

Heaven's Light is Our Guide
Rajshahi University of Engineering and Technology



Course Code
ME 3220

Course Title
Basic Mechanical Engineering Sessional

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Lab Report 4:
Study & Performance Test Of A Diesel Engine

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Experiment No.: 04

Experiment Name: Performance test of Diesel Engine

Objectives:

- i) To perform a load test on a four stroke diesel engine to study its performance.
- ii) To plot the following engine performance graph based on the experiment.
- iii) To know the actual Efficiency of diesel engine.

Theory:

Diesel engine is an internal combustion engine in which heat is produced by the compression of air and fuel in the cylinder.

The four stroke diesel engine is an internal combustion engine in which the piston completes four separate strokes per crankshaft cycle:

- 1) Intake stroke - Air enters the cylinder.
- 2) Compression stroke - Air is compressed, raising temperature.
- 3) Power stroke - Fuel is injected, ignites due to compression, and produces power.
- 4) Exhaust stroke - Burnt gases are expelled.

The engine's performance is evaluated using key parameters:

$$\text{Brake Power, } BP = \frac{2\pi NT}{60}$$

Where, N = Engine speed (RPM)

T = Torque (Nm)

$$\text{Brake Thermal Efficiency, (BTE)} = \frac{BP \times 3600}{M_f \times C_v} \times 100 \%$$

Where, BP = Brake power

M_f = Fuel Mass flow rate (kg/hr)

C_v = Calorific value of fuel (kJ/kg)

Brake Specific Fuel Consumption (BSFC)

$$BSFC = \frac{M_f}{BP}$$

Hence, lower BSFC indicates better fuel efficiency.

These parameters help analyze engine performance, efficiency & fuel consumption, making engines suitable for power generation, transportation & industrial applications.

Required Apparatus:

- 1) Four-Stroke Petrol Diesel Engine.
- 2) Generator for electrical load.
- 3) Dynamometer for load measurement
- 4) Stopwatch for fuel consumption time

Working Procedure:

- 1) The diesel engine was connected to a generator to generate electrical power.
- 2) There ~~was~~ electrical load was setup to in-increasing steps to increase load on the generator.
- 3) A mechanism was used to convert the electrical load, mimic it to mechanical load for the diesel engine.
- 4) The weight (mechanical load) was recorded.
- 5) Fuel consumption time was measured by recording the time taken for a fixed amount of fuel. ~~to~~
- 6) Shaft length was measured to determine torque.
- 7) Using recorded values, BP, BTE & BSFC was calculated.

Data:

No. of Test	Speed RPM (N)	Load (kg)	Fuel Consumption (sec)	Length of shaft (m)	Brake Power (W)	BTE (%)
1	972	4	75	13	996.48	11.68
		7.2	68		1074	19.08
		8.4	64		1255	20.98
		9.4	61		1402.6	22.85%

Calculation:

Formulas used:

$$\text{Torque, } T = w \cdot l$$

$$w = mg$$

$$\text{Mass of fuel, } m_f = \rho \cdot v$$

$$\text{Fuel Consumption rate, } M_f = \frac{m_f \times 3600}{\text{time}}$$

$$BP = \frac{2\pi NT}{60}$$

$$BTE = \frac{BP \times 3600}{M_f \times C_v} \times 100\%$$

$$BSFC = \frac{M_f}{BP}$$

$$\rho = 0.86 \text{ gm/cc}$$

$$C_v = 44500 \text{ kJ/kg}$$

$$BP \text{ in kW}$$

$$T \text{ in Nm}$$

$$N \text{ in RPM} = 972$$

$$M_f \text{ in kg/hr}$$

$$\text{Length of shaft in m}$$

$$\text{Load, } w \text{ in N}$$

$$v = 10 \text{ cc}$$

Speed, $N = 972 \text{ RPM}$

Length of shaft, $l = 13'' = 0.3302 \text{ m}$

Mass of fuel, $m_f \text{ g} = 0.86 \times 10 = 8.6 \text{ gm}$
 $= 8.6 \times 10^{-3} \text{ kg}$

