.53645979 \times 10^{-3}) \times 12.5$

$$\frac{17{,}411.764}{4 \times 0.125\,(4.53645979 \times 10^{-3}) \times 12.5} = Imep = 614109.4276\ (Pa)$$

6.14 Bar

b) $$\text{Thermal Efficiency} = \frac{BP}{\text{mass per second} \times \text{cal val}}$$

$$\text{Consumption of Fuel} = \frac{4.36\ \text{Kg}}{1\ \text{hour}} = \frac{4.36}{3600} = 0.0012111\ \text{Kg/sec}$$

$$\text{cal val} = 42 \times 10^3\ \text{KJ}$$

$$\text{Thermal Efficiency} = \frac{14.8}{0.0012111 \times 42 \times 10^3} = 0.2909$$

29.09 %

$$b_{specific} = \frac{4.36 \text{ kg/h}}{14.8 \text{ kW}} \quad 0.2945 \frac{\text{kg}}{\text{kWh}}$$