PROJECT OF EMBARKED SYSTEM OF INSTRUMENTATION TO MONITORING THE PERFORMANCE OF THE URBAN BUS ENGINE USE GNV FUEL.

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Abstract. *This study it has as objective to develop an on-board system of instrumentation, aiming the data register that characterize engines performance of the urban transport vehicles. These data will make possible a comparative analysis of performance between two configurations of bus: one moved diesel and the other, after the conversion, moved the natural gas vehicular (NGV).*

The performance of bus engine are characterized by instantaneous speed of the vehicle, rotation of the engine, the mass air flow into in the engine, air/fuel ratio, throttle position sensor and the temperatures of the cooling liquid, oil e the environment (with the use of platinum resistance). The data will be stored in one data logger.

Through the one chassis dynamometer, will be raised the curves of torque, power, consumption specific of fuel and emissions of pollutants of the vehicles used in experiment.

The instrumentation system will be mounted in way not to intervene with the normal functioning of the vehicle.

Keywords*: on-board instrumentation, NGV fuel,*

1. Introduction

To each year if they raise the ambient restrictions to the vehicles emissions, mainly in the great urban centers, saturated of automobiles, bus and trucks. The permissible indices of composites in exhaust gas go diminishing, raising the research for alternatives and extending the space for using of clean fuels [1]. In Brazil, the natural gas vehicular (NGV) appears as alternative already implanted successfully in the light vehicles and, associate the natural reserves just discovered in the country, the federal government it initiates one politics of incentives aiming at to the substitution of diesel, used as combustible of the fleet of collective transport of passengers, for GNV. In this context, the Federal University of the Rio Grande do Sul - UFRGS, through the group of Processes of Manufacture e Industrial Automation - GPFAI, together with PETROBRAS, Bee/Dynatec, TGB, SulGás, Tomasetto Achille and Soul initiate the development of project GASBUS. This pilot project has as intention a comparative analysis of performance a urban transport vehicles with diesel and, the same vehicle, after the conversion for GNV use.

The differential of this project in relation at previous experiences of the use of NGV in the urban collective transport consists in the use of composed material cylinders for GNV storage, thus reducing weight when compared to the traditional steel. The process of the conversion of the diesel engine for NGV was carried through by the Argentina Company Tomasetto Achille.

The vehicle used in the project (Fig. 1) is an urban transport bus, Mercedes-Bens chassis, model 1721, with engine OH366LA (turbo) (Tab. 1), manufactured by Comil at year of 1999.

Figure 1. Photo of the bus converted for test of GNV use.

To make possible a comparative analysis of performance between diesel and GNV vehicles, are necessary the use of a on-board instrumentation system that monitors the data that characterize performance of the vehicles, being the project of this system the main focus of this article.

2. Project of instrumentation system

The on-board instrumentation system has for objective the register of data to make possible the comparative analysis of performance between urban transport vehicles that use different fuels for movement. In the first stage of the project, a study was executed of dynamic characteristics of the vehicle that suffer alterations with the conversion from diesel for GNV. In this study, the interest data had been determined for the performance analysis. These are:

- Fuel consumption;
- Throttle valve position;
- Air mass in the entrance collector;
- Temperature of cooling liquid;
- Environment temperature;
- Temperature of the engine oil;
- Rotation of the engine;
- Instantaneous speed;
- Emission of gases;

To follow the components of the system will be argued of implemented instrumentation.

2.1. Unit of register of data

The Unit of Register of Dados (URD) is the main element of instrumentation system, where all sensors are connected to be monitored and the collected data are stored. It is composed for two data logger manufactured by NOVUS (Fig. 2), with Flash memory for the register of collected data and serial communication with microcomputer.

Figure 2. Unit of data acquisition and storage.

