# Soy oil as fuel in a four stroke engine

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*Abstract:* - Due to the fact that petroleum is decreased in nowadays and also the fact that the environment sustains a lot of damage, it is necessary to be replaced by renewable fuels that can be used in the engines and are friendlily to the environment. This paper examines the use of diesel-sun oil mixtures in Diesel four-stroke engine. The mixtures used are the following: diesel-5% soy oil, diesel-10% soy oil, diesel-20% soy oil oil, diesel-30% soy oil, diesel-40% soy oil, diesel-50% soy oil. For those mixtures the gas emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen monoxide (NO) are being measured and the fuel consumption is also examined.

*Key-Words:* - Gas emissions, Soy oil fuel, Biofuels

## 1 Introduction

One of the problems that air pollution causes in human health is emphysema and asthma. Another problem is the damage to the environment in general (vegetation, trees, plants). It can also damage the buildings, especially the marble monuments. The pollution of the atmosphere it is a global problem that concerns all the humanity and it leads to many global problems such as the greenhouse effect and the protective ozone layer depletion in the stratosphere[1,2,3].

Road traffic is one of the main factor that cause air pollution. The main pollutants from car emissions are carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulate matter. When carbon monoxide is present in the lungs, displaces oxygen from hemoglobin and reduces the amount of oxygen that can be delivered to the tissues. Unburned hydrocarbons that are produced from incomplete combustion of the fuel can cause cancer to humans and they also have the role of precursors of photochemical ozone. The pollutants nitrogen oxides are nitrogen oxide (NO) and nitrogen dioxide (NO2)[4,5,6]. Exposure to oxides of nitrogen includes human respiratory problems and damages to plants. Nitrogen dioxide takes part in photochemical smog reactions and when is oxidized to nitric acid contributes to acid rain formation[7,8] .

There are a number of parameters that effect the vehicle exhaust emissions, such as the fuel and air mixing, the temperature of combustion and the time available for combustion in the engine. Also the fuel that is used to power the engine influences emissions[9,10]. When alternative fuels are used instead of the usual petroleum-based fuels, the vehicular emissions are reduced. Using renewable fuels, such as biofuels, there is also a reduction of carbon dioxide ($CO_2$) in the atmosphere. Carbon dioxide is non-toxic but contributes to the greenhouse effect[11,12,13,14]. One of the advantages of biofuel is that decreases emissions when it is used as it is renewable. As a result biofuel is friendly to the environment when it is used as a fuel instead of petroleum[15,16,17,18].

Biofuels are the fuels that are being produced from biomass. They can replace conventional fuels, completely or partially, in the internal combustion engines.[19,20,21] This paper deals with the use soy oil as fuel in a four stroke diesel engine.

The major issue is how a four-stroke diesel engine behaves on the side of pollutants and operation, when it uses mixed fuel of diesel -soy oil.

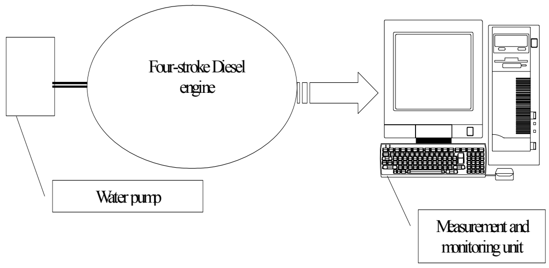
## 2 Instrumentation and experimental results

In the experiment stage has been used directly cotton oil in the mixture of diesel in to a four – stroke Diesel engine. Specifically it has been used Diesel, mixture Diesel-5% soy oil (S5), Diesel-10% soy oil (S10), Diesel-20% soy oil (S20), Diesel-30% soy oil (S30), Diesel-40% soy oil (S40), Diesel-50% soy oil (S50) in a four-stroke diesel engine named Ruggerini type RD-80, volume 377cc, and power 8.2hp/3000rpm, who was connected with a pump of water centrifugal. Measurements were made when the engine was function on 1000, 1500, and 2000rpm.

### 2.1. Experimental measurements

During the experiments, it has been counted:

- The percent of (%) (CO)
- To ppm(parts per million) HC
- To ppm(parts per million) NO
- The percent of smoke
- The supply of water
- Fuel consumption




Picture1. Experimental layout

The measurement of rounds/min of the engine was made by a portable tachometer (Digital photo/contact tachometer) named LTLutron DT-2236. Smoke was measured by a specifically measurement device named SMOKE MODULE EXHAUST GAS ANALYSER MOD 9010/M, which has been connected to a PC unit. The CO and HC emissions have been measured by HORIBA Analyzer MEXA-324 GE. The NO emissions were measured by a Single GAS Analyser SGA92-NO.

