# ANALYSIS OF FUEL CONSUMPTION IN PUMP USING MIXED-DIESEL BIODIESEL

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***Abstract.*** *In agriculture areas the diesel cycle motors enable activities such as centrifugal pump actuation in places where there is availability of other energy sources. At the present study it has been produced biodiesel from soybean, coconut and passion fruit oil, later these oils are mixed to the diesel S50. Then, the physico-chemical characterization was executed and the following properties from the mixture were verified: kinematic viscosity, specific mass, cloud point and pour point. The determination of the specific mass, in digital densimeter, showed a clear trend of proportional rise to the addition of the biodiesel in the mixture, and yet confirmed the tendency of reducing the specific mass to the rise of temperature. The hourly consumption of the blends was studied when the engine is operated with rotation at 100 rpm intervals. The motor fed with diesel S50, reached 3299 rpm as maximum rotation, and operating with the passion fruit oil, it was registered 3234 rpm at maximum rotation, both remaining between 3200 and 3300 rpm. The specific consumption was reduced in all the mixtures as the motor runned in smaller rotations.*

***Keywords:*** Energy, oil, characterization, speeds, densitometer.

## 1. INTRODUCTION

Some technologies for the production of biodiesel through vegetable oils are well known, and raw materials such as soybean oil and sunflower oil participate at the service of the required demand by ANP, on the percent added to the biodiesel. Nonetheless, it is of great importance the study of alternatives sources to the biodiesel production. Issariyakul & Dalai (2014) performed an extensive review involving raw materials, production technologies and characteristics of biodiesel, and specifically, gave further attention to the vegetable oils that are explored as raw materials to the biodiesel production. At the same opportunity, production technologies were discussed, including newest development of catalysts.

According to Gazzoni et al. (2009) some producers species of oilseed are shown more effective than others, due to factors such as, for example, greater energetic density or least input utilization during its growing. The *Pinhão Manso* is being considered as one of the most promising oil sources to the biodiesel production in Asia, Europe and Africa. This plant can grow under a big variety of climate condition such as heat, low or high rainfall and frost (KARMAKAR ET AL., 2010).

The study of the biodiesel and diesel mixtures indicates acceptable limits as the addition of biodiesel to diesel. Corrêa et al. (2008) studied the use of sunflower biodiesel mixtures (Helianthus annuus L.) and diesel at the behavior of a compression-ignition motor, concluding that the use of mixtures B5, B10, B20 e B100 of ethylic ester in sunflower oil provided a change at the behavior of the motor, with maximum reduction of 2.2% at power and maximum increase of 7.3% at specific consumption.

The biodiesel production process and the chosen mixtures demand cares that reflects at its quality. Therefore, the biodiesel and its respective mixtures to diesel must pass through a series of analysis that attest its aptitude to use.
Physical properties, such as viscosity and specific mass, influence at combustion quality. Undertaken tests in stationary motors may attest the efficiency of used mixtures.
Diesel cycle motors are of great importance for the development of society, and the challenges found from the conception to the improvement of its efficiency are known. The first diesel cycle motor was created by Rudolf Diesel, in Germany, being patented on February 23, 1987 and subsequently presented on 1898, at Paris Global Fair (SOUZA, 2010). Those motors that are destined to the actuation of stationary machines, weld machines, pumps or further uses that requires a constant rotation such as hydraulic pumps, are generally used in access difficult areas to the energy supply, and integrates the present study. Usually, the motor pump set is installed at a near location to the water reservoir avoiding issues at the suction system. For this purpose, the costs to the suitability of the electrical grid can impair the project. An applicable alternative is to actuate the system by a diesel motor that offers mobility and can work in more than one point fulfilled by others reservoirs.

The goal of the present study was to produce the biodiesel from the oil obtained by passion fruit seeds and soybean and coconut commercial oils, prepare mixtures of produced biodiesel and diesel S50, perform the physico-chemical characterization of referred mixtures and use them in intrumented motorpump set, registering the hourly consumption of mixtures.

