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Evaluating The Performance Of Single Cylinder Petrol Engine Working On Different Types Of Gasoline Fuel Used In Iraq

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Abstract: *An experimental study has been conducted in Baghdad Technical Institute to evaluate the gasoline fuel that used in Iraq and their effects on petrol engine performance. A single cylinder four stroke air cooled petrol engine was used in this research, the engine fixed on a test engine rig that consists of a hydraulic dynamometer (that used to connect with engine outlet shaft to dominate and control the load) and instrumentation unit which contains of many devices that measure the fuel consumption, exhaust gas temperature, engine speed and torque. Four types of gasoline fuel were used which include imported gasoline named (A1),Shuaiba gasoline (A2), Al-Daura gasoline (A3) and Nasiriya gasoline (A4). The engine was run on three levels of speed 1500, 2000and 2500 rpm with three levels of loads 2,4 and 6 Nm respectively. The engine performance that were studied includes brake specific fuel consumption (bsfc), brake specific energy consumption (bsec), brake thermal efficiency (BTE) and exhaust gas temperature (EGT). The experimental results were statistically analyzed by using the split-split plot design and SAS (2012) software based on a complete randomized design (CRD) within three replications. The least significant difference (LSD 0.05) under probability of 0.05 was utilized to compare the means of treatments. Results obtained from this research showed that gasoline fuel type (A1) registered the lowest rate for bsfc and bsec while this fuel showed the highest rate in BTE and EGT 45.26% and 553C° respectivelyunder engine speed 2500rpm and load 6Nm.*

Key Words:*gasoline fuel, petrol engine, brake specific energy consumption, brake thermal efficiency.*

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I. Introduction

Gasoline is used as a fuel for combustion engines by burning in wheels and agricultural equipment. Benzene is a hydrocarbon substance when combustion breaks down into hydrogen atoms and carbon atoms; these atoms in turn combine with oxygen atoms. Combustion is carried out in the combustion chamber and its components vary depending on the type of crude oil, the process of filtration and chemical substances added during the process of filtration. It is classified according to its octane and evaporation rate at different temperatures, which have a significant impact on engine performance and exhaust emissions [1].

Gasoline can be obtained through a complex crude oil refining process. Gasoline is the lightest type of liquid produced by the crude oil refining process. Its composition depends on the type of crude oil. Benzene has an important property that is sensitive to the road. The gasoline density is between 700 and 780 kg / m^3. The phenomenon of slapping can be prevented by using benzene resistant to this highly octane [2].

An experiment done by [1] evaluated the effect of octane fuel on the performance of ignition engines. Five types of fuel with different octane were used (70, 75, 80, 85, 90) and different speeds (1000-2800)for enginetype (TD115) that was connected to a hydraulic dynamometer. The results obtained from this study registered higher engine performance when the octane fuel is increased. The thermal efficiency of the booster increased by 12.48% at a maximum speed of 3800 rpm and the capacity increased (8.97%), while the specific consumption declined by 15%. Researchers [3] experimented four different octane fuel and four speeds (1000, 2000, 3000, 4000) on a TDS200 four-stroke gasoline engine, and they proved that brake power and BTE were increased, while BSFC decreased when the octane number was increased.

the heavy fuel containing high proportion of carbon and low proportion of hydrogen thus, will have the largest specific weight and less heat than light fuel. [4].

A research done by [5] achieved that the value of BSFC decreases by increasing loads. This is attributed to the reduction in the amount of fuel entering the combustion chamber, contrary to what the engine requires to obtain the highest capacity, to compensate the load stresses on the engine,

The brake specific energy consumption (bsec) depends on the brake specific consumption of fuel and the lower calorific value of the fuel. [6].

The aim of this research is to evaluate the effect of using different types of gasoline fuel(that were using in Iraq) on some performance of spark ignition engines.

