NATIONAL "ΜΕΤΣΟΒΙΟ" POLYTECHNIC
DEPARTMENT OF MECHANICAL ENGINEERS
HEAT SECTION

STUDY OF THE EFFECT OF THE ''FITCH FUEL CATALYST F300'' ON THE FUEL CONSUMPTION AND ON THE EMISSIONS OF AN ENGINE USING ULTRA LOW SULFUR DIESEL FUEL WITH 55 CETANE INDEX

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STUDY REQUESTED BY: ASPIS PROTECT S.A.

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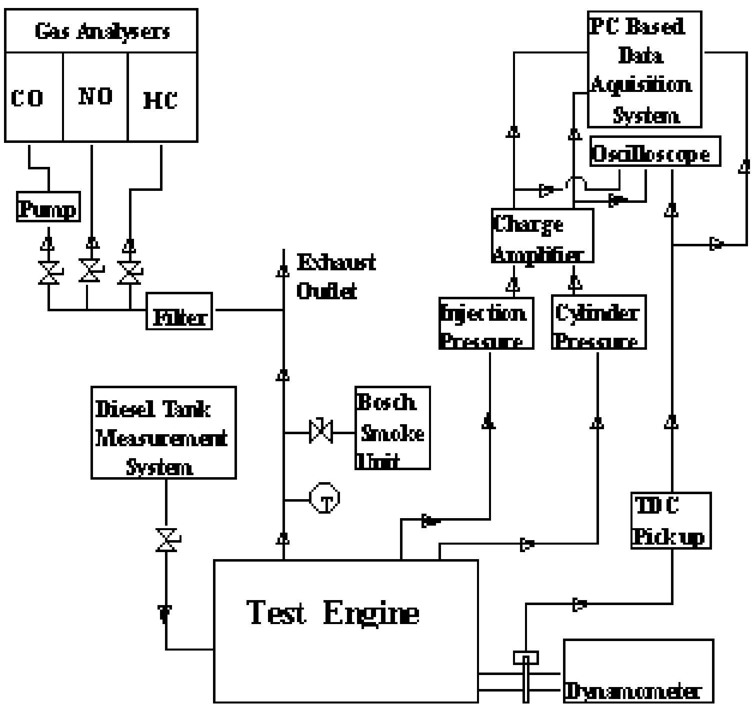
1. AIMS OF THIS STUDY

In the laboratory of internal combustion engines of the National "ΜΕΤΣΟΒΙΟ" polytechnic, a requested by ASPIS PROTECT S.A. was made for the study and evaluation of the usage of Fitch Fuel Catalyst (F300) on the fuel consumption and on the emissions of an engine using diesel fuel. It is a product of which the composition is unknown to the Polytechnic. The aim of this experimental study is to evaluate the ability of the catalyst to reduce the fuel consumption and the emissions of the engine.

2. THE EXPERIMENTAL ARRANGEMENT

2.1 Description of the experimental installation

A simple diagram of the whole measuring arrangement is show on picture 1, where the experimental engine and the rest of the installation are shown.



Picture 1

Looking at picture 1, we can observe the following:

- The experimental one-cylinder engine of direct injection of modern technology
- The dynamometer
- The fuel tank
- The fuel measuring system
- The tube for the emissions (Exhaust outlet)
- The unit measuring the temperature of the emissions
- The analyzer system for the emissions (CO, NO, HC and Shoot)

The system for analyzing the emissions, includes the devices mentioned on the following table (according to the international measuring standards)

Measured Emissions	Device manufacturer	Type	Way of measuring
Shoot	Bosch	RTT100	Optical
NO	Signal	4000 Series	Chemical/Light
HC	Ratfisch	RS55	Flame ionization
CO	Signal	7200 Series	Selective absorption of infrared light

For the measuring devices for the NO and HC, a heating line with controlled gas temperature was used, where for the CO a cooling device in order to deduct the humidity was used before the analyzer. Picture 1, shows a graphic representation of the way the analyzers were set for the extraction and analysis of the emissions.