① For load = 4 lb

$$T_1 = w_1 l = m_1 g l = 4 \text{ lb} \times (9.8 \times 0.3302)$$

$$= 1.81 \times 9.8 \times 0.3302$$

$$= 5.86 \text{ Nm}$$

$$M_{f_1} = \frac{m_f \times 3600}{75} = \frac{8.6 \times 10^{-3} \times 3600}{75} = 0.4128 \text{ kg/hr}$$

$$BP_1 = \frac{2\pi NT_1}{60} = \frac{2\pi \times 972 \times 5.86}{60} = 596.48 \text{ W}$$

$$= 0.596 \text{ kW}$$

$$BTE_1 = \frac{BP_1 \times 3600}{M_{f_1} \times C_v} = \frac{0.596 \times 3600}{0.4128 \times 44500} \times 100\%$$

$$= 11.68\%$$

$$BSFC_1 = \frac{M_{f_1}}{BP_1} = \frac{0.4128}{0.596} = 0.693 \text{ kg/kWh}$$

② For load = 7.2 lb

$$T_2 = w_2 l = m_2 g l = 7.2 \times 9.8 \times 0.3302 = 10.55 \text{ Nm}$$

$$M_{f2} = \frac{m_f \times 3600}{68} = \frac{8.6 \times 10^{-3} \times 3600}{68} = 0.4553 \text{ kg/hr}$$

$$BP_2 = \frac{2\pi NT_2}{60} = \frac{2\pi \times 972 \times 10.55}{60} = 1.074 \text{ kW}$$

$$BTE_2 = \frac{BP_2 \times 3600}{M_{f2} \times C_v} = \frac{1.074 \times 3600}{0.4553 \times 44500} \times 100\% = 19.08\%$$

$$BSFC_2 = \frac{M_{f2}}{BP_2} = \frac{0.4553}{1.074} = 0.424 \text{ kg/kWh}$$

(iii) For load = 8.4 lb

$$T_3 = \omega_3 d = m_3 g d = 3.81 \times 9.8 \times 0.3302 = 12.33 \text{ Nm}$$

$$M_{f3} = \frac{m_f \times 3600}{64} = \frac{8.6 \times 10^{-3} \times 3600}{64} = 0.4838 \text{ kg/hr}$$

$$BP_3 = \frac{2\pi NT_3}{60} = \frac{2\pi \times 972 \times 12.33}{60} = 1.255 \text{ kW}$$

$$BTE_3 = \frac{BP_3 \times 3600}{M_{f3} \times C_v} = \frac{1.255 \times 3600}{0.4838 \times 44500} \times 100\% = 20.98\%$$

$$BSFC_3 = \frac{M_{f3}}{BP_3} = \frac{0.4838}{1.255} = 0.385 \text{ kg/kWh}$$

(iv) For load = 9.4 lb

$$T_4 = \omega_4 d = m_4 g d = 4.26 \times 9.8 \times 0.3302 = 13.78 \text{ Nm}$$

$$M_{f4} = \frac{m_f \times 3600}{61} = \frac{8.6 \times 10^{-3} \times 3600}{61} = 0.5075 \text{ kg/hr}$$

$$BP_4 = \frac{2\pi NT_4}{60} = \frac{2\pi \times 972 \times 13.78}{60} = 1.4026 \text{ kW}$$

$$\text{BTE}_4 = \frac{\text{BP}_4 \times 3600}{\text{M}_{f4} \times \text{CV}} = \frac{1.4026 \times 3600}{0.6075 \times 44500} \times 100\% = 22.35\%$$

$$\text{BSFC}_4 = \frac{\text{M}_{f4}}{\text{BP}_4} = \frac{0.6075}{1.4026} = 0.362 \text{ kg/kWh}$$

$$\text{Mean BTE} = \frac{11.68 + 19.08 + 20.98 + 22.35}{4}$$

$$= 18.52\%$$

$$\text{Mean Brake Power} = \frac{0.596 + 1.074 + 1.235 + 1.4026}{4}$$

$$= 1.0819 \text{ kW}$$

$$\text{Mean BSFC} = \frac{0.693 + 0.424 + 0.385 + 0.362}{4}$$

$$= 0.466 \text{ kg/kWh}$$

Result:

