The Effect of Increasing of Diesel Fuel Temperature Upon the Engine Performance By Using Two Magnetic Fields

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Abstract: *The aim of this experimental study is to investigate the effect of the increasing of temperature and the magnetized fuel on the performance of compression ignition engine. The engine performance was observed by examining the engine brake power (BP), thermal efficiency, specific fuel consumption (SFC), air to fuel ratio (A/F) and exhaust emissions. In this study the gasoil refiner type (ANKRA) was used to increasing the fuel temperature . The fuel was subjected to a magnetic field which is placed to fuel supply line to magnetize the fuel before admitted to* *the engine cylinder. Two types of magnetic field were adopted in this study, the first one with (1000 Gauss) and the second with (1000 Gauss). The results show a significant improvement in engine performance after increasing the fuel temperature and the magnetic field to which the fuel is subjected. The thermal efficiency increased by (4.68%) and a reduction in the specific fuel consumption by (5.67 %). The exhaust gas emissions show a reduction nearly by (34.3 %) of CO, (33.46 %) of CO2 and (29.26%) of HC.*

Keywords: Internal combustion engine, magnetic field , fuel consumption, exhaust emissions.

1. Introduction

Conventional internal combustion engine have been around for more than a century .Due to inherent high efficiency and low cost, IC engine continue to dominate many commercial markets, from passenger cars to ocean going vessel to on site power generation .Because of its very high efficiency, the diesel engine is industry's leading prime mover, and will likely remain so for the foreseeable future (Gustafsson, 2009) [1]. Diesel engine achieves very high fuel efficiency for a number of reasons. First, part load operation is achieved without throttling .Second a high compression ratio leads to high thermal efficiency. Third turbo charging allows high specific loads by forcing higher quantities of air in a given displacement, which leads to even greater thermal efficiency

(Wu,2011&kim,2009) [2]. Direct injection (DI) diesel engine becomes acceptable choice as prime moves in many application to improve their fuel consumption and emission characterize (Shu,2001) [3]. Many of experimental studies which present evidences of the benefits of magnetic treatment are carried out. Mingdongetal [4] observed for motor that vehicles, much fuel economy and noticeable soot suppressions could be approached when the magnetic treatment was introduced. Charles H. Sanderson [5], submitted a method and apparatus for treating liquid fuel in an internal combustion engines by passing it through a magnetic field prior to mixing it with air in the carburetor or the fuel injector. Farrag A. and Gad [6] revealed experimentally that the magnetic effect on fuel consumption reduction was up to 15%. CO reduction at all idling speed ranged up to 7%. Results showed that no emission reduction at all idling speed ranged up to 30%. The reduction of CH_4 at all idling speed was range up to 40%. Faris et.al, [7], experimentally research comprised the using of permanent magnets with different intensity (2000, 4000, 6000, 9000) Gauss, which installed on the fuel line of the two-stroke engine, and study of its impact on gasoline consumption, as well as exhaust gases. For the purpose of comparing, the results necessitated the search for experiments without the use of magnets. The overall performance and exhaust emission tests showed a good result, where the rate of reduction in gasoline consumption ranged between (9-14) %, and the higher value of a reduction in the rate of 14 % was obtained using field intensity 6000 Gauss as well as the intensity 9000 Gauss. It was found also that the percentages of exhaust gas components (CO, HC) were decreased by 30%, 40%, respectively, but CO_2 percentage increased up to 10%. Rashid [8], studied the effect of magnetic field on internal combustion engine with unleaded gasoline ,then was found that the effect of magnetic field on CO was the most significant at most engine's loads and speeds.

2. Methodology

The effect of the magnetic field on fuel (diesel Iraqi) used in the engines and its impact on the amount of consumption, as well as emission of exhaust gases, the appropriate method was examined. The description of the materials and equipment used is given as follows:

2.1 Magnetic Devices

Figure (1) shows a photo of the magnetic device used in this research which was manufactured in the U.S.A. The fuel is subjected to the lines of forces from permanent magnets mounted on fuel inlet lines. The magnet for producing the magnetic field is oriented so that its (South Pole) was located adjacent the fuel line, and its (North Pole) was located spaced apart from the fuel line. The magnetic field strength 1000 Gauss. A magnetic field was applied to ionizing fuel to be fed to combustion chamber [9].

