GARVIT SHAH
F-24

EXPERIMENT : No. 2

Page No.
Date

- **Aim:** To determine the brake thermal efficiency of 4-stroke diesel engine at various load conditions. Also plot the characteristics curve of efficiency & power versus % of load.

- **Engine Specifications:**

No. of cylinders	=	1
No. of strokes	=	4
Fuel	=	HS Diesel
Rated Power	=	5.2 kW @ 1500 Rpm
Cylinder diameter	=	87.5 mm
Stroke length	=	110 mm
Compression ratio	=	17.5 : 2
Orifice diameter	=	20 mm
Dynamometer arm length	=	185 mm

- **Procedure -**

1. Check lubrication and fuel system & start fuel
2. Start the engine by cranking handle at no load.
3. Start water supply for engine cooling and adjust proper flow rate of water.
4. Allow engine to run at no load ~~by~~ for few ~~dynamometer~~ minutes so that it gets warmed up.
5. Gradually increase the load by dynamometer at various load conditions and measure the time for consumption of specific quantity

Sundaram

Teacher's Sign. : _____

EXPERIMENT : No. _____ Page No. _____ Date _____

of fuel (V). The reading are taken at each load condition.

6. Note down the reading of load on the dynamometer (W) in kg.
7. Measure the speed (N) & moment arm (R) of the engine, which remains constant throughout the test.
8. After the test unload the engine gradually
9. Cut off the fuel supply for stopping the engine by pulling the lever.
10. After 10 mins, stop the water supply.

- ~~Observations:~~
- Conclusion:

By using this experiment we can find brake thermal efficiency of 4-stroke diesel engine at various loads. It depends on calorific value of fuel & mass flow rate of fuel.

- Questions:

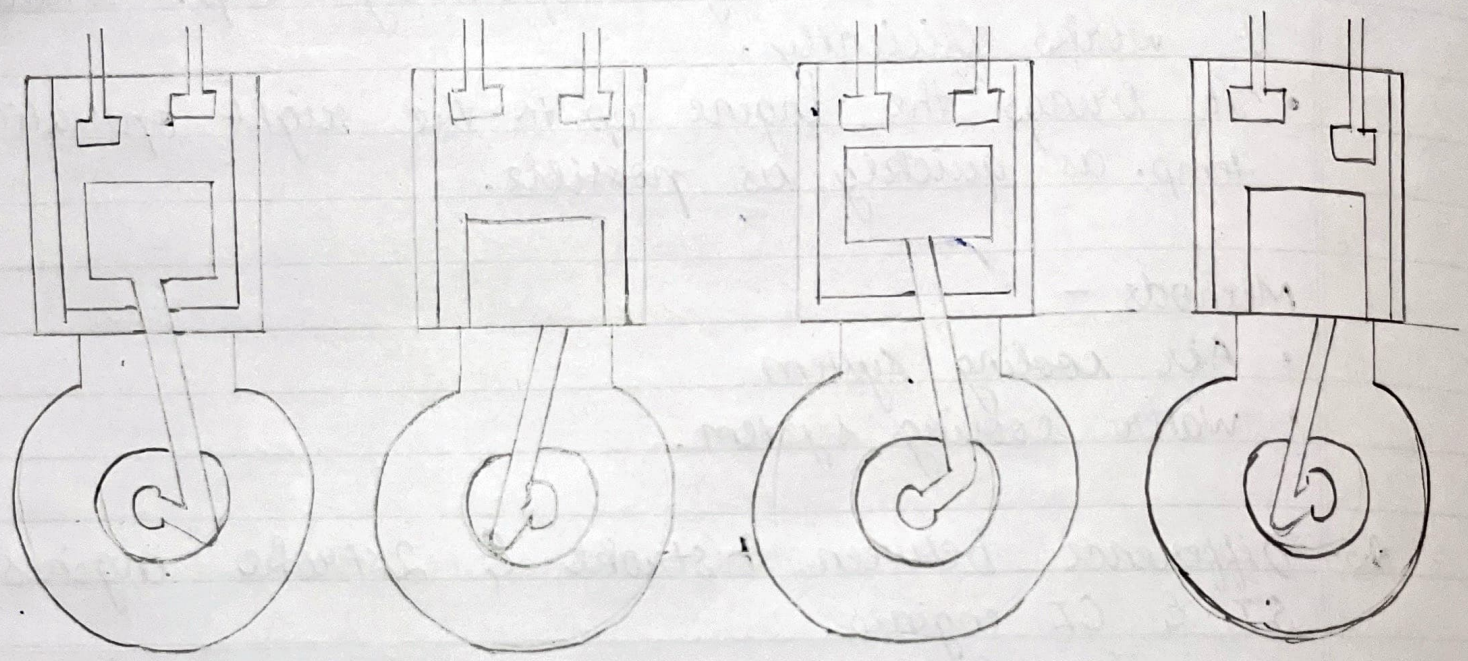
1. List the various components of ICE schematically show all strokes in SI & CI engines.