$$\text{Brake Power, (Average)} = 1.0819 \text{ kW}$$

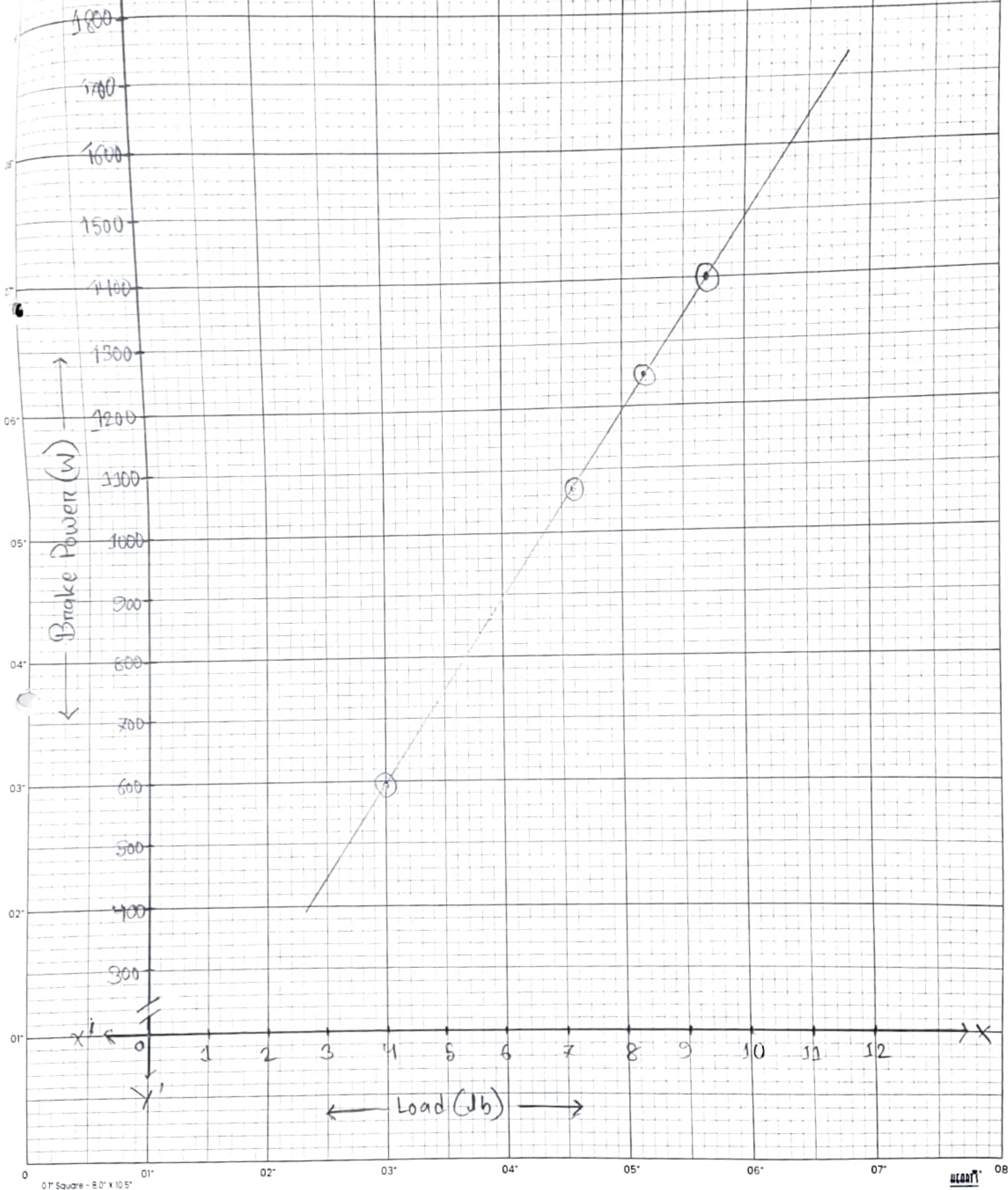
$$\text{Brake Thermal Efficiency (Average)} = 18.52\%$$

$$\text{Brake Specific Fuel Consumption (Average)} = 0.466 \text{ kg/kWh}$$

[Brake Load vs. Brake Power]

