Reduction of Pollutant Emission in Ethanol-Gasoline Blends Engines with Magnetic Fuel Conditioning

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Abstract

This paper represents an experimental investigation to evaluate the effect of magnetic field on exhaust emissions and engine performance of four-stroke, single piston spark-ignition engine working with (10% vol.)Ethanol-Gasoline blends. Carbon monoxide CO, carbon dioxide CO_2 and unburned hydrocarbon HC are examined during running of the engine with and without the presence of magnetic coils. The engine performance parameters (brake power, brake specific fuel consumption and brake thermal efficiency) are investigated too .Two magnetic coils with different intensities (1000 and 2000 Gauss) were used . The magnetic coil is placed on the line of fuel supply before the carburetor. All tests were conducted at a wide open throttle (WOT) , compression ratio 10:1 , speed of 2000 rpm and ignition timing (between 5^0 and 30^0 BTDC) . Results show a significant reduction in exhaust gas emissions when applying the magnetic field. A maximum reduction of 68.8 % of CO, 15 % of CO_2 and 42.5 % of HC are observed when using 2000 Gauss magnetic coil. Moreover, it was noticed that all engine-affecting parameters were improved. Running the engine with 2000 Gauss and 10 vol.% ethanol-gasoline blends shows better results (concerning pollution emissions and brake thermal power) than 1000 Gauss magnetic coil .

تقليل انبعاث الملوثات الغازية من محركات الاحتراق الداخلي التي تعمل بمزيج الايثانول – الكازولين الممغنط

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المستخلص

يهدف هذا البحث إلى تقييم مدى تأثير المجال المغناطيسي على انبعاث الملوثات الغازية من محركات الاحتراق الداخلي التي تعمل بمزيج 10% ايثانول - كازولين . شمل البحث اختبار كمية انبعاث غازات اول اوكسيد الكاربون و ثاني اوكسيد الكاربون و الهيدروكاربونات غير المحترقة عند اشتغال المحرك مع او بدون المجال المغناطيسي . تقييم أداء المحرك شمل أيضا كل من القدرة الفرملية و معدل استهلاك الوقود النوعي و الكفاءة الحرارية . تم استخدام نوعين مختلفي الشدة من الملفات المغناطيسية , الأول شدته (1000 كاوس) و الثاني شدته (2000 كاوس) وضعا على خط تجهيز الوقود قبل المبخرة . أجريت كافة الاختبارات عند سرعة دورانية مقدارها (2000 دورة / دقيقة) , بنظام فتحة خنق واسعة للمبخرة , نسبة انضغاط 10الى 1 و بتغيير وقت بدء القدح من 5 إلى 30 درجة . أظهرت النتائج انخفاضا ملحوظا في كمية انبعاث الملوثات الغازية عند استخدام المجال المغناطيسي , حيث انخفض انبعاث غاز اول اوكسيد الكاربون بمقدار (68,8%) و غاز ثاني اوكسيد الكاربون بمقدار (15%) و الهيدروكاربونات غير المحترقة بمقدار (42,5%) عند استخدام الملف المغناطيسي (2000 كاوس) . إضافة إلى ذلك فقد لوحظ تحسن واضح في أداء المحرك مثل القدرة الفرملية و معدل استهلاك الوقود النوعي و الكفاءة الحرارية عند مغنطة مزيج وقود ايثانول – كازولين . بشكل عام فقد كانت كمية الملوثات الغازية المنبعثة عند استخدام الملف المغناطيسي (2000 كاوس) اقل منها عند استخدام الملف (1000 كاوس) .