## 2. Material and Methods

The production of soybean and coconut biodiesel was from the ethyl route, and passionfruit biodiesel was produced by methyl rout 40%V/V according to Tulcan (2009). Part of the process was made with the assistance of ultrasound equipment Cole Parmer, 750 W, that allows its operation in batches up to 250ml, or in continuous flux at $19Lh^{-1}$. At the present study it was opted to work with batches up to 100ml.
The produced biodiesels were mixture to the diesel S50 at proportions of 0%, 25% and 100%. The physico-chemical properties of the mixtures were subsequently characterized using the standards described at Table 1.

Table 1. Studied physico-chemical properties

| Property | Standard |
|---|---|
| Kinematic viscosity | NBR 10441 Petroleum Products – Transparent and Opaque Liquids – Kinematic Viscosity Determination and Dynamic Viscosity Calculation. |
| Specific Mass | ASTM D 4052 Density and Relative Density of liquids by Digital Density meter. |
| Cloud Point | ASTM D2500 Test Method for Cloud Point of Petroleum Products. |
| Flow Point | ASTM D97 Test Method for Pour Point of Petroleum Products. |
| Superior Calorific Power | ASTM D4809 - Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method). |

### 2.1 Procedure to fuel consumption determination

The fuel consumption was studied considering two conditions, in which the first the motor rotation was varied in six ranges of 100 rpm, divided between 2700 and 3300 rpm. The rotation was manually verified with the aid of laser tachometer, label Sinometer, model DT-2234C.

For the motor rotation adjust, the accelerator was positioned at stipulated rotation range by means of attempts. As the first rotation, the maximum, was the motor starter rotation, the following were reached with slights displacements of the screw of the accelerator at downwards direction, where it was made the manual locking of the screw and verified the corresponding rotation with the digital tachometer positioned at the cooling overture (figure 1), targeted at reflexive tape stock at the motor wheel. Figure 2 show the location of the screw of the motor accelerator and figure 3 details the sequence of occupied positions by the accelerator.

Figure 1. Overture for rotation reading with the use of tachometer.

Figure 2. Screw location of motor accelerator

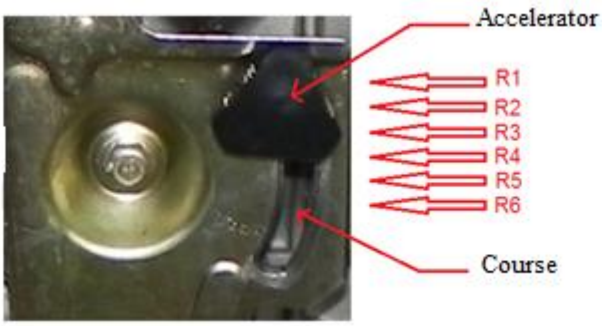


Figure 3. Screw positions and its course.

It was proceeded supplying with fuel the reservoir positioned at a digital balance with precision of two decimal places and free from vibration generated by the motor. Another balance was positioned with another tank with the purpose of collecting and quantifying the biodiesel resumed from combustion.

## 3. RESULTS AND DISCUSSION

### 3.1 Physico-chemical characterization

Kinematic viscosity of the mixtures of biodiesel to diesel S50 remained between the limits established by ANP, and Table 2 shows that the increase of biodiesel percent at the mixture with diesel leads to a rise at the viscosity of the mixture, once the biodiesel is more viscous than the oil diesel used in the present study.

Table 2. Kinematic viscosity of biodiesel/diesel mixtures

| Mixture | Diesel S50 | BioSoybean | Biococonut | BioPassionfruit |
|---|---|---|---|---|
| B0 | 2.545 | // | // | // |
| B25 | // | 3.325 | 2.660 | 3.195 |
| B100 | // | 4.316 | 3.839 | 4.720 |

The measurement of Specific Mass presented a clear tendency of proportional increase to the addition of biodiesel at the mixture, as shown in Table 3.

Table 3. Specific mass in $kg.m^{-3}$ at 20°C.

| Samples | Diesel S50 | BioSoybean | BioCoconut | BioPassionfruit |
|---|---|---|---|---|
| B0 | 832.166 | // | // | // |
| B25 | // | 842.028 | 840.061 | 844.381 |
| B100 | // | 879.836 | 866.911 | 884.619 |

At tables 4 and 5 it is registered, respectively, the values of Cloud Point and Flow Point. The Cloud Point verified at samples of Diesel S50, -2.7°C, was near to the verified in other works (Sarin, 2009; Tulcan, 2010). The Flow Point from the mixtures kept the expected tendency, being registered differences inferior to 10.5°C below the Cloud Point at Mixtures B100.

