Lab in Thermodynamics

Name

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Course

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Date

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The major objective for carrying out this experiment was to report on the expected performance of some available motor and pump combinations for the system. The successful completion of the experiment helped to determine the efficiency of internal combustion engines. In the course of achieving the purpose, engines chosen for the experiment were a 232cc four-stroke diesel motor and a 172cc four-stroke petrol motor. Test beds and dynamometers were used in measuring the performance of the engines. During the experiment, diesel was revealed to use a higher compression ratio compared to petrol. The diesel engine was found to be 39% efficient, which was 14% more than the petrol engine in terms of their thermal efficiency. The latter led to the conclusion that diesel engines are better to be used as internal combustion engines.

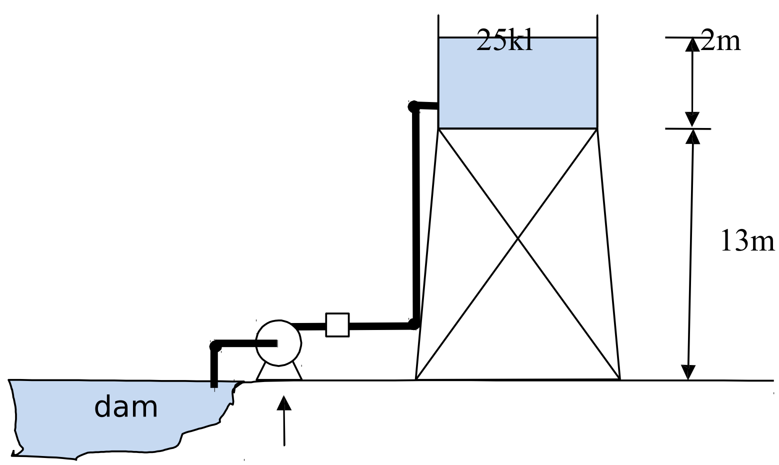


Figure 1. Diagram of the pump used

Results and Discussion

1. **The noise in dB made by each of the motors (measured in the laboratory). Note also the location where the noise measurement was made.**

Diesel = 104 dB (2360 rpm, near muffler)

Petrol = 100 dB (2390 rpm, near muffler)

2. **The duty points for pumps A, B and C (i.e. flow rate, head and pump efficiency corresponding to where Eq. (1) intersects the characteristic curves shown in Fig. 2).**

Diesel

A = 50

B = 55

C = 57

Petrol

A = 50

B = 55

C = 57

3. **The power (and torque) required to turn the shaft of the pump at each of the three duty points.**

Diesel

A = 580

B = 690

C = 920

Petrol

A =598

B = 785

C = 920

4. **Whether or not the engines in the lab are capable of delivering enough power to run the pumps at each of the duty points.**

Yes, the engines are capable of delivering enough power to run the pumps at each of the duty points because there is enough output power to supply the torque.

5. **The thermal efficiency of the engines at each of the three duty points at the specified rpm (measured in the laboratory)**

Mass flow rate = density * cross sectional area * velocity

Diameter = **0.035 m radius = 0.0175**

Cross sectional area = 3.14*0.0175^2

= 0.0009616

Diesel

A

Density = 1000 kg/m^3

1000 kg/m^3 x 2599.83 m/s x 0.0009616 m^2

2500 kg/s

B

1000 kg/m^3 x 3.0

3000 kg/s

C

1000 kg/m^3 x 3.2

3200 kg/s

Petrol

A = flow rate = 2.5 m^3/s

Velocity = 2.5/0.0009616

= 2599.83 m/s

Density = 1000 kg/m^3

1000 kg/m^3 x 2599.83 m/s x 0.0009616 m^2

2450 kg/s

B

1000 kg/m^3 x 2.0

2000 kg/s

C

1000 kg/m^3 x 3.0

3000 kg/s

6. **Time needed to fill the 25000 L water tank for each pump/motor combination.**

Measured time was 8 seconds for each combination.

