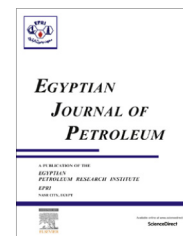




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FULL LENGTH ARTICLE

Fuel consumption of gasoline ethanol blends at different engine rotational speeds

Y. Barakat*, Ezis N. Awad, V. Ibrahim

Egyptian Petroleum Research Institute (EPRI), Egypt

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KEYWORDS

Mid-level ethanol-gasoline blends;
 Fuel consumption rate;
 Chemical composition and consumption;
 Some developed equation relating consumption and ethanol concentration

Abstract Fuel consumption (m_f kg/h) was estimated for two hydrocarbon gasolines (BG₁-OE and BG₂-OE) and their ethanol blends which contain from 4 to 20 vol.% of ethanol. Fuel consumption experiments for sixteen fuel samples (5 L each), were conducted on a four cylinder, four stroke spark ignition test vehicle Sahin car, Type 1.45, model 2001. The engine has a swept volume of 1400 c.c., a compression ratio of 8.3:1 and a maximum power of 78 HP at 5500 rpm. The obtained data reveal that the relation between fuel consumption and ethanol concentration is linear. Six linear equations for BG₁-ethanol blends and BG₂-ethanol ones at the investigated rotational speeds, were developed. Fuel consumption values of the first set of gasoline-ethanol blends are lower than that of the second set. This may be attributed to the difference in the chemical composition of base gasolines BG₁ in the first set which is enriched in the less volatile reformat if compared with the second set which is more enriched in isomerate, the more volatile refinery stream.

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1. Introduction

Developing renewable energy has become an important part of a worldwide energy policy to reduce greenhouse gas emissions caused by fossil fuel [1]. Alternative transport fuels such as hydrogen, natural gas and biofuels are seen as an opinion to help the transport sector in decreasing its dependency on oil and reducing its environmental impact [2–5]. The effects of ethanol-gasoline blends on engine exhaust emission and performance have been examined by many investigators [6,7]. Also the effects of 5, 10, 15 and 20 vol.% ethanol on fuel

consumption rate, brake thermal efficiency, volumetric efficiency and brake specific fuel consumption, have been tested and computed [1,8,9].

Using high- and mid-level ethanol blends, led to a significant reduction of CO and HC emissions. NO_x emission depends on the engine operating condition rather than the ethanol concentration [10]. NO_x concentrations are increased due to rising of the cylinder temperature with increasing ethanol percentage in the blends [7,11]. The addition of ethanol to gasoline fuel enhances the octane number of the blended fuels and changes distillation temperature [12–15]. Ethanol is reported to be an important contributor to decreased brake specific energy consumption in spark-ignition (SI) engine with an electronic fuel injection (EFI) system [16]. The effects of using ethanol-unleaded gasoline blends on cyclic variability and tailpipe exhaust emissions in spark-ignited engine have

* Corresponding author.

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Table 1 GC analyses and properties of refinery streams used for gasoline formulations.

Composition (wt.%)	Reformat 21C ₁ Bott.	Isomerase 30-SN-5	L. Naphtha* TOP C ₇
Iso-butane	0.09	0.34	0.00
<i>n</i> -Butane	0.42	3.78	0.00
Iso-pentane	2.00	38.15	13.07
<i>n</i> -pentane	1.67	11.24	17.33
2,2-Dimethylbutane	0.35	12.47	0.37
Cyclopentane	0.12	1.45	1.75
2,3-Dimethylbutane	0.33	3.88	1.33
2-Methylpentane	2.28	11.11	8.33
3-Methylpentane	1.78	6.34	5.46
<i>n</i> -Hexane	2.45	4.14	13.13
Methylpentane	0.75	2.33	6.15
Benzene	3.65	0.01	2.26
Cyclohexane	0.11	3.10	4.36
C ₇ ⁺	84.00	1.66	26.46
Total	100.00	100.00	100.00
Sp. gravity 60/60°F	0.7931	0.6471	0.67528
Sulphur, wt.%	0.1142	0.0763	0.1185
RON	93.8	86.2	63.5
MON	83.5	83.8	68.6
(RON + MON)/2	88.7	85.0	66.0

RON and MON = research and motor octane number.

been investigated by [17]. They concluded that 10 vol.% ethanol in fuel blend gave the best results.

2. Experimental

2.1. Fuel blend formulation

Two hydrocarbon base gasolines, BG₁, BG₂, as non-oxygenated reference test fuels, were formulated from the locally available refinery streams supplied by Cairo Petroleum Company-Mostorod Refinery, Cairo, Egypt. Table 1, lists gas chromatographic (GC) individual analysis along with some properties of these distillates as received from the producer. Composition and specifications of the formulated hydrocarbon-base gasolines (BG₁ and BG₂) are given in Table 2.

Each of BG₁ and BG₂ was blended with 0, 4, 6, 8, 10, 12, 15 and 20 vol.% ethanol to get two different sets of gasoline-ethanol blend fuels. The first was designated BG₁-xE and the other BG₂-xE. For example, BG₁-10E indicates a gasoline-ethanol blend that consists of 10 volume ethanol and 90 vol.% hydrocarbon gasoline. Volatility characteristics, octane number and other specifications of the sixteen test fuels are given in Tables 3 and 4.

2.2. Vehicle/engine preparation

Prior to commencing each experiment, the test vehicle was prepared in strict accordance with the following requirements [1,14,18–20]:

- (1) A new air filter was installed and the recommended engine oil was used.
- (2) Vehicle was fuelled with 90 octane gasoline and 8000 km was conducted.

- (3) The external fuel tank was fitted with a simple drain device to allow the tank to be completely emptied between a test fuel and another.

2.3. Test engine setup

Experiments were performed on Sahin Car Type 1.4S, Model 2001, four-cylinder, four-stroke spark ignition (SI) gasoline

Table 2 Refinery streams and composition of the hydrocarbon-base gasolines (BG₁ and BG₂).

Refinery stream	Blend composition, vol.%	
	BG ₁	BG ₂
Reformat	80	60
Isomerase	10	32
Light Naphtha	10	8
Total	100	100
<i>Specifications</i>		
Density (g/cm ³)	0.7629	0.7615
RVP, 37.8 °C, psi	5.5	7.4
BTEX, wt.%	39	30
Sulphur, ppm	90	79
Oxidation stability, min.	> 480	> 480
Corrosivity (3 h, 50 °C)	1	1
T _{V/L=20} (°F)	157.6	144.0
DI (°F)	1205	1124

RVP = Reid vapour pressure, ASTM-D323.

BTEX = benzene, toluene, ethylbenzene and xylenes, by GC.

T_{V/L=20} (°F) = vapour/liquid ratio of 20, ASTM-D2533.

DI (°F) = driveability index. ASTM-D4814-98a.

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