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STUDY THE EFFECT OF OCTANE NUMBER ON THE PERFORMANCE OF THE SPARK IGNITION ENGINE

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Abstract

This paper investigates the effect of octane number on the performance of the spark-ignition (SI) engines using Lotus Engine Simulation program. To this aim, the engines model for a commercial automotive spark-ignition engine was constructed and engine performances, determine for gasoline and different types of research octane number (RON).The results show that brake thermal efficiency increases while fuel consumption decreases according to the increases in the octane number of the fuel.

Keywords: (SI engine); Gasoline; Research octane number; Specific fuel consumption;

1- Introduction

Octane number is one of the most important properties of gasoline streams and is a measure of its antiknock quality. It is named as the volume percentage of *i*-octane in a blend of *n*-heptane and *i*-octane, which produces the same knock power as the test fuel under standard test conditions in an ASTM internal combustion engine (ICE). ASTM defines two different types of Octane number, the research octane number (RON) and the motor octane number (MON), which are evaluated using the ASTM D2699 and the ASTM D2700 tests, respectively.1,2 Both methods use the same standard test engine but differ in the operating conditions. Research octane number (RON) is measured in an engine running at (600 RPM) and a fuel/air mixture at a temperature of 60 °F, while motor octane number (MON) is measured with the engine running at (900 RPM) and a fuel-air mixture at a temperature of 300 °F. The engine idle speed (RPM) and the lower (fuel- air) temperature as required in the RON test are representative of the fuel performance for city driving while the faster engine speeds and higher fuel/air temperature represent the fuel performance for highway driving. Mohammed Hassan Aboud, [1], 2006, studied the effect of the octane number of the fuel on the performance of the spark ignition engine. The study included the preparation of fuel with octane number (70, 75, 80, 85, and 90). The results show that the engine performances are increased step by step according to the increases in the octane number of the fuel.

Experimentally investigate the performance of an SI engine (Armfield CM11) using two commercially available fuels in the kingdom of Saudi Arabia: gasoline-91 and gasoline-95. Open literature shows that no such investigation has been done so far. Since the difference in octane number between the two fuels is small, and knowing that the addition of oxygenates such as methyl tertiary butyl ether (MTBE) increases the octane number of SI engines fuel, yet, it is not clear whether the increase in octane number is due to original fuel quality or to the addition of MTBE and therefore it needs further investigation. A variable speed test was performed for a spark ignition engine using both fuels at two different throttle openings. Results revealed that both power & torque at various speeds is lower for Gasoline-95 than for Gasoline-91. [2]

2- Engine simulation

In this study, Engine simulation (LES) is used for simulation and computation. Engine simulation program able of predicting the complete performance of an engine method. The application can be made to predict the full- and part-load performance of the (ICE) under steady-state and transient operating conditions. Instantaneous gas property and heat transfer data in manifolds and cylinders of the engine can be estimated for stratified, or turbocharger or supercharger is meeting conditions. Engine simulation program (LES) needs, to engine and different specifications; cylinder bore (D), stroke (L) and connecting rod dimension(C.R), compression ratio(CR), valve sizes (VS) and valve timing (VT) data, intake and exhaust port stream data, inlet and exhaust manifold dimensions, maps defining the performance of turbine , Compressors, engine speed, heat release data, characterising the combustion , air-fuel ratio and inlet air temperature and pressure. Fuel type and characteristics are established for physical completion of the form and then running states are required to execute the engine simulation model. An S.I engine laboratory was moulded with LES software in this study. A general layout of SI engines is shown in Fig. 1.