2.2 *Brief description of the engine*

The diesel engine that was used, is a prototype experimental engine "HYDRA" of the Ricardo/Cussons manufacturing company, direct injection, four-stroke, one cylinder, natural breathing and water-cooled. The main geometric elements of the engine are shown on the following table:

Diameter	80,26 mm
Drive	88,90 mm
Length of conrod	160 mm
Compression ratio	19,8:1
Valve opening inlet	8^o before TDC
Valve closing inlet	42^o after BDC
Valve opening outlet	60o before BDC
Valve closing outlet	12^o after ***TDC***
Infusion precedence	-28^o

Geometric elements for the "HYDRA" Ricardo/Cussons engine

3. EXPERIMENTAL PROCEDURE

3.1 Measuring procedure

The experimental procedure included the following:

- Taking measurements with the engine running on 1500, 2000 and 2500 rpm In every one of the above mentioned speeds, three (3) measurements were taken which corresponded to 40%, 60% and 80% of the total load capacity of the engine. During those experiments the fuel consumption of the engine as well as the emissions of the engine were measured. By doing this, the basis was formed in order to act as "baseline values" for the comparison of the operation of the engine between running on ultra low sulfur diesel fuel with 55 cetane index and then running with the Fitch Fuel Catalyst installed.

- Taking new measurements again on 1500, 2000 and 2500 rpm, on exactly the same loads for the engine, while using diesel fuel which was treated with the Fitch Fuel Catalyst (an element) as well as installing the catalyst in the fuel line according to the directions given by ASPIS PROTECT S.A.
  During the experiments, the main parameters of the operation of a Diesel engine were measured which are the following:
  - Fuel consumption
  - Power
  - Emissions temperature
  - CO
  - NO
  - HC
  - Soot
  - Various peripheral measurements like lubricant temperature, cooling temperature etc

3.2 Explanation of symbols – parameters

In order to make the results of the measurements understood, in the diagrams of this report, the main symbols and explanations of the different measured parameters are:

PPM = Parts Per Million

4. ANALYSIS OF EXPERIMENTAL RESULTS

4.1 Fuel Consumption

In diagrams 1, 2 & 3 the fuel consumption is shown in respect of the power on 1500, 2000 & 2500 rpm respectively for the operation of the engine with and without the usage of the catalyst.
From the analysis of those results, we can determine that by using the catalyst there is an average reduction of the fuel consumption of 4-5% which is higher on the low and middle rpm's and loads

4.2 Emissions of CO

In diagrams 4, 5 & 6 the results for the emissions of CO from the engine are shown. From these results, we do not see a significant change occurring by using the catalyst on the emissions of CO. In any case, the absolute figures are low and do not represent a problem for this type of engine, i.e. diesel engine

4.3 Emissions of HC

In diagrams 7, 8 & 9 the results for the emissions of HC from the engine are shown. Generally, a reduction on the emissions of HC is observed which is higher on 2500 rpm, where a reduction of up to 20% in the emissions of HC can be observed by using the catalyst

4.4 Emissions of NO

In diagrams 10, 11 & 12 the results for the emissions of NO from the engine are shown. From these results, we can not see a significant change on the emissions of NO by using the catalyst

4.5 Emissions of Soot

Regarding the emission of Soot, the results of the tests are shown on diagrams 13, 14 & 15 for 1500, 2000 & 2500 respectively. In the whole spectrum of testing with the exemption of only one point, a reduction in the emission of Soot can be obtained by using the catalyst, which is more intensive on higher loads.

4.6 Emissions temperature

Finally, regarding the emissions temperature, the results are shown on diagrams 16, 17 & 18 for the 1500, 2000 & 2500 rpm respectively. As we can observe, with the use of the catalyst, the temperature of the emissions is lower especially on low and middle rpm's which agrees with the observed reduction on the fuel consumption.

5. FINAL CONCLUSION

From the analysis of the above results, the following conclusions can be derived, which show the effect of the catalyst in the operation and in the emissions of the tested diesel engine.

a) By using the Fitch Fuel Catalyst we observe a reduction of 4-5% in the fuel consumption especially in low and middle rpm’s and low and middle loads.
b) No significant change in the emissions of CO were observed
c) Generally a reduction in the emissions of HC is observed which on average is about 10%. In high rpm’s reaches 20%.
d) No significant change was observed in the emission of NO which is the second most important gas emission for Diesel engines after the emission of Soot.
e) Using the catalyst, brings a reduction to the emission of Soot of about 15%

