# ENVIRONMENTAL IMPACT OF CHANGES IN GASOLINE OCTANE IN AN ENGINE WITH ELECTRONIC INJECTION CATALYTIC CONVERTER

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**Summary.** Today, pollution levels have been increasing, therefore, governments are to take various restrictions related to environmental issues. The greatest contribution to the increase is due to fossil fuel burning, this, because the main means of transport used worldwide, is the automobile. One of the main problems with fuel, fuel is the quality of being responsible for the various refineries this planet responsible for this work. The octane number of a fuel indicates its quality, the higher this value, it is said that the fuel is of better quality; thus the environmental pollution generated is less impact. Gasoline is a fuel type, generally used for operation in internal combustion engines. During the development of this work four samples of gasoline, two local and two in the neighboring country of Colombia will be used, thereby determining which of these samples has a major and minor impact to the environment, despite the low octane with which will feature Colombian gasoline was evident that the level of carbon monoxide is below the set limit, the emission levels of Ecuadorian gasoline are lower than Colombia is mainly due to the number of octanes influencing engine performance and therefore emissions, the case of Ecuadorian gasoline also a decrease in the percentage of oxygen, due to increased engine however regime was registered, it must be mentioned that having higher octane the percentage of oxygen present in the emissions is much higher than that recorded by Colombian gasolines, of all the emissions after combustion inside the engine, three gases emitted to be treated for their high toxicity, these are: carbon monoxide (CO), nitrogen oxides (NOx) and hydrocarbons (HC), in order to control the pollutant index generated by vehicles manufacturers were obliged to implement systems devices to reduce these emissions, with less polluting engines, manufacturers decided use a catalytic converter, which is responsible for treating the gases resulting from combustion before it goes into the atmosphere.

### Keywords
Fuel, motor gasoline, additives

## 1. Introduction

Most vehicles within a city have a gasoline engine, said engine is nothing more than a thermodynamic machine consisting of a set of parts and fixed and mobile devices. The production of low-octane gasoline from refineries, makes electronic fuel injection systems and elements as the catalyst not fulfill their function because they are not going to work under the conditions for which they were designed.

The main objective of this study is to determine the importance of the octane number of a fuel, verifying the impact it can cause burning a fuel with a low octane number.

At the same time, it is considered as a bibliographical research, because it requires information from documents, where aspects such as the variation of the environmental impact in relation to the octane number of a fuel, just as are indicated, is considered as an investigation scientific, this, because during development analyzing data generated by the tests performed with several samples gasoline engine with the catalyst by a gas analyzer is performed

During development gasoline four samples, each has a different octane number is used. Emissions generated with each sample will be subjected to a gas analyzer to determine how this affects the octane number of a fuel in the environmental impact during the burning of fossil fuels. From the results in the experimental analysis Ecuadorian and Colombian extra 87 octane gasoline is determined that the Ecuadorian gasoline allows better engine performance, while their emission levels were lower.

With 81 and 87 octane gasoline stream and extra Colombian respectively; presents greater presence of polluting gases that Ecuadorian gasoline, which has higher octane and less polluting, with the following percentages of contamination:

In the end it may conclude what are the benefits of using a fuel of better quality. Each user of an internal combustion vehicle should require, as well as reduce environmental pollution, another benefit they receive directly, occurs in the extension of maintenance to your vehicle engine.

## 1. Theoretical framework

Petroecuador, (2015), mentions that at the end of 2011, the first imports were presented 95 octane gasoline, this was mixed and processed in refineries in the country with gasoline that had previously thereby be able to improve the octane

rating of gasoline on the market , thus the extra step gasoline from 81 to 87 octane , while gasoline super went from 90 to 92 octane

## 2.1 Fuels

The quality of a fuel is measured in relation to the degree of octane, however, besides indicating its quality, discloses the capacity of fuel consumption; that is, in the case of a gasoline with a higher degree of octane, improve the power and performance of an engine while the fuel consumption will be slowed I.

