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ADAPTATION OF A DIESEL MWM ENGINE, STACIONARY, MODEL 229/4, TO WORK WITH BIOFUEL: DIESEL-NATURAL GAS

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Abstract. *This work is about an adaptation of a Diesel engine MWM, estacionary, model 229/4, installed in Laboratorio de Inovação em Conversão (LI) of UFPB-Campus I, to work in dual way (Diesel-Natural Gas), without modify the original engine structure. For this test, it was installed some devices like a pressure reduction, a mixer stove mouth type and a zero valve to obtain the best performance in the Dual engine work. After installation of all devices, it was made tests in the Diesel engine and in the Dual, evaluating the thermal efficiency, the costs of operation and the emission of particulate (opacity of smoke), comparing the results in both engines.*

Keyword: *Diesel engine, Dual engine, Diesel-Natural Gas*

1. INTRODUCTION

According to Agência Nacional de Energia data, Brazil is among the ten countries that more electricity energy consumption in the world (AIE, *apud* FERNADES, 2012). Among the factors that contribute to the electricity energy consumption be in the current level can be found the population and industrial growing, increase of the home appliance sales, etc. The industrial sector is where can be found the major electricity energy consumption in the country, this way, this is the main sector affected by energy supply problems, suffering financial losses due production decrease and higher prices of the electricity rates (MME, 2017). To reduce costs and assure the electricity energy supply in the time that rates are more expansive, the industries used to use a generator set fired by Diesel engines. Those engines, however, can contaminate the environment due the great quantities of emissions of the particulates material and sulfur compounds in its exhausted gases.

In this context, this work has as main goal, adapt a Diesel MWM engine, stationary, model 229/4 to play in a Dual form (Diesel-Natural Gas), without change its original structure, and compare the thermal efficiency, the operational costs e the particulate emission (opacity of smoke) of the engine this two configurations.

2. METHODOLOGY

In the making for Diesel engine conversion to Dual, it was necessary some adaptations as: an installation of pressure reduction, a zero valve and a mixer stove mouth type. After those adaptations, it was made tests, that was developed in Laboratório de Inovação em Conversão Térmica (LI) on UFPB-Campus I, to Diesel engine and after to Dual engine. In this topic will be explain whole procedures in a detail form.

2.1 Generator set used in the Conversion

The generator set used in this work, see Figure 1, is compound by a stationary Diesel engine from MWM brand, direct fuel injection, model D229-4, aspirated type, with full displacement of 3.92 liters; compression rates 17:1 and rated power 60 hp (44,13 kW) at 1800 rpm. The generator is from Bambozzi brand, three-phase, model 46151/07, with rated power of 36 kVA at 1800 rpm with a frequency of 60 Hz.

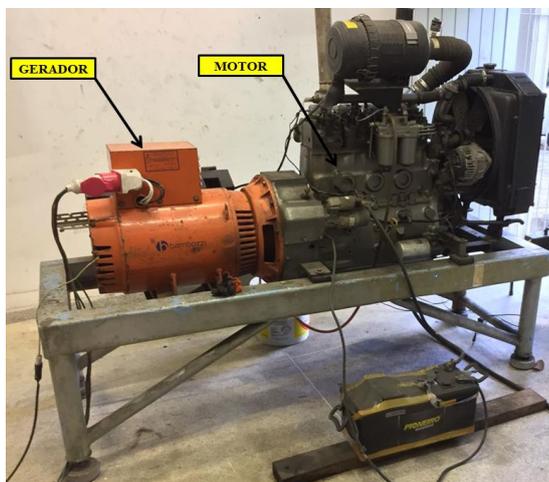


Figure 1: Generator set used in this work

2.2 Pressure Reduction Installation

The natural gas line, coming from Companhia Paraibana de Gás (PBGÁS), existent at LI is submitted to a pressure of 2 bar. It was needed the installation of a pressure redactor, for the natural gas coming to the intake collector with a lower pressure, making possible the control of the gas flow to the intake collector through a zero valve, see Figure 2.