DIAGRAMS-GRAPHIC REPRESENTATION OF THE TESTING RESULTS

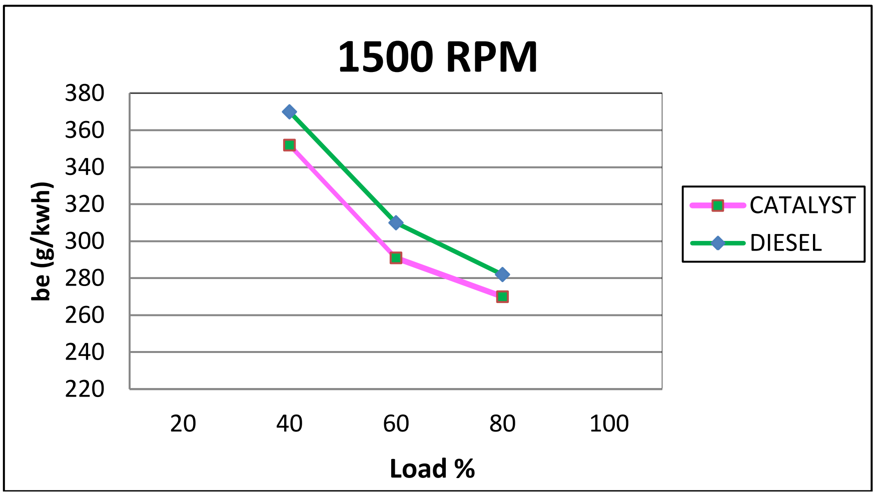


Diagram 1. Fuel consumption with and without the use of the catalyst at 1500 rpm.

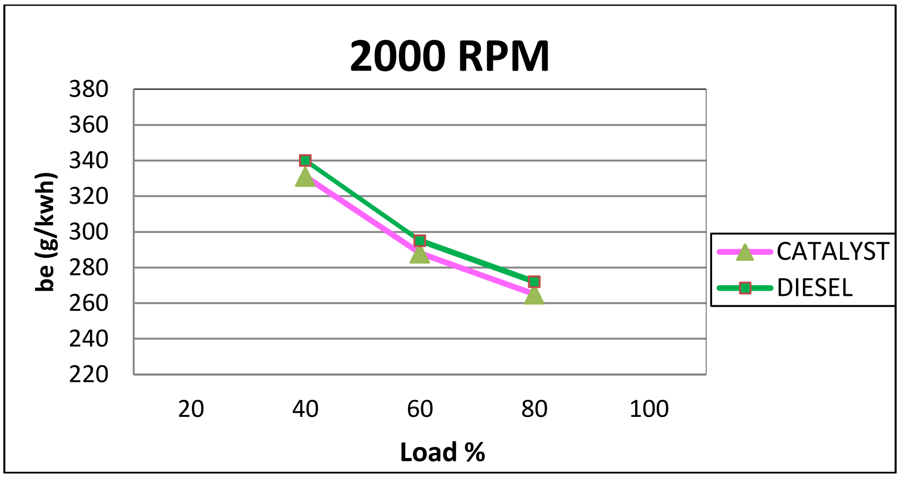


Diagram 2. Fuel consumption with and without the use of the catalyst at 2000 rpm.

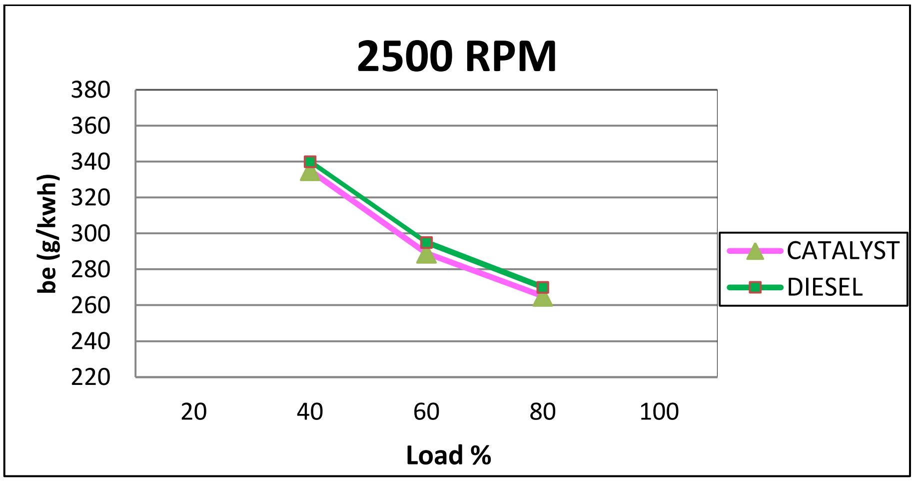


Diagram 3. Fuel consumption with and without the use of the catalyst at 2500 rpm.

