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ANALYSIS OF IMPACTS ISSUE GAS PRODUCTION BY DIESEL MOTOR CYCLE INTERNAL COMBUSTION WITH NATURAL GAS FUEL OR BIODIESEL BLENDS

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Abstract. *The brazilian energy matrix has undergone a review of its policy when it comes to fossil fuels, using the 70's with the oil crisis, imposing an energy saving and reduction of dependence derived from imported oil. Since then measures have been taken, such as increased domestic production and increased use of natural gas in the brazilian energy matrix. The vehicular natural gas (VNG) is able to reduce significantly the emission of pollutants, reducing public spending on health and diesel oil import costs. The biodiesel, renewable energy source contrary to diesel derived from fossil, can reduce emissions by 78% carbon dioxide and 90% smoke propriciando reduction of sulfur oxide. This paper will be the analysis of exhaust gases from a diesel engine MWM 4:07 TEC based on electronic common-rail injection system and a wide range of engine vehicular using this model such as GM truck S10; Minibus Volare and Nissan Frontier. In the production of biodiesel in the internal combustion engine testing for gas analysis, the percentages mixtures are equivalent to B7 (7%), B20(20%) and B50 (50%) biodiesel added to the diesel oil, as well as pure B100 biodiesel in mixtures assays. In tests, the VNG or biodiesel, the use of such fuels predominant role in reducing pollution in the environment. Currently, issues related to the environment and the protections of consumer economic power are matters of concern for government agencies and society in the search for energy alternatives in environmental economic improvements.*

Keywords: *Natural Gas, Biodiesel, Emissions, Engine Internal Combustion*

1. INTRODUCTION

In the 70s with the oil crisis, the Brazilian energy matrix was reviewed in its energy politics, imposing a saving energy and reducing dependence on imported oil derivatives. In this sense measures have been taken, such as increasing domestic production, increased use of natural gas in the Brazilian energy matrix and the implementation of biodiesel in vehicle gradually matrix.

Currently environmental issues and the protection of the environment are reasons for great concern and compressed natural gas is presented as an alternative energy cleaner and as a more economical option for users. Thus, much has been studying with respect to natural gas, which now has an important role in meeting primary energy demand in Brazil. The current natural gas reserves guarantee a long-term supply. In recent years new reserves have been discovered. Biodiesel compared to diesel oil derived from oil, can reduce by 78% the net emissions of carbon dioxide and reduces by 90% the emissions of smoke and virtually eliminates emissions of sulfur oxide, thus the use of biodiesel to natural gas vehicle will have a predominant role in reducing pollution in the environment (Holanda, 2006).

This work proposes the development of a flow control system that allows the simultaneous use of biodiesel and compressed natural gas. To maintain the original engine power, which uses original fuel (diesel oil), the proposed control system focuses on the use of electronics in process instrumentation, providing a dual-fuel system (biodiesel-VNG) maintaining the same power of the original fuel.

The development of natural gas vehicle with biodiesel application of technology can contribute to improving man's quality of life in large cities, as it will contribute to the reduction of emissions and contribute to generate employment and income in rural areas, aspects these that justify the importance of the research presented here. So it is important to consider that the use of biodiesel to natural gas will allow gains to the national economy from the reduction in brazilian imports of diesel oil and will enhance the use of renewable energy sources and diversification of the Brazilian energy matrix.

This work uses the biodiesel with natural gas vehicle, which has important technical advantages when compared to conventional fuels, gasoline, alcohol and diesel oil, indicates a promising alternative in terms of automotive fuel. The Tab. 1 shows the main advantages of using natural gas and biodiesel as fuel.

Table 1. Advantages in the use of fuel in the vehicle matrix

Fuel	Natural Gas	Biodiesel
Advantages	Relatively low cost relative to other fuels; Durability of the lubricating oil; Durability of the engine; It is non-toxic to the air; Lower density than air, thus enabling rapid dissipation in the atmosphere.	It is produced from renewable raw materials; It is biodegradable; Reduces the emission of polluting gases (except nitrogen oxides, NOx); It has a high flash point; Its properties are compatible with diesel oil (Knothe et al., 2006).