(Ecopetrol, 2011) mentions that earlier this year, will be marketed in fuel distributors, the second generation of green gasoline, where the increased octane number is highlighted, so that regular gasoline went from 78 83 octane, while premium gasoline rose from 81 to 87 octane. The benefits of gasoline with higher octane are notable also for every thousand meters above sea level, a gain that varies from 2 to 3 units octane is obtained, this is mainly due to the lower density presenting oxygen the atmosphere.

### 2.1.1 Gasoline

Gasoline is a fuel type, generally used for operation in internal combustion engines. It is a mixture of hydrocarbon chains five to nine carbon atoms relative volatility. It is obtained by fractional distillation of petroleum. It is known in some countries under the name of naphtha or benzine. It has a density of 760 g / L.

### 2.1.2 Ecological Additives

The most used additives are TAME MTBE and this because they have a high octane value, a low vapor pressure and especially high availability. For processing methanol, butane, butylene, isobutylene and isoamylene is used, these elements are raw material within the refining process, so it represents an economic advantage.

| Tipo de oxigenado | 0% EtOH | | 10%vol. EtOH | | 15% vol. EtOH | |
|---|---|---|---|---|---|---|
| | Magna | Premium | Magna | Premium | Magna | Premium |
| ETBE[1] | < 0.1 | 0.2±0.0 | < 0.1 | 0.2±0.0 | < 0.1 | < 0.1 |
| EtOH[2] | < 0.1 | < 0.1 | 9.8±0.2 | 11.3±0.1 | 15.1±1.0 | 16.1±0.3 |
| MTBE[3] | 10.5±0.1 | 17.9±0.0 | 9.7±0.1 | 16.0±0.0 | 9.6±0.8 | 15.2±0.1 |
| tBa[4] | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Oxígeno total experimental | 1.9±0.0 | 3.3±0.0 | 5.2±0.1 | 6.8±0.1 | 7.0±0.5 | 8.4±0.1 |
| Oxígeno total teórico | 1.9±0.0 | 3.3±0.0 | 5.2±0.1 | 6.9±0.1 | 7.0±0.5 | 8.4±0.1 |

[1] Etil ter-butil éter, [2] Etanol, [3] Metil ter-butil éter, [4] Ter-butil alcohol

### 2.1.3 Engines electronic injection

The temperature measurement is one of the main difference in relation to the engine carburetor is that an injection system controlled by an ECU is integrated, that is responsible for controlling the lambda factor, fuel consumption and emissions into the atmosphere.

The operation of the injection system is based on data collected by the sensors, same that is processed by the ECU. The measurement of flow and temperature of air sucked into the engine relative to the throttle position, this will determine the proper amount of fuel, including in it the engine.

## 2.2 Toxicity of exhaust gas

As the resulting product of the combustion process of an air / fuel mixture, toxic gases are harmful to humans and the environment are produced.

carbon monoxide, nitrogen oxides, hydrocarbons, soot, carcinogens, sulfur compounds and lead: During the combustion process the following toxic substances are generated. Furthermore internal combustion engines are responsible for other toxic substances, as is the case of crankcase gases and fuel evaporation, all emitted into the atmosphere.

Emissions: Among the main emissions generated by an internal combustion engine, we have:

Carbon dioxide ($CO_2$). Its unit of measurement is the percentage of volume. It is generated by burning combustible carbon compounds.

Water vapor ($H_2O$). In this case the hydrogen gas reacts with oxygen in the air to form water vapor.

Carbon monoxide (CO). Its unit of measurement is the percentage by volume. It occurs to be little presence of oxygen within the combustion chamber, therefore the complete oxidation of carbon is not performed.