→ Components of ICE:

1. Cylinder head cover
2. Cylinder head
3. Engine block
4. Oil pan
5. Intake & Exhaust value
6. Piston
7. Combustion chamber
8. Crank shaft
9. Spark Plug.

Sundaram

Teacher's Sign. : _____



INTAKE COMPRESSION. EXPANSION EXHAUST

EXPERIMENT : No.

Page No.
Date

Q.2. What is the indicated power & frictional power of engine ?

→ Indicated power is defined as the total power developed by combustion of fuel in combustion chamber.

→ Frictional power is defined as the difference between the power delivered to piston while working fluid is contained within one cylinder & the usable work delivered to drive shift.

Q.3. Define mechanical efficiency, thermal efficiency & specific fuel consumption of one engine.

A.3. Mechanical Efficiency : It can be defined as the ratio of the powers obtain at the crank shaft i.e $\eta = \frac{BP}{IP}$

Thermal Efficiency : $\eta = \frac{W_{net}}{Q_{In}}$

Special Fuel Consumption : A measure of engine economy

$SFC = \frac{m_f}{BP}$ (kg/kW Hr)

Q.4. State the importance of cooling of an IC engine. What methods are generally employed for cooling of an IC engine.

A.4. The cooling system serve 3 important functions-

- It removes excess heat from the engine.

Sundaram

Teacher's Sign. : _____

EXPERIMENT : No.

Page No.
Date

- It maintains the engine operating temp. where it works efficiently.
- It brings the Engine up to the right operating temp. as quickly as possible.

Methods –
- Air cooling system
- Water cooling system.

Q.5. Difference between 4 stroke & 2 stroke engines, SI & CI engines.

A.5.

Two Stroke	Four Stroke
1. It has 1 revolution of crank shaft during one power stroke	1. It has two revolution of the crank shaft during power stroke.
2. It generates high torque.	2. It generates low torque
3. It uses port for fuel's outlet & inlet.	3. It uses valves for fuel's outlet & inlet.

SI Engine	CI Engine
1. It is an engine in which the spark is used to burn the fuel.	1. It is an engine in which the heat of compressed air is used to burn ashes.
2. Petrol is used as fuel.	2. Diesel is used as fuel.
3. It operates on Otto cycle.	3. High compression ratio.
4. Low Compression Ratio.	4. It operates on diesel cycle.
5. High Thermal Efficiency.	5. Less Thermal Efficiency.

Sundaram

Teacher's Sign. :

EXPERIMENT : No.

Page No.
Date

Q.6. List engine specifications for 2 various models of bikes & light commercial vehicles.

A.6.