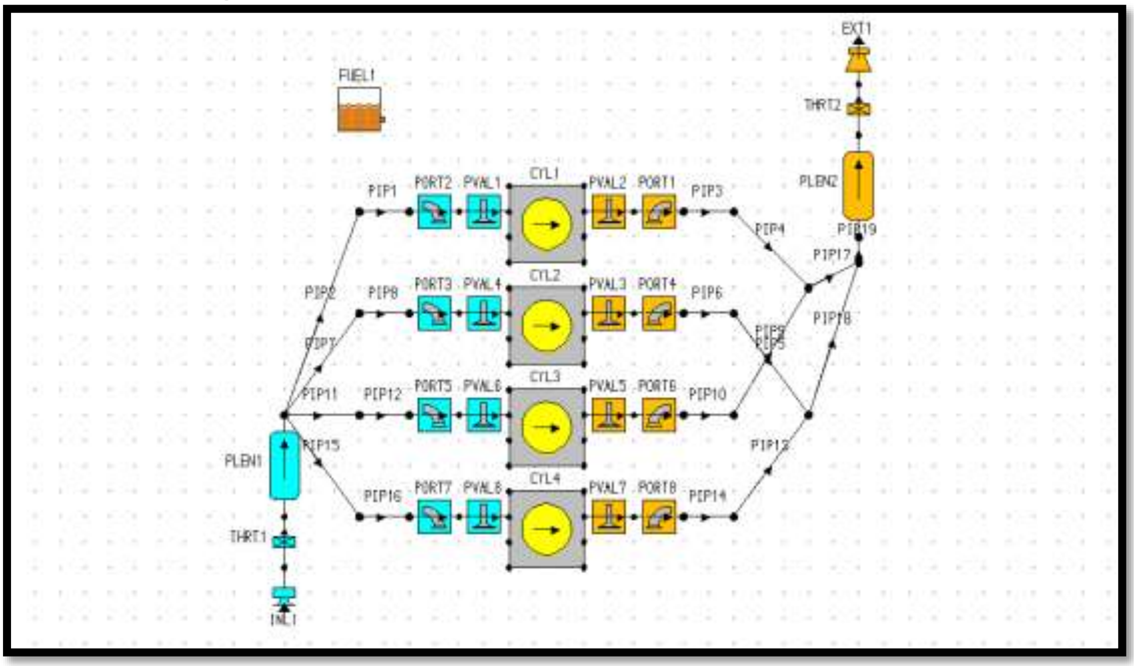


Fig (1): The network model of S-I-engine.

The defining features of the S.I engine laboratory, Properties of the gasoline fuels and the main parameters used in the (LES) input file are detailed below in Tables (2-1), (2-2) and (2-3).

Feature	Value
Bore	86 mm
Stroke	86 mm
Displacement	1.998 L
Con-Rod Length	130.00 mm
Compression ratio	8.8:1
Fuel System:	Injection
Cooling:	Water System

Table 2-1: S-I engine specification.

Inlet valve timing	
Inlet valve opening (IVO)	15.0 bTDC
Inlet valve closing (IVC)	60.0 aBDC
Maximum opening point (MOP)	112.5
Exhaust valve timing	
Exhaust valve opening (EVO)	40.0 bBDC
Exhaust valve closing (EVC)	20.0 aTDC

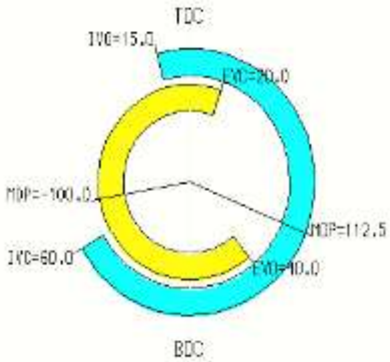


Table 2-2 : Inlet and exhaust valve timing (S-I engine)

RON	Density at 15 °C (g/cm^3)	Lower heating value (kJ/kg)	H/C	A/f
80	730	45040	2	14.8
85	720	43000	1.875	14.6
92	740	44220	2.2	15.1
100	750	44300	2.25	15.1

Table 2-3: Properties of the gasoline fuels with different octane number

2-2MATHEMATICAL RELATIONS

LES uses widely known relationships given below to determine the engine performance parameters [3]. The indicated work per cycle is defined as follows:

$$WC = \int p \, dV \qquad (1)$$

The indicated power is defined as in Eq.

$$Pi = Wc \; N \; Z \; / \; 60 \; n \; R \qquad (2)$$

Here, n R is the revolutions per cycle which are 2 for four-stroke engines; Z is the cylinder number.