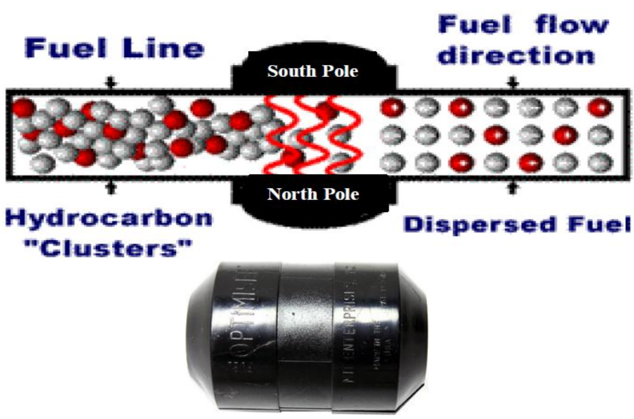

Figure (1): Magnetic Devices

2.2 Gasoil Refiner

In this work, it was use the gasoil refiner type (ANKRA) to increasing the fuel temperature (initial temperature of the fuel entering to combustion chamber is 58 Ċ) this device as shown in Figure (2).

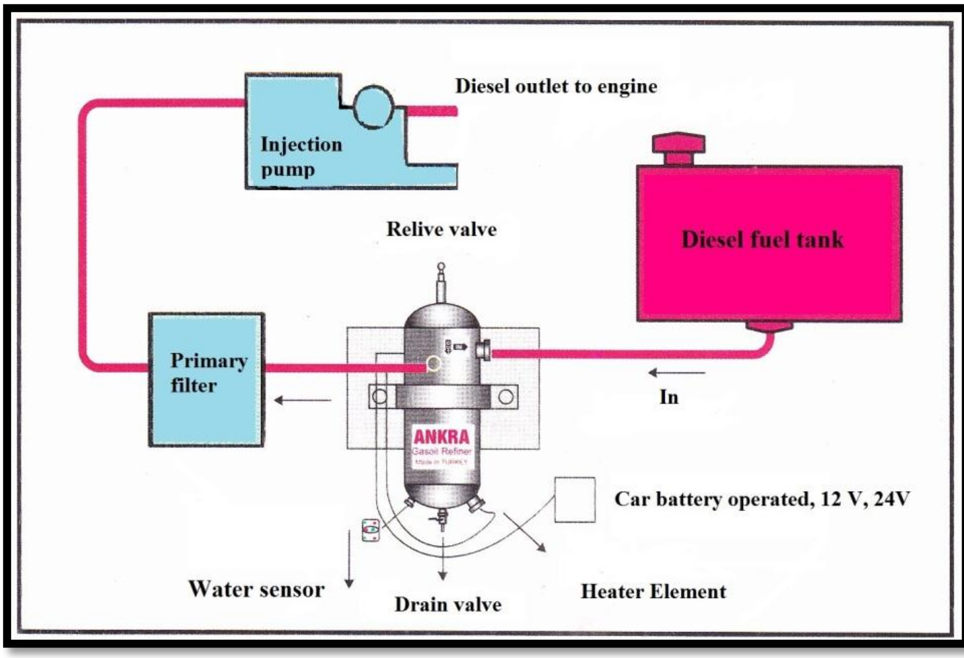

Figure (2): Schematic Diagram of the Gasoil Refiner.

2.3 Engine

The engine used in the experimental work was compression ignition engine (C.I. engine) type (FIAT) model (TD133), 4 cylinders, 4 strokes; the displacement volume at this engine was (3.666L). The engine was coupled to a hydraulic dynamometer to measure the brake torque. Fig (3) shows the experimental rig of (C.I. engine), and table (1) lists the main technical specifications of this engine.

Figure (3): The Experimental Rig of (C.I. engine)

2.4 Measurement of Brake Torque

The hydraulic dynamometer, type [isilingegneriadidattica] was used to measure the brake torque of (C.I. engine) by using friction fluid. The water was used as a friction fluid.

2.5 Fuel Consumption

The glass tube was used to measure the fuel consumption of the (C.I. engine). This glass tube has a constant volume (100) ml, and a stop watch was used to measure the fuel consumption of this volume.