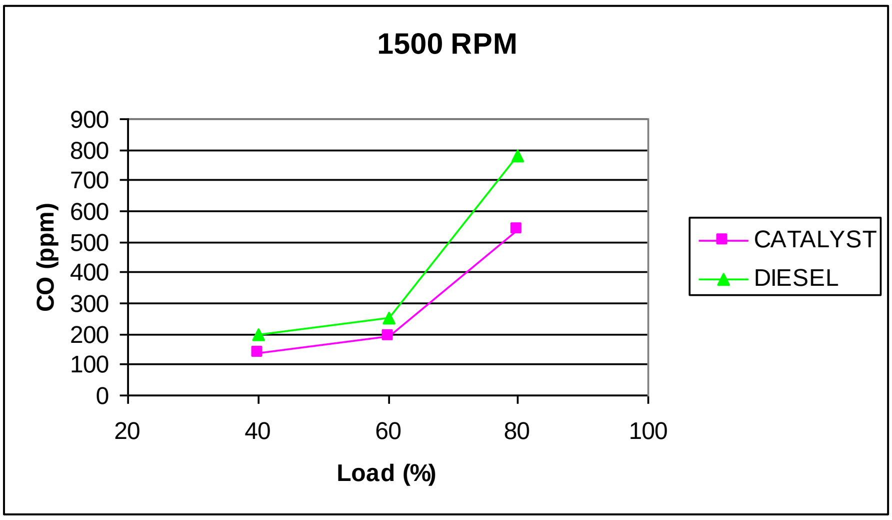


Diagram 4. CO emissions with and without the use of the catalyst at 1500 rpm.

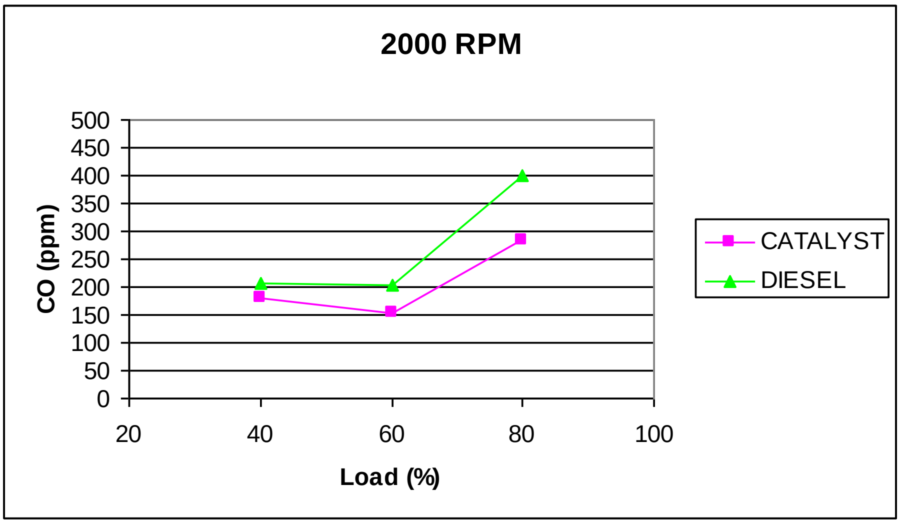


Diagram 5. CO emissions with and without the use of the catalyst at 2000 rpm.

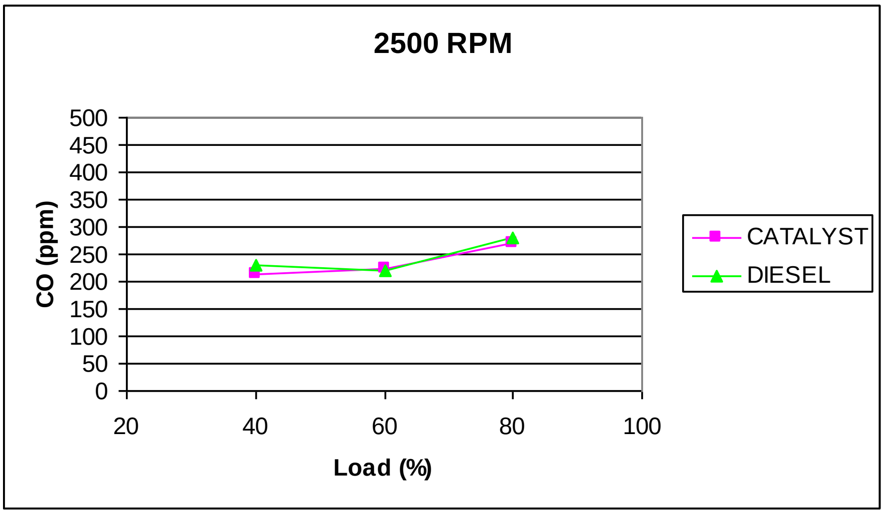


Diagram 6. CO emissions with and without the use of the catalyst at 2500 rpm.

