CASE STUDY

FERROCARRILES NACIONALES DE MEXICO

Mexico Valley Terminal
Tlanepantla
México

Fuel: Diesel
Machine/Type: Train/Engine
Test: Emissions Control

Xp Lab, Inc.
946 Hawthorn St. San Diego, CA 92101
Tel. (619) 233-3111 Fax: (619)233-3112
Xp3@xplab.com http://www.xp3.com

INDEX

1 INTRODUCTION

The environmental protection policy adopted by the Federal Government, seeking to protect the environment and human well-being, trough the maximum permissible emission levels rules that are discharged to the atmosphere, water and soil.

These norms are based on the "ECOLOGICAL AND ENVIROMENT PROTECTION GENERAL LAW " as well as the Mexican Official Norms that establish the procedures and techniques of how emissions should be evaluated to comply with the established norms, and regulations in each case or any particular process applicable to correct and preventive actions that should reduce emissions of pollutants from processes, use of materials less harmful, control systems, recycling or other appropriate means.

Public institutions such as the Federal Attorney Office in charge of protecting the Environment (PROFEPA). National Commission of Water (CNA) or the State or municipal entities that are responsible for implementing monitoring programs in this regard, encouraging the private and government sectors for the implementation of environmental protection policies, thus avoiding the application of sanctions if they are not complied.

In this way monitoring programs, indicate the best way to each source of emissions, the activities and obligations, giving the time needed to integrate them into their policies and make them a common and permanent procedure.

As part of these actions, including among others, the manifest of discharges or pollutant emissions discharged to the environment from the industrial activities, and the official Mexican NORM concerning the control of atmospheric pollution, the ECOL group which were published in the years of 1994 y1995 in the Official Gazette of the Federation are used as elements of diagnosis.

During the year of 1994, new standards have been emitted in relation to the quality of fuels, and the adequacy of the permissible emission limits from combustion equipment employing them, as well as the emissions of specific rules for some processes not referred previously, like those who use organic solvents, including photochemical reactive. In this way in standardization committees working groups, are already underway to be published and applicable norms for the year 1996.

Recently it has been approved the nomenclature of the Mexican official standards, and the rules governing emissions of particles in fixed source unit has change the number from the so-called NOM-CCAT-006-EC0l. / 1993 to NOM-043-ECOL-1993, keeping the same elements and mathematics for the calculation of the maximum permissible emissions by geographic area of the country.

As part of activities for the prevention and control of pollution, companies seek devices or other means to comply with the regulations. So measurements are conducted to obtain comparative parameters and quantify the benefits of these alternatives to reduce pollutant emissions. That is the reason the Mexico National Railway Company has decided to evaluate an additive, which is added directly to the fuel of diesel locomotives, to determine if it should be considered within this contextual framework

For the purposes of measurement. ISOTECNIA INDUSTRIAL, SA DE CV. has been hired to provide the service of measuring the emissions in the framework established by the company that supplied the additive.

This document presents the methodology and tests that were conducted according to the National Legislation to fulfill the assigned task. The performed measurements are considered only as internal control, due to the fact that the norm for fixed source are not included in the Mexican regulations in terms of the norm NOM-043-ECOL-1993 6 of the NOM-085-ECOL1994, relative to fixed sources of emissions of pollutants. The only use of the results are to evaluate, and use them as elements of analysis and evaluation of benefits the use of the additive may produce.

Based on the data presented we based the conclusions, recommendations and the numbers, calculation reports, graphs, attachments, and additional information submitted for its understanding and justification. It is worth mentioning that comparisons against the NOM-043-ECOL-1993 presented is just used as an indicator and not as a normative

In the same manner, the calculation pages were written following the precise procedure established by the Mexican official standards, building together a document containing extensive informational and technical value for the purposes of this work.

In the “TABLES" attachments, we presented all the features and dates when the evaluations were conducted, as well as all the parameters determined in each chimney. Table 1, contains the system proposed by the company. Table 2 shows the specification and characteristics of the chimneys. Table 3 shows the sampling technique employed for the evaluations. Table 4 shows the sampling

sites and representativeness, as well as the instruments used for the installation of the sampling ports. Analytical results of the sampling carried out on the chimneys raised in the scheme of work of the first and second evaluation are showed in tables 5-6. Tables 7 and 8 show the results of particulate emissions in the first and second evaluation respectively, comparing them against their specific permissible maximum emission for fixed sources

In the "Graphics" exhibit, we showed in the form of graph the Mexican official norm, NOM-043-ECOL-1993, uses as a reference for the approval of the emissions of particles in the chimney. As a complement we also show the relationship between emissions/norm using "1" as the maximum permissible emission standard.