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Introduction:

Engines manufacturers worldwide concentrated their efforts to develop spark ignition engines with high thermal efficiency and low specific fuel consumption without violating the accepted level of emissions regulations. For the reduction of pollutant emissions , researchers have focused their interest on the use of bio-fuels to limit and decrease the greenhouse gases (CO_2) . The best candidate bio-fuels are alcohols, which can be blended with gasoline. Ethanol will probably be the most important alternative fuel since it has a higher octane number than gasoline. Adding ethanol to gasoline will increase the octane number and thus improve the performance of the vehicle. Today ethanol-gasoline blends with different percentages are commonly used in various countries around the world, especially Australia (10%), Brazil (up to 25%), Canada (10%) , Sweden (5%) and USA (up to 10%). There still debate about whether, how and what extent ethanol in gasoline may affect the materials in the vehicle, cause excessive wear of parts in the fuel system, and engine. However, in the USA, car manufacturers have agreed that the use of gasoline with up to 10% ethanol will not affect the warranties of their vehicles [1].

M. A. Cevez , F. Yuksel [2] ,investigated experimentally the effect of ethanol-unleaded gasoline blends on cyclic variability and emissions in an SI engine . Results showed that using ethanol-unleaded gasoline blends as a fuel decrease CO and HC emission concentration and the 10 vol.% ethanol in fuel blend give the best result .

Abdel-Rahman and Osman [3] , found that the maximum improvement in engine indicated power occurred with a 10% ethanol blend when adapting variable compression ratio .

Hassan S. Hamoody [4], in his MSc thesis showed that the best performance of the SI engine with little emission of pollutants was during operating the engine with compression ratio 10:1, ignition timing (20^o BTDC), equivalence ratio ($\Phi=1$) and engine speed at (2000 rpm) when using 10 vol.% ethanol-gasoline blends .

Janezak and Krensel [5] , conducted an experimental test for treating gasoline with magnetic field for more efficient combustion and pollution .Their invention relates to permanent magnet units mountable as retrofit adaptors outside a fuel line without disconnection or modification of the fuel or ignition system .

Charles H. Sanderson [6] , in his invention , showed 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.

Al-Dossary , Rashid [7] , in his Msc thesis , conducted an experimental research to study the effect of magnetic field on internal combustion engine with unleaded gasoline .Al-Dossary found that the effect of magnetic field on CO was the most significant at most engine's loads and speeds .

Govendasamy and Dhandapani [8] , investigate experimentally the effect of using magnetic field on reduction of exhaust emissions in Bio-diesel engine with exhaust gas recirculation (EGR). They found that with the presence of the magnetic field , a satisfactory reduction in CO and HC emissions with an increase of 5% in the brake thermal efficiency are obtained .

In the present study, 10 % by volume ethanol-gasoline blends was used in a single– piston, four – stroke, water-cooled variable compression spark ignition engine supplied with Dc-dynamometer and on-line exhaust gas analyzer. The study concentrates on the effect of magnetic field (two magnetic coils with different intensities applied on the fuel supply line before entering the engine carburetor) on exhaust gas emissions (CO, CO_2 & HC) and engine performance (brake power , brake thermal efficiency and specific fuel consumption) .

Experimental work:

Experiments were carried out on a single piston , four - stroke cycle , variable compression ratio spark ignition engine . The engine is operated at wide-open throttle (WOT) with an equivalence ratio of Φ=1. The compression ratio was adjusted to be 10:1 and ignition timing was varied from 5^0 to 30^0 BTDC with (5^0) intervals .Engine speed was set at 2000 rpm . The engine was fueled by blends of 10 vol. % ethanol-gasoline. The gasoline which has been used was a leaded gasoline produced by Iraqi Northern Oil Company (Beiji refinery) . Two magnetic coils with different intensities (1000 & 2000 Gauss) were used to treat the bio fuel before entering the carburetor of the engine.

Exhaust emissions gases (CO, CO_2 and HC) were measured by using an on-line digital gas analyzer during all tests, with and without the presence of magnetic coils. Engine parameters such as brake power, brake specific fuel consumption and brake thermal efficiency were studied too .Figure [1] shows a schematic arrangement of the engine test bed .