2.6 Air Consumption.

The air supplied to compression ignition engine was measured by using air box. The orifice and manometer were used to measure the pressure differential between the atmosphere and pressure in the air box.

2.7 Measurement of engine speed (rpm).

The measuring of the engine speed of compression ignition engine (C.I. engine) was carried out by using instrument tachometer used to measure the rotation speed of a shaft engine. This instrument usually displays the revolutions per minute (rpm). Tachometer has been fixed the shaft engine test rig by coupling.

2.8 Gas analyzer

The exhaust gas analyzer type (2000-4) was used to analyze the emissions of exhaust, as shown in Figure (4). The analyzer detects the CO-CO2-HC contents.

Figure (4): The Exhausts Gas Analyzer Type (2000-4Italy).

3. Data analysis

The following equations were used in calculating engine performance parameters: [10].

1- The brake specific fuel consumption.

$$bsfc = \frac{\dot{m}_f}{bp} \times 3600 \quad kg/(kW.hr) \qquad (1)$$

2- Brake thermal efficiency is defined as in Eq.

$$\eta_{b)th} = \frac{bp}{\dot{m}_{f} * L.C.V} \qquad (2)$$

3- Air mass flow rate.

$$\dot{m}_{a,ac} = \frac{12\sqrt{h_o}}{3600} \times \rho_{air} \quad (kg/sec) \qquad (3)$$

4- Fuel mass flow rate.

$$\dot{m}_f = \frac{V_{f \times 10^{-6}}}{time} \times \rho_f \quad (kg/sec) \qquad (4)$$

V_f =fuel volume (m^3)

5- Air-Fuel ratio.

$$A/F = \frac{\dot{m}_a}{\dot{m}_f} \qquad (5)$$

6- Brake power

$$bp = \frac{2\pi \times N \times T}{60 \times 1000} \quad (kW) \qquad (6)$$

4. Results and Discussions

To determine the impact resulted from using of the magnetic field two sets of experiments were carried out.

First set:

Experiments were carried out without using the magnetic field at different speeds (N r.p.m).

Second set:

Experiments were carried out by using the magnet field at the same speeds as in the first stage.

Figure (5) shows the relation between brake specific fuel consumption (bsfc) and engine speed with using magnetic field and without of (C.I. engine) . It can be seen that the brake specific fuel consumption (bsfc) decreased nearly by (N=1500 rpm), and when the magnetic field was used, this reduction was measured to be approximately by (5.67%).

Figure (6) shows the relation between the brake thermal efficiency and engine speed with using magnetic field and without of (C.I. engine). The using of magnetic field increased the brake thermal efficiency by about (4.68%), and the maximum value of the brake thermal efficiency for using of magnetic field operation is at (N= 1500 rpm).

Figure (7) shows the relation between (A/F) and the engine speed with using magnetic field and without of (C.I. engine).The using of magnetic field increased the(A/F)by about(5.46%).

Figure (8) shows the effect of magnetic field on the present of (CO) of the (C.I. engine), indicating that the present of (CO) decreases when the engine speed increases, and the using of magmatic field reduced the amount of the present of (CO) by about (34.3%).

It was found that the reducing percentage of the gases (CO2 and HC) were up to (33.46%, 29.6%), respectively for the (C.I. engine), as shown in Fig (9 and 10) because of the effect of magnetic field on the bonds of hydrocarbon fuel makes them weaker and as a result the combustion of fuel will be more efficient.

