The gas emissions variation when it is used diesel-palm oil mixtures as fuel on different fuel temperatures

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Abstract: - The main aim of this work is to examine the effect of fuel temperature in the gas emissions that is used in a four-stroke diesel engine. The temperatures of fuel that were used are 20^{o}C, 30^{o}C, 40^{o}C, 50^{o}C, 60^{o}C, 70^{o}C and 80^{o}C. The engine was function on 1000rpm, 1500rpm, 2000rpm, 2500rpm, 2000rpm, 1500rpm, 1000rpm(pyramid of rpm) when it used different mixtures of diesel-palm oil as fuel. For those fuel temperatures the gas emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen monoxide (NO) and smoke are being examined.

Key-Words: - Gas emissions, Fuel temperature, Palm oil

1 Introduction

In the past few years it has been observed an increased worldwide interest in biofuel as an alternative source of energy.
Biofuels are fuels that derived from biomass. Biomass is the biodegradable part of products, waste or residues from agricultural, forestry and related industries as well as the biodegradable part of industrial and municipal wastewater. Energy crops are a type of biomass used for energy production [59]. In the category of biofuels are bioethanol, biodiesel or methyl of fatty acids, biogas, biomethanol, synthetic biofuels, i.e. synthetic hydrocarbons or mixtures of synthetic hydrocarbons produced from biomass, biohydrogen, pure vegetable oils and more.
The most popular liquid biofuels in market are biodiesel and bioethanol, which they have replaced partially or whole diesel and petrol [1,2].
In Europe biofuels become to claim the bigger part of fuel market and this is mainly due to the following reasons: Reducing the gas emissions of greenhouse (mainly CO_2) in the transport sector.
In the contribution of achievement the national targets of Kyoto protocol regarding to climate changes and the expected restrictions of emissions of pollutants from the exhaust of car engines[1,3,4].
To ensure fuel supply and reducing imports and dependence on oil producing countries, as the raw materials for biofuels are more evenly distributed, but vary in cost and quality from country to country.
In the creation of new fields of business and commercial activity in an area with large turnover, as it is the fuel sector and their growth in countries and regions that up to today are not related with oil extraction. The rising price of oil makes alternatives economically viable. Finally the uses of biofuels have the potential for a new rural policy and provide new agricultural activities creating new jobs.
The intensification of energy crops that lead to degradation of habitat and biodiversity. An example of biodiesel is palm oil. Palm oil is produced from palm tree Elaeis Guineensis**.** The fruit of the palm is the only one that can lead the preparation of two types of oils – oil from the flesh of the fruit and oil from the fruit kernels. Virgin palm oil is rich in carotenoids (provitamin A) and contains no trans fatty acids. Palm oil is often confused with oil that it is produced from the core of the fruit of the palm, but in reality it composition differs. The color of palm oil is reddish because it contains high percentage of beta carotene. It is used as cooking oil and in the manufacture of margarine as well. It is also used as an ingredient in many processed formulations. After a few minutes of boiling the carotenoids of palm oil are destroyed and its color become white. Palm oil contains high percentage of saturated fat and thus is semi-solid at room temperature[1,2,5,6,7].
In Malaysia at 2008, was cultivated 4.49 million hectares of which produced 17.73 million tons of palm oil and 2.13 million tons of palm kernels, offering in Malaysia 65.19 billion Ringgit (Malaysian currency is 1 Ringgit (RM) = 0,22 €) income from exports. The relevant industry provides

direct and indirect employment to around 860,000 people. The same year Malaysia made 27.75 million tons palm oil exports and related products including 182.108 tons of biodiesel to: USA (71.224 tons), EU (65.681 tons), Singapore (29.485 tons), Romania (3.500 tons), Taiwan (3.000 tons) and Australia (1.200 tons)[1].

The question that arises is how a four-stroke diesel engine behaves on the side of pollutants and operation, when it uses as fuel mixtures diesel-palm oil in different temperatures, functioning the engine in different rounds: 1000 rpm, 1500 rpm, 2000 rpm, 2500 rpm, 2000 rpm, 1500 rpm, 1000 rpm (pyramid of rpm).

2 Instrumentation and experimental results

Specifically it has been used as fuel mixtures of diesel-palm oil (finikelaio) at different temperatures: 10°C, 20°C, 30°C, 40°C, 50°C, 60°C, 70°C, 80 °C in a four-stroke air cooled diesel engine, named Ruggerini type RD-80, volume 377cc with one cylinder and power 8.2hp/3000rpm. The engine was connected with a centrifugal water pump. The fuel diesel that was used had the following characteristics:

Attributes	Min	Max
Density (15°C), kg/m^3	-	845
Point of ignition, °C	55	
CFPP, °C		
From 1/10 until 31/3		-5
From 1/4 until 30/9		5
Water, ppm		200
Hovering particles, mg/kg		24
Anthracites remains, % vol(in remains 10%)		0,30
Ash % vol		0,01
Elements of distillation, % vol		
Distillation in the 250 °C		65
Distillation in the 350 °C	85	
The 95% it has distillated in their °C		360
Viscosity on 40 °C, cst	2	4,5
Sulphur, mg/kg		50
Lubrification, diameter of deterioration of spherule (wsd) on 60°C, μm		460
Corrosion of cupreous lamina, group	1	
Cetane number	51	
Indicator of ketene	46	
Resistance in the oxidation, gr/m^3		25
Polycyclic aromatic hydrocarbons, % vol		11

Table 1. The diesel attributes

The engine was function on 1000 rpm, 1500 rpm, 2000 rpm, 2500 rpm, 2000 rpm, 1500 rpm, 1000 rpm (pyramid of rpm). In every category of rounds the engine remained 60sec, according the figure below:

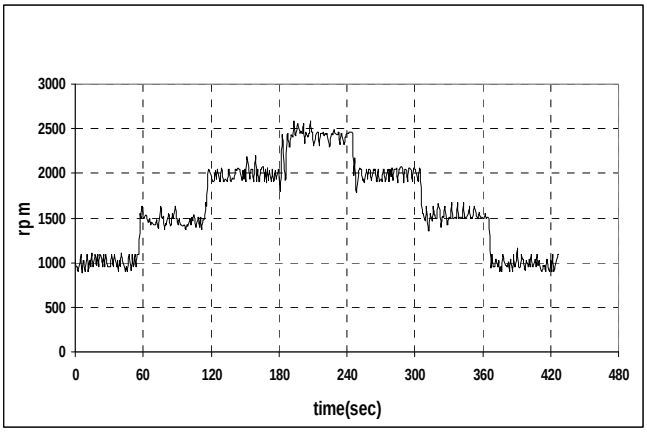
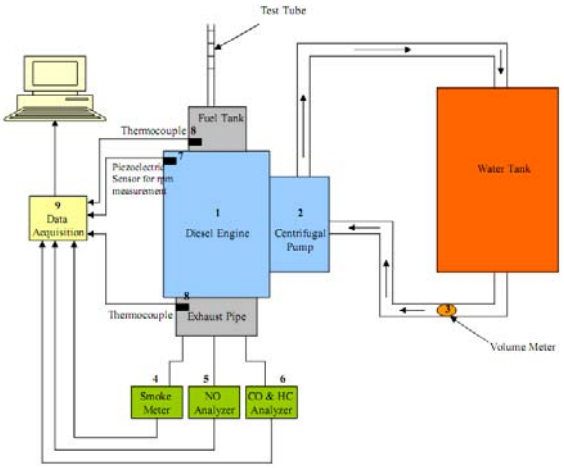


Figure 1. The ´´pyramid´´ rpm

2.1. Experimental measurements

During the experiments, it has been measurement: The CO %, the HC(ppm), the NO(ppm) and the % smoke.