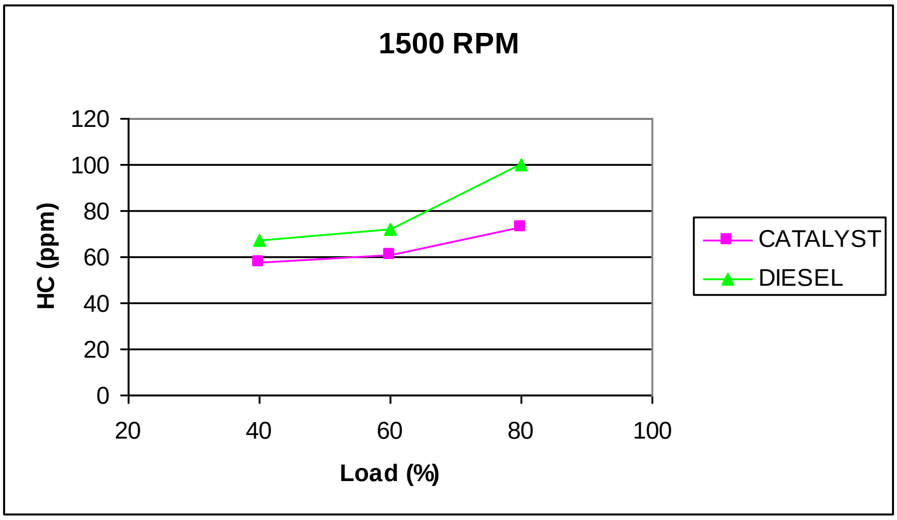


Diagram 7. HC emissions with and without the use of the catalyst at 1500 rpm.