Is worth mentioning that as a part of the methodology of sampling employed, the determination of gases from combustion, and isocinetic sampling for the quantification of emissions of particles, the computing and calculation reports are the source of volumetric flow, humidity and flow gap of equal number, as well as the support of the minimum number of sampling points selected. In the cases of the deviations of the optimum, established in the instructions for the sampling ports and platforms installation to comply with the guideline of the SEMARNAP, in monitoring sampling in fixed source, we presented the isocinetic evaluations conducted twice, and the summary of the sampling, following the structure of the format "CCATFF-002", edited by the them.

In summary, this document presents evaluation to determination particle and gas emissions in a train locomotive machine operated with an diesel engine,.

2. BACKGROUND

Based on monitoring programs, we put together a chart of the evaluation of emissions obtained from a chimney adapted to a diesel engine locomotive, and we clearly identified by the company for your easy reference. This document presents the emissions from the sources expressed in the parameters listed in table 1

It is worth mentioning that during the time in which this work was done, they have been issuing additional official rules in the ecology field and guidelines for the validation of studies such as this. This document represents and was formulated following to the current guidelines, and any change in the evaluation criteria issued by the Secretary, after the issuing of this report may be required in the

future. There are in fact rules laying down the maximum permissible emission for mobile sources.

The following is a brief additional description of those techniques and methods of sampling used for assessment, presented in table 3.

For the measure of the molecular weight of the gases, C02, CO, and 02, we used an electronic equipment that operates an electrochemical cell associated to an electronic processor of information. The equipment measured them continuously during the process.

To determine the particles quantity that flow through the exhaust, we follow the isocinetic method, which requires the use of a special equipment that should be operated applying the method established by the Mexican official standards. We should mention that both the equipment as the staff used during the test have been approved and are technically competent to follow the guidelines set by the SEMARNAP. Records of calculation, forms, as well as field sheets used for the sampling, and the evidence of the physicochemical analysis have been attached.