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 ANALYZER 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.

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2.2. Experimental results

The experimental results are shown at the following figures:

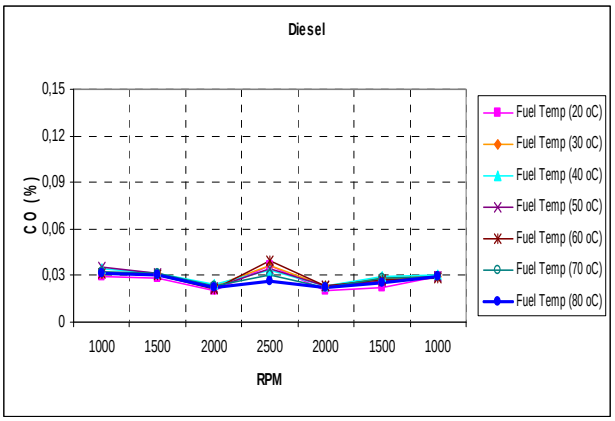

Figure 2. The CO variation used diesel as fuel on different rpm regarding to the fuel temperatures

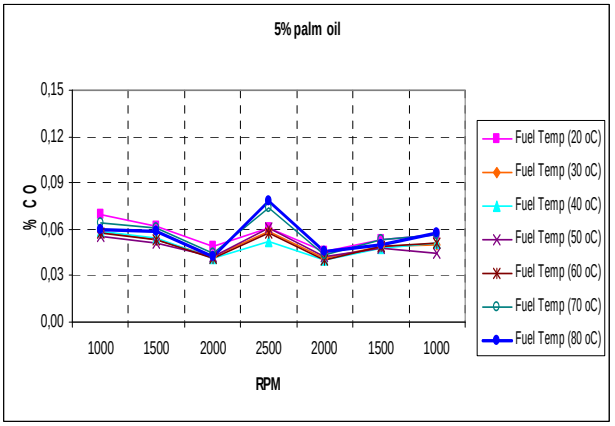

Figure 3. The CO variation used as fuel diesel-5%palm oil on different rpm regarding to the fuel temperatures

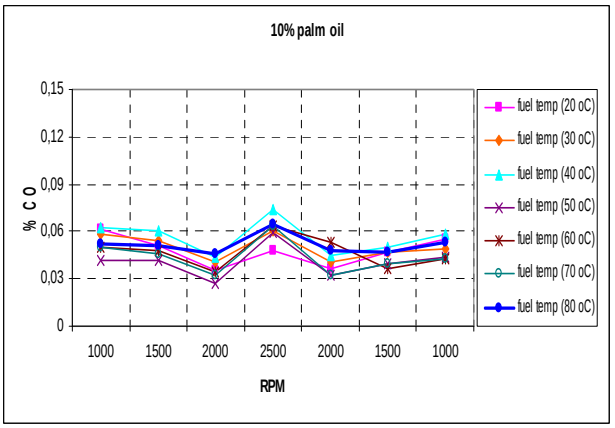

Figure 4. The CO variation used as fuel diesel-10%palm oil on different rpm regarding to the fuel temperatures

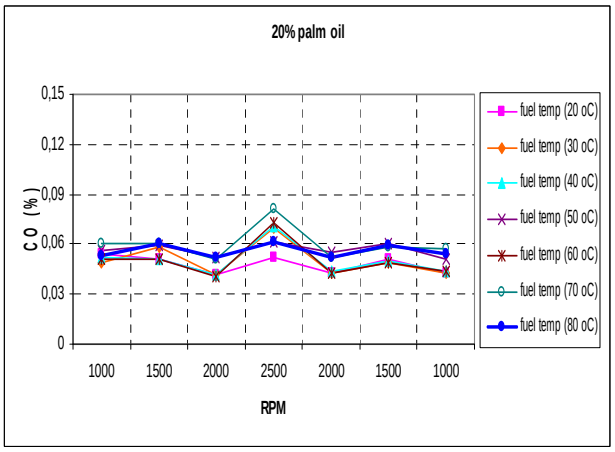

Figure 5. The CO variation used as fuel diesel-20%palm oil on different rpm regarding to the fuel temperatures

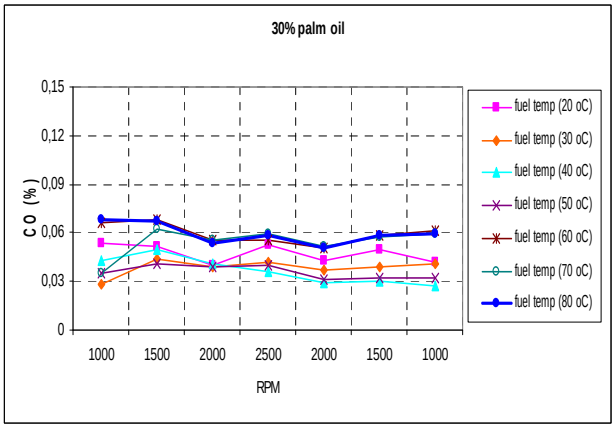

Figure 6. The CO variation used as fuel diesel-30%palm oil on different rpm regarding to the fuel temperatures

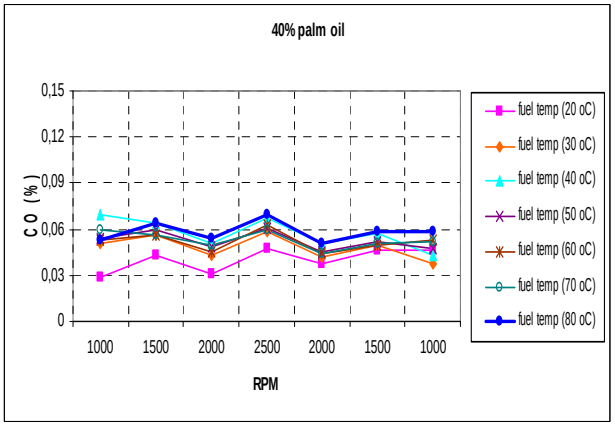

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Figure 7. The CO variation used as fuel diesel-40%palm oil on different rpm regarding to the fuel temperatures

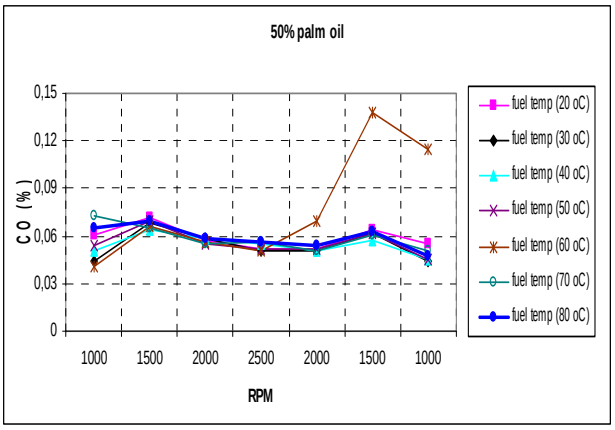

Figure 8. The CO variation used as fuel diesel-50%palm oil on different rpm regarding to the fuel temperatures