Model Name	Kawasaki Ninja H_2	Hero Splendor
Engine Type	Liquid Cooled, inline, cylinder with super charger	Air cooled, 4-stroke engine OHC
Engine displacement	998 cc	97.2 cc
Max Power	231 HP @ 1500 rpm	8.02 HP @ 800 rpm
Max Torque	141.7 Nm @ 1100 rpm	8.05 Nm @ 6000 rpm
Emission Type	BS6	BS6
Bore	76 mm	50 mm
Stroke	55 mm	49.5 mm
Fuel Type	Petrol	Petrol
No. of Cylinders	4	1
No. of Valve per Cylinder	4	2

Model Name	Mercedes Sprinter	Tata Yodha
Engine Type	Interculated Turbo Premium unleades	4 stroke, Water cooled, Indirect inj.
Engine displacement	2L	2.2L
Max Power	188 HP @ 5000 rpm	100 HP @ 3750 rpm
Max Torque	250 Nm @ 2500 rpm	250 Nm @ 2500 rpm
Emission Type	656	656
Fuel Type	Diesel	Diesel
NO. of cylinders	4	4
No. of Valves/cylinder	6	4

Sundaram

Teacher's Sign. : _____

Observations :

Testing Laboratory : IC Engine Laboratory
Density of fuel : 830 kg/m
Calorific Value of fuel (CV) : 43500 kJ/kg
Momentum arm of dynamometer R (m) = 185 mm

Observation Table :

Sr No.	Speed (rpm)	Load (kg)	Fuel Consumption (cm^3/min)	Fuel Consumption
1	1574	0.03	9	0.4482
2	1563	4.08	12	0.5976
3	1554	8.04	16	0.7968
4	1522	12.25	19	0.9462
5	1523	16.05	21	1.0458

Formula -

- Brake Power, $BP = \frac{2\pi NT}{60 \times 1000}$ KW where Torque, $T = W.R.(9.81)$
- Mass of fuel consumption (mf) = $\frac{\text{Vol. of fuel (mL)} \times 3600 \times \text{sp. gr. of fuel}}{\text{Time (s)} \times 1000}$
- Friction Power (FP) =

- Determining Friction Power (FP) →

$$FP = IP - BP$$

Sr no.	Load (kg)	BP (KW)	mf (kg/hr)
1	0.03	0.0089	0.4482
2	4.08	1.21	0.5976
3	8.04	2.37	0.7968
4	12.25	3.54	0.9462
5	16.05	4.64	1.0458

From Williams Line method F.P. = 3.4 KW

$$IP = B.P + FP$$

- Input Power to the engine (Heat Supplier)

$$= m_f \times V_{(mL)}$$

- Brake Interal Efficiency.

$$\eta_{B_{th}} = \frac{B.P \times 3600 \times 100}{m_f \times C_v}$$

- Inducted Thermal efficiency –

$$\eta_{i_{th}} = \frac{IP \times 3600 \times 100}{m_f \times C_v}$$

- Mech efficiency = $\frac{\text{Brake Power}}{\text{Indicated Power}}$

- Specific Fuel consumption (SFC)

$$BSFC = \frac{mf}{B.P.}$$

1.) BRAKE POWER $BP = \frac{2\pi NT}{60 \times 1000}$ kW

$BP_1 = \frac{2\pi (1574) \times 0.03 \times 0.185 \times 9.81}{60000} = 0.0089$ kW

$BP_2 = \frac{2\pi (1503) \times 4.08 \times 0.185 \times 9.81}{60000} = 1.21$ kW

$BP_3 = \frac{2\pi (1554) \times 8.04 \times 0.185 \times 9.81}{60000} = 2.37$ kW

$BP_4 = \frac{2\pi (1522) \times 12.25 \times 0.185 \times 9.81}{60000} = 3.54$ kW

$BP_5 = \frac{2\pi (1523) \times 16.05 \times 0.185 \times 9.81}{60000} = 4.64$ kW