2. INTERNAL COMBUSTION ENGINE IMPLEMENTED IN TRANSPORT

In 2012 in Brazil, among the sectors that consume energy, the transport sector was the most consumed (BEN, 2013). Consumption involving the carriage of cargo and people grew at rate of 7.2%. Between the years 2011 and 2012 have been licensed over 312 000 new trucks justifying the increase ds 6.1% in the consumption of diesel oil, which can be seen in Tab. 2.

Table 2. Energy consumption of transport vehicles

Year	Consumption (Mtep)	Growth (%)
2012	79,3	7,2
2011	74,0	

Font: BEN, 2013.

The Fig. 1 shows the graph of participation in the distribution of consumption of each fuel in the energy matriix of load and passengers.

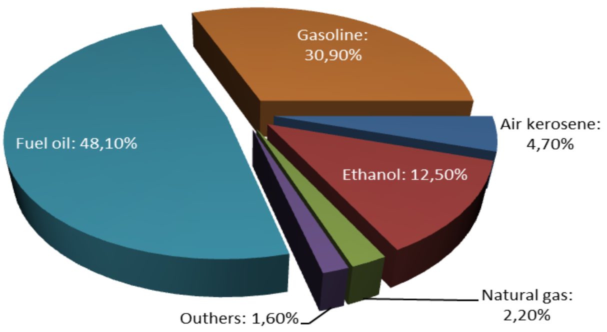

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Figure 1. Power consumption distribution graph in transport vehicles

2.1 Studies VNG and Biodiesel in internal combustion engines

Several studies have been directed to the use of compressed natural gas and biodiesel in stationary engines and vehicle diesel cycle and the Otto cycle.

In the internal combustion engine (thermal engine), transforms energy from a chemical reaction of the fuel into mechanical energy. Power is supplied by burning a fuel within the system boundaries. In internal combustion engines the working fluid does not undergo complete thermodynamic cycle. It is expelled as the engine exhaust gases, instead of returning to the initial state. The open cycle is the feature of all internal combustion engines. The gas studies, Villanueva (2002) studied the impact on emissions resulting exhaust gases of replacing gasoline by compressed natural gas in light vehicles. This study concluded that a vehicle converted to CNG, emits less carbon in the atmosphere that the vehicle running on gasoline, with an average reduction of CO on the order of 71% and a 23% reduction in CO_2 emissions.

Second, Costa (2007) the use of diesel oil and natural gas are indicated as one of the best ways to control emissions of pollutants coming from the diesel engines. In his work was used diesel engine working cycle of dual form and was found a reduction in the emission of pollutants such as CO, CO_2, NO and SO_2.

In their study, Junior and Fagá (2005) concluded that the replacement of electric motors for internal combustion engines to natural gas, in the oil pumping systems in refineries, is feasible and offer good technical and economic prospects for its implementation such as lower operating costs, diversification of fuel, better yield to partial loads to the electric motor and the possibility of cogeneration.

According to Pereira et al (2004) an alternative to the import of diesel oil, is the use of compressed natural gas in diesel engines, even if the replacement is partial. An alternative to reducing diesel fuel demand in Brazil can be the conversion of diesel engines to use natural gas in partial replacement diesel oil. It was found in this study that simultaneously engines consuming diesel and natural gas present above the engine thermal efficiency that only works with diesel oil.

2.2 Test system of internal combustion engine

Current requirements regarding pollutant emissions from motor vehicles, requires that the engine operating conditions throughout its useful life is devoid of problems. To reach this level of confidence, it is necessary to test the engine several times in order to isolate and solve potential problems. In addition to engine manufacturers, oil companies also test combustion engines to verify the specific characteristics of fuels and lubricants (Martins, 2013).

The engine tests are conducted in laboratory tests using a dynamometer, which is an energy absorbing instrument which is capable of applying a controlled load on the engine being tested.

