

Analysis of Compromising Degree of an Internal Combustion Engine Using Biodiesel

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ABSTRACT

This work intends to present a study about the application of a standard methodology for the evaluation of the mechanical components compromise as result of the use of biodiesel, based on the lubricating oil analyses. The fuel oil that will be analyzed is produced in PUCRS' Faculty of Chemistry. As we know, the physical-chemical analysis of lubricating oils can indicate a series of parameters that allow valuing the quality and the compromising degree of the mechanical engine components. The results of these analyses will be based on tests in an Electronic Microscopy. This type of analysis will allow us to determine the quality of the lubricating oil, degradation and contamination with metal materials (mechanical compromising). The work presupposes the functioning of Diesel engine cycle with several proportions of biodiesel (B2, B5, B10, B20 and B100). The test cell is based on the analysis and evaluation of the gaseous emissions levels in the unloading, through gases analyzer and evaluation of fuel consumption with the different proportions of biodiesel added to the diesel fuel. All these tests are comparative, being the standard of reference the data obtained from the use of pure diesel fuel in tests with the engine test stand.

INTRODUCTION

Observing the environmental problems caused by the mankind irrational use of energy for centuries, the world is passing through an adaption using new energy alternatives for everything. The biodiesel is been used to move since combustion engines of buses, trucks and cars until stationary engines. We should remind ourselves that the compression engines were made originally to use bio-fuel.

Biodiesel is becoming important as an alternative renewable and useful, but it must be tested in the engines to give better mechanical performance and better rate of fuel consumption and efficiency.

This project is concerned in analyze what really happens with the mechanical parts of a combustion internal engine using biodiesel. Some characteristics of biodiesel we already know when compared with diesel, like: biodiesel have higher cetane number and lower fuel heating. So, when biodiesel starts being used in a compression engine, it will have power reduction, higher consumption and lower global efficiency. But, if the necessary modifications were made, all these disadvantages can be transformed in advantages and higher performance could be developed. Other problems using biodiesel is the dilution of the lubrication oil and the deposits in fuel pumps. However, it is known that bio-fuels pollute less and they are a good alternative for the

energy crises, added with a better life quality that could be developed (new jobs, lower greenhouse effect). [1]

To test all the parameters which will determinate how the engine must be modified and what parts are more compromised with the use of biodiesel, this paper intends to show a full test cell which will analyze the performance, the consumption, the gaseous emissions and the compromising degree using the electronic microscope. The same engine will be tested with different biodiesel-diesel proportions. Beginning with only diesel – D100 –, then 2% of biodiesel, so 5% until 100% of biodiesel, or as it is known, B100. The oil is produced from waste cooking oil by PUCRS' Chemistry Department.

To compare these results, a vehicle using the same engine type will be used to analyze the lubrication oil and consumption too. That will give us results of a machine, which is used by regular users. So that will help in the final conclusions about how the people accept the biodiesel and, of course, for the future modifications, what will be needed to do in the engines and vehicles.

TESTS PLAN

First of all, the engine will pass through a superficial inspection in the parts which suffer more compromising, like fuel pump, fuel injector tips and retainers.

Dynamometer tests will be applied to create performance curves. The fuel reservoir will be measured before the performance tests begin and after the tests end. With this we will have the consumptions values at the end of each test and the brake specific fuel consumption. During the performance tests will be also measuring and analyzing the emission gases. At last, the lubrication oil will be collected during and at the end of the test to analyze in the microscope the compromising of each engine part.

DYNAMOMETER - Before the test begin the engine must be warmed up until the work temperature, this is a necessary procedure to prevent damage in non lubricated parts which compromises the tests results and the engine itself.

The dynamometer that will be used to determinate torque and power will be Froude type, from MotorPower. It works until 447 kW and 9,000 rpm, it is equipped with an electronic system which collects data and sends to its software that works under Microsoft Windows ambience. The analyzed engine has the following specifications in the Table 1:

Table 1: Engine specifications: 2.8L Diesel

Type	Diesel Cycle
Cylinders	4, in line
Number of main bearing	5
Injection order	1-3-4-2
Bore x Stroke	93 mm x 103 mm
Compression Rate	17.8:1
Displacement	2,800 cm ³
Idling rotation	720-780 rpm
Maximum Power	97 kW @ 3,600 rpm
Maximum Torque	333 N.m @ 1,800 rpm

After the working temperature is reached the test will proceeded by the following sequence:

1. Turn the engine on and let it in idling;
2. Apply charge and check the equipment;
3. Increase the rotation; apply more charge slowly;
4. Increase the charge and accelerate at the same time;
5. Withdraw the charge gradually. Slow down the rotation and close the charge.

The rotation will be increased by 250 rpm until the maximum acceleration, where it has the maximum combustible injection.

EMISSION GASES ANALYZES - Biodiesel is biomass, because of that there is a reduction of almost all greenhouse gases, like SO_x and, considering the life cycle of the plants, CO_x reduction too.

The equipment that will be used is SAGEM – Model 5040, with diesel opacimeter, and it measures the following gases:

- Carbon monoxide in volumetric %;
- Lambda value;
- Oxygen in volumetric %;
- Not burned hydrocarbons in ppm;
- NO_x in ppm;
- Carbon dioxide in volumetric % or k coefficient measure in m⁻¹.

An important factor measured by the diesel exhaust analysis is the k factor. It will determinate how is the mixture working, so it will decide what is the better way for the engine to work. In this test the gases will be analyzed during the entire performance test.

SPECIFIC FUEL CONSUMPTION - These data say important characteristics of a combustible, mainly about the thermal efficiency.

Before and after the dynamometer test the fuel reservoir will be weighed, so the consumption will be measured in combustible mass per time. With this is possible to calculate the brake specific and that will show how more efficient the engine is and how economic the fuel is.

COMPROMISING DEGREE ANALYZES WITH MICROSCOPE - Studies have shown biodiesel benefits in lubrication of fuel pumps and in all engine wear, but it creates deposits in fuel injector tips and piston rings.

The lubrication oil analysis is a well-know technique that allows monitoring how mechanical parts are suffering degradation and the amount of degradation. When the lubrication oil is collected, first of all, its conditions are analyzed to determinate the presence of contaminants and its physical-chemical properties. These analyses allow identifying and making the necessities improvements in general engine conditions of use.

To check which parts suffer more when biodiesel is used, it will be used the electronic microscope that determinates the contaminants and analyzes the parts.