The (Pb) is defined by considering the friction power:

$$Pe = Pi - Pfr \qquad (3)$$

The brake mean effective pressure and torque is defined as:

$$bmep = \frac{10^{6} \, Pe \, nR}{60 Vd \, N} \qquad (4)$$

$$Te = 10^{3} Pe / w \qquad (5)$$

Here, $Vd = (S \, \pi B^2/4)$ and $\omega = 2 \, \pi \, N / 60$

The brake specific fuel consumption is determined as in Eq.

$$Bsfc = \frac{\dot{m}_f}{pe} \qquad (6).$$

Brake thermal efficiency is defined as in Eq.

$$\eta_{e.} = \frac{3600}{\dot{m}_f \, QLHV} \qquad (7)$$

Here, $\dot{m}_{i}$s and $\dot{\rho}_{is}$ are inlet air mass flow rate and density which is calculated as

$$\dot{\rho}_{is} = \frac{10 \quad \text{three} \; p_{ia}}{R \, Tia}$$

Moreover, the mass burn rate is simulated by using Wiebe function that is expressed in Eq.

$$X_b = 1 - \exp[-a(\varnothing - \varnothing s / \Delta\varnothing b)^{m+1}] \qquad (9)$$

Here, a and m are the fixed parameters which are taken as 10 and 2, respectively.

Lotus simulates the shape of the pc f (port flow co

$$C f = \frac{\square_{real}}{\dot{m}_{there}} \qquad (10)$$

C_f – port flow coefficient,

$\dot{M}_{real}$ - *Real mass flow through the port*

$\dot{M}_{theor}$ - *Theoretical mass flow through the port*

3- Results and Discussion

3-1 Effect of octane number upon fuel consumption

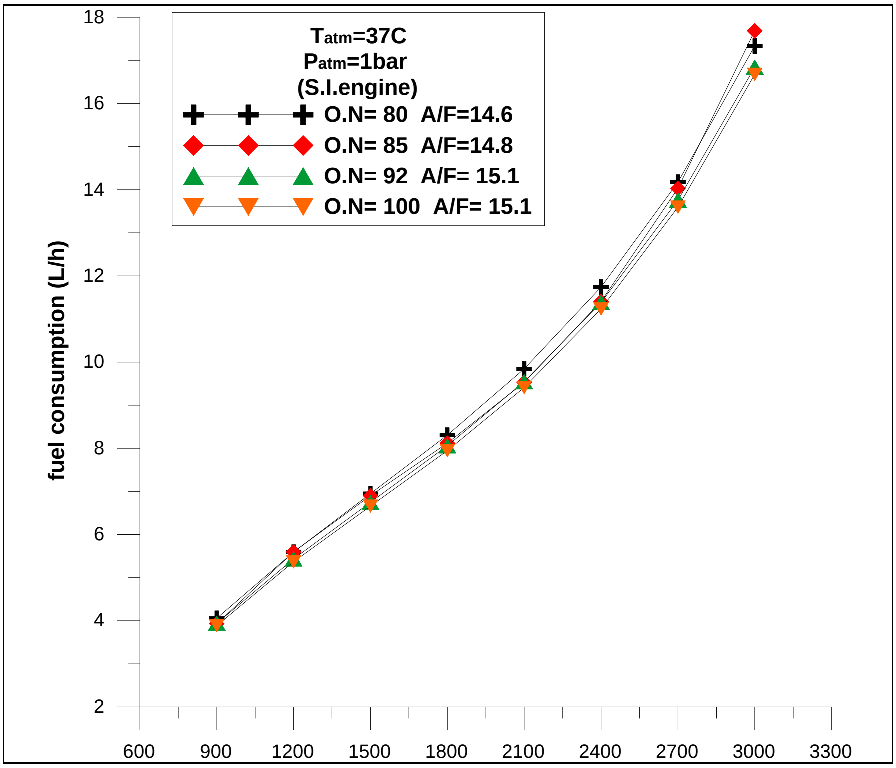
For S.I. Engine using different values of octane number (80, 85, 92,100) the fuel property that describes how well a fuel will or will not self-ignite is called the octane number.To show the effect of raising of octane number upon the fuel consumption (L/h), it is seen in Fig (2) when the octane number increased[like 100]. The fuel consumption (L/h) decreased more than the fuel consumption(L/h) of octane number(80) by about (4.14%), as shown in Fig(2).

$$\dot{M}_{theor} = v(f(po,PC,T)) \cdot Sref \cdot \rho$$

where: - *v(f(po,PC,T))* – theoretical flow speed,

ρ – Density of medium.

S ref – valve throat area,



Fig(2): Fuel consumption (L/h) as the function of engine speed of S.I. Engine for different values of octane number

3-2 Effect of brake power

Figure (3) reveals the relation between the brake power and engine speed for various values of octane number (80, 85, 92, 100) for S.I. engine .It is noticed that the(Pb) increased when the engine speed increased for all values of octane number, but using of octane number [like 85] as shown in Fig (3),it is seen that the brake power is greater than the brake power of octane number (80) by about (3.24%).