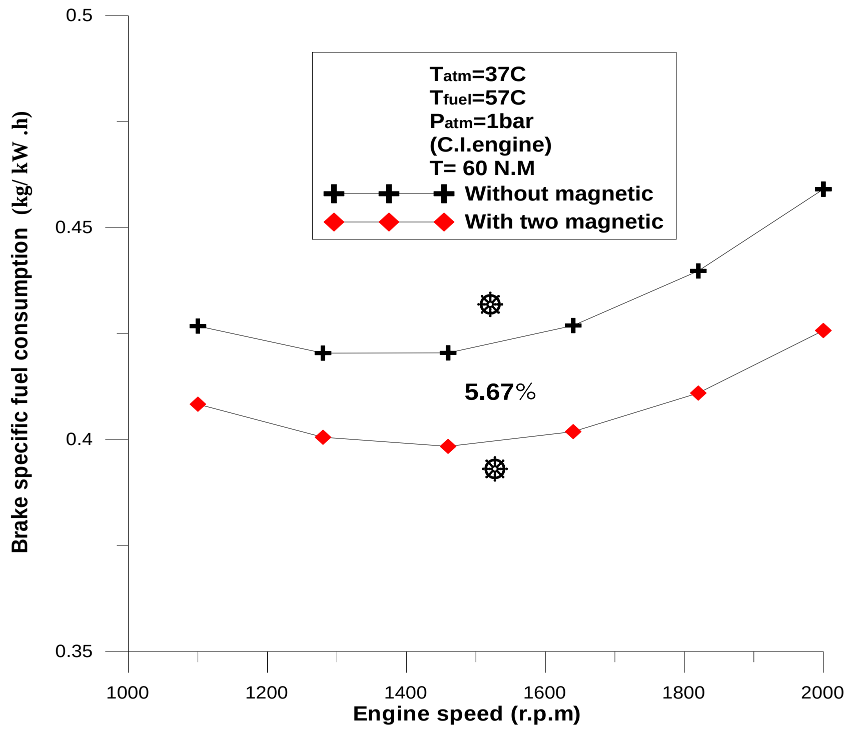

Figure (5): Brake specific fuel consumption (bsfc) as function of engine speed of (C.I. engine) with and without magnetic field.

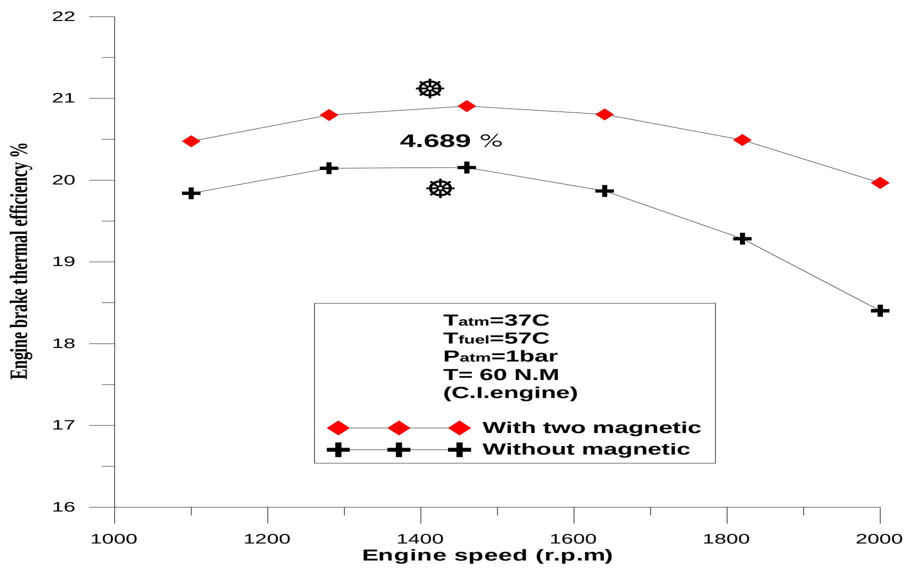

Figure (6): Brake thermal efficiency as function of engine speed of (C.I. engine) with and without using magnetic field .

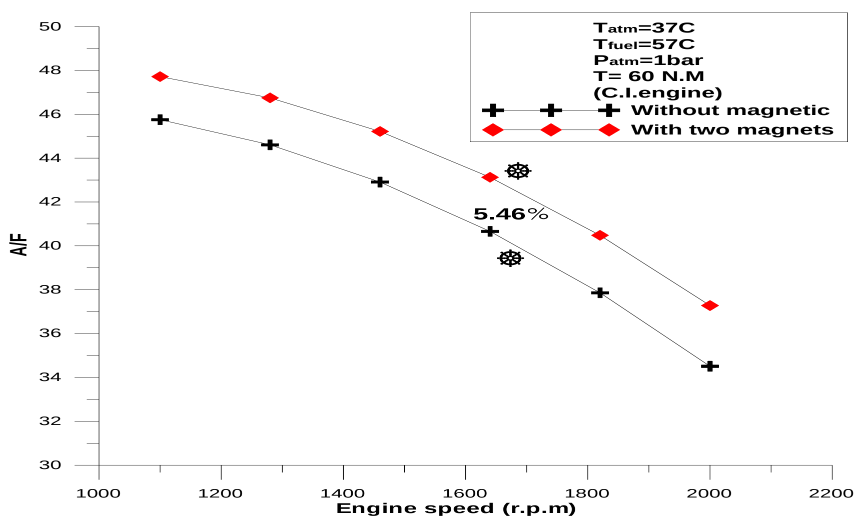

Figure (7): Air to fuel ratio as function of engine speed of (C.I. engine) with and without magnetic using field.