3. MATERIALS AND METHODS

3.1 MWM engine 4:07 TEC

To develop this work was found several models of engines that are used in Brazil for the vehicular line and was being used in a wide range of motor vehicles. The choice of engine MWM 4.07 TCE was based on the electronic Common Rail injection system and a wide range of vehicles using this engine model such as: The Coach S10 of GM, Micro-bus Volare, Nissan Frontier and Nissan X terra, the latter two changes in the engines already in the process of this research.

The Table 3 presents some technical data MWM engine and Fig. 2 shows the engine image study being subjected to two fuels under study.

Table 3. Technical data engines

Engine Data	4.07 TCE
Vacuum	Turb fed pest cold
Type of construction	Four times - Direct Injection with Electronic Management
Cylinders number	Four in line
Number of valves	12
Compression ratio	17,2:1

3.2 Biodiesel and VNG control system

This research necessary to develop a system to control the flow of diesel / biodiesel and compressed natural gas in such a way that allows the simultaneous use of both fuels, therefore it was necessary to make use of electronic instrumentation and fabricate some electronic subsystems:

- Signal acquisition system;
- Control system Diesel / VNG;
- Drive system of the diesel injectors;
- Drive system actuation VNG;
- Modulo peak-hold of VNG injectors;

Each subsystem has cited specific functions in biodiesel / VNG control system.

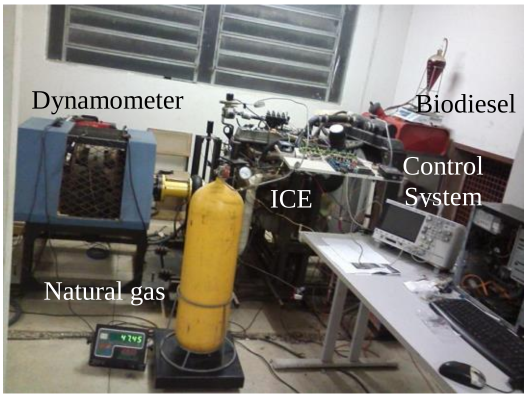


Figure 2. Engine MWM 4:07 TEC fed by natural gas or biodiesel, couplet to dynamometer electric LOGS

4. MEASUREMENTS OF THE ENGINER CYCLE GAS RESULTING FROM BURNING DIESEL MWM

The measurements of exhaust gases from the combustion of diesel cycle engine was made to rotations: idle 800 rpm, 1000 rpm, 1200 rpm, 1400 rpm, 1600 rpm, 1800 rpm, 2000 rpm, 2200 rpm and 2400 rpm, where each rotation cycle of eight measurements at intervals of 60 seconds were taken and calculated. Average values of measurements enables verifying the concentration of major pollutants, engine under study. Measurements were made in two steps according to the fuel used, the first step was using biodiesel B5, which served as a reference for the use of biodiesel VNG, The second step was using diesel oil (B5 biodiesel) and VNG.

The measurement of the ratio of carrier gas used with biodiesel B5 was performed using the mass measuring method of the two fuels, biodiesel and B5 VNG. It was necessary to develop a computer program in C language, to acquiring data from the balance measuring biodiesel consumption and scale that measures the CNG consumption, for the worked proportion of fuel injected engine study was required to inhibit pre-injection of biodiesel in the engine speed being 1000 rpm and replace the amount of mass fuel from pre-injection of biodiesel by a mass quantity of CNG fuel that kept the same operating the engine rotational speed of 1000 rpm. The time found the injection of CNG replacing biodiesel pre-injection in the rotation 1000 RPM plays for the other engine speeds.

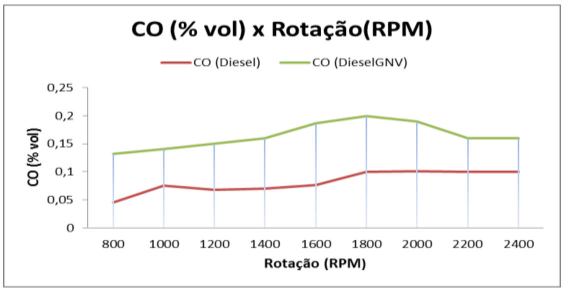
The time found the injection of VNG replacing biodiesel pre-injection in the rotation 1000 RPM plays for the other engine speeds. Analysis was made of the intake of diesel and diesel with CNG at various engine speeds at eight minute time interval. From the data obtained, builds graphs showing the individual concentrations of each gas in terms of rotations and the types of fuels on emissions of gases.