2) Mass of fuel consumption (mf) —

$mf_1 = \frac{9 \times 3600 \times 0.83}{60000} = 0.448$

$mf_2 = \frac{12 \times 3600 \times 0.83}{60000} = 0.597$

$mf_3 = \frac{16 \times 3600 \times 0.83}{60000} = 0.79$

$mf_4 = \frac{19 \times 3600 \times 0.83}{60000} = 0.94$

$mf_5 = \frac{21 \times 3600 \times 0.83}{60000} = 1.04$

3) $IP = BP + FP$

$IP_1 = 0.0089 + 3.4 = \underline{3.408}$

$IP_2 = 1.21 + 3.4 = \underline{4.61}$

$IP_3 = 2.37 + 3.4 = \underline{5.77}$

$IP_4 = 3.54 + 3.4 = \underline{6.94}$

$IP_5 = 4.64 + 3.4 = \underline{8.04}$

4) Input Power in kW = $m_f \times C_v$ (kW)

$I_1 = \frac{0.4482 \times 43500}{3600} = 5.42$

$I_2 = \frac{0.597 \times 43500}{3600} = 7.22$

$I_3 = \frac{0.796 \times 43500}{3600} = 9.63$

$I_4 = \frac{0.946 \times 43500}{3600} = 11.43$

$I_5 = \frac{1.0458 \times 43500}{3600} = 12.64$

5) Brake Thermal Efficiency — $\eta_{Bth} = \frac{BP \times 3600 \times 100}{m_f \times C_v}$

$\eta_{B_1} = \frac{0.0089 \times 360000}{0.04482 \times 43500} = 0.165\ \%$

$\eta_{B_2} = \frac{1.21 \times 360000}{0.597 \times 43500} = 16.76\ \%$

$\eta_{B_3} = \frac{2.37 \times 360000}{0.79 \times 43500} = 24.61\ \%$

$\eta_{B_4} = \frac{3.54 \times 360000}{0.946 \times 43500} = 30.97\%$

$\eta_{B_5} = \frac{4.64 \times 360000}{1.0458 \times 43500} = 36.71\%$

6) Indicated Thermal Efficiency - $\eta_{ith} = \frac{IP \times 3600 \times 100}{m_f \times C_v}$

$\eta_{I_1} = \frac{3.40896 \times 3600 \times 100}{0.4482 \times 43500} = 62.9\ \%$

$\eta_{I_2} = \frac{4.61 \times 3600 \times 100}{0.5976 \times 43500} = 63.85\ \%$

