Analysis of a Externally Modified Combustion Engine to Operate with a Immiscible Fuel of 20% Gasoline and 80% Water

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Abstract

In this paper, we present the results of the analysis of a combustion engine modified to operate with an immiscible fuel that has a ratio of 80% water and 20% gasoline. The project consisted also in redesigning the intake and exhaust system circuits of the engine and we observed that there was a substantial change in the composition of exhaust gases, finding that this change was an environment friendly solution to vehicle pollution.

Keywords

Combustion Engine; Alternative Energy; Pantone System

Introduction

The nonplanified and chaotic increase in the number of vehicles circulating in Lima, Peru has brought a number of environmental problems that affect our quality of life. Since gaseous emissions from combustion engines are pollutants that impair air quality. The idea to develop a project that would modify the gaseous emissions produced by a conventional combustion engine seemed important and we set to study and propose one viable solution which could improve this situation. This was done using an external modification to the intake and exhaust systems of the engine.

Fundament

We started by making changes in the combustion engine of a motorbike to work with immiscible fuel 80% water and 20% gasoline. For example, we made the modification described below, which consists in the construction of two independent circuits for the intake (green) and exhaust (orange).

This circuit corresponds to a Pantone engine, where the carburetor has been removed in our modification. See figure 1.
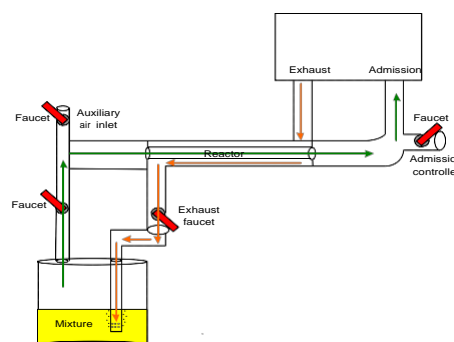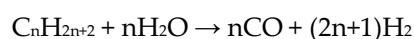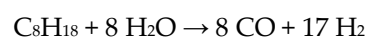

FIGURE 1 SCHEME MODIFIED ENGINE.

With this scheme hydrogen is obtained by hydrocarbon reforming reaction. Generic hydrocarbon-reforming reactions are

$$C_nH_{2n+2} + nH_2O \rightarrow nCO + (2n+1)H_2$$

By replacing n = 8, we obtain

$$C_8H_{18} + 8\ H_2O \rightarrow 8\ CO + 17\ H_2$$

Where C_8H_{18} is gasoline, H_2O is water, CO is carbon monoxide and H_2 is hydrogen gas.

When we made this change we have no a priori information about how this may affect engine performance, which is what we basically wanted to find out. So we make the engine work under stationary conditions in order to study its behavior.

One of the most dangerous emission gasses is carbon monoxide (CO), this gas is colorless, odorless and very toxic, and it is produced by the incomplete combustion of carbon-containing substances in oxygen deficient conditions, such as gasoline and diesel. One of the main sources of air pollution by this gas are the vehicles with gasoline engines.

This gas has the property of rapidly combine with the blood hemoglobin contained in red blood cells (erythrocytes), reducing their ability to transport oxygen from the lungs to body cells.

Normally hemoglobin transports oxygen from the lungs to the cells and collect the CO_2 to be expelled through the lungs.

It is well known that when a person is exposed to CO, it can cause him adverse health effects, even at low concentrations. Permanent hemoglobin blocking may show a neurological picture similar to Parkinson[3].

Methodology

Gas Analysis

Throughout this work we have used a Bosh V5.77 gas analyzer model ETT 008.55 S/N 430 129 623.

This gas analyzer was previously calibrated and certified by Autorex following the ISO 17015, this company also owns Systems ISO 9001 quality management, which gives reliability to the measurements.

The measurements were made with traditional fuel under stationary conditions and then the measurements were repeated again with the arrangement described above. Figure 2 shows the experimental setup. In this way we can have a quantitative comparison with respect to conventional fuel.

FIGURE 2 EXPERIMENTAL SETUP.

Thermic Analysis

For the termic analysis we have used a digital FLIR T400 model previously calibrated. We use these conditions we will have a comparative quantitative value.

Noise Analysis

The equipment used to measure noise level was the Acoustilyzer NTI AL 1. which is a compact acoustic analyzer equipped with a USB interface.. Acoustilyzer AL-1.

In accordance with the provisions of ISO 1996-1-1982, instrumentation shall determine the sound pressure level A-weighted equivalent. The monitoring protocol presented was developed with reference to ISO (1996-1:192 and 1996-2:1987).

Component Analysis

To perform our component analysis the engine was disassembled into components, as can be seen in Figure 3, using a set of previously calibrated measuring instruments.

FIGURE 3 EQUIPMENT DISASSEMBLY.

The use of these instruments will allow us to have a comparative quantitative value in accordance to the manufacturer's data sheets.

Results

Gas analysis

The results were the followings:

TABLE 1 EMISSION MEASUREMENT

	% CO	% CO2	ppm vol HC
Gasoline	3	10	400
Immiscible mixture	0,1885	12,515	205

We observed that with the change of the intake and exhaust systems there is a drastic decrease in carbon monoxide (CO).

In the case of carbon dioxide (CO_2) we see a slight increase which evidences a complete combustion, being this part of the carbon cycle.