7. **No. of litres of fuel (and approximate cost) required to fill the 25000 L tank for each pump/motor combination?**

1 liter of diesel cost $2.33

A = 2.333 X 0.008 X 85 = $1.586

B = 2.333 X 0.008 X 85 = $1.586

C = 2.333 X 0.008 X 85 = $1.586

Petrol

1 liter of petrol cost $3.33

A = 3.333 X 0.008 X 85 = $2.266

B = 3.333 X 0.008 X 85 = $2.266

C = 3.333 X 0.008 X 85 = $2.266

8. **The increase in potential energy of 25000 L of water as moves from the dam to the tank.**

Diesel

A = 146 – 22 = 124 J

B = 167 – 22.2 = 144.8 J

C = 172 – 22.2 = 149.8 J

Petrol

A = 265 – 23.4 = 241.6 J

B = 324 – 24 = 300 J

C = 356– 24.3 = 331.7 J

9. **The energy used by the motor in filling the water tank for each pump/motor combination.**

Diesel

124 X 580 = 71920 J

144.8 X 690 = 99912 J

149.8 X 920 = 137816 J

Petrol

124 X 598 = 74192 J

324 X 785 = 254340 J

356 X 920 = 327520 J

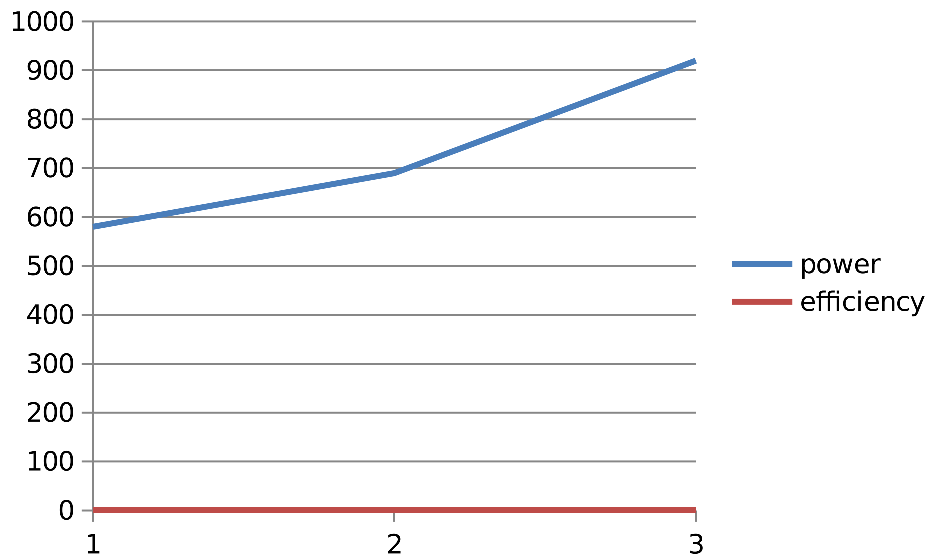
10. The overall thermal efficiency of the system (use lower heating value for the fuel).