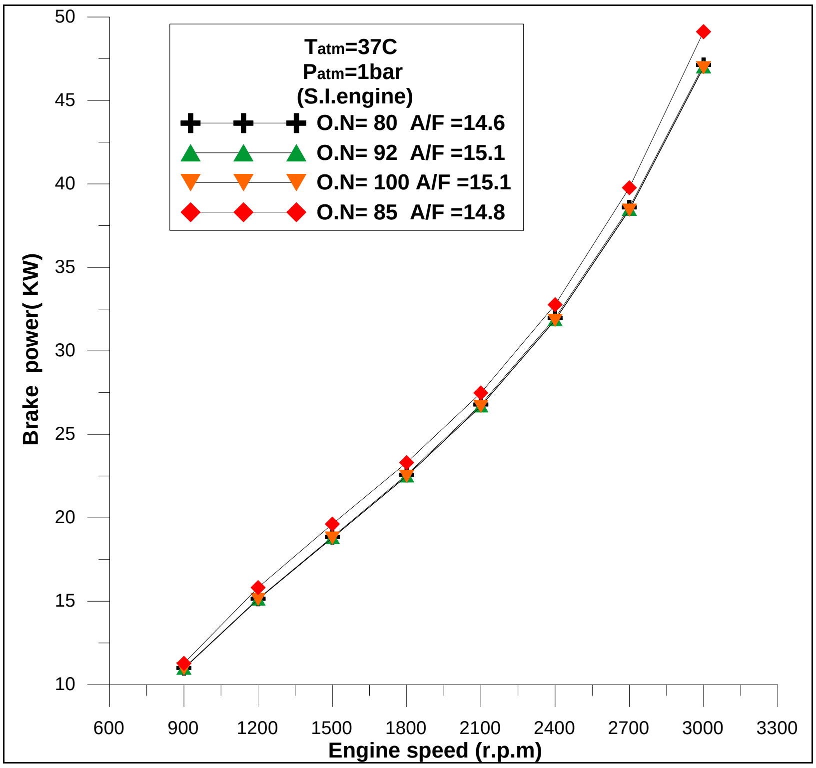


Fig **(**3**):** The brake power as the function of engine speed of S.I. Engine for different values of octane number

3-3 Effect of brake specific fuel consumption (bsfc)

Whereas Fig (4) shows the effect of brake specific fuel consumption on engine speed for different values of octane number of gasoline fuel, In this Figure the values of brake specific fuel consumption of higher like 100 octane number are lower when compared with the others values of octane number 80 by about (4.88%), which used in S.I. engine .