II. Materials and Methods

Fuel

In this study, four types of gasoline fuel were used include imported gasoline A1, and three local gasoline fuel Shuaiba gasoline (A2), Al-Daura gasoline (A3) and Nasiriya gasoline (A4).Analysis of these fuel were showed in table 1.

Table 1 : specifications of gasoline fuel

	A1	*A2*	*A3*	*A4*
Sp. gravity@ 15.6 ˚C	**0.743**	**0.732**	**0.729**	**0.732**
Octane Number	**95.9**	**84.4**	**81.5**	**79.4**
LCV kJ/kg	**34456**	**41851**	**38016**	**35093**

Test engine

Air-cooled, 4-stroke spark ignition engine linked with a hydraulic dynamometer, within a testing platform that includes fuel consumption, engine speed, load, exhaust gas temperature, and other engine measurements. The specifications of test engine showed in table 2 andthe engine test rig illustrated in figure 1.

Table 2: Technical specifications of the test engine

ENGINE	SPECIFICATION
Engine type	**TD211**
Number of engine cylinders	**1**
Number of stroke	**4**
Diameter cylinder engine	**67MM**
Stroke length	**49MM**
Engine Capacity	**172CM^3**
Compression ratio	**8.5:1**
Engine oil type	**- 3010W**
Cooling system	**AIRY**

Engine Test Accessories:

Engine Cycle Analyzer (ECA100):

The ECA100 is used with the test engine that is specially modified with the cylinder head pressure transducer and crank angle encoder. It consists of:

- A hardware unit (interface) with Charge Amplifier and signal conditioning circuits.
- Dedicated software, to log data, calculate indicated mean effective pressure (IMEP), indicated power and create charts of pressure against Crank Angle(P-ϴ) and pressure against Volume (P-V).

The software also includes a useful ‘EngineAnimation’ that simulates the cylinder and crank position in relation to test results.

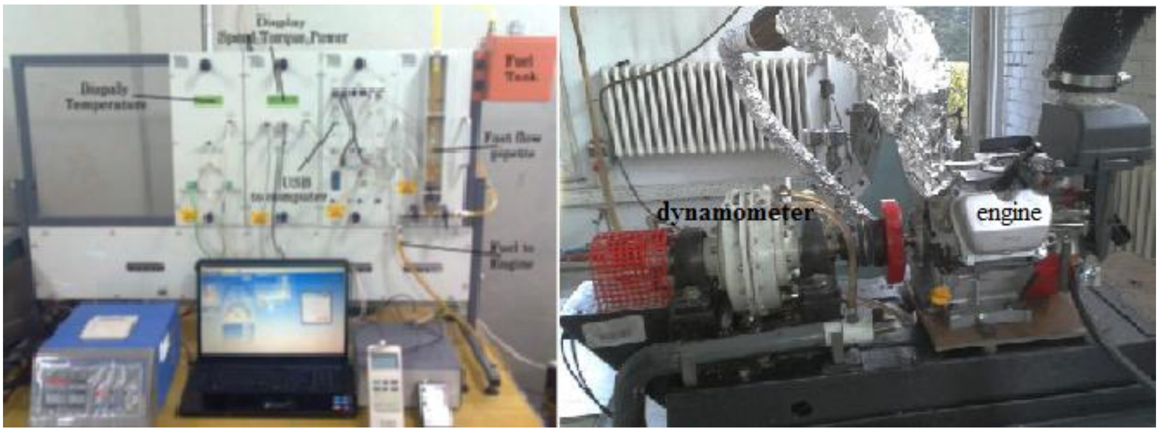

Fig. 1: Engine test and dynamometer linked with instrumentation unit within test rig.

The fuel consumption is determined by measuring the time (t) taken for the engine to consume a given volume of fuel, the fuel consumption can be determined by the following equation ;[7]

$$m^{\circ}{}_{f} = \frac{sg_f \times 8 \times 0.001}{t} \times 3600 \quad \ldots\ldots\ldots\ldots\ldots \ (1)$$

Where:

$m^{\circ}{}_{f}$ = Fuel Consumption (kg/hr).

sg_f = specific gravity of the fuel (kg/L).