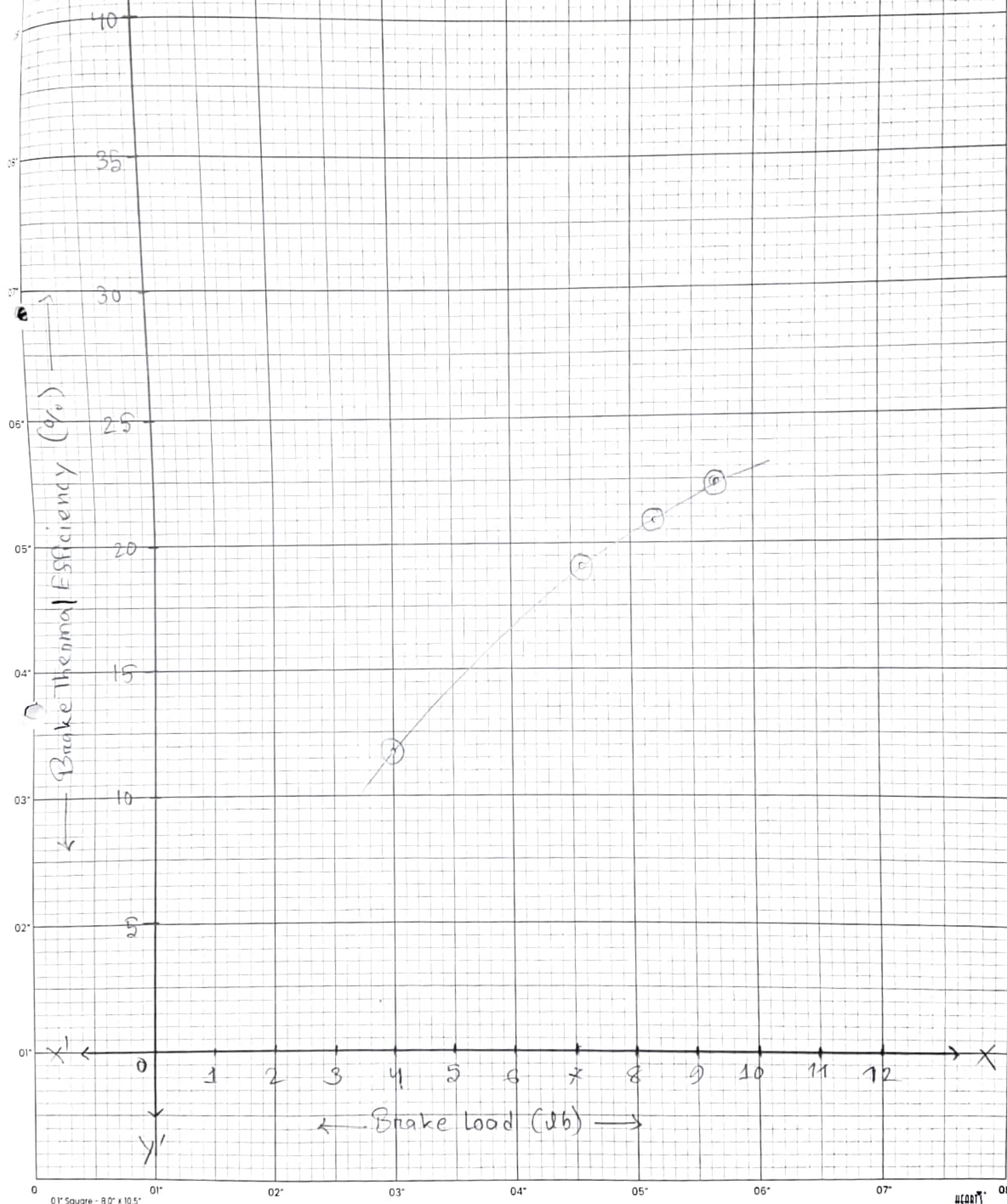
Along X axis 1 small square = 0.2 unit

Along Y axis 1 small square = 20 unit



[Brake Load vs Brake Thermal Efficiency]