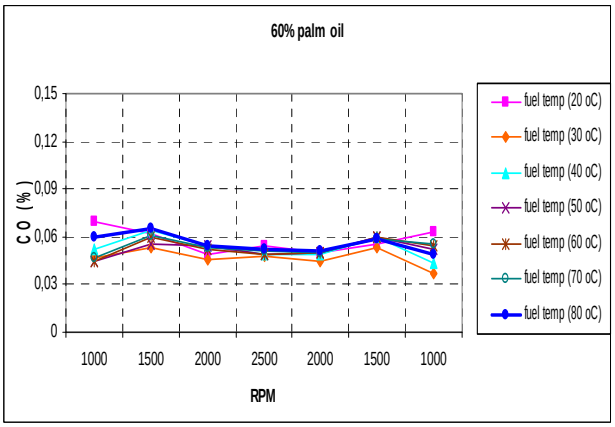

Figure 9. The CO variation used as fuel diesel-60%palm oil on different rpm regarding to the fuel temperatures

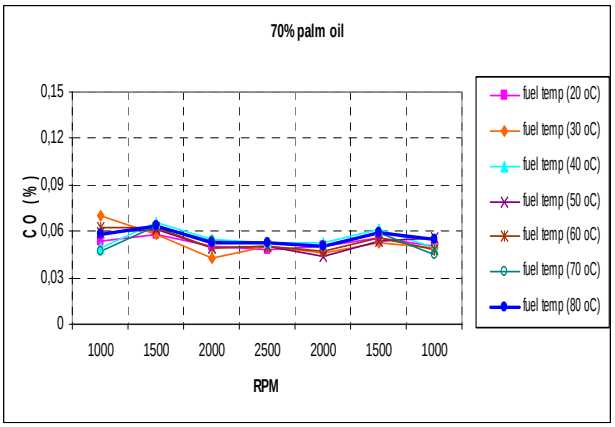

Figure 10. The CO variation used as fuel diesel-70%palm oil on different rpm regarding to the fuel temperatures

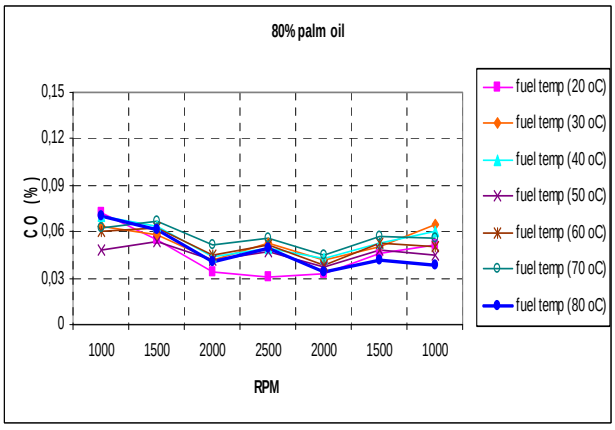

Figure 11. The CO variation used as fuel diesel-80%palm oil on different rpm regarding to the fuel temperatures

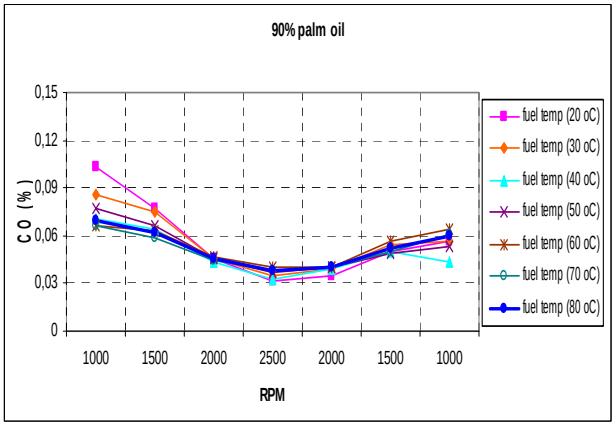

Figure 12. The CO variation used as fuel diesel-90%palm oil on different rpm regarding to the fuel temperatures

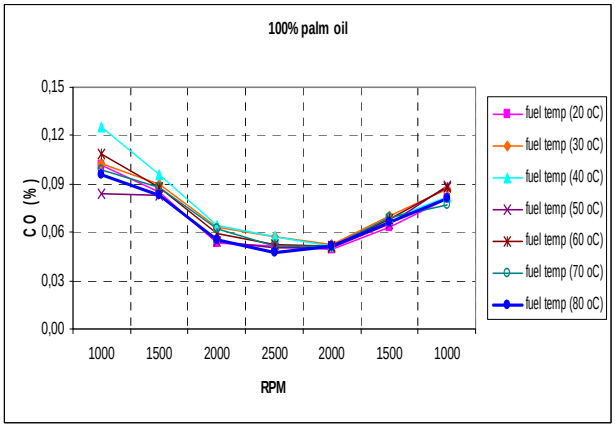

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Figure 13. The CO variation used as fuel 100%palm oil on different rpm regarding to the fuel temperatures

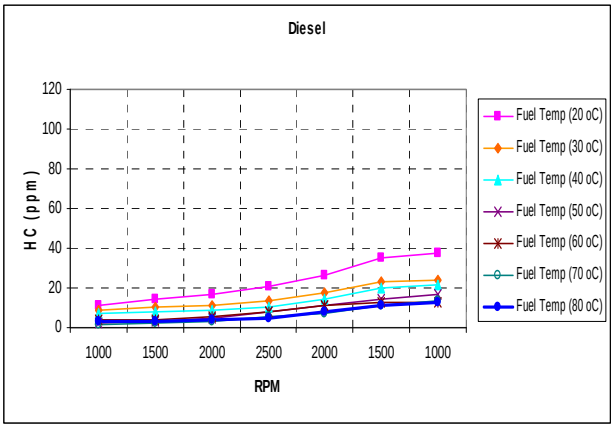

Figure 14. The HC variation used diesel as fuel on different rpm regarding to the fuel temperatures

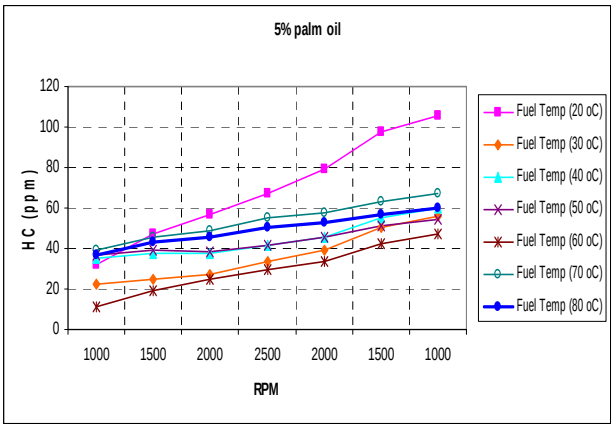

Figure 15. The HC variation used as fuel diesel-5%palm oil on different rpm regarding to the fuel temperatures