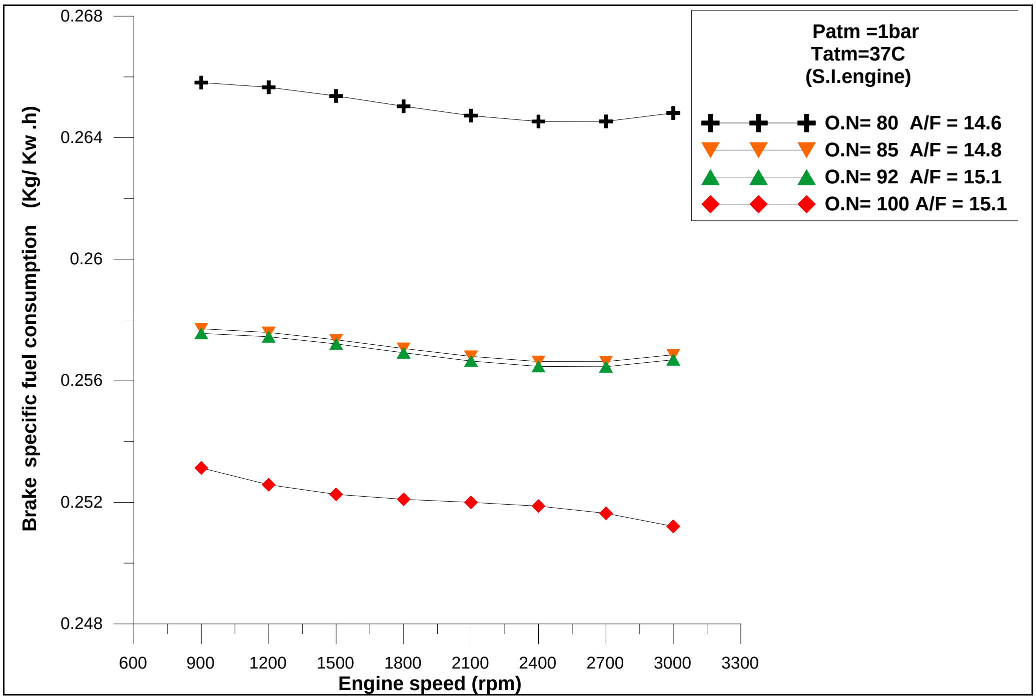


Fig **(4):** The brake specific fuel consumption as the function of engine speed of S.I. Engine for different values of octane number

Effect of brake thermal efficiency

Figure (5) shows the relation between the brake thermal efficiency and engine speed for different values of octane number (80, 85, 92,100).It is seen that the brake thermal efficiency which increased when the engine speed increased for all values of octane number, but using of octane number [like 85], as shown in Fig (5) indicates that the brake thermal efficiency is greater than the brake thermal efficiency of octane number (80), but these difference are very low.

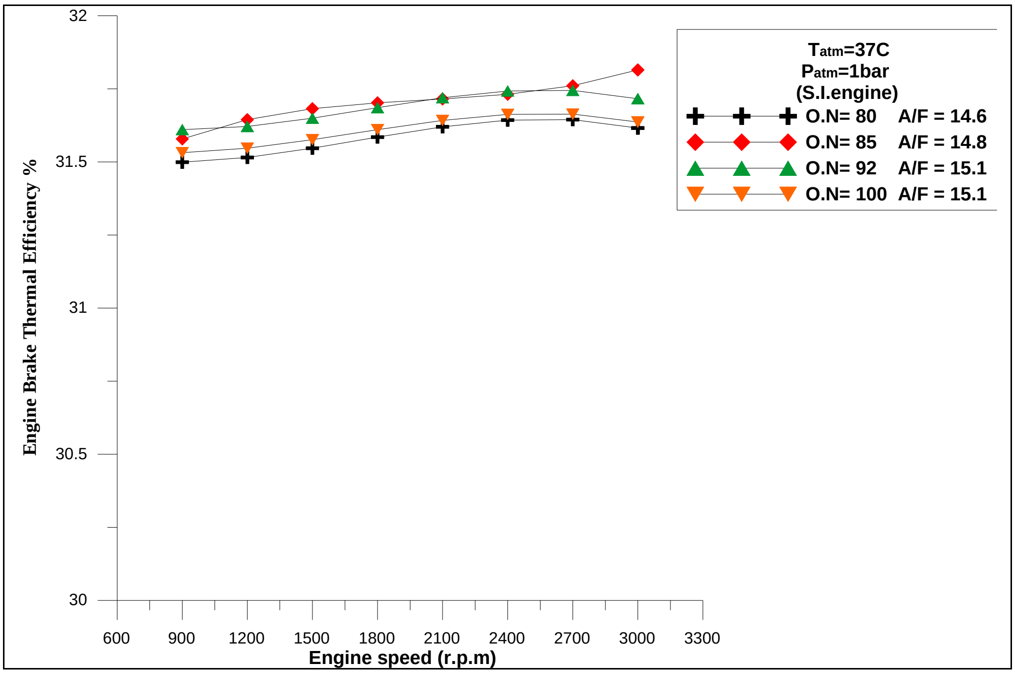


Fig **(**5**).**Brake thermal efficiency as the function of engine speed of S.I. Engine for different values of octane number

4- CONCLUSION

In this study, it was seen that when an engine was fueled octane number, engine performance parameters such brake thermal efficiency increases with increasing (RON) octane number while bsfc decreased. The results show that the concentration of exhaust emissions decreases with increases (RON) octane number.

Reference

1- Dr Mohammed Hassan Aboud Al-Mosawi, Experimental study the effect of octane number on the performance of the spark ignition engine.2006.

2- Performance of Spark Ignition Engine using Gasoline-91 and Gasoline-95.

3- Getting Started Using Lotus Engine Simulation 5.05.