### 2.2. Experimental results

The experimental results are shown at the following tables and figures:

| rpm | CO% | | | | | | |
|---|---|---|---|---|---|---|---|
| | Diesel | S5 | S10 | S20 | S30 | S40 | S50 |
| 1000 | 0,056 | 0,063 | 0,056 | 0,052 | 0,062 | 0,069 | 0,072 |
| 1500 | 0,055 | 0,053 | 0,043 | 0,041 | 0,045 | 0,049 | 0,042 |
| 2000 | 0,043 | 0,044 | 0,037 | 0,04 | 0,032 | 0,037 | 0,029 |

**Table 1**. The CO average value variation on different rpm regarding to the mixture.

| rpm | HC(ppm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Diesel | S5 | S10 | S20 | S30 | S40 | S50 |
| 1000 | 31,78 | 21,15 | 21,88 | 8,28 | 5,76 | 54,61 | 28,01 |
| 1500 | 38,00 | 24,30 | 51,65 | 9,16 | 5,80 | 55,53 | 30,04 |
| 2000 | 38,33 | 23,70 | 89,90 | 28,68 | 22,34 | 84,88 | 67,47 |

**Table 2**. The HC average value variation on different rpm regarding to the mixture.

| rpm | NO(ppm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Diesel | S5 | S10 | S20 | S30 | S40 | S50 |
| 1000 | 454,2 | 387,6 | 397,5 | 416,1 | 414,8 | 341,0 | 277,9 |
| 1500 | 715,3 | 739,8 | 743,6 | 720,9 | 758,8 | 718,8 | 651,1 |
| 2000 | 1109,6 | 621,7 | 829,6 | 808,2 | 915,6 | 919,8 | 920,2 |

**Table 3**. The NO average value variation on different rpm regarding to the mixture.

| rpm | %smoke | | | | | | |
|---|---|---|---|---|---|---|---|
| | Diesel | S5 | S10 | S20 | S30 | S40 | S50 |
| 1000 | 9,99 | 8,72 | 9,41 | 11,61 | 14,26 | 18,32 | 24 |
| 1500 | 7,36 | 8,23 | 8,43 | 9,87 | 13,02 | 18,21 | 17,84 |
| 2000 | 6,63 | 6,25 | 7,70 | 8,08 | 11,27 | 17,21 | 20,5 |