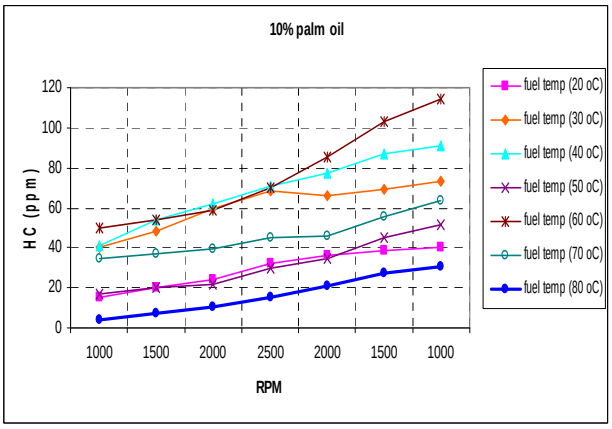

Figure 16. The HC variation used as fuel diesel-10%palm oil on different rpm regarding to the fuel temperatures

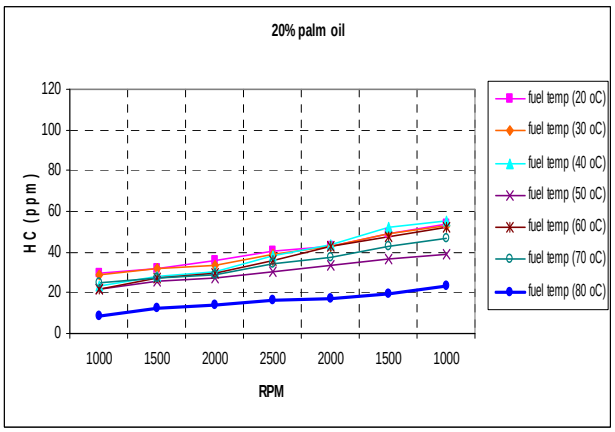

Figure 17. The HC variation used as fuel diesel-20%palm oil on different rpm regarding to the fuel temperatures

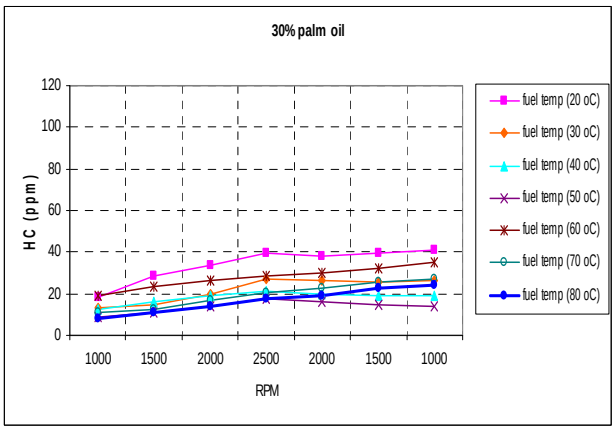

Figure 18. The HC variation used as fuel diesel-30%palm oil on different rpm regarding to the fuel temperatures

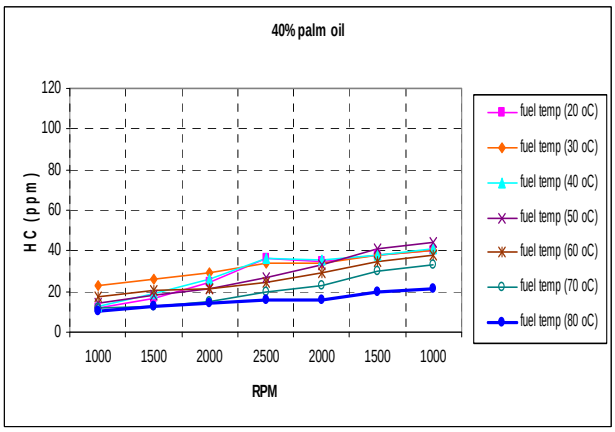

Figure 19. The HC variation used as fuel diesel-40%palm oil on different rpm regarding to the fuel temperatures

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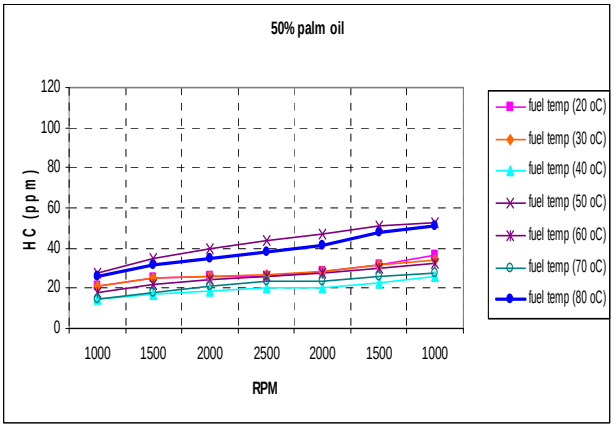

Figure 20. The HC variation used as fuel diesel-50%palm oil on different rpm regarding to the fuel temperatures

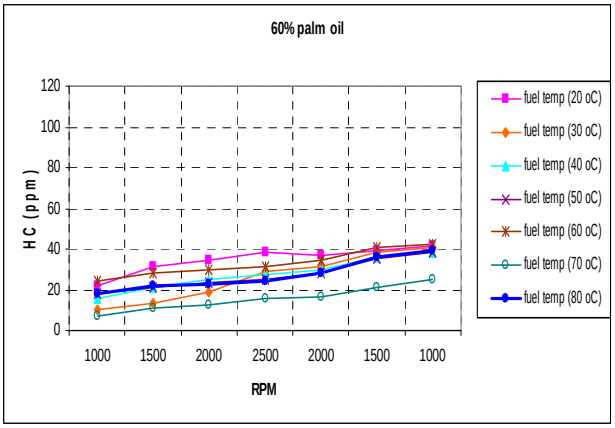

Figure 21. The HC variation used as fuel diesel-60%palm oil on different rpm regarding to the fuel temperatures

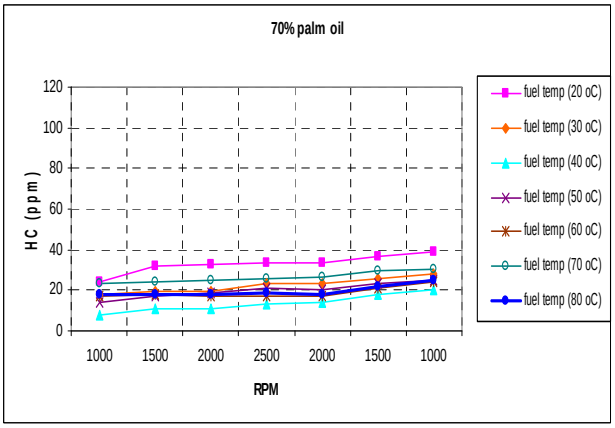

Figure 22. The HC variation used as fuel diesel-70%palm oil on different rpm regarding to the fuel temperatures

