ETHANOL APPLICATION AS FUEL: PLASMA IGNITION FOR VEHICLE ENGINES

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Figure 1. Spark plug electric discharge

Petroleum oil is an important source of energy and a raw material that has been widely exploited by mankind. There is a concern about its storage in nature, since it is a non-renewable source and will be exhausted in near future. The indiscriminate use of oil products produces serious consequences for environment, like carbon compound emissions. Therefore, it is necessary to develop strategies to minimize emissions of air pollutants. The replacement of fossil automotive fuels by alternative and renewable fuels is increasing in order to reduce emission of toxic gases in the atmosphere. In this sense, the ethanol fuel, in Brazil, was implemented through National Alcohol Program (Pro-Alcool). More recently, the National Laboratory of Science and Technology of Bioethanol (CTBE) was also created in order to ensure Brazil leadership on sustainable production of sugarcane and bioethanol through development and innovation. The ethanol is undoubtedly cleaner than gasoline due to less toxic emission substances, such as benzene and butadiene. Furthermore, by having a simpler composition, bioethanol releases lower levels of complex substances into the atmosphere during its combustion.

Ignition engines by spark discharges (or internal combustion engines) initiate their combustion mechanisms leaded through electrical discharges. For a fuel-air mixture ignites into an engine combustion chamber, an electric discharge which occur between the electrodes of spark plug, provides enough energy to the mixture to be completely burned, thus obtaining the maximum engine power.

This project focuses on the investigation of processes occurring during the ignition of plasma and its consequences in post-discharge for an internal combustion engine, especially considering the spark plug discharge (*Figure 1*), aimed at finding the proper parameters to be applied in cars that operate on "poor mixtures" reducing pollutants released into the atmosphere. The research aims is to point out methods and materials to be used in order to provide an analysis of the processes occurring in plasma and combustion.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

After the implementation of a synchronic circuit, we are able to generate controllable electrical discharges . These discharges were characterized in terms of electrical properties from a high resolution oscilloscope. Voltages and currents were measured according to the applied pulses. The voltage values were found to be around 6 kV for 40ns. However, the current values were found to be around 100 mA for 2.3ms (*Figure 2*). Through these data, it is possible to conclude that even without electric field, there still exist the production of ions and reactive species.

In collaboration with the Geophysics Space Division Group of National Institute for Space Research (INPE), the emission light during the breakdown process of the discharges was recorded from
a high-speed camera usually used to shoot lightning. From these data, the discharge light intensity was inferred as a function of time. Comparing the light curve with the normalized electric current graph (*Figure 3*), it is possible to check that the discharge duration is about 2.3ms.

By using techniques of emission spectroscopy, several discharge parameters, such as temperature, electron density and electron temperature will be obtained during the combustion.

The aim of our work is then to optimize these discharges in order to improve the burning of the bioethanol fuel inside a high-pressure combustion chamber and therefore to use a "poor mixture" to achieve good engine performance.

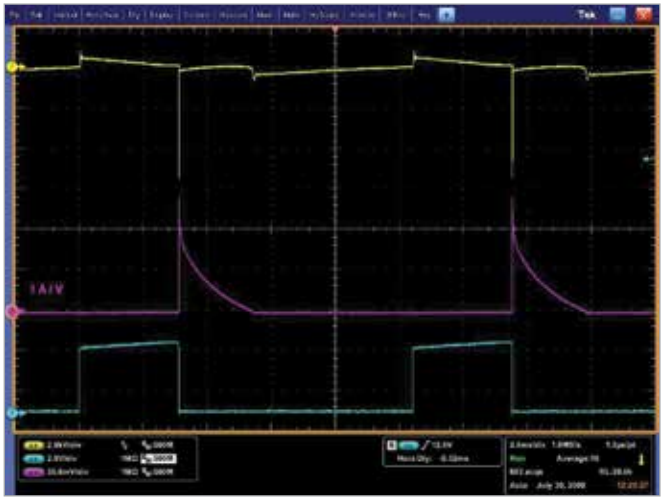

Figure 2. Curves of voltage (yellow) and current (purple) for the entrance pulse (blue) with 10ms and 30 % of duty cycle

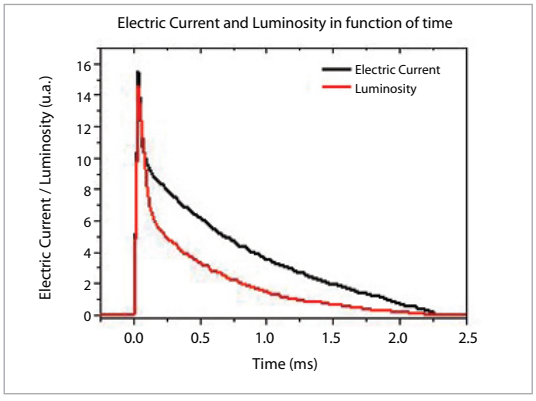

Figure 3. Curves of electric current and luminosity as a function of time

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