COMPARATIVE PERFORMANCE OF A MOTORCYCLE FLEX-FUEL USING DIFFERENTS MIXTURES OF ETHANOL AND GASOLINE

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Abstract. *Ethanol has been used as fuel to several decades and recently the motorcycle manufacturers began producing motorcycles flex-fuels that use gasoline and ethanol in any proportion, providing to the motorcycle user the possibility of using ethanol, renewable fuel and less polluting, very abundant in Brazil.*
This study aimed at testing dynamometer vehicle motorcycle flex-fuel, analyzing the development of performance parameters such as speed, torque and power versus engine speed (rpm) when using gasoline and ethanol in different proportions. It has been created charts and tables for comparison of the use of ethanol and gasoline as fuel for flex-fuel motorcycle.

Keywords*: motorcycles flex-fuel, ethanol and gasoline, performance.*

1. INTRODUCTION

Users of flex-fuel vehicles are continually increasing using alcohol as fuel, because it is a cleaner alternative fuel and more financially viable during many months of the year. It uses has been largely consolidated in four-wheel vehicles, which comes from the 80's, however, only recently, manufacturers have started producing flex-fuel motorcycles, so it gets extremely important to study the pros and cons of using alcohol as fuel at high rpm engines.

This study aims at analyzing the efficiency of a flex-fuel motorcycle of 150cc working with different proportions of ethanol and gasoline. In order to demonstrate this, tests were conducted on a dynamometer to obtain the comparative performance, torque and power versus rpm (revolutions per minute) of a motorcycle running on E22, F75 and HEF (hydrous ethanol fuel). Performance tests were conducted in a R&D laboratory of a large motorcycle manufacturer, located in the Industrial District of Manaus, Amazonas, Brazil.

2. FUELS USED AND ADOPTED PROPORTIONS

The fuels used in the performance tests were hydrated alcohol and gasoline, lonely or mixed in different percentages. Gasoline and alcohol when mixed in different proportions yield different results regarding the performance, hence the importance of defining the values of mixture to be used in field tests and dynamometer.

2.1. Determination of anhydrous ethanol in gasoline

The analysis of the ethyl alcohol content in gasoline was performed according to ABNT NBR 13992 "Automotive gasoline - Determination of anhydrous ethanol fuel . Indeed it is important to conduct this analysis, since it allows knowing the actual proportion of alcohol and gasoline in a fuel to be studied. Materials used: 250 ml Beaker to collect fuel from gallon of fuel; Beaker for adding water and fuel in the container for analysis and Beaker 100 ml to 50 ml of the mixture of fuel, 50 ml of water.

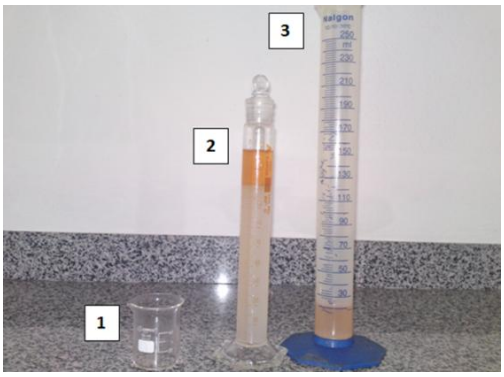

Figure 1. 50 ml beaker (1), 100 ml Beaker (2) and 250 ml Beaker (3).

For analysis, it was considered the following:

a) First, with a 100 ml beaker, add 50 ml of water and then 50 ml of fuel to be analyzed.
b) Cap test beaker and invert 10 times and leaving it on a flat surface for 10 min.
c) Record the final volume of the aqueous phase in milliliters to the nearest 0.5 ml.

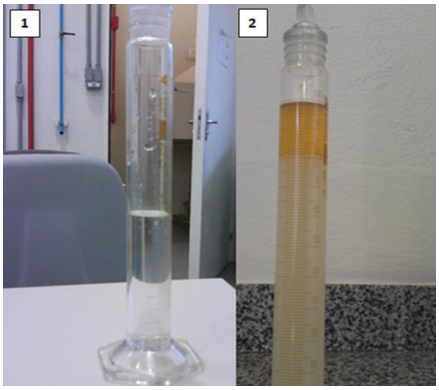

Figure 2. 100 ml beaker with 50 ml of water (1), beaker with 50 ml of water and 50 ml of fuel.

2.2. Proportions of alcohol and gasoline used in tests

In tests it was used three fuel blends:
- Standard gasoline E22, with 22% anhydrous ethanol fuel (AEF) and 78% of pure gasoline.
- HEF (hydrous ethanol fuel), with 5-7% water in its composition according to the Brazilian Agency ANP (National Agency of Petroleum, Natural Gas and Biofuels).
- F75, with 75% hydrous ethanol fuel (HEF) and 25% standard gasoline E22.