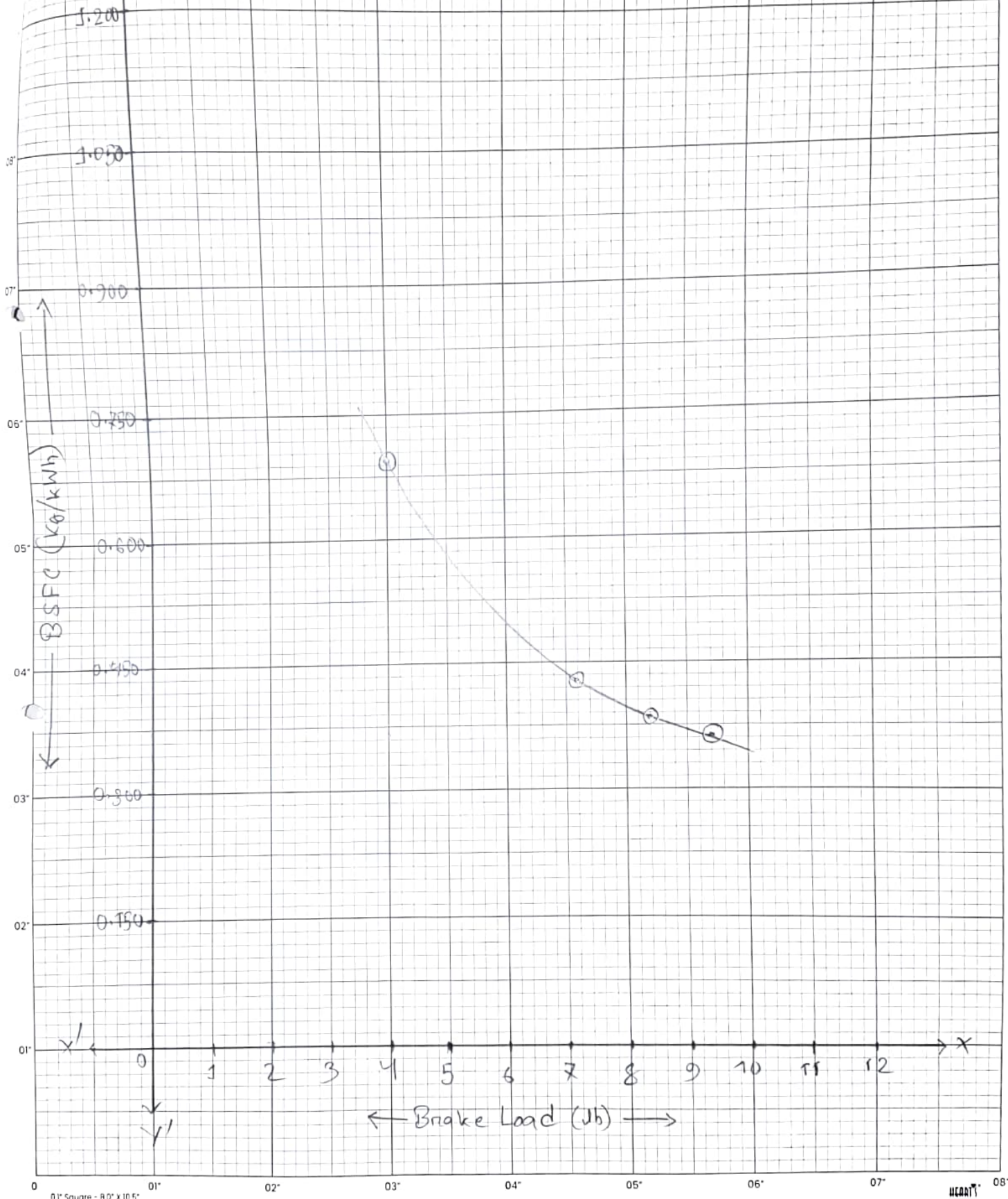
Along X axis, 1 small square = 0.2 unit
 Along Y axis, 1 small square = 0.5 unit



[Brake Load vs Brake Specific Fuel Consumption]

Along X axis, 1 small square = 0.2 unit

Along Y axis, 1 small square = 0.015 unit



Discussion:

The experiment successfully determined the performance parameters of the diesel engine. Minor errors occurred due to fuel measurement inaccuracies, heat loss, round up errors in calculations as well as the age (old) of the engine. Variations in load affected the efficiency & fuel consumption as expected.

Conclusion:

The calculated parameters help evaluate engine performance for fuel efficiency & power output. The diesel engine operates efficiently within a certain load range, making it suitable for power generation, transportation & industrial machinery.