**Table 4**. The %smoke average value variation on different rpm regarding to the mixture.

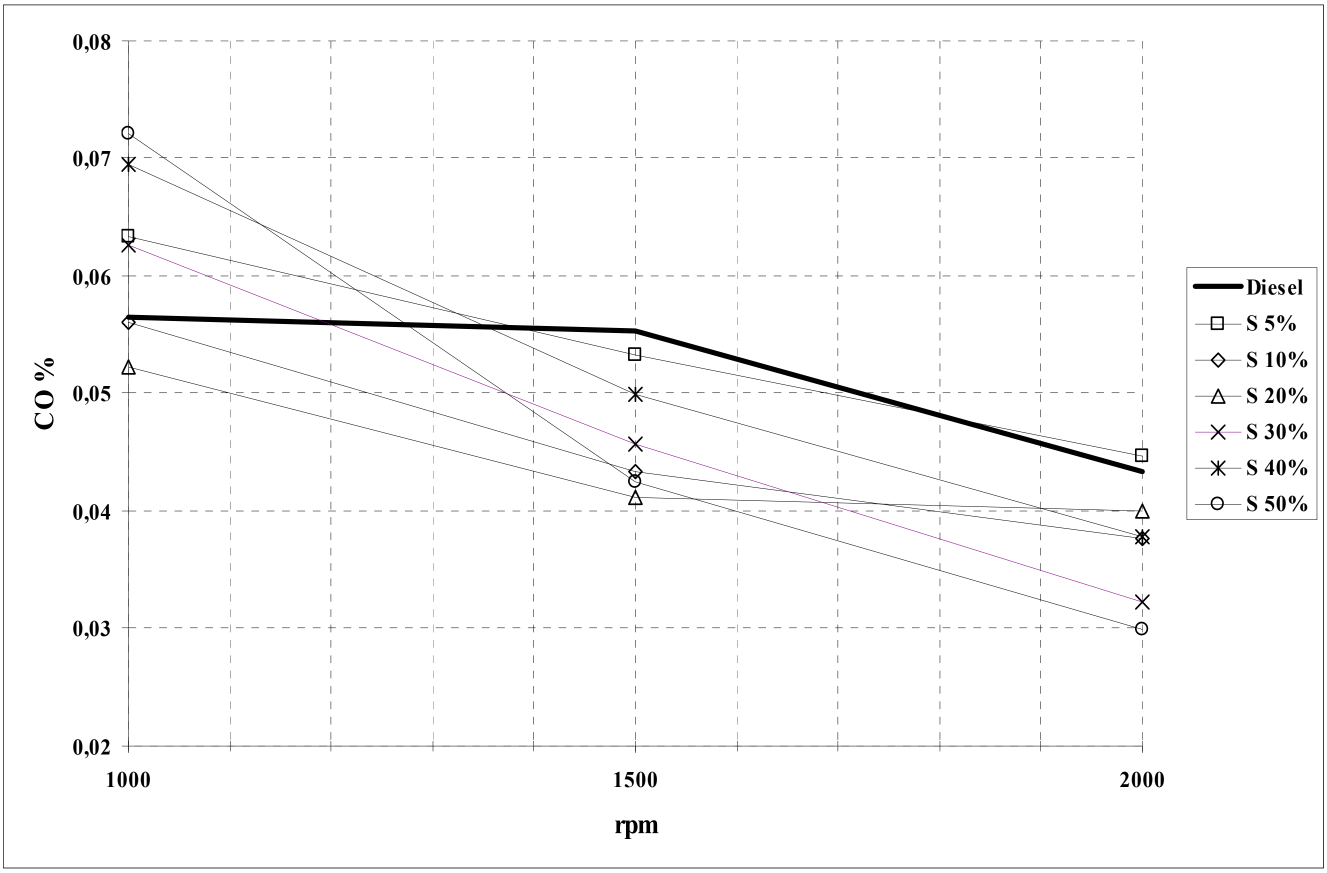



**Figure 1.** The CO variation on different rpm regarding to the mixture

From figure 1 it is clear that when the soy oil is increased on the fuel regarding to diesel, it appears an decrease of CO, except in the cases S5,30,40,50/1000rpm.