Thus, specific fuel consumption can be calculated from this equation which suggested by[8]:

$$\text{bsfc} = \frac{m^{\circ}{}_{f}}{BP} \ \ldots\ldots\ldots\ldots \ (2)$$

Where:

bsfc = brake specific fuel consumption (kg/kW.hr).

$m^{\circ}{}_{f}$ = Fuel Consumption (kg/hr).

BP = Brake Power (kW).

Brake Thermal Efficiency

The brake thermal efficiency of the engine can be defined as the efficiency of the engine to convert the existing energy into fuel and mechanical energy, calculated from the equation below; [9]

$$\eta_{bth} = \frac{\text{BP}}{\text{m} * \text{LCV}} \ \ldots\ldots\ldots\ldots\ldots . (3)$$

As:

η_{bth} ; Brake Thermal efficiency (%):

BP: Brake Power (kW)

m: Fuel consumption (kg / s)

LCV: lower calorific value (kJ / kg).

Exhaust Gas Temperature

It is measured by a chrome/alumel thermocouple. The thermocouple is located brazed into the exhaust pipe close to the cylinder block of the engine.

Test procedure

Four types of gasoline were used in this research that were widely used in Iraq, these types include imported gasoline named (A1),Shuaiba gasoline (A2), Al-Daura gasoline (A3) and Nasiriya gasoline (A4). The engine was run on three levels of speed 1500, 2000and 2500 rpm with three levels ofloads 2, 4 and 6 Nm respectively.

Initially, drained the old gasoline from the fuel tank and refilled with first sample gasoline (A1), Torque meter must be zeroed.

After that run the engine by A1 gasoline type at idle speed for 20 minutes to reach stability, then increased the engine speed by control lever to 1500 rpm and the load to 2 Nm gradually by increasing the flow of water in hydraulic dynamometer which is controlled by a needle valve. The fuel consumption is determined by measuring the time (t) taken for the engine to consume a given volume of fuel (8 ml). During that procedure, parameter which included fuel consumption, exhaust gas temperature, speed, and torque were recorded. Indicated power was measured electronically by a device (ECA100).All these results were displayed in the instrumentation unit, while fuel consumption measured manually.

In the second step, the engine speed was fixed at 1500 rpm and the load was changed to 4 Nm, and recorded the results like fuel consumption, exhaust temperature and torque, by the same previous steps and so as for the rest loads 6, Nm. , and do the same steps for the rest speeds 2000, 2500 rpm. Gasoline A2 was applied with the same steps of previous work, and so that for gasoline A3 and A4. When changing gasoline to another type, completed draining and flushed the fuel tank before filling with the other type of gasoline.

Every test was repeated three times to be more accurate. After making 180 plot , the engine performance was analyzed by using the (ECA100, VDAS) programs.

III. Results and discussion

The experimental results were statistically analyzed using the Split-Split plot design and SAS (2012) software based on a complete randomized design (CRD) within three replications. The least significant differences (L.S.D = 0.05) under probability of 0.05 was utilized to compare the means of treatments.

Brake specific fuel consumption

the triple interaction between fuel types, engine speeds and loads showed the significant effect on the studied indicators Table (3) and figure (2) illustrate theeffect of triple interaction between fuel type,speedand load on bsfc, .Gasoline type A1 registered the lowest rate of bsfc (0.231 kg/kWhr)at engine speed 2500 rpm with load 6 Nm, the reason may be due to the highest rate of ON for gasoline A1 than the other types, while the highest rate of bsfc (0.771) kg/kW.hr registered for gasoline type A4.

Table (3) Effect of the interaction between fuel type, speeds and torques on bsfc (kg/ kW.hr).