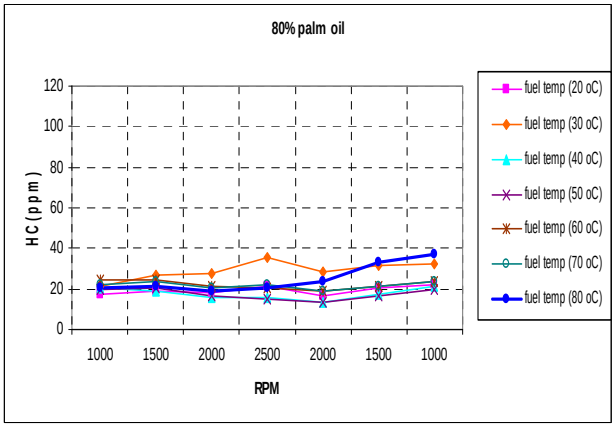

Figure 23. The HC variation used as fuel diesel-80%palm oil on different rpm regarding to the fuel temperatures

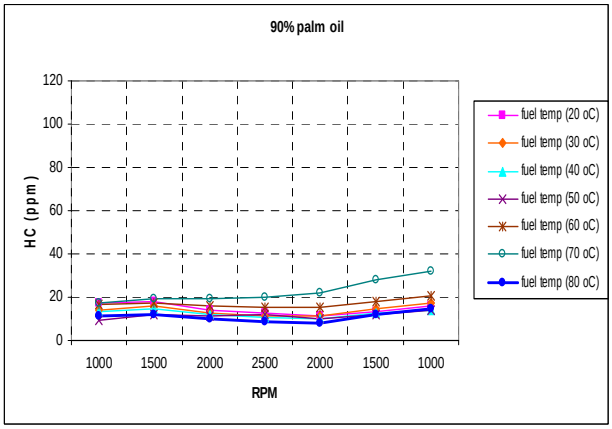

Figure 24. The HC variation used as fuel diesel-90%palm oil on different rpm regarding to the fuel temperatures

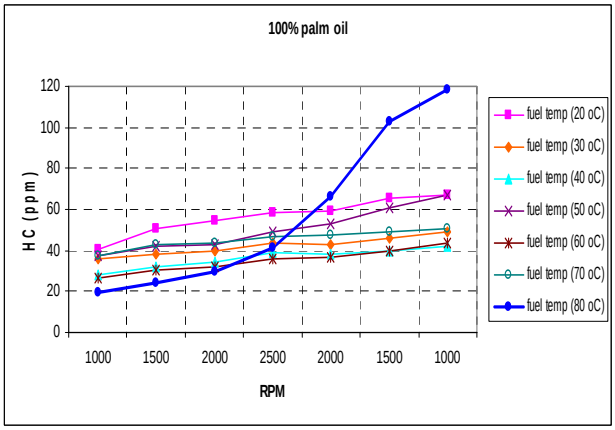

Figure 25. The HC variation used as fuel 100%palm oil on different rpm regarding to the fuel temperatures

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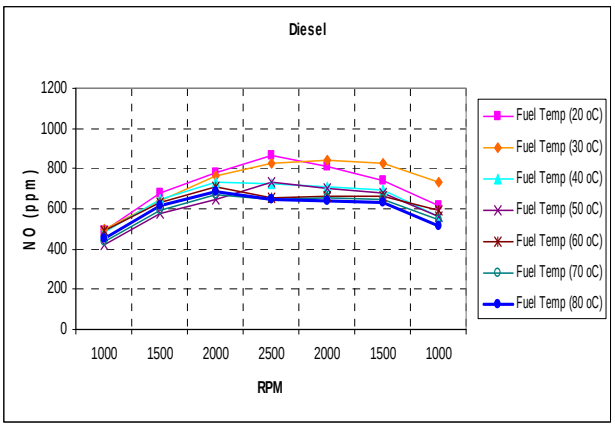

Figure 26. The NO variation used as fuel diesel on different rpm regarding to the fuel temperatures.

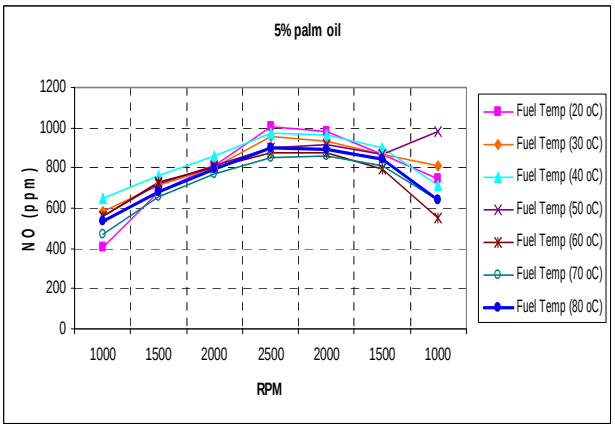

Figure 27. The NO variation used as fuel diesel-5%palm oil on different rpm regarding to the fuel temperatures

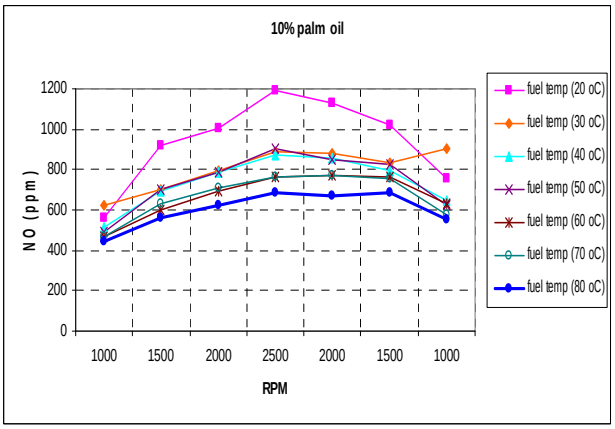

Figure 28. The NO variation used as fuel diesel-10%palm oil on different rpm regarding to the fuel temperatures

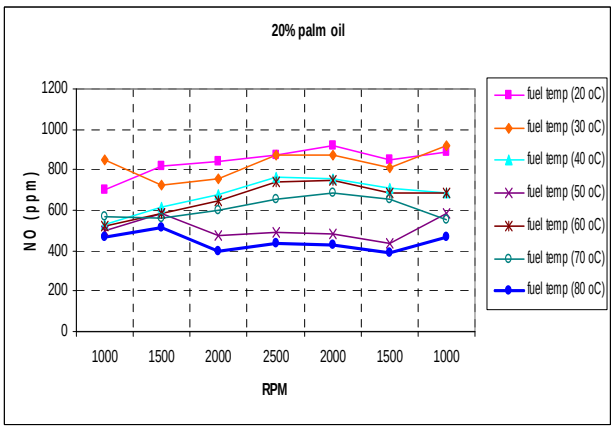

Figure 29. The NO variation used as fuel diesel-20%palm oil on different rpm regarding to the fuel temperatures