The main characteristics of the URD are described to follow:

- 4 canals of analogical entrance of tension (0 - 5V), 10 bits of resolution;
- 8 canals of analogical entrance (Entry of tension, PT100 or Thermocouple), 12 bits of resolution;
- Ratio of acquisition: 10 samples/s;
- 2 serial communication port and 1 Ethernet port;

The URD was installed in the compartment of the electrical center of due the easiness of access and to the available space.

Aiming at to monitor the temperatures during the period of engine cooling was implemented a timer that keeps feeding of the URD during this period.

During the acquisition of data, the registers are stored in one recorded archive of data in the memory Flash of the URD.

2.2. Sensors and signal conditioning

The sensors are specificate to work in adverse conditions, subject a vibration and high temperatures variation. The squematic diagram of instrumentation implemented is show in figure 3.

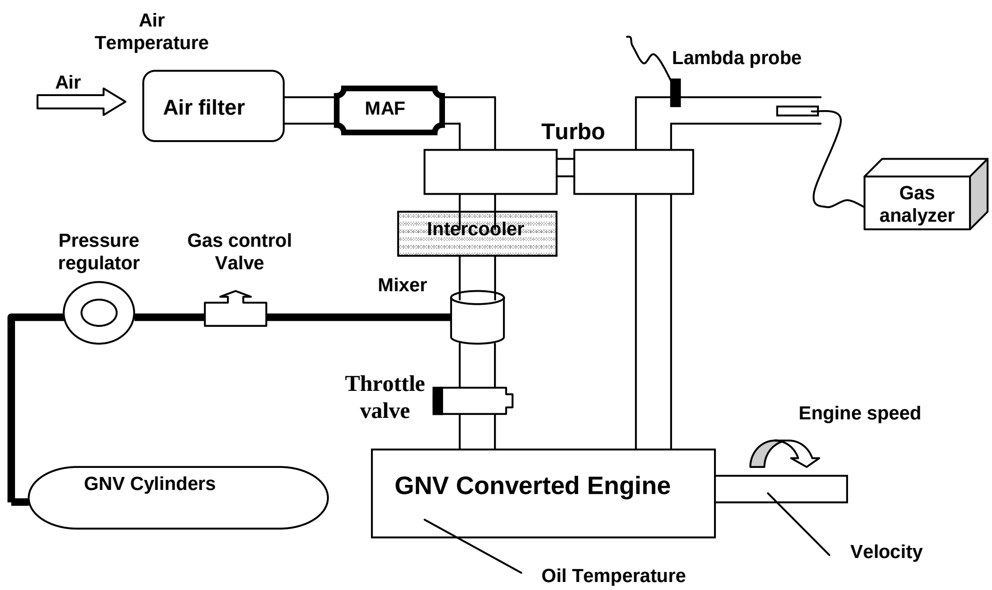

Figure 3. Schematic diagram of instrumentation system monted in urban vehicle transport.

2.2.1. Instantaneous speed

The instantaneous speed can be defined as the speed average of displacement of the vehicle in a small time interval, tending zero.

Being in the distance covered proportional to the number of revolutions of the wheel of the vehicle, this is measured through an installed rotation sensor in out of gear box that measures the cardan rotation (Fig. 4).

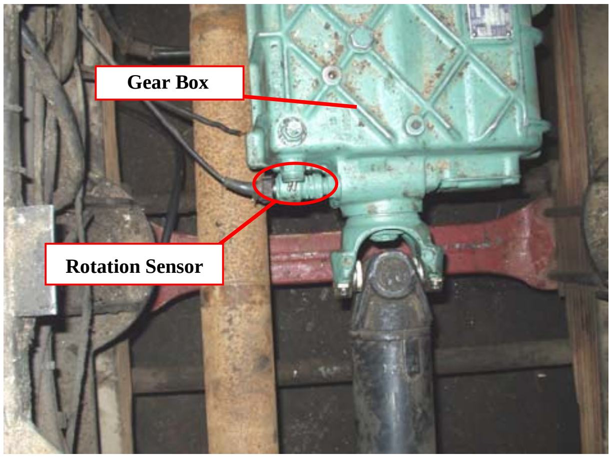

Figure 4. Rotation sensor installed in out of gearbox to measure velocity.