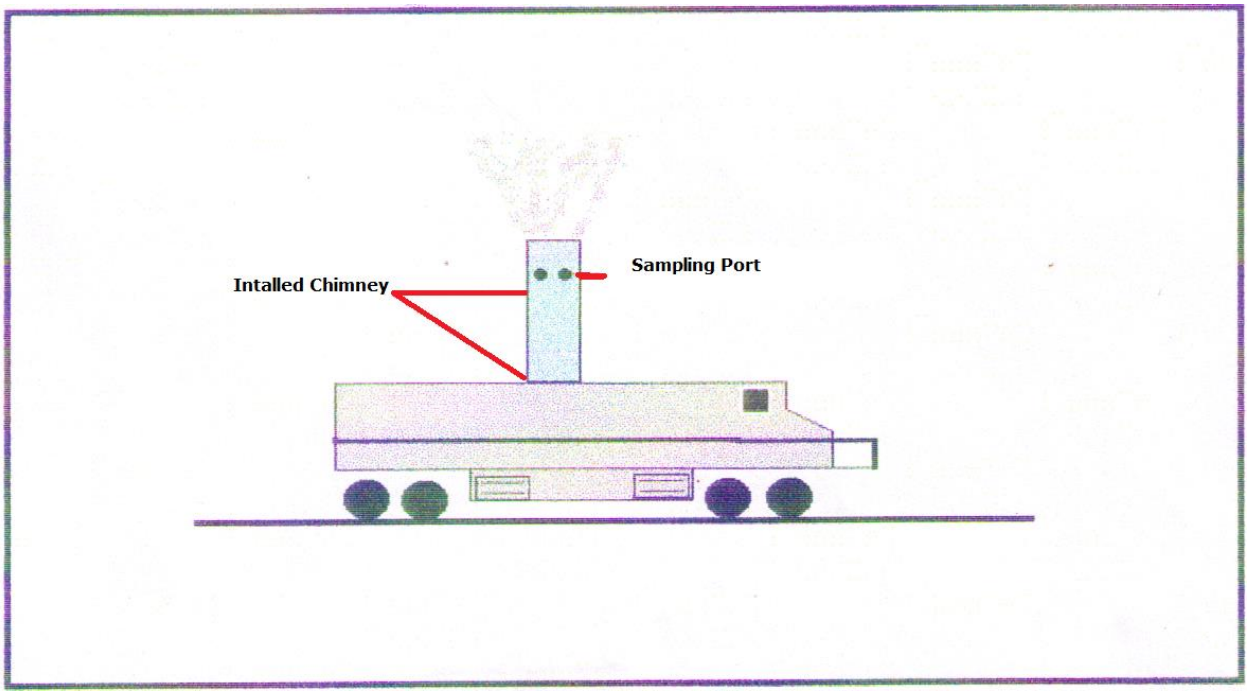
3. OBJECTIVE

Assess the emissions of one locomotive diesel engine machine, based on the results of sampling twice the particles emissions. The first evaluation was made without the use of the additive, and the second after applying the additive. This generated a conclusions document

4. SCOPE

The evaluation work was done according to the following scope:

1. Basic characterization of equipment subject to be evaluated
2. Sampling of the gases and particles emissions, according to the specified parameters established by the Mexican official standard NOM-043 "ECOL-1993, as well as the characterization of the volumetric flow.
3. Preparation of a document that will include recommendations and conclusions.



Location of the sample ports used in the evaluation

5. METHODOLOGY

The method we followed in order to perform various activities mentioned in the scope are being detailed in this section

5.1 CHARACTERISTICS OF THE EVALUATED EQUIPMENT

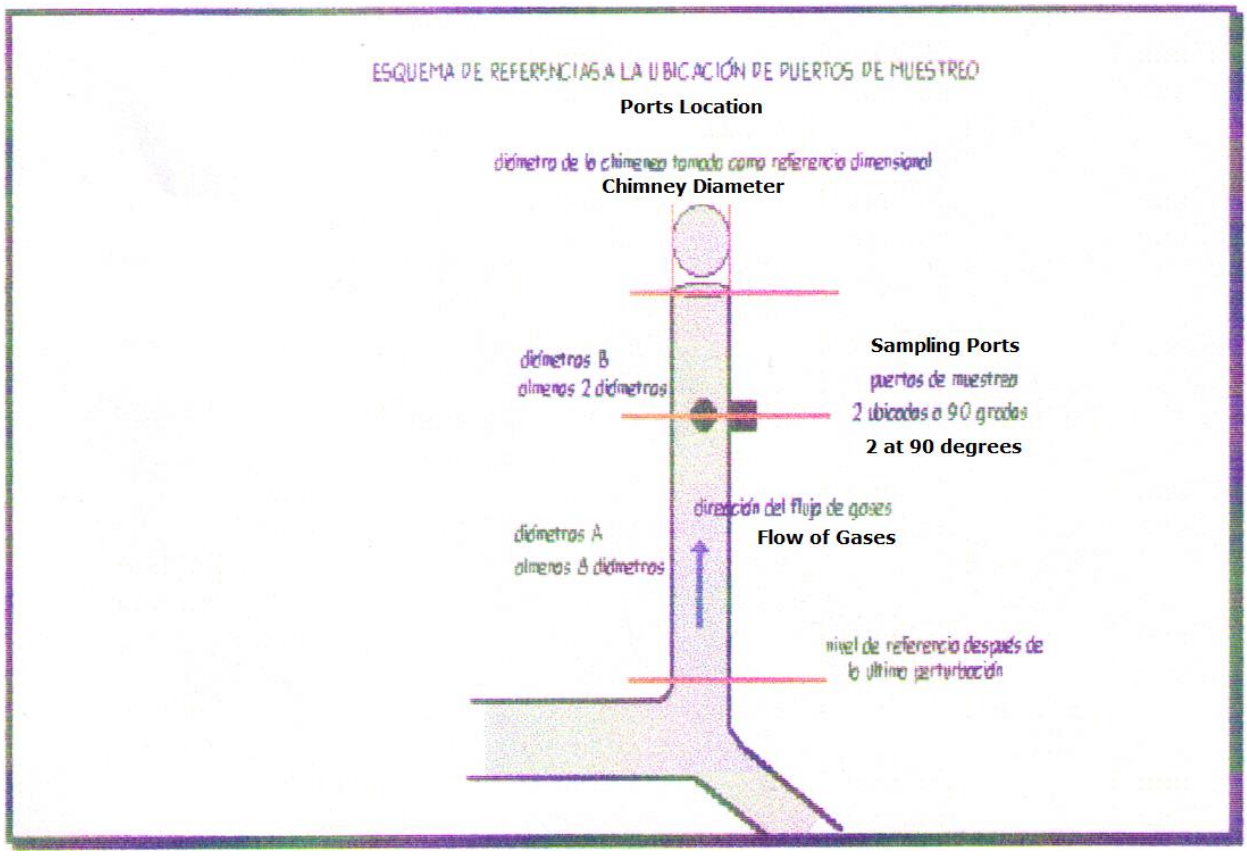
The evaluation took place in a pipeline whose features appear in the tables 2 and 4, as well as in the figures that were presented showing the sampling ports in relation to the size of the chimney