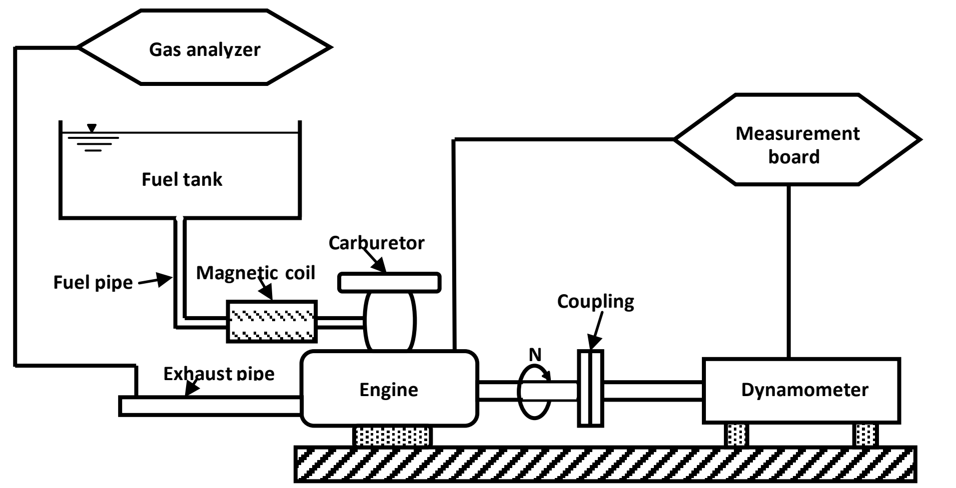

Fig. 1 schematic arrangement of the engine test bed

Results and Discussion:

Exhaust gas emissions and engine performance were investigated with the use of a blend of 10% vol. ethanol – gasoline (leaded) and magnetic coil applied to the line of fuel before entering the carburetor at engine speed of 2000 rpm, compression ratio of 10:1 and wide open throttle (WOT) . All tests were carried out either with the presence of 1000 gauss magnetic coil, 2000 gauss coil or without the magnetic effect. Figure (2) shows the variations of carbon monoxide CO emissions with ignition timing. A significant reduction of 68.8 % in CO was found to be at 30^0 BTDC, when using 2000 Gauss, while, the maximum reduction when using 1000 Gauss was 50 % at 25 and 30 degrees BTDC. Carbon dioxide CO_2 was reduced by 15 % at 25^o BTDC and 3.7 % at 15^o BTDC, when using the magnetic coils with intensities of 2000 Gauss and 1000 Gauss respectively as shown in figure (3). A good improvement in unburned hydrocarbons HC emissions were found when applying the magnetic field. Figure (4) shows that the maximum reduction in HC was 42.5 % at 15^o BTDC with a magnetic coil of 2000 Gauss. Using a magnetic coil of 1000 Gauss showed a reduction of 12.5 % at 15^{o}BTDC.