For the register for the URD of the signal of frequency generated for sensor was implemented a frequency to voltage converting that, on the basis of frequency of the signal of the sensor, generates a proportional tension between 0 and 5V. The URD have a differential tension entrance, not to effect functioning alterations in the original system of the vehicle.

2.2.2. Rotation of engine

The engine rotation register is realized through dentate wheel fixed in the rotor of alternator, with a magnetic sensor installed in alternator body. This generates a signal of tension alternated with frequency proportional the alternator rotation. This is connected at engine by one strap.

The signal is conditional with the use of a frequency/voltage converter implemented for the UFRGS, which generates a tension between 0 and 5V.

2.2.3. Admitted air mass

The air mass admitted for the engine is used together with value of the air/fuel ratio for estimate the fuel instant consumption of and also, together with the engine rotation, throttle position and instantaneous speed indicates of which the regimen of operation of the engine.

Some methods more used by the automotive industry today are density of speed and MAF. The density of the air speed uses rotation of the engine and the pressure and the temperature of air in the entrance collector together with one table of volumetric efficiency esteem the air flow. MAF it uses a sensor of air mass to measure the air flow, being this sensor used for the instrumentation.

The sensor was installed between air filter exit and turboblower entry (Fig. 5).

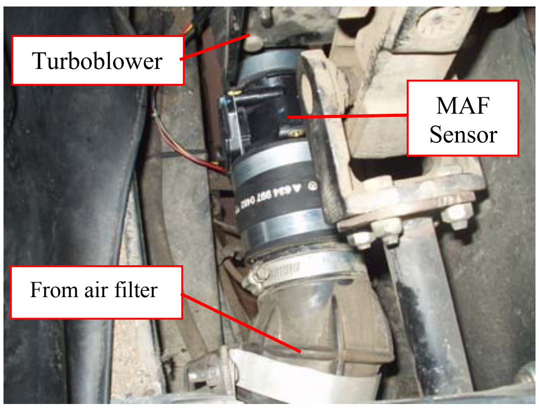

Figure 5. MAF sensor installed in bus.

2.2.4. Throttle position

The pedal of the accelerator is the interface between the driver and the engine. Through the position of the accelerator, that is the interface between the vehicle and driver, is determined how much vehicle power the driver requires.

The position of the pedal of the accelerator measured indirectly with register of the angle of opening of the throttle valve using a TPS (Throttle Sensory Position) (Fig. 6) connected to the axle of valve.

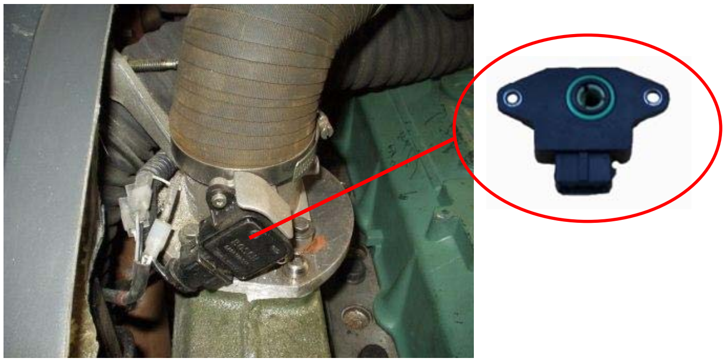

Figure 6 - TPS mounted in throttle valve.

2.2.5. Air/Fuel ratio

One of the parameters to verify the correct burning of fuel in the engine is the level of oxygen in the exhaust system. The Lambda factor that it indicates the relation between the amount of real air supplied to the engine and the amount necessary air theory for the total burning of the fuel ($\lambda = A/F_{real}/A/F_{theory}$). When the engine admits more air that the necessary for the burning is called lean mixture (excess of oxygen) and, in the case of lack of oxygen to complete the burning is called rich mixture. In general the automotives engines work with lean mixture.