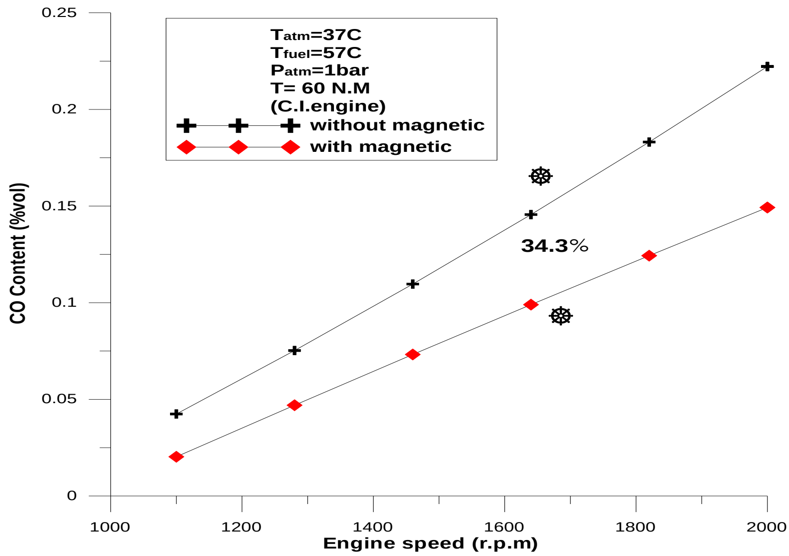

Figure (8): The present of (CO) as function of engine speed of (C.I. engine) with and without using magnetic field.

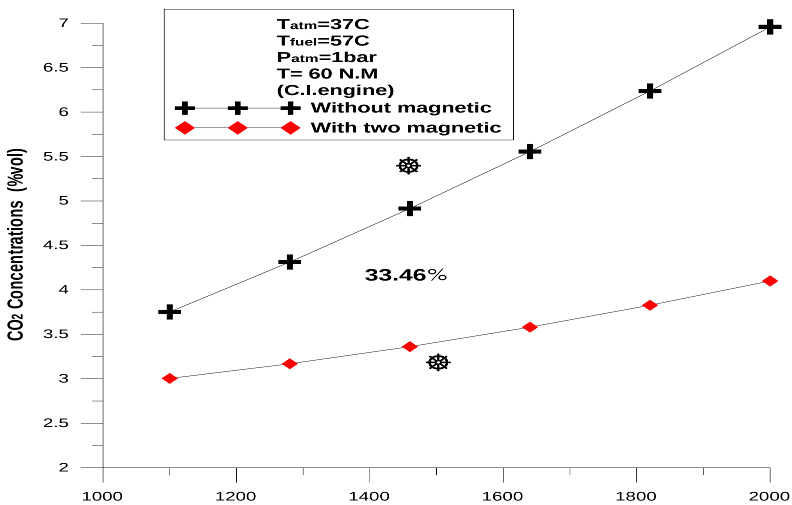

Figure (9): The present of (CO2) as function of engine speed of (C.I. engine) with and without using magnetic field