3. METHODOLOGY FOR THE TESTING OF POWER AND TORQUE TESTS

The dynamometer tests has gotten a great importance for testing vehicles in order to obtain some curves like power X rpm, torque X rpm, speed X rpm among others. It can thus, aided by a vehicular dynamometer, get the performance parameters of the vehicle in tested. In the specific case of this work, it was used a vehicular dynamometer to analyze the performance of a flex-fuel motorcycle 150 cc with different proportions of alcohol and gasoline.

3.1. Data from vehicular dynamometer for motorcycle tests

The dynamometer used has the following specifications (taken from manual):
• Modeled Mass (Standard) - 450lbs
• Modeled Mass (High - Inertia) - 650 lbs
• Maximum Horsepower - 750 hp
• Maximum Speed - 200 mph
• Maximum Torque 750 ft / lbs
• Temperature Range 32 ° F to 158 ° F (0 ° C to 70 ° C)

3.2. Description of power and torque X rpm tests

Below it is the methodology for conducting a test to determine the power curve and torque X rpm after mounting the motorcycle in the dynamometer:

a) Heat the motorcycle in neutral up to 80 ° C;
b) Start 1st, 2nd and 3rd gear and stabilize rotation at 3000 rpm (it is chosen to 3rd gear for the test because it is running mid work of a motorcycle on a day-to-day in the city);
c) Start data acquisition software of the dynamometer and speed up to full speed motorcycle;
d) Slow down the motorcycle and stop data acquisition software of the dynamometer;
e) Save chart issued by the software of the dynamometer;
f) Repeat the test four more times, totaling five tests;
g) Format for the display of graphic power, torque and rpm and set their intervals.

4. RESULTS

4.1. Speed curve from 0 to 60 km/h

The motorcycle was put at full throttle in the dynamometer watching the time spent so that it reached its maximum speed. In total it was collected 7,257 (seven thousand two hundred fifty seven) observation points, among these, was used 820 (eight hundred twenty) points to plot the graph from Fig (3) which shows the time taken to the motorcycle reaches 60 km/h. Despite having 7,257 observations, it was chosen to show the curve only in the stretch velocity between 0 and 60 km/h, it is a pattern in the segment for two-wheel to low cubic capacity motorcycles, because the average speed is commonly used urban roads by users of motorcycles.

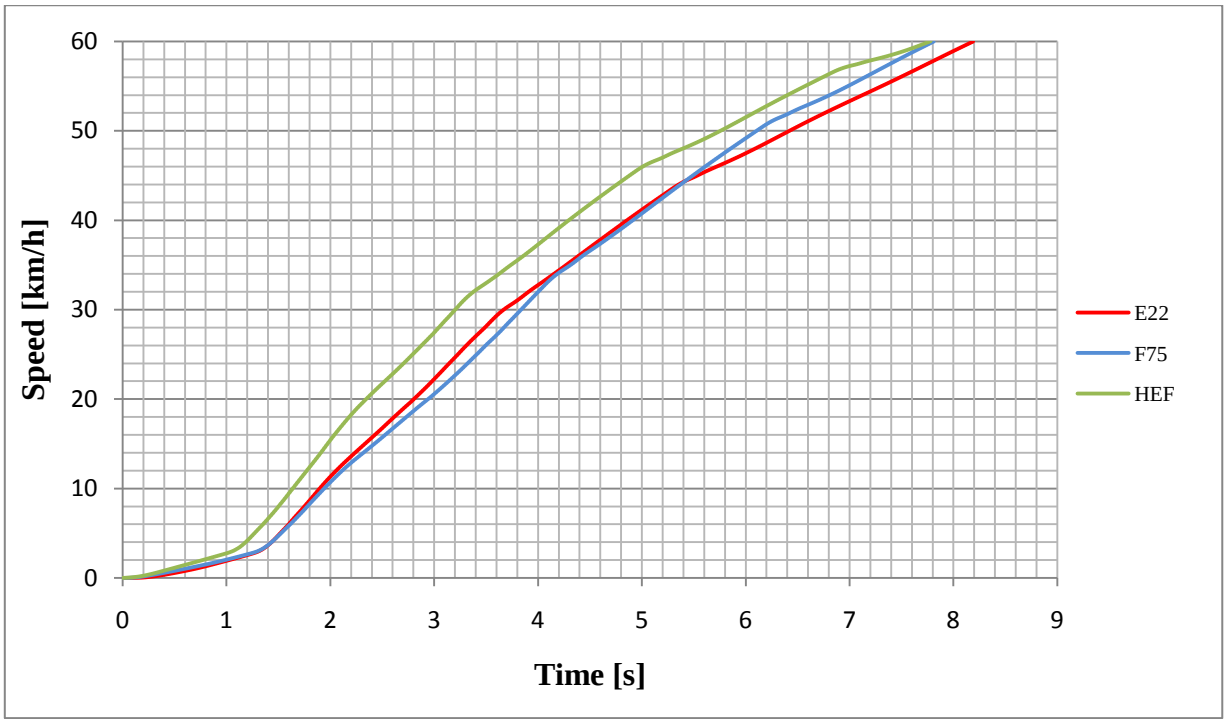

Figure 3. Graph of speed versus time for fuel E22, F75 and HEF.