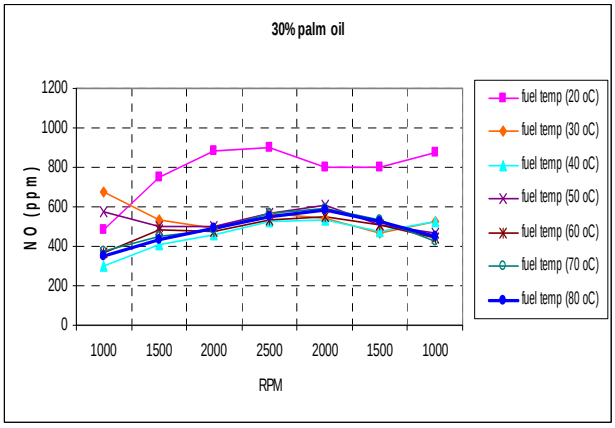

Figure 30. The NO variation used as fuel diesel-30%palm oil on different rpm regarding to the fuel temperatures

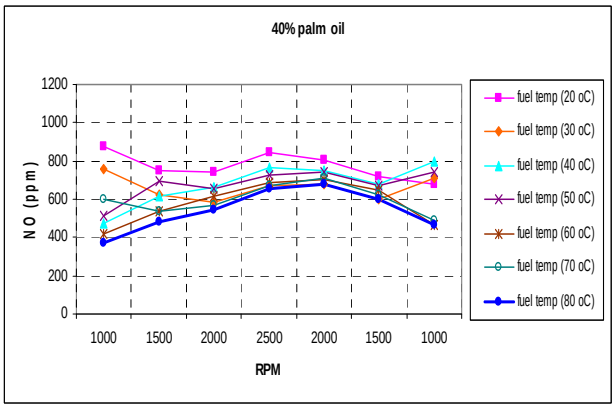

Figure 31. The NO variation used as fuel diesel-40%palm oil on different rpm regarding to the fuel temperatures

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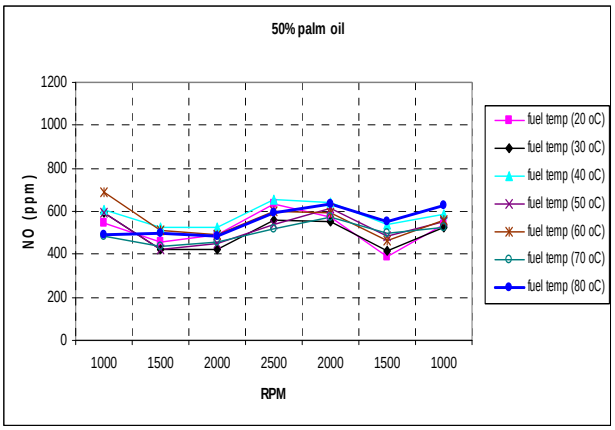

Figure 32. The NO variation used as fuel diesel-50%palm oil on different rpm regarding to the fuel temperatures

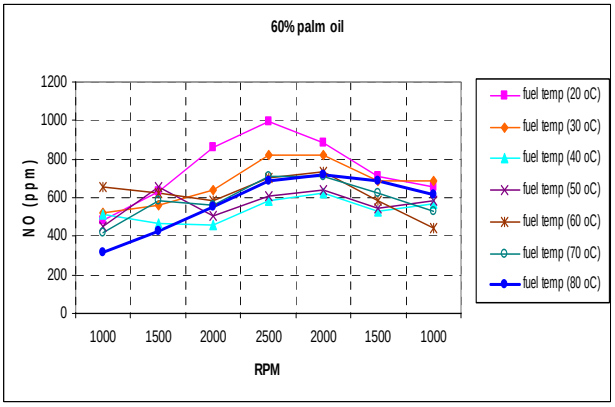

Figure 33. The NO variation used as fuel diesel-60%palm oil on different rpm regarding to the fuel temperatures

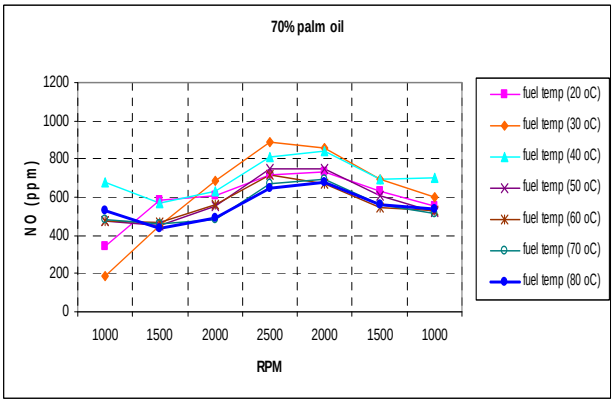

Figure 34. The NO variation used as fuel diesel-70%palm oil on different rpm regarding to the fuel temperatures

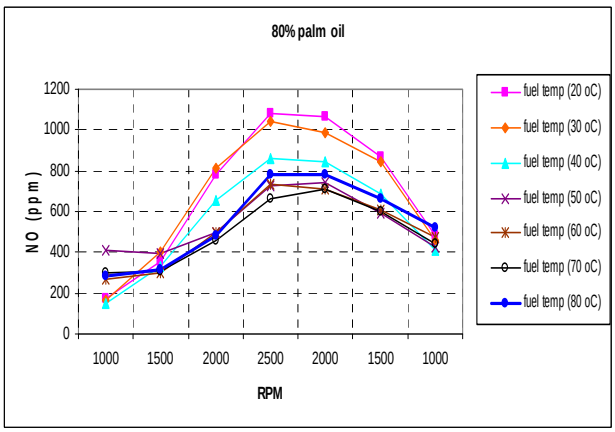

Figure 35. The NO variation used as fuel diesel-80%palm oil on different rpm regarding to the fuel temperatures

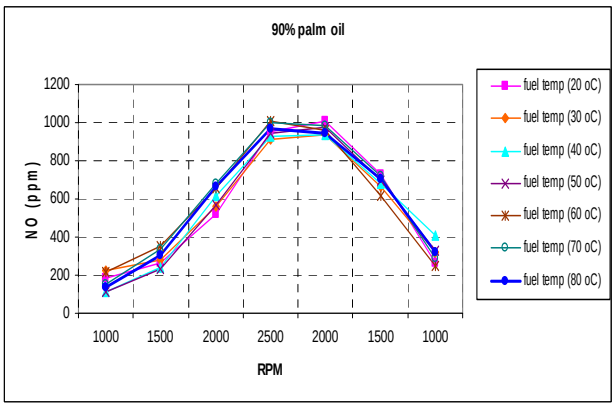

Figure 36. The NO variation used as fuel diesel-90%palm oil on different rpm regarding to the fuel temperatures

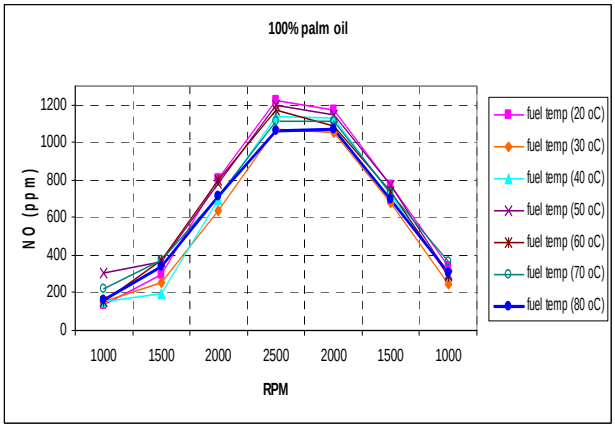

Figure 37. The NO variation used as fuel 100%palm oil on different rpm regarding to the fuel temperatures