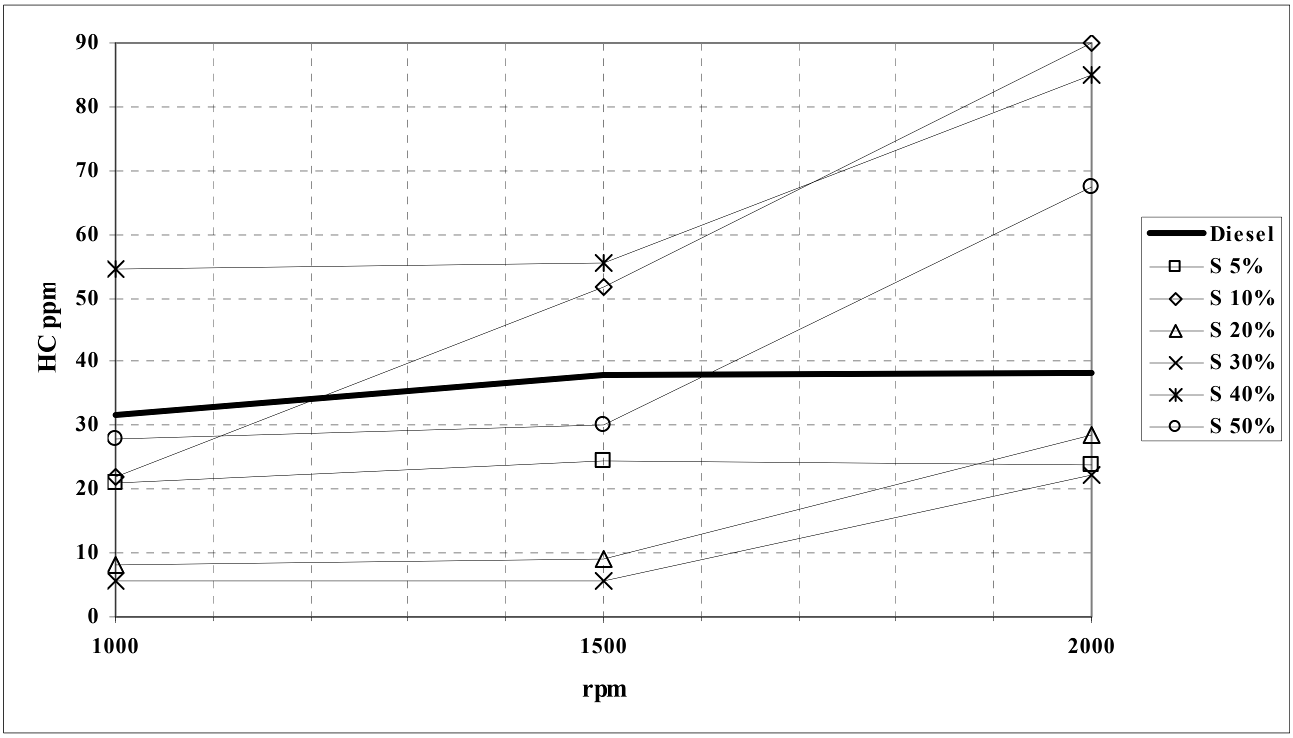



**Figure 2.** The HC variation on different rpm regarding to the mixture

From figure 2 it can be noticed the biggest reduction of HC regarding to diesel in case of the mixtures S5, S20 and the mixture S40.

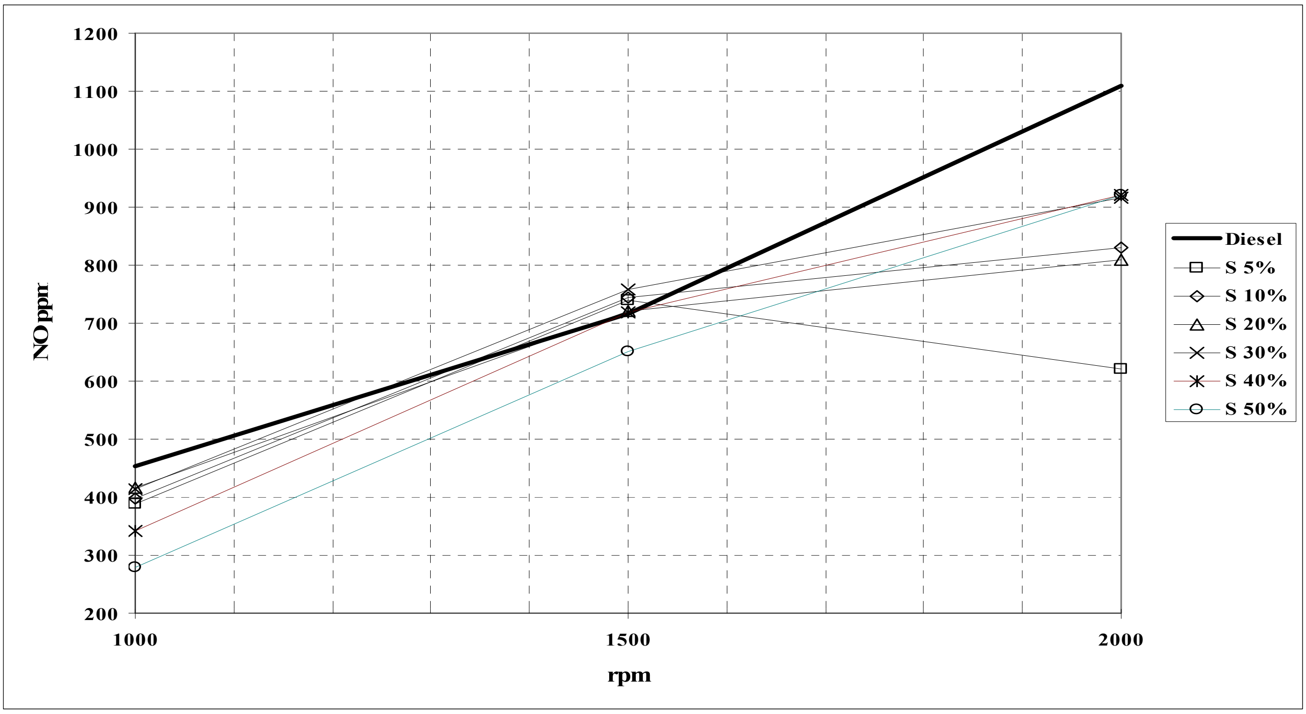



**Figure 3.** The NO variation on different rpm regarding to the mixture

From figure 3 it can be noticed the biggest reduction of NO regarding to Diesel in the case of the mixture S50.