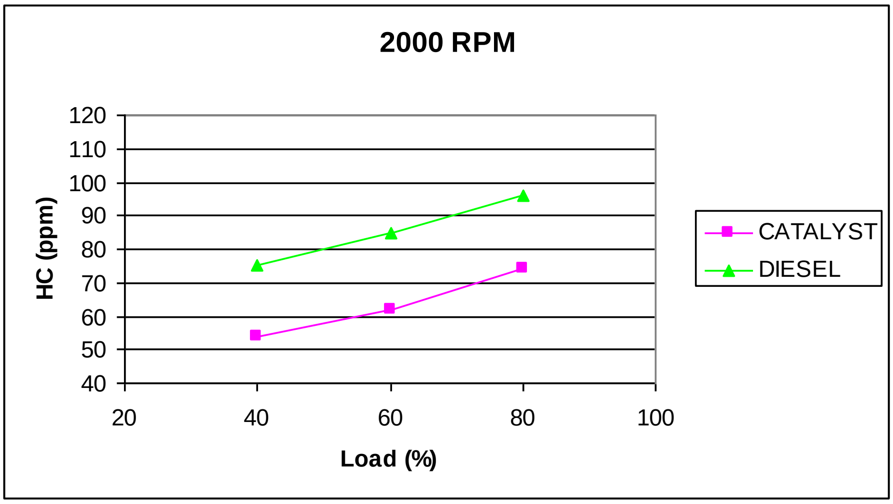


Diagram 8. HC emissions with and without the use of the catalyst at 2000 rpm

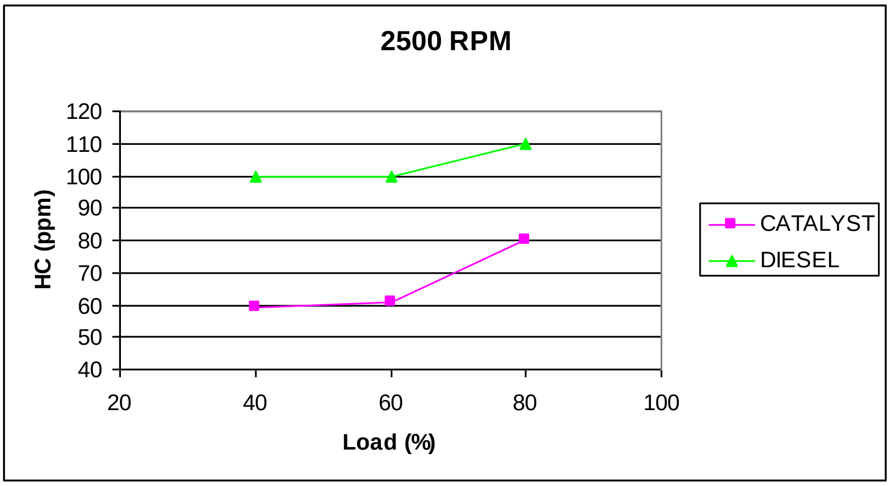


Diagram 9. HC emissions with and without the use of the catalyst at 2500 rpm

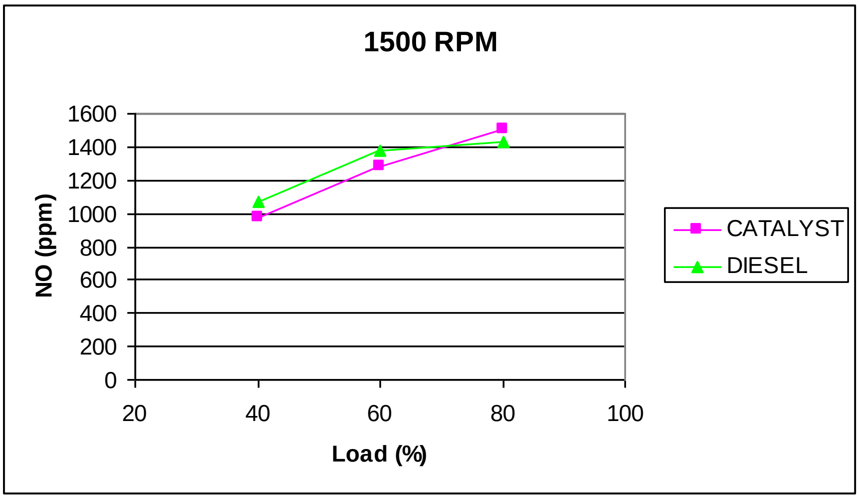


Diagram 10. NO emissions with and without the use of the catalyst at 1500 rpm

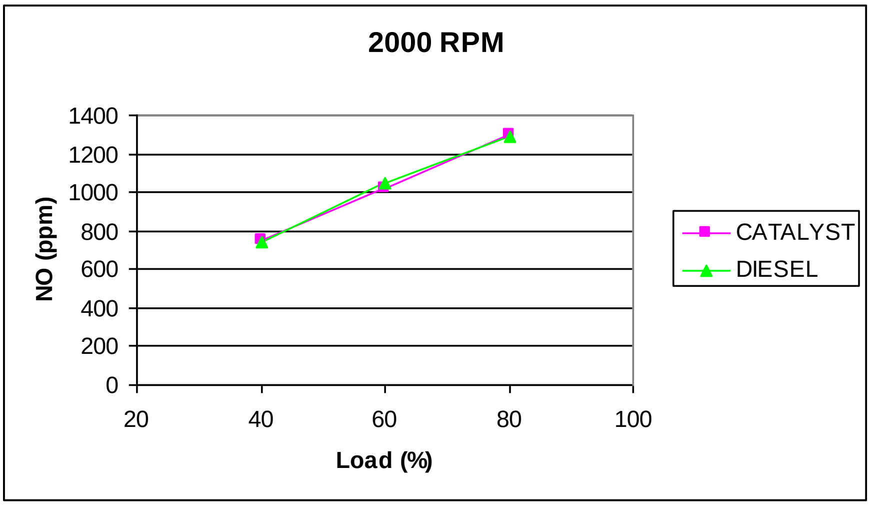


Diagram 11. NO emissions with and without the use of the catalyst at 2000 rpm