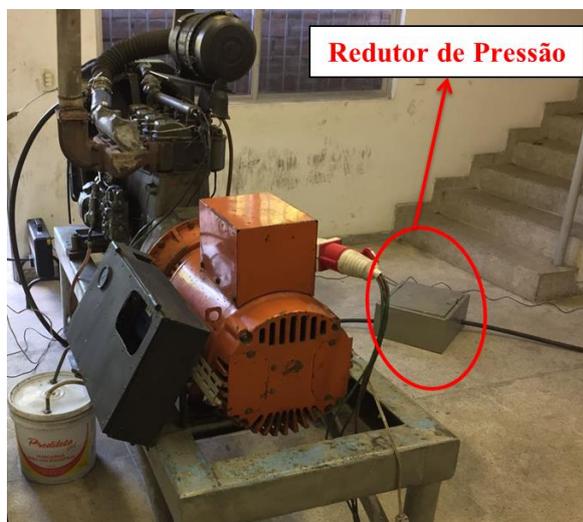


Figura 2: Redutor de pressão instalado na linha de gás natural

2.3 Intallation of the Zero Valve and Stove Mouth Mixed Type

After the pressure redactor, in order to control the natural gas flow to into intake collector of the engine, it was necessary to install a manual zero valve, see Figure 3. Right after the valve, it was installed the stove mouth mixed type, in the pipe that links the air filter to the intake collector, which is a device used to promote a more homogeneous mix among the fluids, in this case the air/natural gas mix.

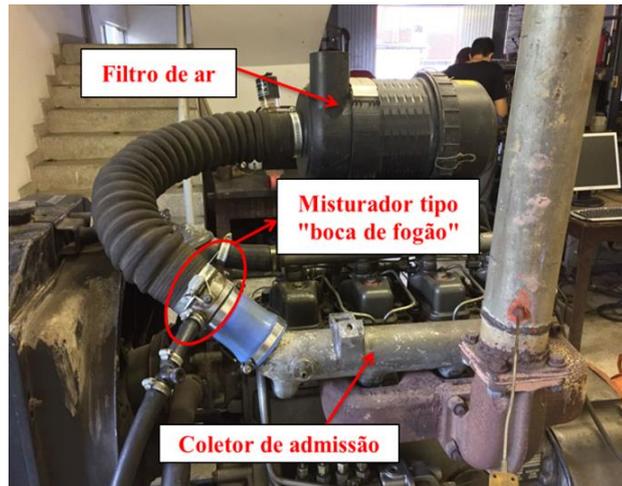


Figure 3: Zero Valve and Stove Mouth Mixer Type

2.4. Tests

Initially it was made tests with the engine in the Diesel configuration and following that in the Dual form. To both configurations, it was checked the generated power using the electricity energy generator linked to a resistor bank of a resistor cargo simulator, where it is possible to increase and decrease the charge through a control panel, see Figure 4a and 4b. It was also gathering data to the consumption and smoke opacity.



Figure 4: a) Control Panel and Resistor Bank Of The Charge Simulator b) Generator

In the tests, it was varied the charge from 10 kW until the max power reached by the engine, with increments of 5 kW.

3. PRELIMINARY RESULTS

After the experimental phase, it was possible to make some graphics comparing the performance between the Diesel engine and Dual engine.

In Figure 5 are shown the curves of thermal efficiency on dependence of the Diesel engine power to the Dual engine.

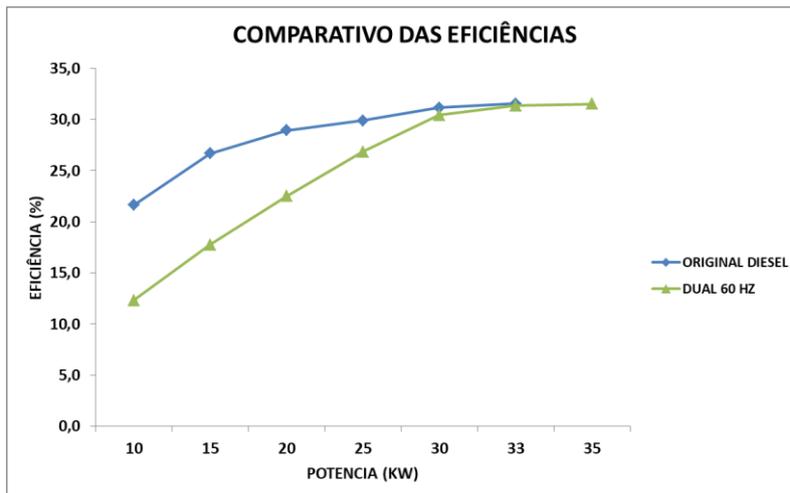


Figure 5: Curves of power on dependence of thermal efficiency, made from the original engine, Diesel and Dual

Another factor analyzed it was the costs of engine operational. In the Figure 6, can be seeing the rates of the operational costs of the Dual and original engines, operating in similar conditions.