Diesel

A = (1312.5 – 580)/1320 = 55.8%

B = 1506.24 – 690)/1506.24 = 54.2%

C = (2046.61 – 920)/2046.61 = 55.0%

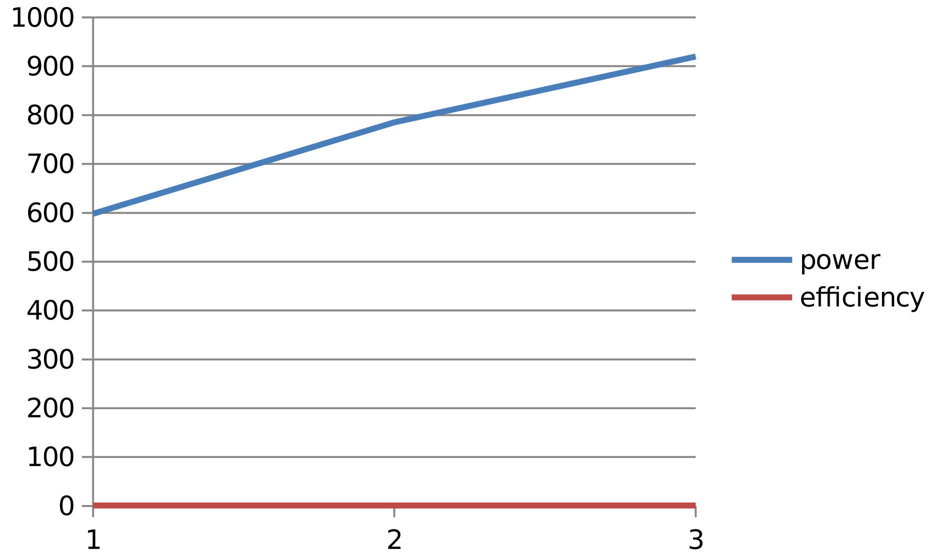


Petrol

A = (1310.5 – 580)/1320 = 50.8%

B = 1589.24 – 690)/1506.24 = 49.2%

C = (2023.61 – 920)/2046.61 = 48.0%



11. The air/fuel ratio at the conditions tested.

Diesel

A = 22/146 = 0.15

B = 22.2/167 = 0.13

C = 22.2/172 = 0.13

Petrol

A = 23.4/265 = 0.086

B = 24/324 = 0.074

C = 24.3/356 = 0.068

Conclusion

Compression ratio is limited primarily by the tendency of fuel to detonate, resulting in a condition called knock. Otherwise, the ratio should be as high as practicable if good efficiency is the primary goal. As compared to petrol, diesel had a relatively higher compression ratio, thereby allowing them to be more efficient. Consequently, the experimental results and calculations also confirm the same as shown in the thermal efficiency obtained for each. In order to increase efficiency, the engine's torque should be high while maintaining low engine speed. This works by allowing the diesel engine and pump to utilize most of the power input.

Appendix

Engine:	Diesel			Petrol		
Noise (dB):						
Pump:	A	B	C	A	B	C
Flow rate (kg/s)*: (water)						
Pump Head (m)*:	30	25	20	30	25	20
Pump Efficiency*:	50	55	57	50	55	57
RPM*:	2320	2405	2360	2390	2368	2380
Power Required from motor	580	690	920	598	785	920
Torque Required from motor	2.2	2.5	3.5	2.3	3.2	4.2
Can engine deliver required	yes	yes	yes	Yes	yes	no
Thermal efficiency of	55.8	54.2	55.0	50.8	49.2	48.0
Time needed to pump 25000 L of water	85	79	70	68	62	55
No. of litres of fuel required to pump	0.008	0.008	0.008	0.008	0.008	0.008
Cost of fuel required to pump	$2.266	$2.266	$2.266	$1.586	$1.586	$1.586
Increase in potential energy of	124	144.8	149.8	241.6	300	331.7
Energy used by motor to fill the tank (J)	71920	99912	137816	74192	254340	327520
Overall thermal efficiency of						
Air/Fuel Ratio:	0.15	0.13	0.13	0.086	0.074	0.068

	Petrol			Fuel		air and exhaust		
meas no	engine speed	engine torque	engine output power	Fuel volume	Fuel drain time	ambient air temperature	exhaust gas temperature	airbox differential pressure
1	2320	2.2	580	8	85	22	146	-350
2	2405	2.5	690	8	79	22.2	167	-340
3	2360	3.5	920	8	70	22.2	172	-325
4	2360	4.9	1290	8	59	22.3	199	-305
5	2370	6.2	1510	8	53	22.5	224	-290
6	2300	8	1910	8	44	22.9	240	-275

	Diesel engine			Fuel		air and exhaust		
meas no	engine speed	engine torque	engin e	Fuel volum	Fuel drai	ambient air temperatur	exhaust gas temperatur	airbox differentia

			output power	e	n time	e	e	l pressure
1	2390	2.3	598	8	68	23.4	265	-10
2	2368	3.2	785	8	62	24	32	-22
3	2380	4.2	920	8	55	24.3	356	-30
4	2340	4.9	1200	8	52	24.5	394	-45
5	2340	5.9	1450	8	49	24.7	405	-52
6	2250	9	2050	8	36	23.3	471	-90