Fuel Types	Speed rpm	Interaction between fuel, Speed and Torque		
		Torque (N.m)		
		2	4	6
A1	1500	0.625	0.324	0.248
	2000	0.624	0.319	0.240
	2500	0.601	0.305	**0.231**
A2	1500	0.633	0.325	0.251
	2000	0.630	0.322	0.250
	2500	0.629	0.319	0.248
A3	1500	0.704	0.363	0.289
	2000	0.698	0.358	0.283
	2500	0.692	0.358	0.278
A4	1500	0.771	0.394	0.315
	2000	0.764	0.393	0.310
	2500	0.760	0.395	0.305
LSD= 0.005	*0.393			

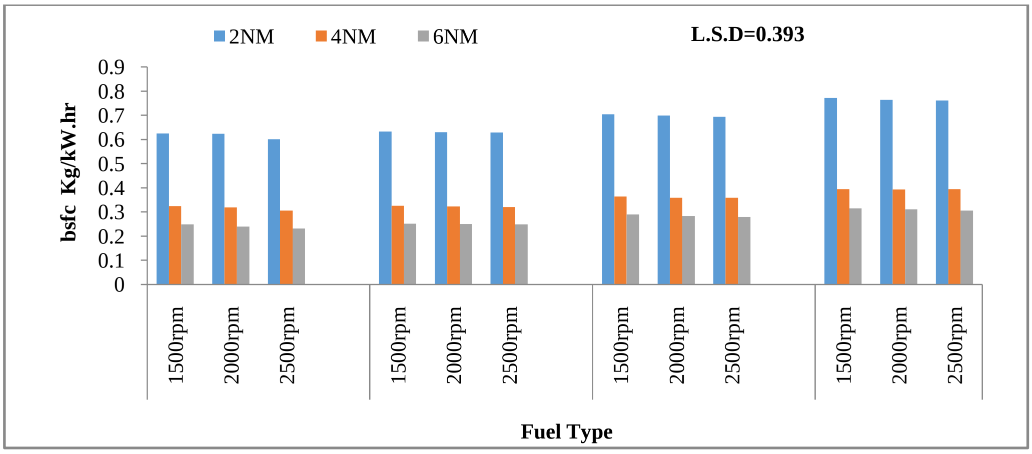

Fig 2: The triple interaction between fuel type,speed and load and their effect on bsfc.

Brake specific energy consumption.

Table (4) and figure (3) illustrated effect of triple interaction between fuel type, speed and load on bsec, .Gasoline type A1 registered the lowest rate of bsec (7.97 MJ/kWhr) at engine speed 2500 rpm with load 6 Nm, the reason may be due to the highest rate of ON for gasoline A1 than the others types, while the highest rate of bsec (27.07) MJ/kW.hr registered for gasoline type **A4.**

T able (4) Effect of the interaction between fuel type, speeds and torque on bsec (MJ/kW.hr)

Fuel Types	Speed rpm	Interaction between fuel, Speed and Torque		
		Torque (N.m)		
		2	**4**	**6**
A1	1500	21.55	11.19	8.58
	2000	21.54	11.02	8.27
	2500	20.73	10.52	7.97
A2	1500	26.51	13.65	10.52
	2000	26.40	13.52	10.49
	2500	26.34	13.39	10.41
A3	1500	26.80	13.84	11.02
	2000	26.57	13.64	10.79
	2500	26.36	13.64	10.61
A4	1500	27.07	13.86	11.07
	2000	26.84	13.82	10.91
	2500	26.71	13.87	10.71
LSD= 0.005	* 6.084			