Grp No. 04

Exp Date: 19-1-25

Roll: 2010025

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Exp. Name: Performance test of Diesel Engine

Data:

= (P) ✓

No. of Test	RPM (N)	Load (N)	Fuel Consumption		Length of Arm (inch)	Brake Power (W)	BTE
		No load	1.12 7.2			597.49	
	972	4	1.13	7.5	13 inch	↓	11.69%
		7.2	1.08	6.8		1075.69	19.11%
		8.4	1.02	6.4		1255.04	20.98%
		9.4	1.01	6.1			

Calculation:

$$\text{Brake Power} = \frac{2\pi NT}{60} \text{ W} \quad \text{--- (I)}$$

$$\text{Brake Thermal Efficiency} = \frac{BP \times 3600}{M_f \times C_v} \times 100\% \quad \text{--- (II)}$$

$$\text{BSFE} = \frac{M_c}{BP}$$

$$C_v = 44500$$

$$\rho = 0.86 \text{ gm/cc}$$

Torque, T = wd

w = Load (N)

d = Length of Arm (m)

M_f = Mass of Fuel (kg/hr)

$$C_v = 44500 \text{ kJ/kg}$$

BP → kW

$$N = \text{rpm} = 972$$

$$\rho = 0.86 \text{ gm/cc}$$

For Load = 4 lb

$$w = 4 \text{ lb} = 1.814 \text{ kg} \\ = 17.78 \text{ N}$$

$$d = 13 \text{ inch} = 0.3302 \text{ m}$$

$$N = 972 \text{ rpm}$$

$$\left\{ \begin{aligned} T &= w d \\ &= 17.78 \times 0.3302 \\ &= 5.87 \text{ Nm} \end{aligned} \right.$$

$$\text{Mass of Fuel, } m_{\text{fuel}} = \rho \times V \\ = 0.86 \times 10 = 8.6 \text{ gm}$$

$$\begin{array}{ll} 75 \text{ s} & \text{Fuel consumption} \rightarrow 8.6 \text{ gm} \\ 3600 \text{ s} & \text{" " " " } \rightarrow \frac{8.6 \times 3600}{75} = 412.8 \text{ gm/hr} \end{array}$$

$$M_f = 0.4128 \text{ kg/hr}$$

$$\text{BTP} \quad BP = \frac{2\pi NT}{60} \\ = \frac{2\pi \times 972 \times 5.87}{60} = 597.49 \text{ W} \\ = 0.597 \text{ kW}$$

$$BTE = \frac{BP \times 3600}{M_f \times C_v} \times 100\% = \frac{0.597 \times 3600}{0.4128 \times 44500} \times 100\% \\ = 11.69\%$$

$$\begin{aligned}
 75s &\longrightarrow 8.6 \text{ gm} \\
 3600s &\longrightarrow \frac{8.6}{75} \times 3600 \\
 &= 412.8 \text{ gm} \\
 &= 0.4128 \text{ kg/m}
 \end{aligned}$$

$$\begin{aligned}
 2g &\longrightarrow \frac{10 \text{ cc} \times 3600}{75} \\
 &= 86 \times 480 \text{ cc} \\
 &4
 \end{aligned}$$

$$\begin{aligned}
 W &= 7.2 \text{ lb} = 32.003 \text{ N} \\
 \mu &= 0.3302 \text{ m} \\
 T &= \boxed{10.568 \text{ Nm}}
 \end{aligned}$$

$$m = \cancel{8.6} \times 10 \quad 8.6 \text{ gm}$$

$$68s \longrightarrow \frac{8.6 \times 3600}{68}$$

$$= 455.29$$

$$= 0.4553 \text{ kg/m}$$

$$BP = \frac{2 \times 972 \times 10.568}{68}$$

$$= 1075.69 = 1.076$$

$$BVE = \frac{\cancel{1.076} \times 3600}{0.4553 \times 44500} = \boxed{19.11\%}$$

$$G \cdot y_{1b} = 37.34 \text{ N}$$

$$T = 12.33 \text{ Nm}$$

$$\frac{8.6 \times 3600}{.64} = 483.75$$

$$M_g = 0.48375 \text{ vol/hr}$$

$$BP = 2\pi \cdot 972 \cdot 12.33$$

$$= 1255.04 = 1.255$$

$$\frac{1.255 \times 3600}{0.48375 \times 44500} = 20.98\%$$