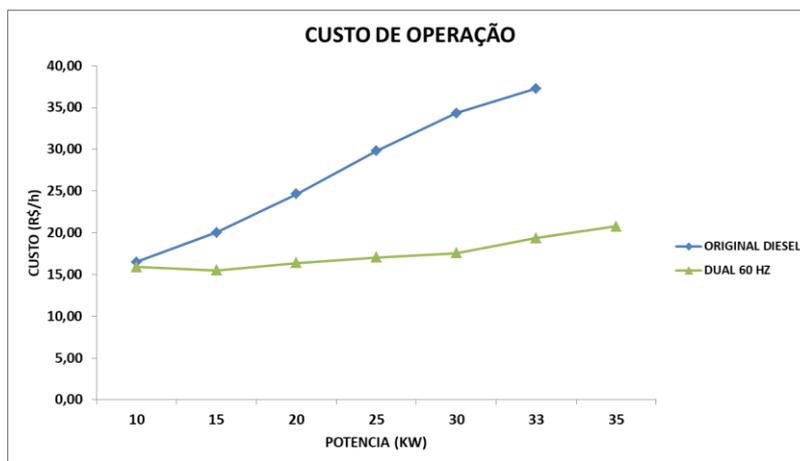


Figure 6: Curves of operational costs on dependence of power, made from the original engine, Diesel and Dual

The last factor analyzed it was the particulated emissions (smoke opacity). The Figure 7 shown the particulated emissions to each power, in both engines, Dual and original.

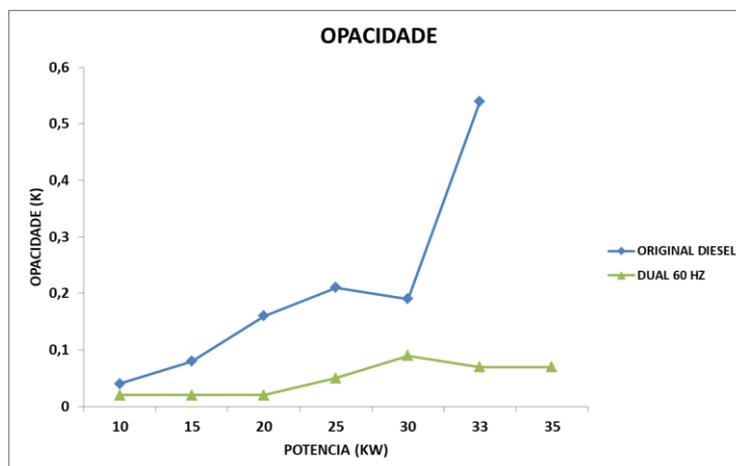


Figure 7: Smoke opacity curves to Dual and original engines.

4. CONCLUSIONS

The engine, in its original Diesel configuration and Dual, had its performance evaluated, about efficiency, operational costs and particulated emission. This evaluation take some conclusions.

The Diesel engine keeps itself more efficient in all rates of power, however, to the Dual engine, can be reached a power of 35 kW (47.58 hp), while the Diesel engine reached only 33 kW (44.87 hp), that is, result in a gain of power of 5.7%.

Taking in account the market prices to the local market, to Diesel and Natural Gas, the dual engine is economically more feasible than a Diesel engine. This economy decrease the operational costs until 17.92 R\$/h. This way, there is a percentage variable from 3.49% until 48.77%, depending on the applied charge.

The conversion of the Diesel engine to Dual provided a significant reduction in the particulated emission (smoke opacity). The major record of opacity to a Diesel engine it was $0.5 \text{ m}^{-1} (\text{K})$, while in the Dual engineit was $0.09 \text{ m}^{-1} (\text{K})$. This results assure that the working of the engine between the limits established by CONAMA 8/93 resolution, which is $0.83 \text{ m}^{-1} (\text{K})$ to natural aspired engines.

REFERENCES

Fernandes, D., 2012. “Brasil é 10º maior consumidor mundial de energia elétrica”. BBC. 21 Apr. 2018 <<http://www.bbc.com/portuguese/institutional-36202452>>

M.M.E., 2017. “Balanço Energético Nacional”. Empresa de Pesquisa Energética – EPE.