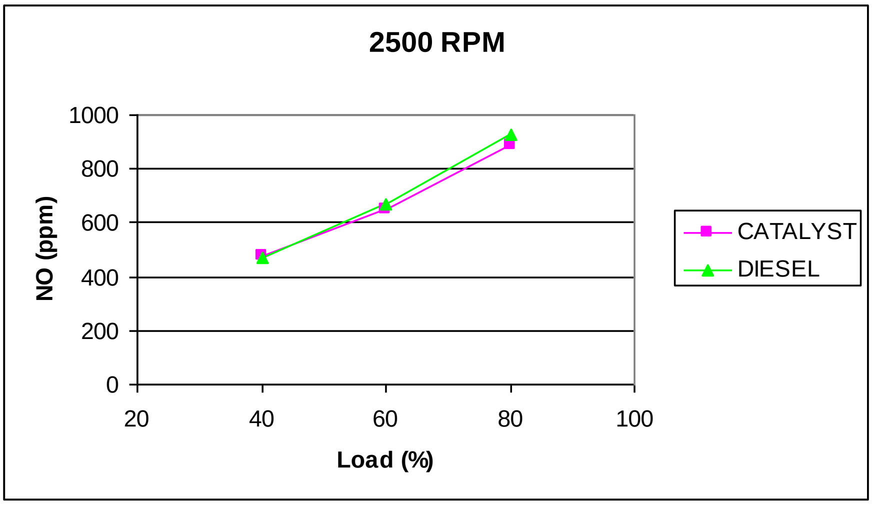


Diagram 12. NO emissions with and without the use of the catalyst at 2500 rpm

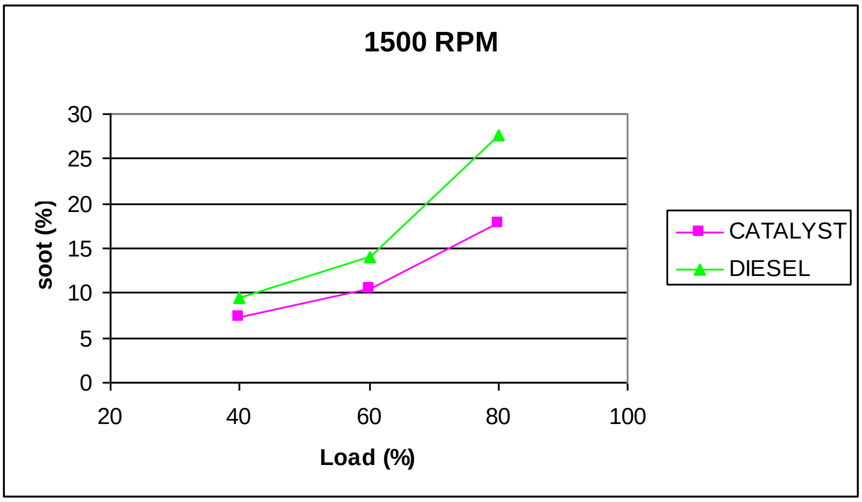


Diagram 13. Soot emissions with and without the use of the catalyst at 1500 rpm

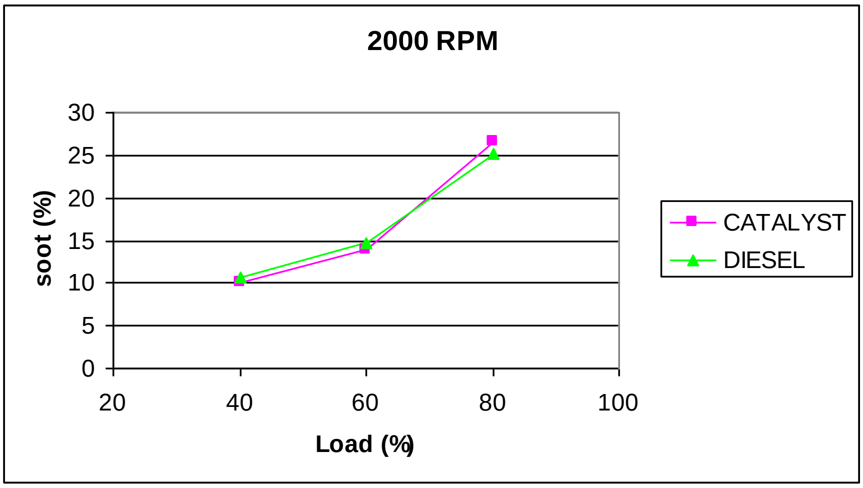


Diagram 14. Soot emissions with and without the use of the catalyst at 2000 rpm

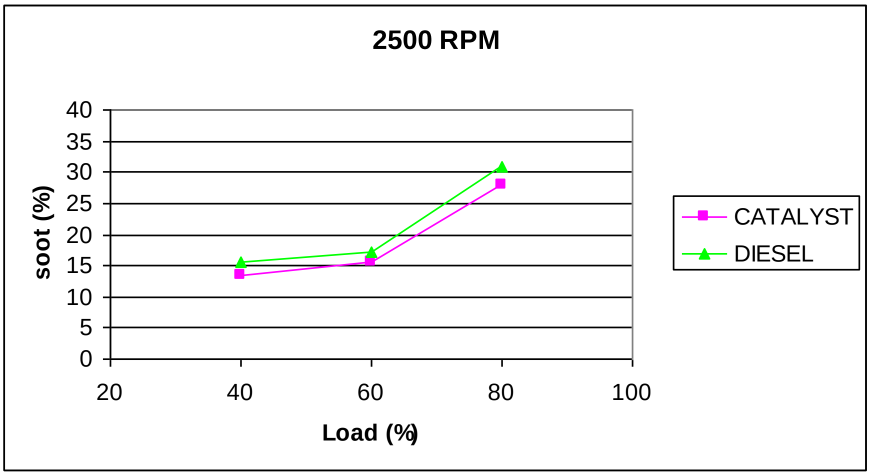