5.2 SAMPLING

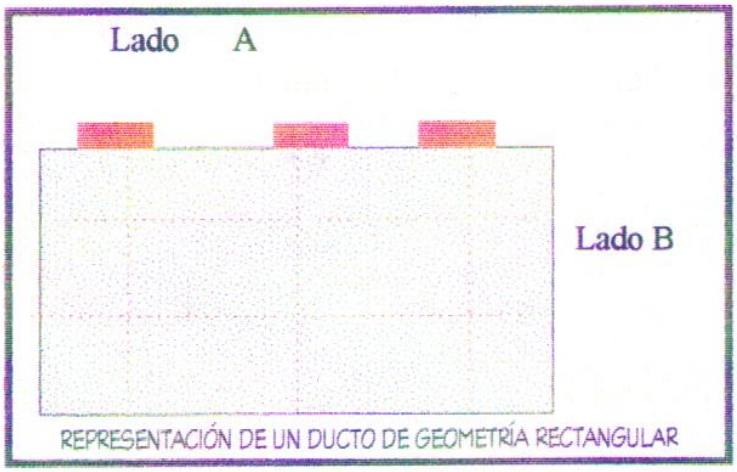
It was obtained the gas output speed, molecular weight and moisture content following the methods approved for fixed sources by the Minister of trade and Industrial Promotion, the Mexican official standards and/or methods approved by the SEMARNAP. Table 3 summarizes the techniques we employed to determine each parameter.

5.3 SAMPLING SITES AND DATES (1st and 2nd evaluation)

Table 1 presents the dates of sampling, and table 4 presents the information about the instructions followed in the installation of the sampling ports. The selection of the number of sampling points are shown in table 4. The representativeness of measurements of flow, under the terms of the average pressures speed, and the standard deviation column of water are referenced to in table 4. It should be noted that the above instructions for the installation of sampling ports and platforms, were dictated by the Engineering Department of the current SEMARNAP, under the name CCAT-FF-01 and CCAT-FF-001-A as internal documents and by the information in the Official Gazette of the Federation based on the Mexican official standards



Schematics of the parameters to be consider to locate the sampling ports, both for circular geometry as well as rectangular geometries with considerations in the calculation of the equivalent diameter for the rectangular geometry pipelines