The level of oxygen in the escape system is monitored through use of the broad band Lambda sensor (PLM), manufactured for the MOTEC. This generates a signal of voltage proportional the variation of the Lambda relation, and this signal registered for the URD. It is installed in the exhaust system of the bus, soon after the exit of the turboblower (Fig. 6).

Figure 7. Broad band Lambda sensor installed in exhaust system.

2.2.6. Temperature of the cooling liquid, the oil of engine and environment

These parameters are used for calculate it of the efficiency of system and as also indicating the state of functioning, since overheating of engine is a critical point in the vehicles converted for GNV.

To monitor the temperature of the cooling liquid it is used a platinum electrical resistance (PT100), inserted in engine block. For the temperature of the oil a thermocouple is used type K, where this goes to be inserted in the orifice of the engine oil rod (Fig. 8).

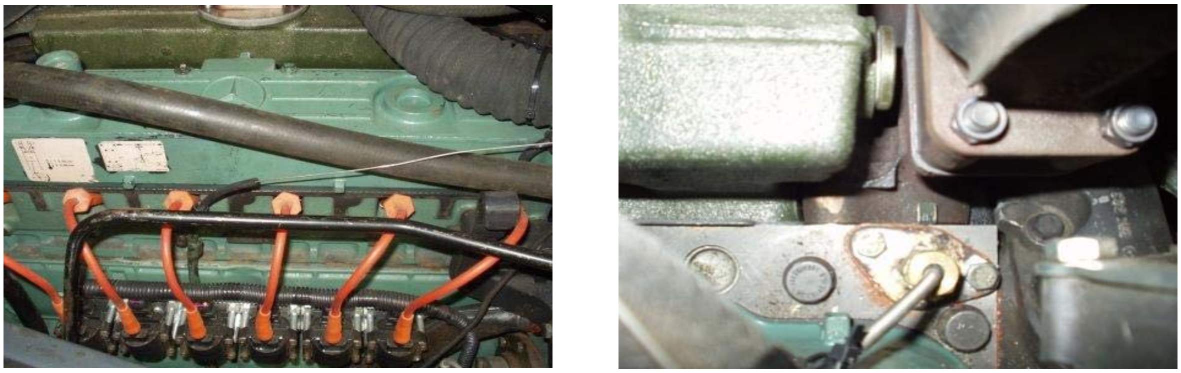

Figure 8. Inserted thermocouple in the block of the engine through rod of oil support (left) and inserted platinum electrical resistance in the liquid of cooling engine block exit (right).

2.3. Preliminary Data

To verify robustness of on-board instrumentation system installed in the vehicle converted for GNV are realized tests of field inside Porto Alegre city, being registered the vehicle operational data.

In the showed stretch of 30 seconds (Fig. 8) where the vehicle has left of the stopped condition until the speed of 44 Km/h, the peaks of rotation indicate the points where the driver exchange the gear.