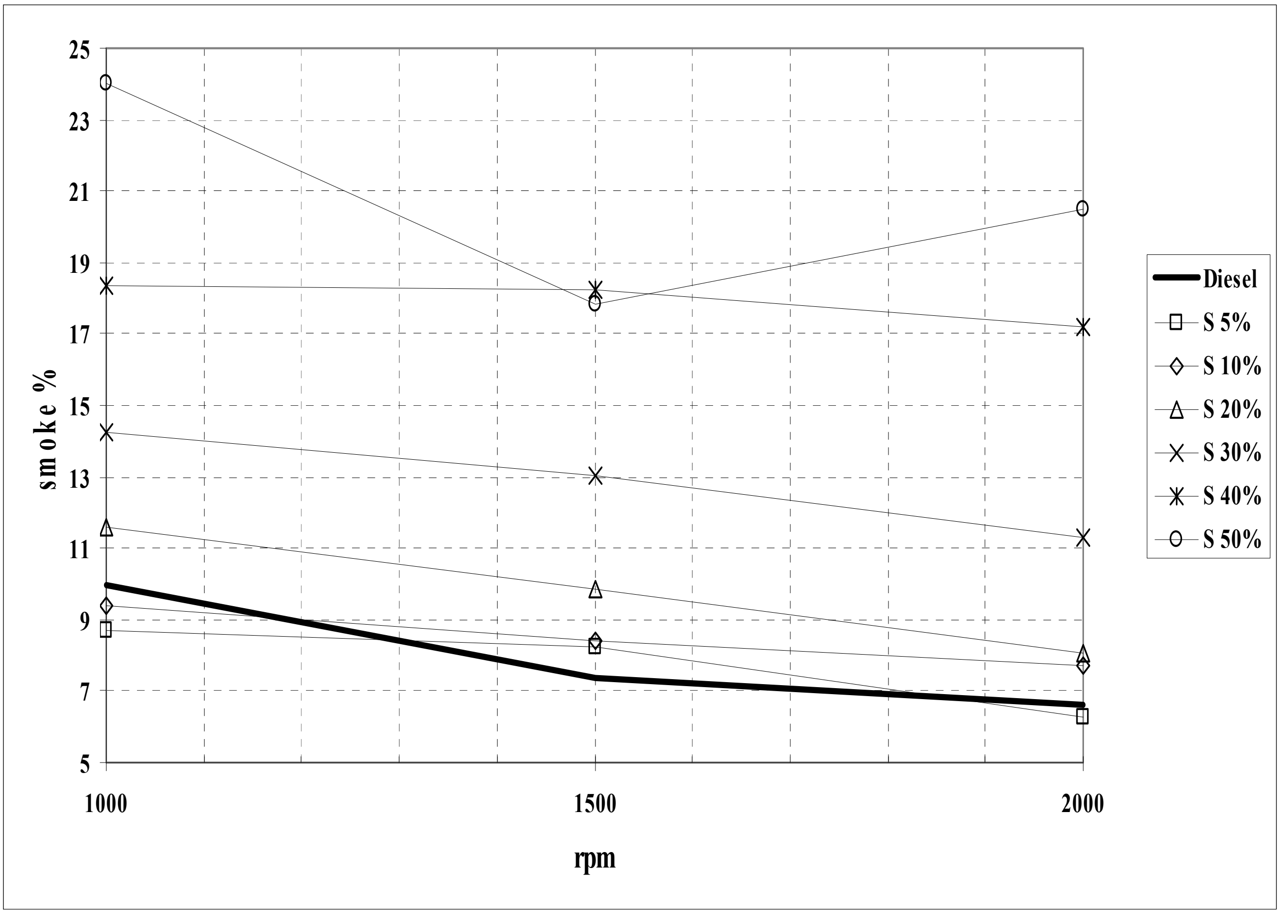



**Figure 4.** The smoke variation on different rpm regarding to the mixture

| rpm | Gas Temperature(ºC) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Diesel | S5 | S10 | S20 | S30 | S40 | S50 |
| 1000 | 102,26 | 100,46 | 82,87 | 107,30 | 88,57 | 108,49 | 108,49 |
| 1500 | 133,48 | 133,62 | 129,20 | 138,37 | 129,36 | 133,74 | 133,74 |
| 2000 | 180,49 | 181,81 | 184,59 | 182,59 | 181,61 | 183,61 | 183,61 |

**Table 5.** The gas variation on different rpm regarding to the mixtures

From figure 4 it can be seen the increase of smoke regarding to diesel for all the mixtures. From the above figures it is clear that the use of different mixtures can constitute changes to CO, HC, NO and smoke too. It is also important the fact that there was no changes in the rounds of the engine, as well as in the supply of water at the use of mixtures.