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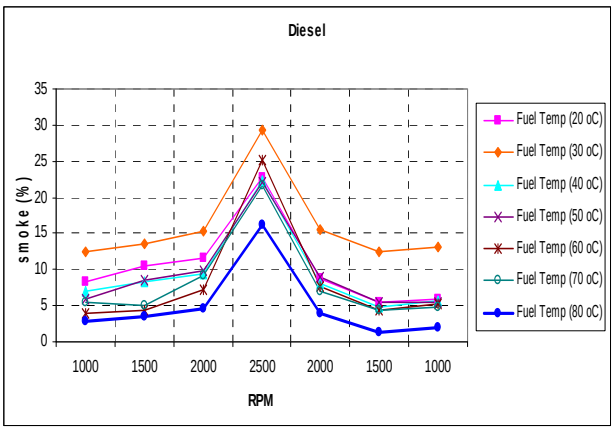

Figure 38. The smoke variation used as fuel diesel on different rpm regarding to the fuel temperatures

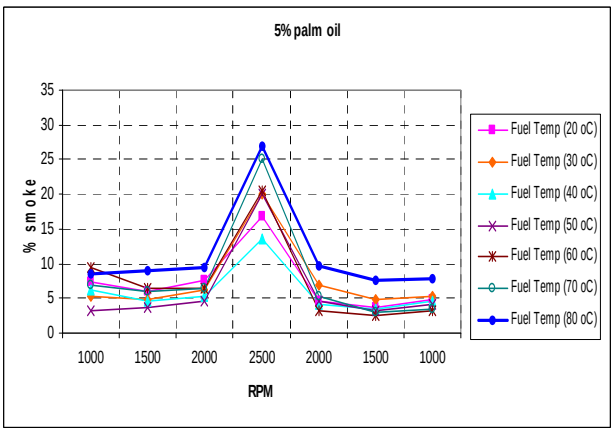

Figure 39. The smoke variation used as fuel diesel-5%palm oil on different rpm regarding to the fuel temperatures

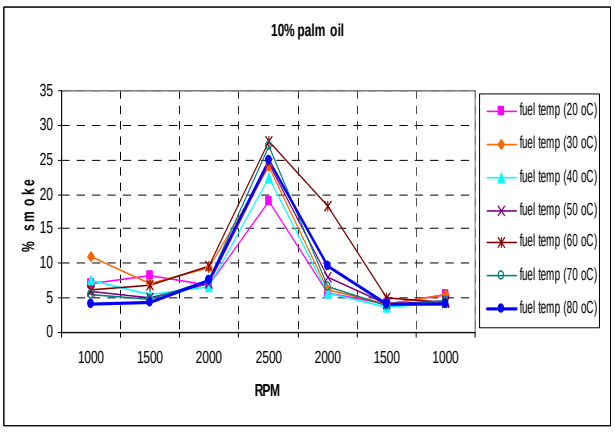

Figure 40. The smoke variation used as fuel diesel-10%palm oil on different rpm regarding to the fuel temperatures

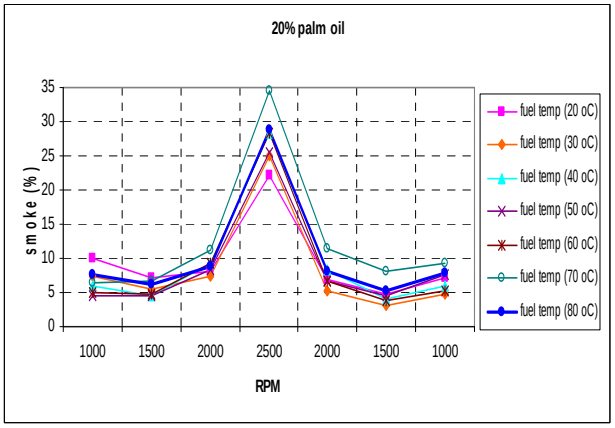

Figure 41. The smoke variation used as fuel diesel-20%palm oil on different rpm regarding to the fuel temperatures

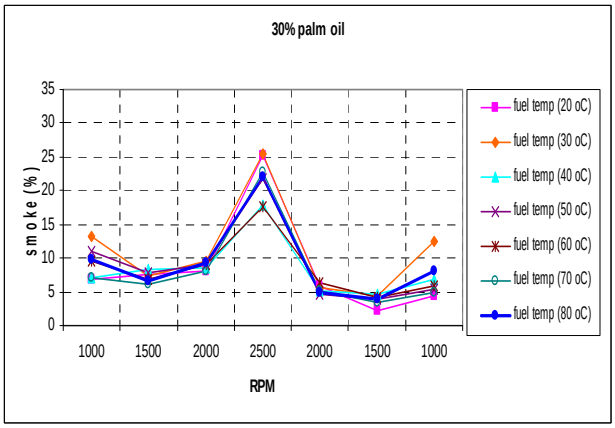

Figure 42. The smoke variation used as fuel diesel-30%palm oil on different rpm regarding to the fuel temperatures

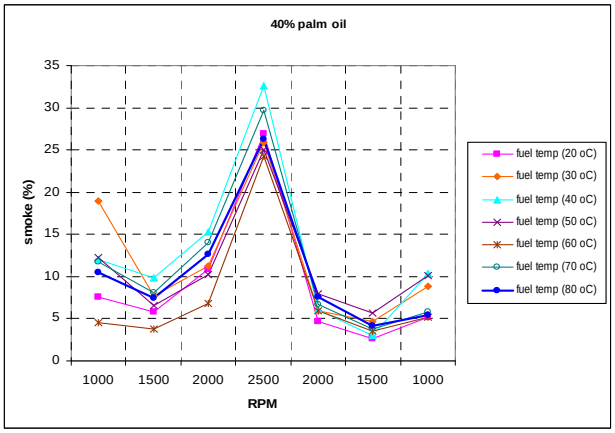

Figure 43. The smoke variation used as fuel diesel-40%palm oil on different rpm regarding to the fuel temperatures

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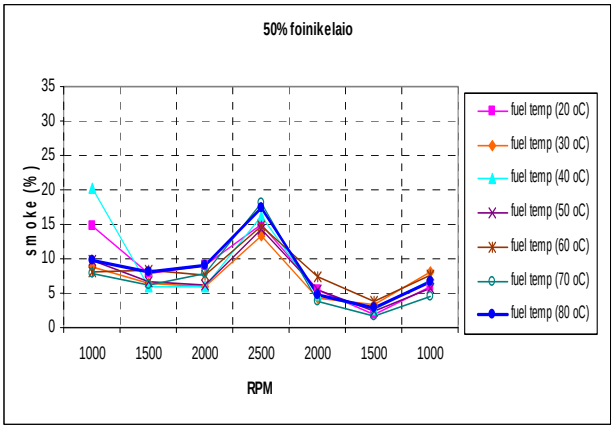

Figure 44. The smoke variation used as fuel diesel-50%palm oil on different rpm regarding to the fuel temperatures