Nitrogen oxides (NOx). It is considered that 78% of the air is nitrogen. Does not react with this under normal temperature, however when it conducts the combustion process where high temperatures and pressures, a reaction which forms carbon monoxide nitrogen occurs

### 2.2.3. Catalytic Converter

In order to control the pollution index generated by vehicles , have created laws that limit the amount of emissions that may occur with a car, with this in mind , manufacturers were obliged to implement systems or devices that help reduce these emissions
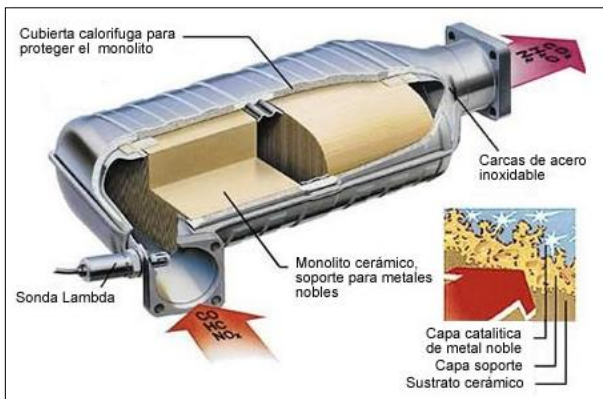
Of all emissions after combustion inside the engine, three gases emitted to be treated for their high toxicity, these are: carbon monoxide (CO), nitrogen oxides (NOx) and hydrocarbons ( HC) to make this possible gas reaching the catalyst must reach a temperature of 500 ° C.

### 2.5 Fuel Economy

There are some options available for the user to save a certain amount of fuel, within it we have:

Height: The height relative to sea level affects fuel consumption and engine performance. In the case of a vehicle located in a city of 2 000 meters, it will lose up to 30% power. Therefore in the sea near cities consumption will be lower due mainly to air density.

Speed: Avoid high speeds, if the user navigates to 100 km / h instead of 120km / h, consumption is reduced by 60% to cover the same distance.

Speed up or slow: both acceleration and braking should be performed smoothly progressively, ie from less to more, with this you can save up to 20% fuel.

Tire Pressure: Maintain proper air pressure in the tires is very important to have a tire whose inflation is minus 2 psi relative to the rest, fuel consumption will increase by 1%. Proper pressure is between 28 and 30 psi.

Maintenance: The good vehicle plays an important role, which is why a review should be performed at regular intervals to prevent damage, this will undoubtedly help in saving fuel.

### 2. 3. Environmental impact

(M. Torres, 2005) mentions that fuels cause pollution during use, production and transfer. Large amounts of CO2 emitted into the atmosphere daily, are considered as one of those responsible for the global warming situation to continue without greater control can cause climate changes that could be catastrophic for the planet and its inhabitants.

### 2.3.1. Air Quality in Ecuador

The Ministry of Environment, 2010) mentions that despite the lack of studies detailing air quality Ecuador, it is possible to mention its quality in some of its major cities. To Quito it was determined that the average carboxyhemoglobin is above acceptable values (COHB 5%), this indicates that the high risk of acute respiratory infections is four times higher.

### 2.3.2. Gas analyzer

(J. Gómez, 2010) mentions that the gas analyzer is a diagnostic tool. It is responsible for analyzing the composition of the exhaust gases with reference to a base that allows you to determine the volumetric percentage composition of the gases resulting from combustion.

### 2.3.2. Allowed emissions limits in Ecuador

(INEN, 2012) mentions that all vehicles with gasoline engine during idling under normal operating temperature shall not emit carbon monoxide (CO) and hydrocarbons (HC), higher than those reported in Table 3 .

| Año | % CO | | ppm HC | |
|-----|---------|------------|---------|------------|
|     | 0 - 1 500 | 1 500-3 000 | 0 - 1 500 | 1 500-3 000 |
| 2010 y posteriores | 0,6 | 0,6 | 160 | 160 |
| 2 000 a 2009 | 1 | 1 | 200 | 200 |
| 1 990 a 1 999 | 3,5 | 4,5 | 650 | 750 |
| 1989 y anteriores | 5,5 | 6,5 | 1 000 | 1 200 |

Any vehicle with gasoline engine may not issue to the carbon monoxide atmosphere (CO ), hydrocarbons (HC ) , nitrogen oxides (NOx ) and evaporative emissions exceed those specified in Table 3 levels.