We also see a decrease in the volume of hydrocarbons measured in parts per million (ppm vol HC) which shows us that the air-fuel mixture is very rich and the air in the mixture is sufficient to burn the fuel content, this is partly because we have removed the carburetor and is perfectly controlled.

Thermic Analysis

We next observe the most representative comparative images that show the temperature of the engine.

We should mention that pictures shown in figures 4 thru 6 were obtained under normal operation temperature.

We can also observe that there is a minimal variation in the operating temperature of the engine under

steady conditions.

In zone 1 corresponding to Figure 4 we observe a variation of 2,46%, in zone 2 of Figure 5 we observe a variation of 0% and in zone 3 corresponding to figure 6 we observe a variation 0,36%, which are minor variations.
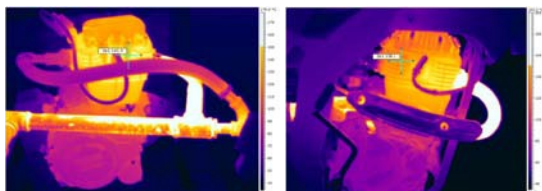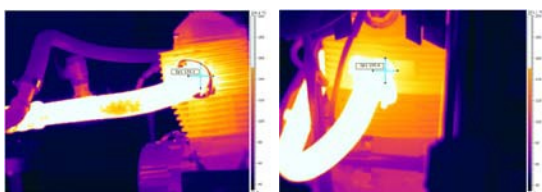

FIGURE 4 MODIFIED AND STANDARD MOTOR TEST 1.

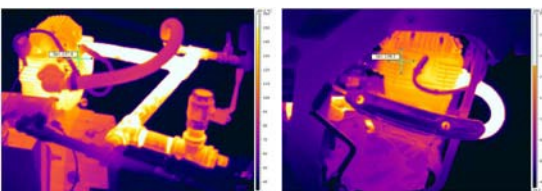FIGURE 5 MODIFIED AND STANDARD MOTOR TEST 2.

FIGURE 6 MODIFIED AND STANDARD MOTOR TEST 3.

TABLE 2 TEMPERATURE VARIATIONS

	Zone 1	Zone 2	Zone 3
Modified	141,5°C	150,4°C	137,6°C
Standard	138,1°C	150,4°C	138,1°C

Noise Analysis

In Table 3 we can observe the relevant data such as dB leq.

TABLE 3 MEASUREMENT IN DB LEQ

	Zone 1	Zone 2	Zone 3	Zone 4
Modified	90,1	91,6	92,3	93,4
Standard	80,4	82,2	81,3	83,5

This evidences the absence of muffler in our arrangement.

Component Analysis

We next observe the images of various parts of the engine.

In Figure 7, we observe the the state of a combustion chamber, where no apparent damage, cracks or crevices can be seen. What one can see is a proper charred and the absence of rust, which is a prrof that water has not been present in the combustion chamber,

nor oil, given us an advance indication of the state of pistons and rings.

What we can observe is an excellent carbonization, which is a proof of an almost complete combustion of the fuel used.

Figure 7 shows a close-up of spark plug where we can also notice a good char and the absence of oxide which gives optimum performance, as this item need carbonization to perform better.
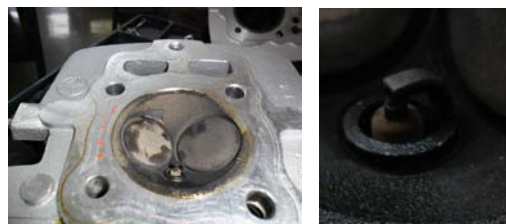

FIGURE 7 COMBUSTION CHAMBER AND PLUG.

In Figure 8 we appreciate the appearance of the piston, not finding an indication at first glance of damage, burrs or something that makes us suspect an inappropriate malfunctioning. we removed the rings and measure the tolerances of these and the piston.

As we noted earlier there is no sign of oil leak in the combustion chamber, which further supports our evidence of the optimal behavior of the piston and rings.

According to the manufacturer the clearance between the piston and cylinder is 0,02 mm with a limit of 0,1 mm, our measurement is 0,03 mm which is maintained within tolerance.

The distance between ends of the piston rings installed is between 0,10 to 0.25 mm with a maximum of 0,25 mm , we have found they are in the 0,12 mm therefore they remain within the tolerance range.

FIGURE 8 PISTON AND PISTON HEAD.

In Figure 8 we appreciate the piston head and did not see any structural damage, fatigue or deformation, which we appreciated is adequate carbonization correct sign and fuel burning.

In Figure 9 the cylinder no eye, scratches, burrs or cracks, mechanically intact, with signs of good lubrication and in excellent cosmetic condition, according to the manufacturer the standard bore is

between 52,40 to 52,41 mm, while ours in 52,40 mm.

FIGURE 9 CILYNDER.

Conclusions

An external modification has been made to an internal combustion engine which drastically lowers the emission of carbon monoxide in 93,72 %, and 48,75% in the volume of HC measured in parts per million.

This modification does not affect the normal external operating temperature of a combustion engine and can be considered optimal for maintaining normal operation.

However, it had an effect in the generation of noise because in the design it was not considered this subject.

After making the change to the combustion engine and having had a working time of approximately 300 hours we have determined that there is no structural damage inside the engine or its components, there is a proper combustion and carbonization on the combustion chamber.

This conversion may be taken into account because it maintains normal operating conditions of a combustion engine.

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