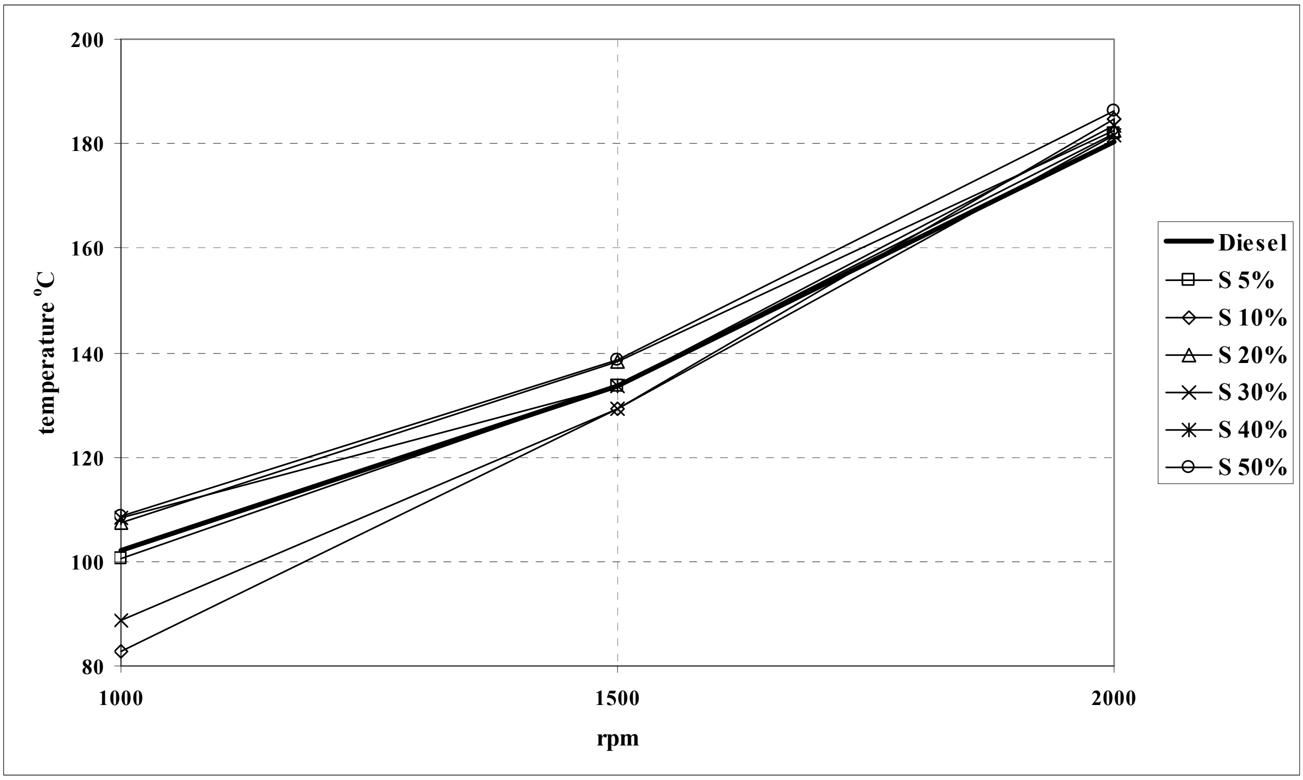



**Figure 5.** The gas temperature variation on different rpm regarding to the mixtures

In Figure 5 is observed that the gas temperature for all the mixtures of soy oil and diesel are almost the same. Their differences are negligible. The lower gas temperature is observed at 1000 rpm, while at 2000 rpm the temperature is higher.

| rpm | Flow($m^3$/sec) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Diesel | S5 | S10 | S20 | S30 | S40 | S50 |
| 1000 | 0,009 | 0,009 | 0,01 | 0,009 | 0,009 | 0,01 | 0,01 |
| 1500 | 0,011 | 0,014 | 0,016 | 0,013 | 0,017 | 0,014 | 0,014 |
| 2000 | 0,018 | 0,019 | 0,019 | 0,018 | 0,018 | 0,016 | 0,019 |