Diagram 15. Soot emissions with and without the use of the catalyst at 2500 rpm

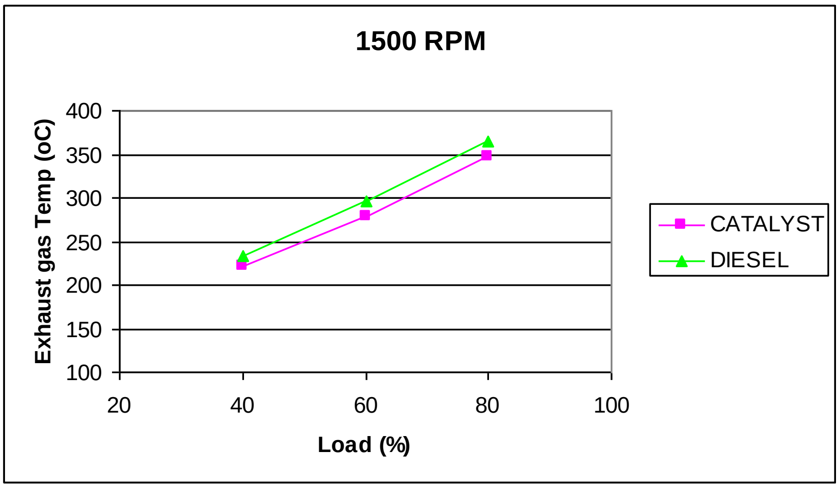


Diagram 16. Emissions Temperature (^{o}C) with and without the use of the catalyst at 1500 rpm

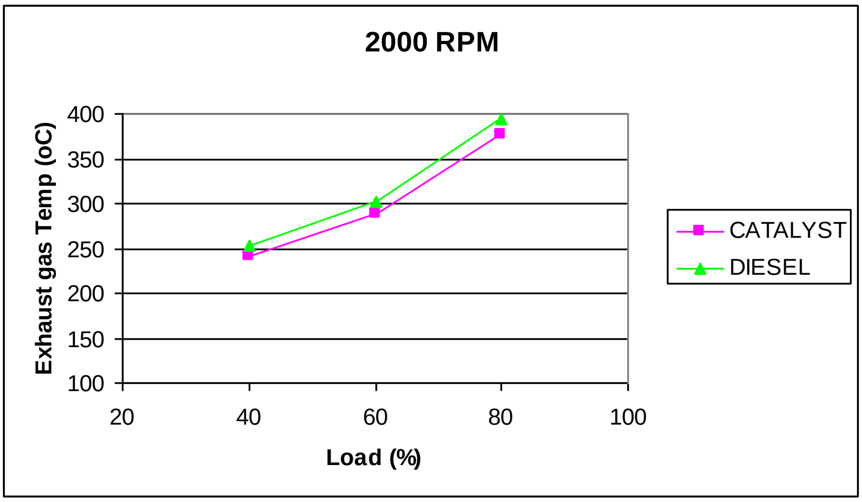


Diagram 17. Emissions Temperature (^{o}C) with and without the use of the catalyst at 2000 rpm

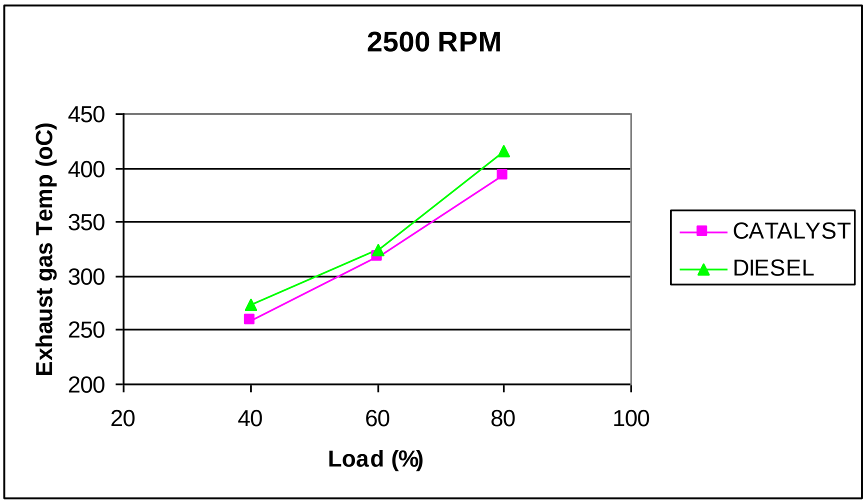


Diagram 18. Emissions Temperature (^{o}C) with and without the use of the catalyst at 2500 rpm