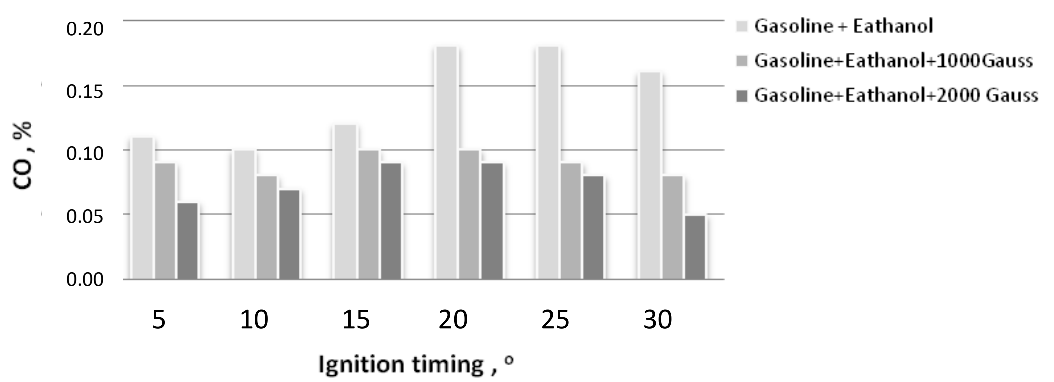

Fig. 2 variation of carbon monoxide with ignition timing

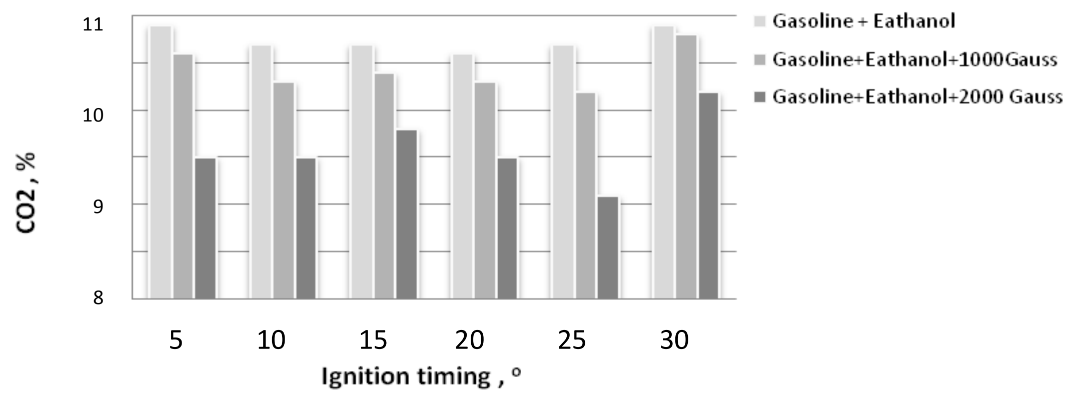

Fig. 3 variation of CO2 with ignition timing

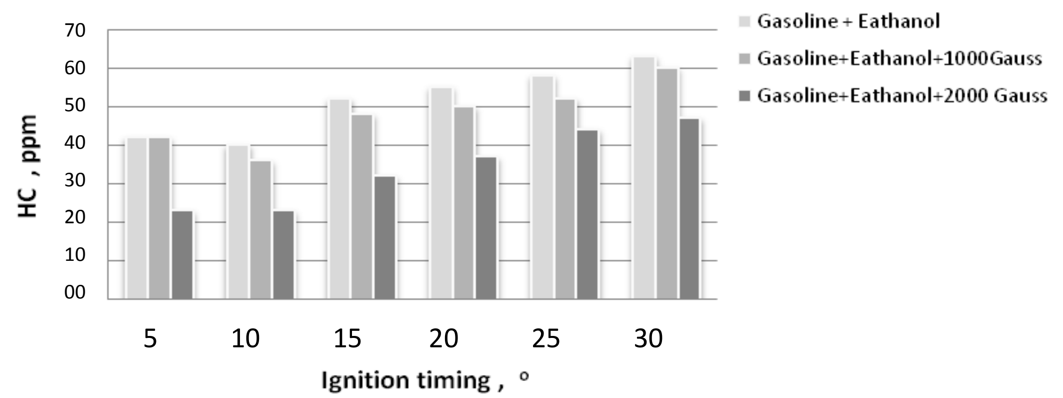

Fig. 4 variation of hydrocarbon with ignition timing

Using the magnetic field with ethanol-gasoline blends improves the engine performance parameters too. Figure (5) shows the relation between brake thermal power and engine ignition timing. Thermal power was improved by 8.6 % at 20^o BTDC when using the 2000 Gauss coil, while implementing 1000 Gauss coil showed a 4.4 % increment in thermal power at 10^o BTDC . It can be seen from figure (6) that the specific fuel consumption is decreased nearly by 8.6 % at 20^o BTDC when a magnetic coil of 1000 Gauss is used ; however , this reduction was measured to be approximately by 3.2 % at 20^o BTDC when a magnetic coil of