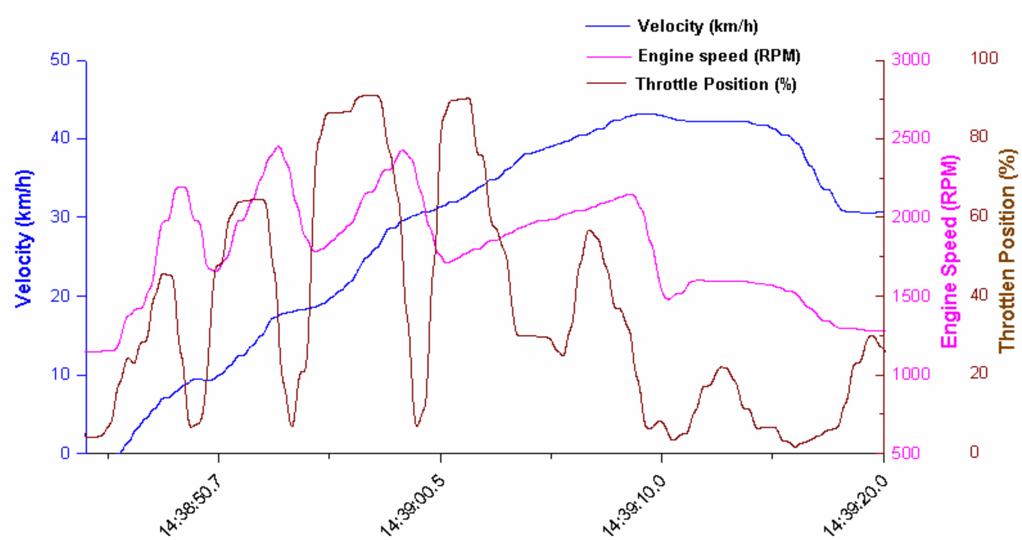

Figure 9. Graphical of acceleration of the vehicle of converted urban transport it stops use of GNV during field tests.

Also, with the on-board instrumentation system it was possible to register the temperatures of the environment, the liquid of cooling of the engine, of oil in carter (Fig. 10). These registers are typical of a complete test and, had been carried through in a passage of commercial line that was operating with passengers.

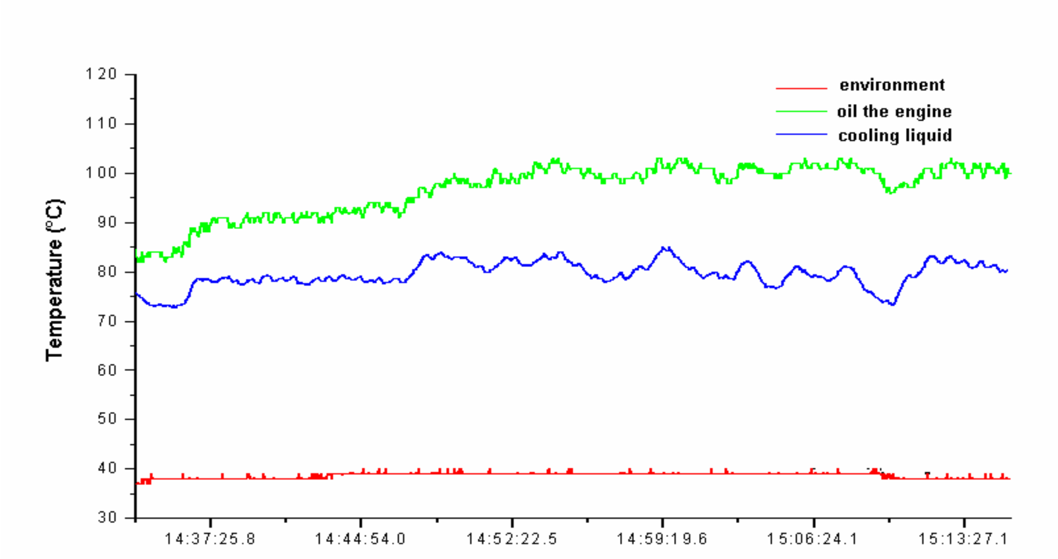

Figure 10. Graphical typical of temperatures of urban transport vehicle converted for GNV registered during field tests.

2.4. Conclusion

With the field tests after installation the instrumentation system showed a good response. In elapsing of the project, the vehicle will be monitored in real conditions of operation passing through in commercial lines inside of the region metropolitan of Porto Alegre.

Through the use of a dynamometer, the curves of torque and power of the used engines will be determined together the analyzer of vehicle pollution emission.

3. Acknowledgements

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5. Responsibility notice

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