5. CONCLUSIONS

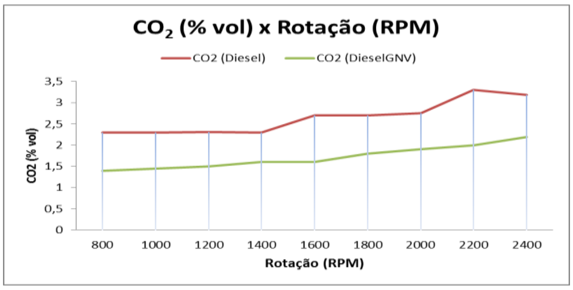
With the data obtained from the main polluting emissions of gases from the combustion engine in a study using commercial diesel fuel containing 5% biodiesel (B5) commercial emissions and related analyzes were performed using compressed natural gas. Natural gas replaces biodiesel, being injected in pre-injection of commercial fuel. The measured values for carbon monoxide (CO) in all rotations were analyzed with regard to CO that is obtained when used the mixture of biodiesel B5 and compressed natural gas.

The values measured for carbon dioxide (CO_2) found in the measurements with the engine rotations of 800 rpm to 2400 rpm was analyzed with respect to CO_2 than was obtained when using biodiesel B5 mixture and carrier gas to replace the pre-injection B5 biodiesel. CO_2 values decrease. In the obtained oxygen gas (O_2), all rotations used in the measurements were analyzed with respect to the O2 that are obtained when using biodiesel B5 mixture and carrier gas. Costa was an increase of O_2. The values obtained for the hydrocarbon (HC) used in all rotations, when using biodiesel B5 mixture and carrier gas. Demonstrate a significant increase of HC when using biodiesel VNG.

The values obtained for Nitrogen Oxides (NOx) were analyzed for the CO obtained when using the biodiesel blend B5 and vehicular natural gas. The data showed a significant reduction of NOx. The Fig. 3 shows graphs of the analyzed emissions.



(a)



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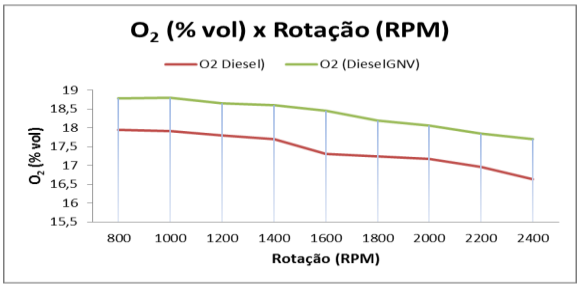

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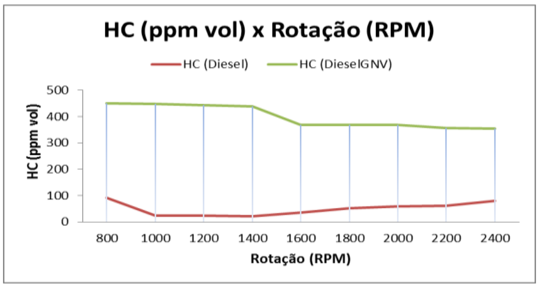

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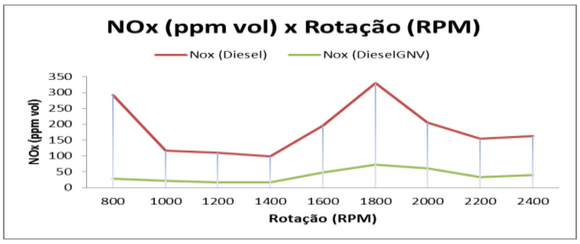

(e)

Figure 3. Concentration of gases to speed 800-2400 rpm (a) CO concentrations;. (b) CO_2 concentrations; (c) O_2 concentration; (d) and HC concentrations; and (e) NOx concentration.

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