Table 4. Cloud Point from Mixtures ( ºC).

| Mixture | Diesel - S50 | BioSoybean | BioCoconut | BioPassionfruit |
|---|---|---|---|---|
| B0 | -2.7 | _//_ | _//_ | _//_ |
| B25 | _//_ | 1.2 | 4.0 | -1.0 |
| B50 | _//_ | 1.9 | 4.0 | 1.0 |
| B75 | _//_ | 4.2 | 5.0 | 1.2 |
| B100 | _//_ | 3.7 | 7.2 | 1.4 |

Table 5. Flow Point from Mixtures ( ºC).

| Mixture | Diesel - S50 | BioSoybean | BioCoconut | BioPassionfruit |
|---|---|---|---|---|
| B0 | -6.3 | _//_ | _//_ | _//_ |
| B25 | _//_ | -6.2 | -9.3 | -13.5 |
| B50 | _//_ | -3.8 | -8 | -7.9 |
| B75 | _//_ | -5.6 | -8 | -7.4 |
| B100 | _//_ | -6.2 | -3.3 | -6.8 |

The expanded uncertainty of measurements are: density = ± 0.00008 kg/L; viscosity = ± 0.006 $mm^2/s$; cloud point = ± 1.5°C and pour point = ± 1.8°C (Santo Filho. 2010; Abreu. 2010).

### 3.2 Hourly consumption variation from mixtures of biodiesel with diesel, and Diesel S50, in different rotations.

The previous establishment of the breaks allowed the reaching of coherent values, since due to the limitations at measurement structure and the nature of diesel motors, it was not possible to fix exact values of rotation for each test. At figure 5 it is found the consumption curves of mixtures B25 and Diesel S50. It is seen that Mixture B25 BioSoybean showed values of hourly consumption between 3200 and 3300 rpm similar to diesel S50.

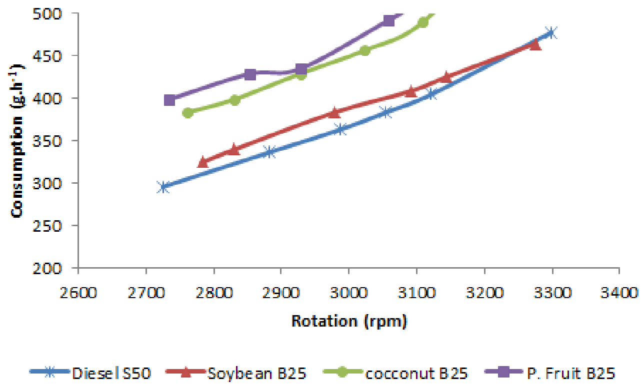


Figure 5. Consumption curves of mixtures B25 and Diesel S50

However, for mixtures of biodiesel B100, it was verified values of hourly consumption higher to diesel S50 for all biodiesels. For soybean biodiesel, at range between 2700 and 2800 rpm, this difference was around 60% (figure 6).

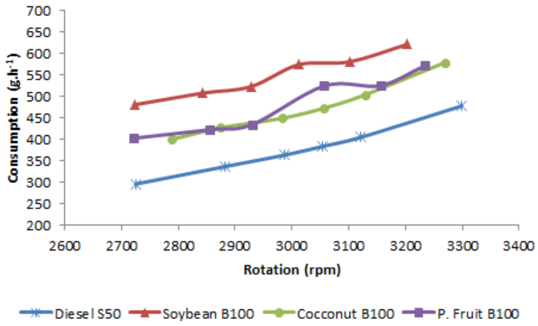


Figure 6. Consumption curves of mixtures B100 and Diesel S50.

## 4. Conclusion

The values of physico-chemical properties of the proposed mixtures for the soybean, coconut and passionfruit biodiesel were found within the established limits by ANP.

The Soybean Biodiesel at proportion of 25% presents values of hourly consumption close to Diesel S50 at different rotations studied.

The biodiesel B100 showed raised hourly consumption for the three raw materials studied.

## 5. Acknowledgment

The author Roberto G. Pereira is grateful to the National Research Council of Brazil, CNPq, for the financial support received.

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