### 1. Results

By this method is verified and obtains information generated by a gas analyzer once different types with different octane gasoline are used in an engine with catalytic converter injection .

• The tests were conducted in the province Imbabura , Ibarra canton .

• The location of the auto shop is located in the city of Ibarra at a temperature of 20 ° C

• four tests , one with each fuel with the same procedure that allowed characterize the quality indicators of gasoline were made

### 3.1 Simulation Operating

For this gasoline four samples are used with different octane for operating an engine with catalyst injection .

The injection engine is used to verify performance and emission levels when using different gasoline to operate.

Four samples of different octane gasoline is used , by the environmental impact that they may cause is determined .

• Super Ibarra - Ecuador
• Extra Ibarra - Ecuador
• Current Pasto - Colombia
• Extra Ipiales - Colombia

## 1. Proposal

Results of tests performed with different gasoline samples octane in an engine with a catalytic converter to determine the variation of the environmental impact in relation to each .
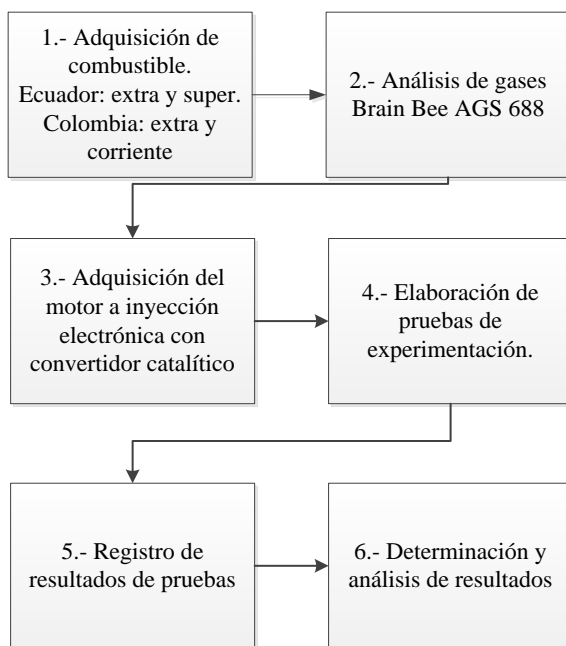


## 4.2. Specifications

To comply with the proposal put forward four gasoline samples, each of different octane, with the following characteristics was obtained:

• 5 gallons of 87 octane regular gasoline (Pasto - Colombia).
• 5 gallon extra 81 octane gasoline (Ipiales - Colombia).
• 5 gallons of 87 octane premium gasoline (Ibarra - Ecuador).
• 5 gallon of super gasoline 92 octane (Ibarra - Ecuador).

Once petrol samples acquired, the experimental process is performed with an electronic injection engine to the availability of a catalytic converter. The engine is the vehicle Chevrolet Sail 2014.

The "Chevrolet Sail is a compact sedan with a roomy interior. This car is manufactured in China. It has an elegant exterior and an equipment level. "

• Equip an engine DOHC 16-valve 1.4 with a power of 102 horsepower (76 kW) at 6000 rpm and torque of 131 Nm at 4200 rpm.

• The gearbox can be manual 5-speed plus reverse (LS version), and manual or four-speed automatic; depending on the choice of the owner (LTZ version)

The maximum speed is 175 declared km / h, and acceleration from 0 to 100 km / h is 12.4 seconds. Chevrolet claims a combined consumption of 5.3 liters / 100 kilometers.