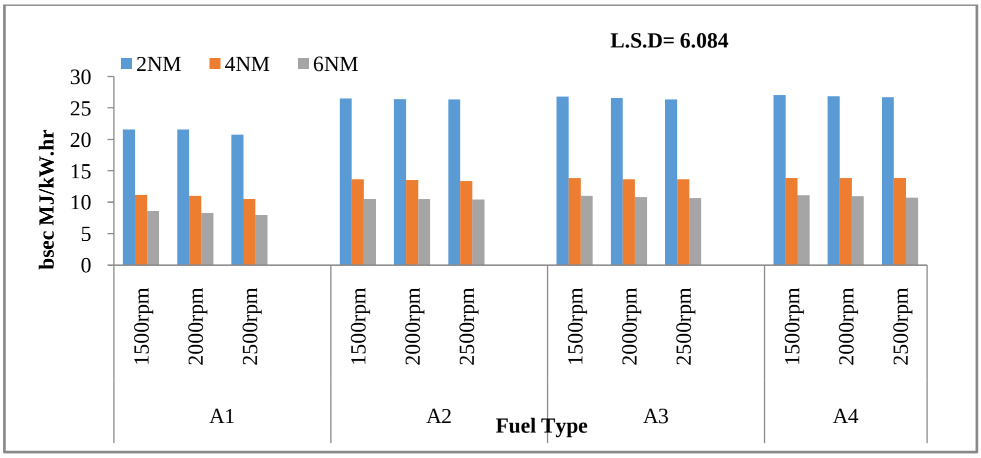

Fig.3: The triple interaction between fuel type,speed and load and their effect on bsec.

Brake Thermal Efficiency BTE

Table (5) and figure (4) showed the effect of triple interaction between fuel type ,speed and load on BTE.Gasoline type A1 registered the highest rate of BTE 45.26% at engine speed 2500 rpm with load 6 Nm the reason may be due to the lowest rate of heating value for gasoline A1 than the others types, while the lowest rate of BTE
(13.29%) registered for gasoline type A4 at engine speed 1500 and load 2Nm.

Table (5) Effect of the interaction between fuel type, speeds and torque on BTE.

Fuel Types	Speed rpm	Interaction between fuel, Speed and Torque		
		Torque (N.m)		
		2	**4**	**6**
A1	1500	16.69	32.16	39.64
	2000	16.71	32.71	43.54
	2500	17.38	34.24	45.26
A2	1500	13.57	26.45	34.30
	2000	13.64	26.64	34.38
	2500	13.67	26.93	34.6
A3	1500	13.44	26.06	32.64
	2000	13.59	26.39	33.38
	2500	13.66	26.40	33.99
A4	1500	13.29	25.95	32.62
	2000	13.43	26.07	33
	2500	13.50	26.16	33.59
LSD= 0.005	* 11.831			