$\eta_{I_3} = \frac{5.77 \times 3600 \times 100}{0.79 \times 43500} = 59.92\ \%$

$\eta_{I_4} = \frac{6.94 \times 3600 \times 100}{0.946 \times 43500} = 60.72$

$\eta_{I_5} = \frac{8.09 \times 360000}{1.045 \times 43500} = 63.61\%$

7) Specific Fuel Consumption (SFC) : $BSFC = \frac{m_f}{BP}$

$BSFC_1 = 50.02$

$BSFC_2 = 0.493$

$BSFC_3 = 0.33$

$BSFC_4 = 0.26$

$BSFC_5 = 0.22$

8) Mechanical Efficiency : $\frac{BP}{IP} \times 100$

$\eta_1 = \frac{0.0089 \times 100}{3.40} = 0.26\%$

$\eta_2 = \frac{1.21 \times 100}{4.61} = 26.25\%$

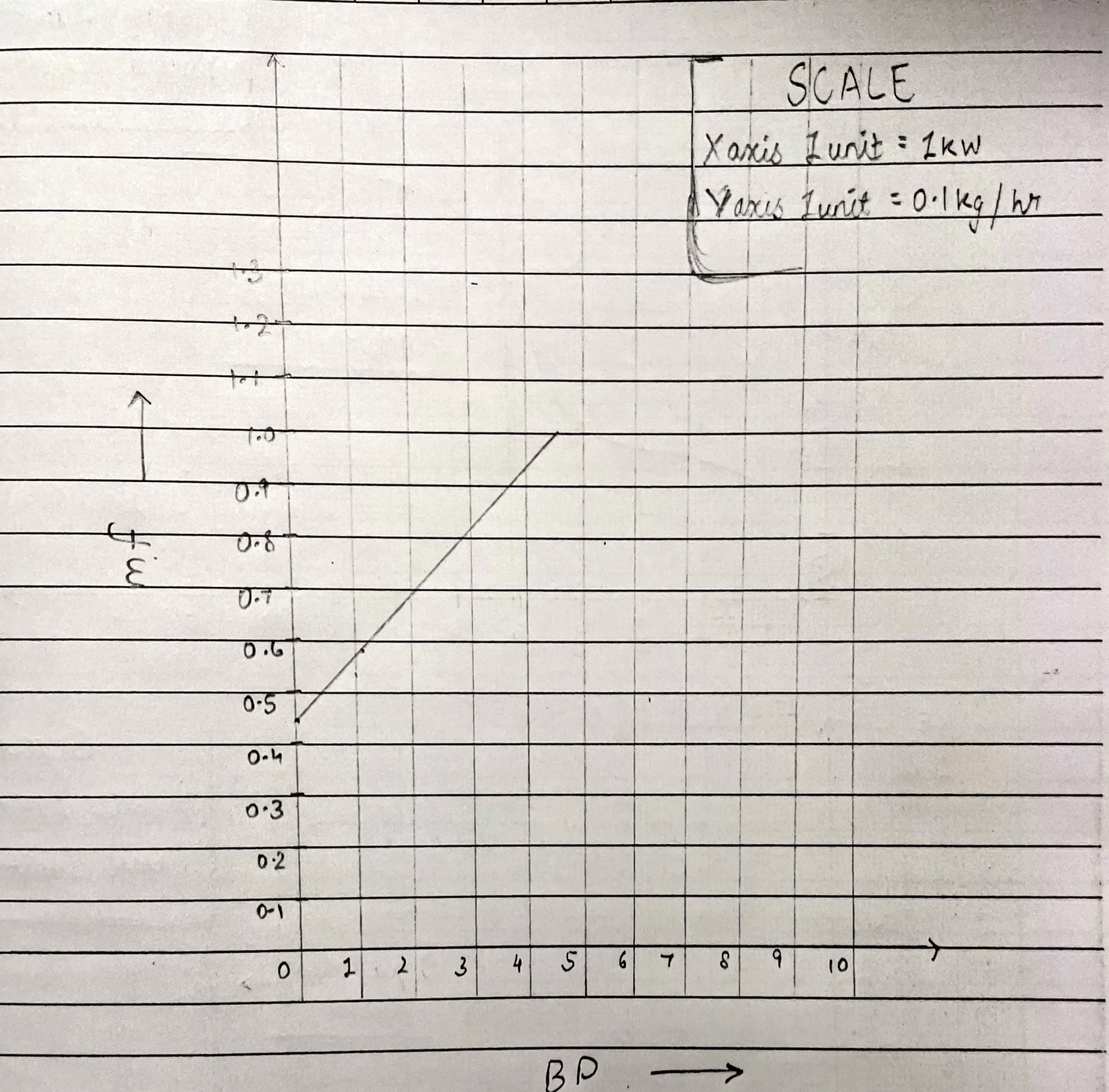
$\eta_3 = \frac{2.37 \times 100}{5.77} = 41.07\%$

$\eta_4 = \frac{3.54 \times 100}{6.94} = 51.01\%$

$\eta_5 = \frac{4.64 \times 100}{8.04} = 57.71\%$

Result :

Speed (rpm)	Load (kg)	Brake Power (kw)	Input Power (kw)	Indicated Power (kw)	Brake Thermal eff η	Indi. Thermal eff	Mech. eff	Specific fuel cons.
1574	0.03	0.008	5.42	3.408	0.165	62.9	0.26	50.2
1563	4.08	1.21	7.22	4.61	16.76	63.85	26.25	0.49
1554	8.04	2.37	9.63	5.77	24.61	59.9	41.07	0.33
1522	12.25	3.54	11.43	6.94	30.97	60.7	51.01	0.26
1523	16.05	4.64	12.64	8.04	36.71	63.6	57.71	0.22


SCALE
X axis 1 unit = 1kW
Y axis 1 unit = 0.1 kg/hr
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
ε
BP