## 4.3. Synthesis

The octane number of a fuel directly influences the results of gas analysis. The fuel containing a higher octane rating will cause less environmental impact, both in their emissions and their impact on humans.

One of the aspects that most caught my attention when testing was that much extra gasoline from Ecuador as extra Colombia, would record the same results, since the octane number of both gasoline is the same (87 octane) however, in practice it was not issued and the results indicate that the Ecuadorian gasoline is better quality by emitting a lower percentage of contaminants.

The regime of engine operation also influences the results of emissions during the process in which the tests were conducted, it was noted that at low speed (800 rpm) emissions increase, unlike registered securities high speed (2,500 rpm).

In the case of the levels of oxygen in emission, it was noted that while lower the operating regime increased presence of oxygen exist because the mixture supplied to the engine is poor, unlike when the engine operates at high revs where the opposite happens.

The lambda factor is directly affected by the rate at which the motor operates as the ratio of the air / fuel mixture is controlled by the ECU, and must adapt in real time to changing engine speed, always trying to get as close as possible to the ideal factor lambda.

## 4.4. Nitrogen oxide (NOX)

Nitrogen oxides or also known as Nox, is another combustion residues, however, mention that the extent of these could not be carried out, since the measurement of this type of issue is high cost while it requires special equipment.

In the countries of Latin America, the Nox practically not measured by the above conditions, instead greater attention to three of the emissions resulting from combustion is provided, which are: CO, HC and CO2.
From the results it is determined that does not meet the basic requirements of quality, the following aspects:

• With a "lambda = 1" relationship, a perfect combustion is obtained because the air sucked agrees with the theoretical (the intake air is 100% of the theoretical needed).

• With a "lambda <1" ratio, for example 0.8 indicates shortage of air so that the mixture is rich fuel (the air intake is only 80% of the necessary).

• With a "lambda> 1" relationship, for example 1.20 indicates excess air, thus a lean mixture (the intake air is 120% of theoretical, that is 20% more than necessary).

## 1. Conclusions

• Ecuador gasolines have a degree of higher octane premium petrol (Ibarra-Ecuador), it has a number of 92 octane, while premium gasoline (Ibarra-Ecuador) its octane number is 87; regarding Colombia gasolines having lower octane premium gasoline (Pasto-Colombia) has an octane number of 87, while regular gasoline (Ipiales-Colombia) has an octane number of 81.

• The emissions of carbon monoxide, tested it with the four samples of Ecuadorian and Colombian gasoline within the recorded values, a maximum value of 0.23% CO, corresponding to the current petrol Colombia, registered to was obtained operate at a rate of 800 rpm; on the other hand, the lowest value recorded corresponds to 0.03% CO, for super gasoline Ecuador under a regime of 2,500 rpm. For this case there is an average of 0.12% of CO.

• Emissions of carbon dioxide, tested it with the four Ecuadorian and Colombian samples, a maximum value of about 16% of $CO_2$, corresponding to the current petrol Colombia, registered to operate at a rate of 800 rpm was obtained; on the other hand, the lowest value recorded was 11.7% $CO_2$ for gasoline super Ecuador under a regime of 2,500 rpm. For this case it has an average of 13.7% $CO_2$.

• Hydrocarbon emissions, carried out with the four Ecuadorian and Colombian samples, a maximum value of 52 ppm was obtained, corresponding to the current petrol Colombia, registered to operate at a rate of 800 rpm; on the other hand, the lowest value recorded corresponds to 31 ppm for petrol super Ecuador under a regime of 2,500 rpm. For this case it has an average of 43 ppm of HC.

• In the case of engine Chevrolet Sail used during testing, the same engine operates at a ratio of 10.2: 1 (high compression). When current Colombian 81 octane gasoline was used, passing the 2000 rpm, the fuel began to self-ignition, causing a rattle in the engine due to premature explosions. Moreover, extra Colombian 87 octane, auto-ignition when the engine itself passed 2500 rpm, causing the same effect on the engine.

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