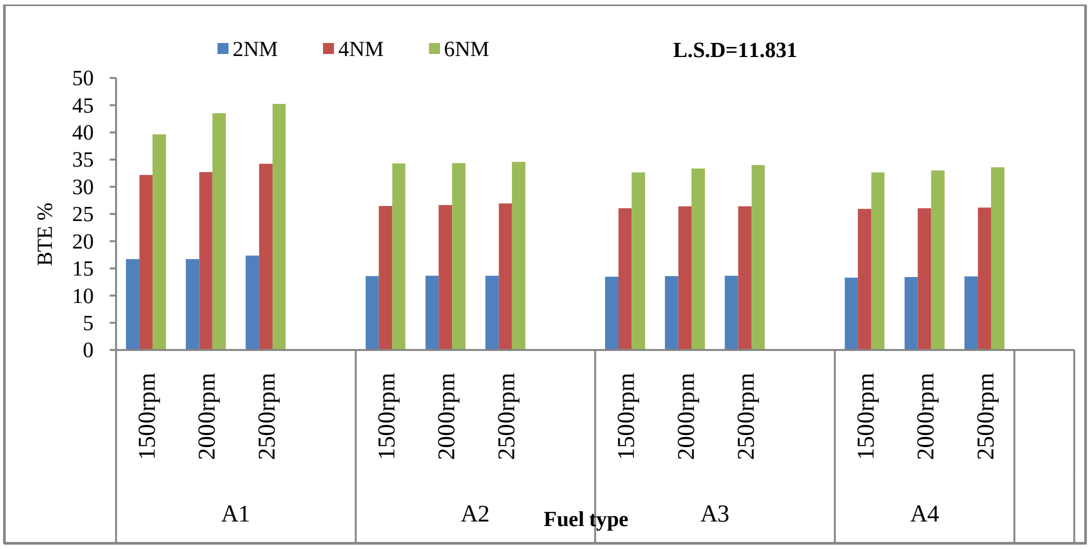

Fig 4: The triple interaction between fuel type,speed and load and their effect on BTE.

Exhaust Gas Temperature EGT

Table (6) and figure (5) illustrated theeffect of triple interaction between fuel type ,speed and load on EGT .Gasoline type A4 registered the lowest rate of EGT 248C˚ at engine speed 1500 rpm with load 2 Nm the reason may be due to the lowest rate of ON for gasoline A4 than the others types, while the highest rate of EGT 553 C˚ registered for gasoline type A1 at engine speed 2500 and load 6Nm.

Table (6) Effect of the interaction between fuel type, speeds and torque on EGT.

Fuel Types	Speed rpm	Interaction between fuel, Speed and Torque		
		Torque (N.m)		
		2	**4**	**6**
A1	1500	340	354	390
	2000	394	437	473

	2500	464	496	553
A2	1500	332	352	379
	2000	368	406	447
	2500	461	465	520
A3	1500	259	315	344
	2000	340	392	412
	2500	457	463	519
A4	1500	248	311	342
	2000	323	367	406
	2500	426	462	500
LSD= 0.005	*73.68			

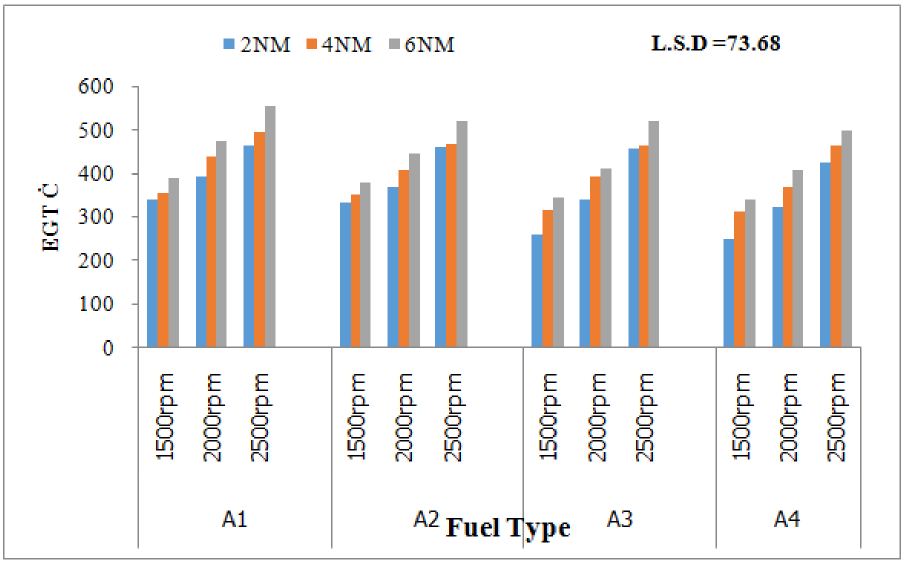

Fig.5: The triple interaction between fuel type, speed and load and their effect on EGT.

IV. Conclusion

The results gained from the experiment showed that ;

- Imported gasoline (A1) registered the lowest rate of brake specific fuel consumption and brake specific energy consumption for all speeds and loads.
- The highest rate of Brake Thermal Efficiency gained by using gasoline fuel A1 at engine speed 2500 with load 6Nm.
- Gasoline fuel A4 registered the lowest rate of Exhaust Gas Temperature at engine speed 1500 and load 2Nm.

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