4.2. Power and torque curves.

In Figure (4), it was observed that the flex-fuel motorcycle shows similar development of power and torque for all three fuels. The fact that the power curve be close shows that it would has a good drivability using any of the three fuels, in addition, the torque curves denote something already expected, the torque curve HEF fuel has a higher peak than the others.

Table (1) displays a summary of results obtained in terms of their maximum values.

Table 1. Maximum values of power, torque and speed.

Fuel Test	Time* [s]	Speed [km/h]	Power [kW]	Torque [N.m]
E22	8,19	106,18	7,99	10,8
F75	7,81	106,54	8,08	10,86
HEF	7,78	107,34	8,08	11,05

*Time to reach 60 km/h.

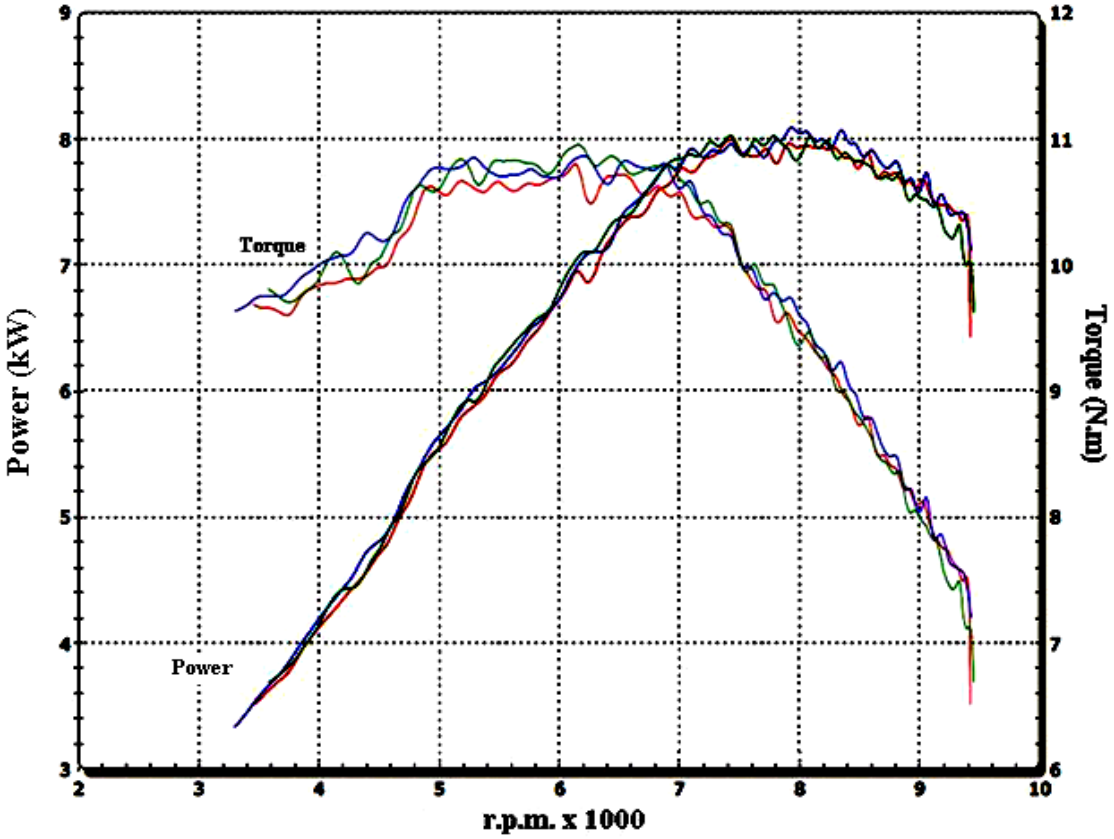

Figure 4. Gasoline E22 in red, F75 in blue and HEF in green.

5. CONCLUSION

From the analysis of tests done with a flex-fuel motorcycle 150 cc, which is used more in big cities because they are more economical, this study allowed to analyze its performance using mixtures of ethanol and gasoline as a fuel in different proportions. It is noteworthy that this type of study has already been discussed from the viewpoint of motor vehicles with four wheels, which are characterized by having engines that operate at low rotation, and the use of HEF leads from the 80's from Programa Nacional do Álcool (program of the Brazilian Federal Government), however, with the recent advent of flex-fuel motorcycles, yet only for low cubic capacity, it became necessary again to approach the topic, especially because both car and motorcycle, have different characteristics (motorcycles work at high rotation).

This study shows that with the HEF the motorcycle got the best results for speed, power and torque, while the E22 blend had the lowest levels. Already the results of speed and torque with F75 were in a mid-line compared with the other two, with the peak power shown equal to fuel HEF. The curves shown in Fig (3) and (4) denote the speed, torque and power showed no significant discrepancies for the three fuels what in turn allows to say that there was no relevant commitment of the vehicle drivability. Based on this, it is clear that ethanol (HEF) would be a good fuel option for users of low cubic capacity motorcycles.

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