**Table 6.** The water flow variation on different rpm regarding to the mixtures

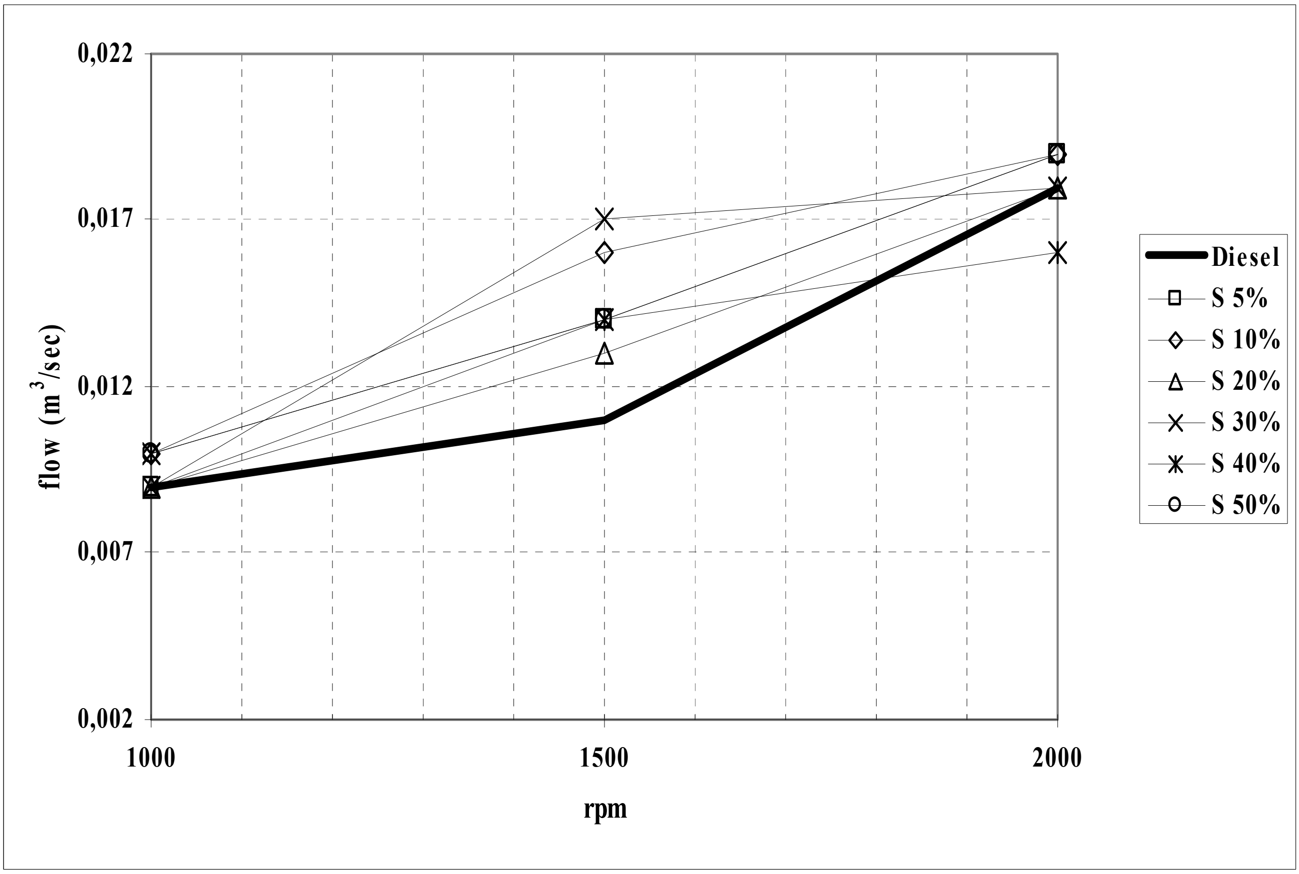



**Figure 6**. The water flow variation on different rpm regarding to the mixtures

In Figure 6 is shown that the water flow doesn't have any difference. As the rpm increases the water flow increases too

| rpm | Fuel consumption(ml/sec) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Diesel | S5 | S10 | S20 | S30 | S40 | S50 |
| 1000 | 0,009 | 0,009 | 0,01 | 0,009 | 0,009 | 0,01 | 0,01 |
| 1500 | 0,011 | 0,014 | 0,016 | 0,013 | 0,017 | 0,014 | 0,014 |
| 2000 | 0,018 | 0,019 | 0,019 | 0,018 | 0,018 | 0,016 | 0,019 |