2000 Gauss was used . Figure (7) showed that the thermal efficiency increased by 4.4 % at 10^o BTDC and 3.6 % at 20^o BTDC when applying 1000 Gauss and 2000 Gauss respectively . Exhaust gases temperature have been measured during all tests .Results show a small effect of magnetic field on exhaust temperature . Figure (8) shows the relationship between exhaust gas temperature and ignition timing for the same engine operating conditions. Results indicate that the maximum increase in exhaust gas temperature was nearly by 1.5 % at 20^o BTDC for 1000 Gauss coil , while applying 2000 Gauss showed a maximum decrease of 2.9 % at 25^o BTDC .

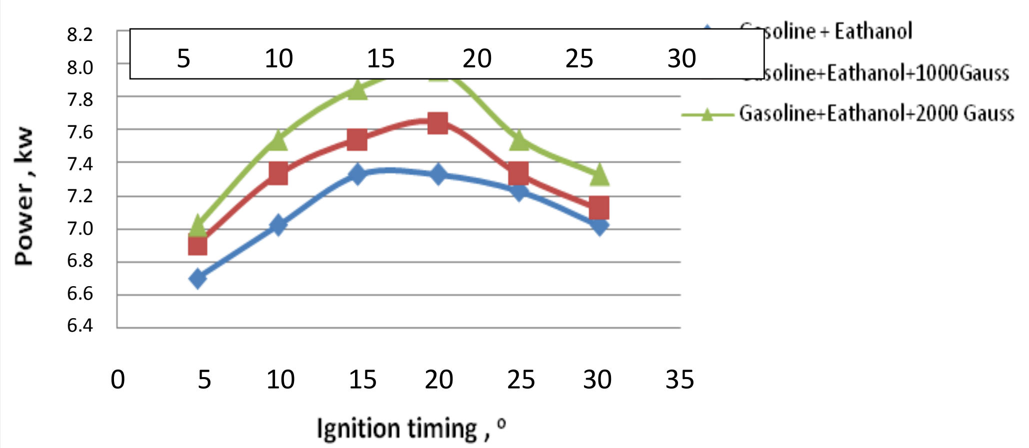

Fig. 5 variation of brake power with ignition timing

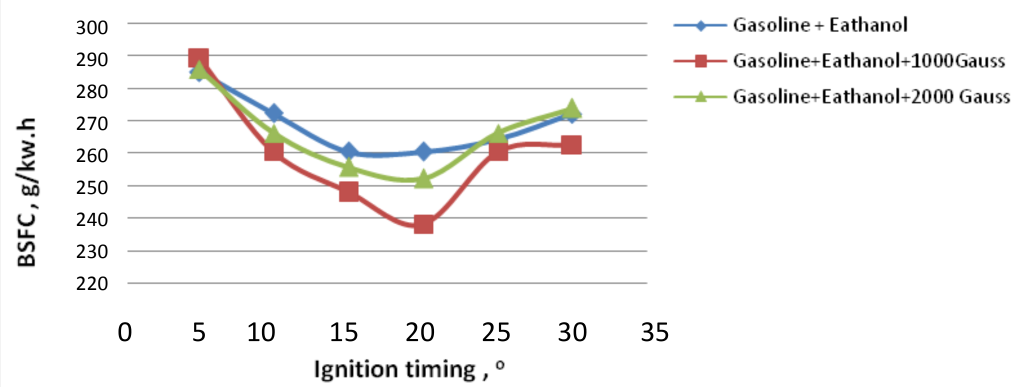

Fig. 6 variation of BSFC with ignition timing

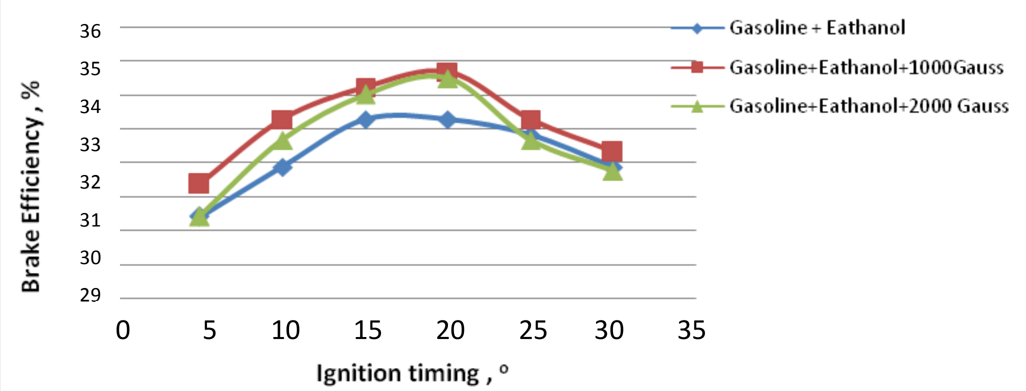

Fig. 7 variation of brake Efficiency with ignition timing

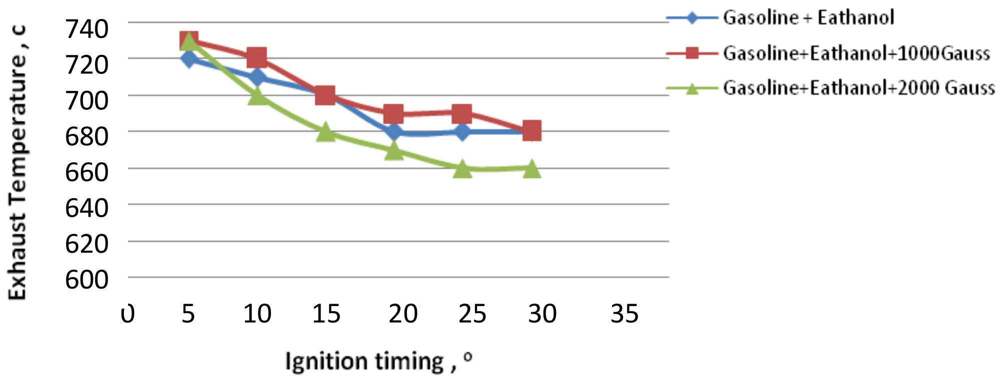

Fig. 8 variation of exhaust temperature with ignition timing

With the presence of magnetic field , the internal energy of the fuel increases which means that molecules fly apart easier , join with oxygen easier and burn more completely . The magnetic field can change the spin state of hydrogen molecules in the fuel (converted from para–hydrogen to ortho–hydrogen) which greatly enhances the energy of the atom and increases fuel reactivity leading to higher engine output , better fuel economy and lower amount of hydrocarbons and carbon monoxide in the exhaust .

Conclusions:

The experimental investigation conducted in this work indicated that applying a magnetic field to the fuel supply line of an internal combustion engine working with blends of 10 % vol. ethanol-gasoline (leaded) is an effective way to reduce the pollutants emissions in the exhaust gases. Implementing a 2000 Gauss magnetic field leads to a reduction of 68.8 % at 30^{o} BTDC in carbon monoxide CO emission, a 15 % at 25^{o} BTDC reduction in CO_2 and a 42.5 % at 10^{o} BTDC reduction in the unburned hydrocarbons HC combined to an increase in engine performance (8.6 % increment in brake thermal power, 3.2 % reduction in BSFC and 3.6 % increment in thermal efficiency). The exhaust gas temperature were slightly affected by the magnetic field. Running the engine with 1000, Gauss coil shows better results concerning brake thermal efficiency and brake specific fuel consumption than that with 2000 Gauss.

Finally, it can be concluded from the experimental results shown that reduced emissions of pollutants as well as improved fuel combustion , increased engine power and reduced fuel consumption for ethanol-gasoline engine as a consequence of magnetic fuel treatment are feasible .

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