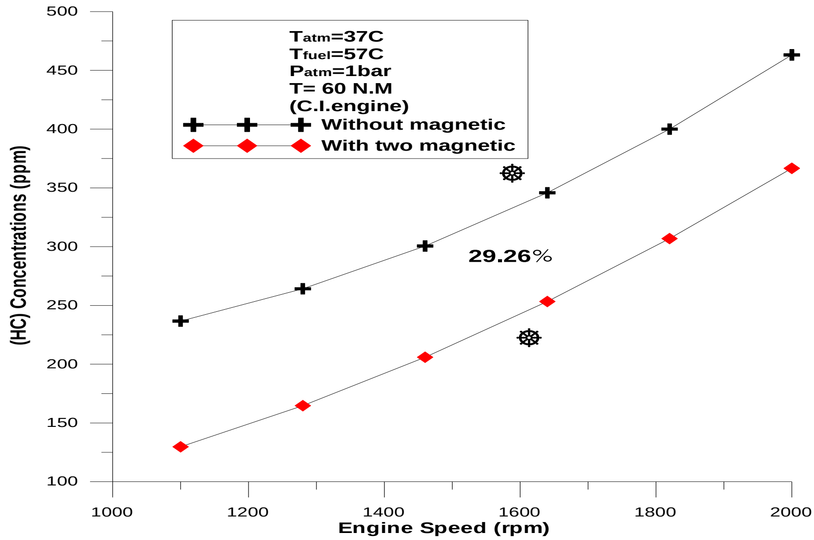

Figure (10): The (HC) concentration (ppm) as function of engine speed of (C.I. engine) with and without using magnetic field .

5. Conclusions

1. When the magnetic field is used, an increase in the internal energy of the fuel to cause specific changes at a molecular level.
2. Increasing the internal energy to obtain easier combustion with using of magnetic field the molecules fly apart easier, join with oxygen easier and ignite easier.
3. The brake specific fuel consumption is lower by about 5.67% in the diesel engine than that without using of magnets.
4. For brake thermal efficiency with the engine speeds of (C.I. engine) for different values of (A/F) brake thermal efficiency was higher when (A/F) increased.

5. Focusing on emission, it was found that CO, CO2 and HC of the (C.I. engine) decreased when the engine using of magmatic field.

Nomenclature

Symbol	Description	Unit
A/F	Air to fuel ratios	
bp	Brake power	KW
bsfc	Brake Specific fuel consumption	kg/(kW.hr)
CO	Carbon monoxide	
CO_2	Carbon dioxide	
C.I.engine	Compression ignition engine	
HC	Unburned hydrocarbons	Ppm
ho	Differential manometer	Cm
$\dot{m}_a$	Air mass flow rate	kg/sec
$\dot{m}_f$	Fuel mass flow rate	kg/sec

Table (1)

FIAT diesel engine	
Engine type	4cyl., 4-stroke
Engine model	TD 313 Diesel engine rig
Combustion type	DI, water cooled, natural aspirated
Displacement	3.666 L
Valve per cylinder	Two
Bore	100 mm
Stroke	110 mm
Compression ratio	17

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تأثير زيادة درجة حرارة وقود الديزل على أداء المحرك باستخدام مجالين مغناطيسيين

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المستخلص

ان الهدف من هذه الدراسة المختبرية استكشاف تأثير تسخين ومغنطة الوقود على أداء محركات الاحتراق الداخلي التي تعمل باالانضغاط. اختبر اداء المحرك عن طريق قياس كل من القدرة الفرملية، الكفاءة الحرارية، الاستهلاك النوعي للوقود، نسبة كتلة الهواء الى كتلة الوقود، وكمية الملوثات المنبعثة. أستخدمت في هذه الدراسة عملية تسخين الوقود عن طريق أستخدام جهاز منقي وقود الديزل من نوع (ANKRA)، اخضع الوقود الى مجال مغناطيسي وضع على خط تجهيز الوقود قبل دخوله الى اسطوانة المحرك. شملت الدراسة على استخدام نوعين من المغانط، الاول بشدة مجال مغناطيسي (1000 كاوس) والثاني بشدة مجال مغناطيسي (1000 كاوس) ايضاً، النتائج العملية أظهرت تحسين أداءالمحرك بعد تسخين ومغنطة الوقود، أذ ازدادت الكفاءة الحرارية بمقدار (4.68 %) مع نقصان بحدود (5.67%) في معدل استهلاك الوقود المكبحي وملوثات غاز العادم تظهر انخفاضا واضحا بنسب تقترب من (34.3%) لغاز احادي اوكسيد الكربون و (33.46%) لغاز ثنائي اوكسيدالكاربون و (29.26 %) للهيدروكاربونات غيرالمحترقة.

الكلمات الرئيسية: مكائن الأحتراق الداخلي، المجال المغناطيسي، استهلاك الوقود وغازات العادم.