**Table 7.** The variation of fuel consumption on different rpm regarding to the mixtures

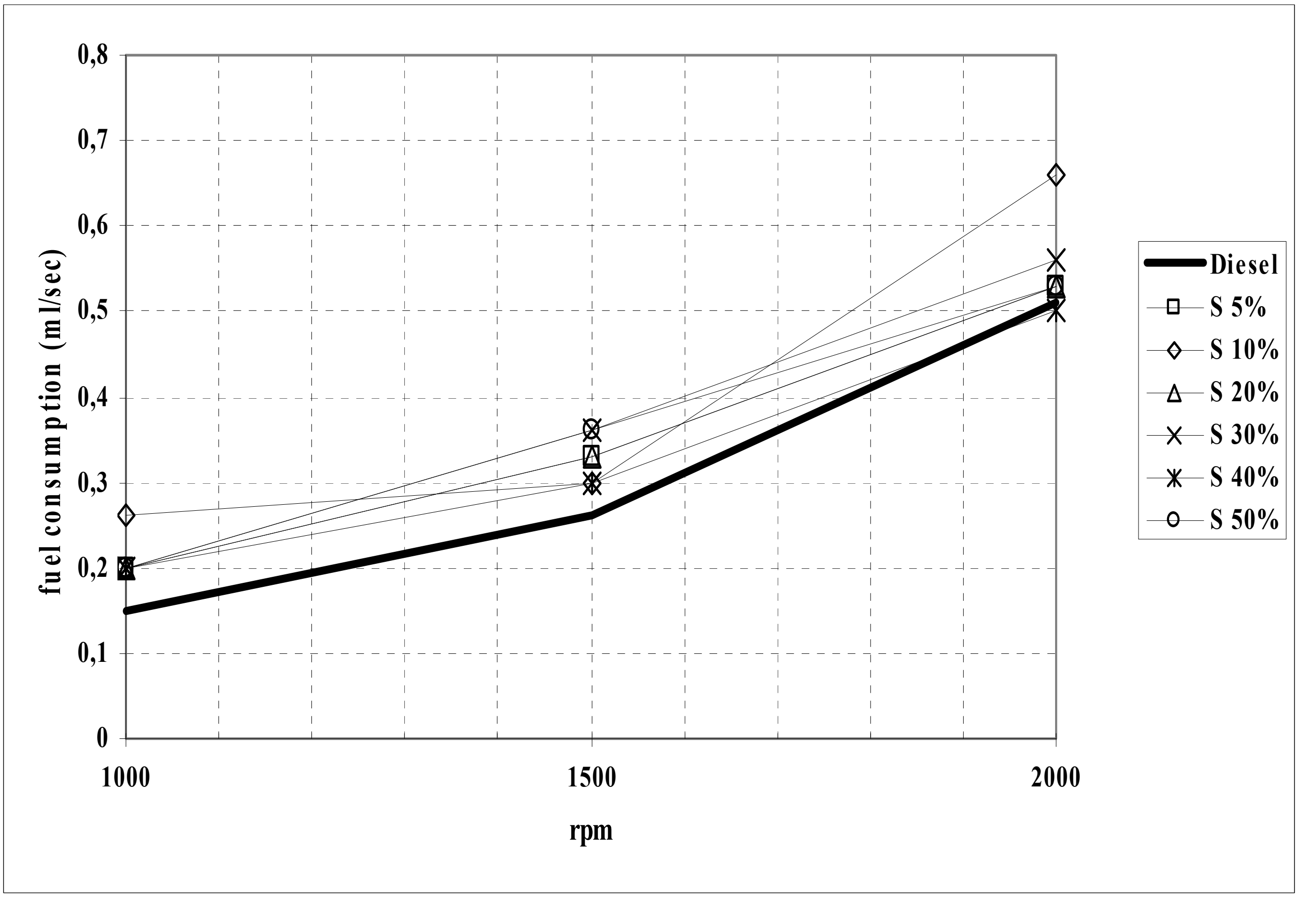



**Figure 7.** The variation of fuel consumption on different rpm regarding to the mixtures

The use of different fuel does not change the fuel consumption. Finally as far as the consumption is concerned, did not observed changes with the use of different mixtures.

# 3 Conclusion

The use of mixture of diesel and soy oil has the following impacts:

- About CO it can be noticed that when the soy oil is increased on the fuel regarding to diesel, it appears an decrease of CO, except in the cases S5,30,40,50/1000rpm.
- About HC it can be noticed the biggest reduction of HC regarding to diesel in case of the mixtures S5, S20 and the mixture S40.In the case of S30 appears the maximum increase of HC in relation to diesel.
- The biggest reduction of NO regarding to Diesel is noticed in the case of the mixture S50.
- The smoke is increased regarding to diesel for all the mixtures. Except the cases S5,50/1000rpm.
- The use of different mixtures of fuel doesn't change the gas temperature.
- Is not observed change in the water flow with the use of different mixtures of fuel, this indicates that there is no change in the engine power with the use of different fuel mixtures.
- Is not observed change of fuel consumption with the use of different fuel.
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