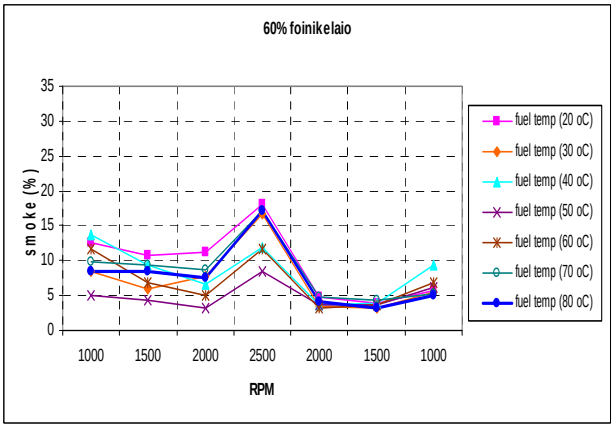

Figure 45. The smoke variation used as fuel diesel-60%palm oil on different rpm regarding to the fuel temperatures

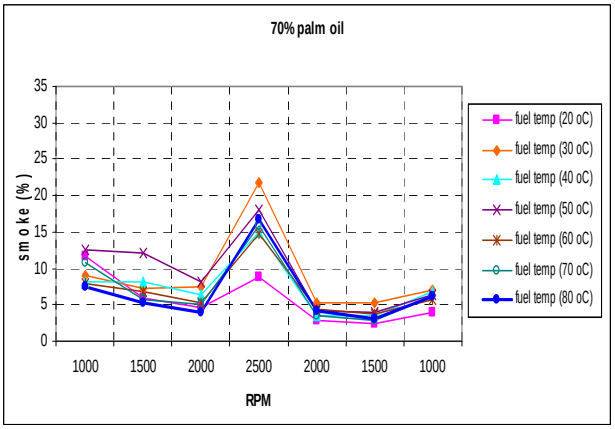

Figure 46. The smoke variation used as fuel diesel-70%palm oil on different rpm regarding to the fuel temperatures

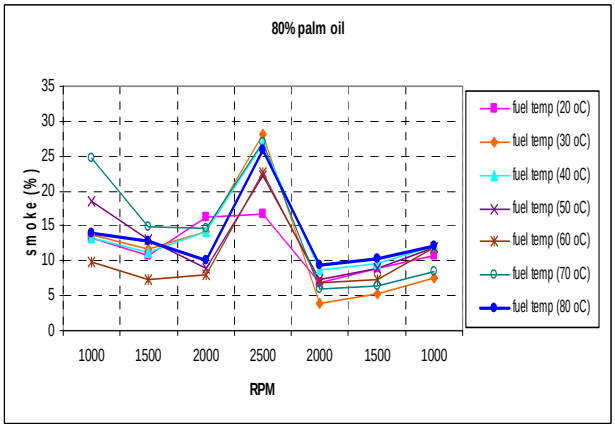

Figure 47. The smoke variation used as fuel diesel-80%palm oil on different rpm regarding to the fuel temperatures

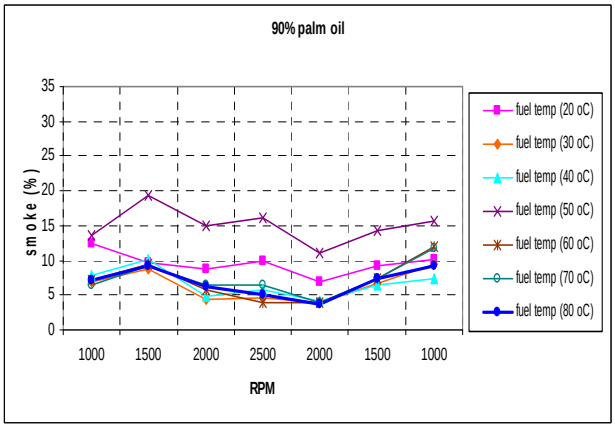

Figure 48. The smoke variation used as fuel diesel-90%palm oil on different rpm regarding to the fuel temperatures

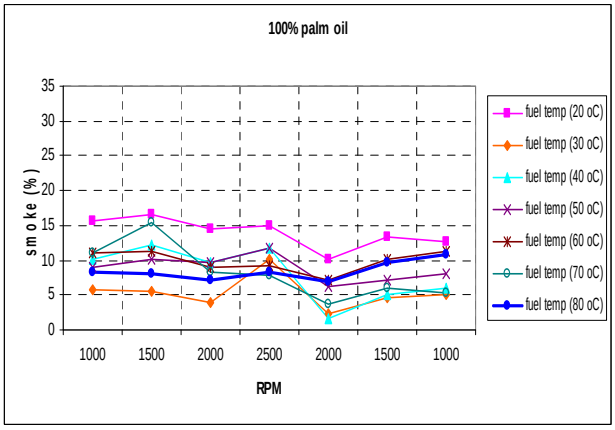

Figure 49. The smoke variation used as fuel 100%palm oil on different rpm regarding to the fuel temperatures

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3. Conclusion

From figures 2 to 49 it can be concluded the following: For the emissions of soot it was observed a sharp increase in emissions at 2500 rpm. Also the prices of soot in the staging of "pyramid" are lightly higher compared to the ones at the descent of "pyramid". Finally, in plain palm as well as in mixtures with high percentage of palm oil (80% and 90%), rates of soot had high fluctuations throughout the measurements, which justifies the low or negative correlation that it has been observed.

For carbon monoxide emissions in diesel appears very low and often lower rates of carbon monoxide at all temperatures. Rounds seem to play a role in emissions at 2000 rpm, either uploading or downloading by giving the lowest emissions in general. In most fuel mixtures, there are slightly elevated values on emissions of carbon monoxide at 2500 rpm.

Finally, in plain palm it has been observed elevated rates of emissions of carbon monoxide, in 2500 rpm, there was a fall in the percentage regarding to the lowest rounds with the 1000 rpm to present the highest percentage. The same thing happened with the fuel mixture of 90% palm oil, but in lower percentages of emissions. By taken into consideration all the figures relating to emissions of unburned hydrocarbons, it is obvious that the emission of unburned hydrocarbons does not seem to be influenced by rounds rotation. Unlike the majority of cases seem to increase during each measurement.

Finally, it should be mentioned that the fuel mixtures with 80% and 90% of palm oil did not follow the above pattern as well as the fuel mixture with 30% of palm oil at 40 ^{o}C and 50 ^{o}C fuel temperature. Diesel has very low emissions of unburned hydrocarbons and very close to it was the fuel mixture with 90% of palm oil, which it has started with higher emissions than diesel, but during the measurement, was not growing particularly those emissions. One main conclusion that comes from the overall study of figures related to emissions of nitrogen oxide is that the emissions are influenced by the number of rounds. It can be seen that the emission is at its highest point at 2500 rpm. Also, plain palm appears lower emissions of nitrogen oxide at lower rounds (1000 and 1500) and very high emissions at 2000 and 2500 rpm. It is observed that at 2000 rpm in downloading the emission level is approximately the same level as that of 2500 rpm. A similar pattern but without large deviations is observed in both fuel mixtures of 80% and 90% of palm oil. The remaining fuel mixtures have smoother rotation pattern of emissions depending on rpm. The emissions of diesel are shown in the middle of figures. Finally there is a difference in the price of gas emissions by changing the fuel temperature.

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