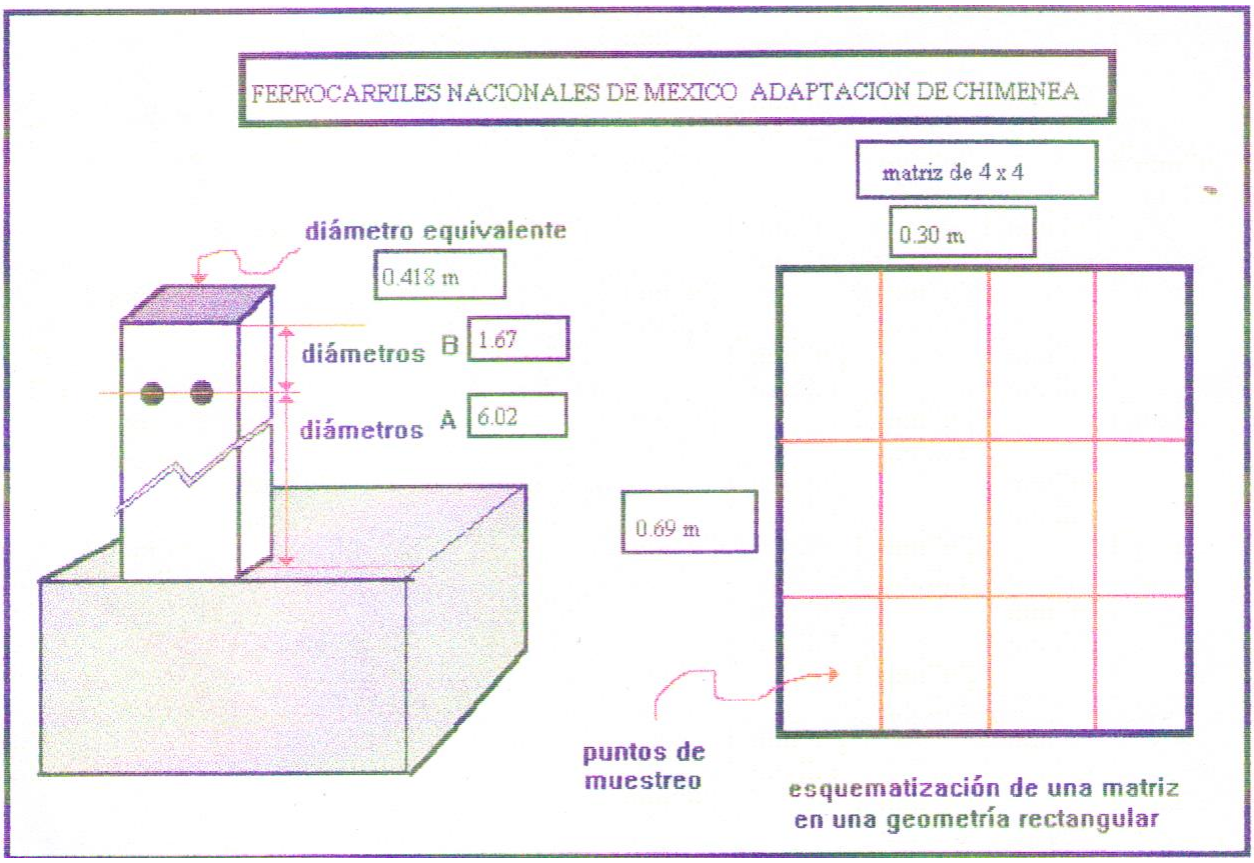


The diameter calculation was based in the relation:

El cálculo del diámetro equivalente se basa en la relación:

$$Deq = \frac{2 * A * B}{A + B}$$

The orientation of the sampling ports was done according to the Mexican official standards guidelines for fixed sources sampling.



Xp Lab, Inc.
946 Hawthorn St. San Diego, CA 92101
Tel. (619) 233-3111 Fax: (619)233-3112
Xp3@xplab.com http://www.xp3.com

6. GASES COMPOSITION, CHARACTERISTICS AND VOLUME

The techniques used for the taking of samples are presented in table 3. Based on the work of sampling and the physicochemical analysis are presented in tables 5 and 6. The results are based on the attached calculation pages

The compositions of gases reflect the presence of combustion gases and therefore the evaluation of the combustion process. Based on the objective of the study, we evaluated the effect of the additive that was added to the fuel, on the emission of pollutants, and especially on the quantity of particles emissions.

Regarding the composition of gases, under the terms of the content of oxygen, determined in the first and second evaluation, 12.4% and 13.7%, would amount to a composition with a differential of 1.3%, this could be produced by a change in operation conditions of the machine between evaluations. This fact by itself does not guarantee that maintenance conditions interfere with the results obtained. On the other hand volumetric flows found during the measurements were 317.94 m3/min and 330.87 m3/min. This confirm the reproducibility of the conditions in which the determinations are made before applying the additive and after the application. This fact was expected and is a result of the direct function of the oxygen content. We can conclude that the relations of air and fuel were similar in both tests. Important to mention is the variation in moisture content in the exhaust in both tests, 4.37% to 1.73% respectively, fact that could only be produced by the additive. The composition of the carbon monoxide content that was present on both occasions, was greater than the 5000 ppm v, and given the characteristics of the test and analytical equipment we used, that cannot measure more than this quantity, no determination could be done, however it can

be argued that the content of carbon monoxide may be greater and no determination could be concluded on this tests.

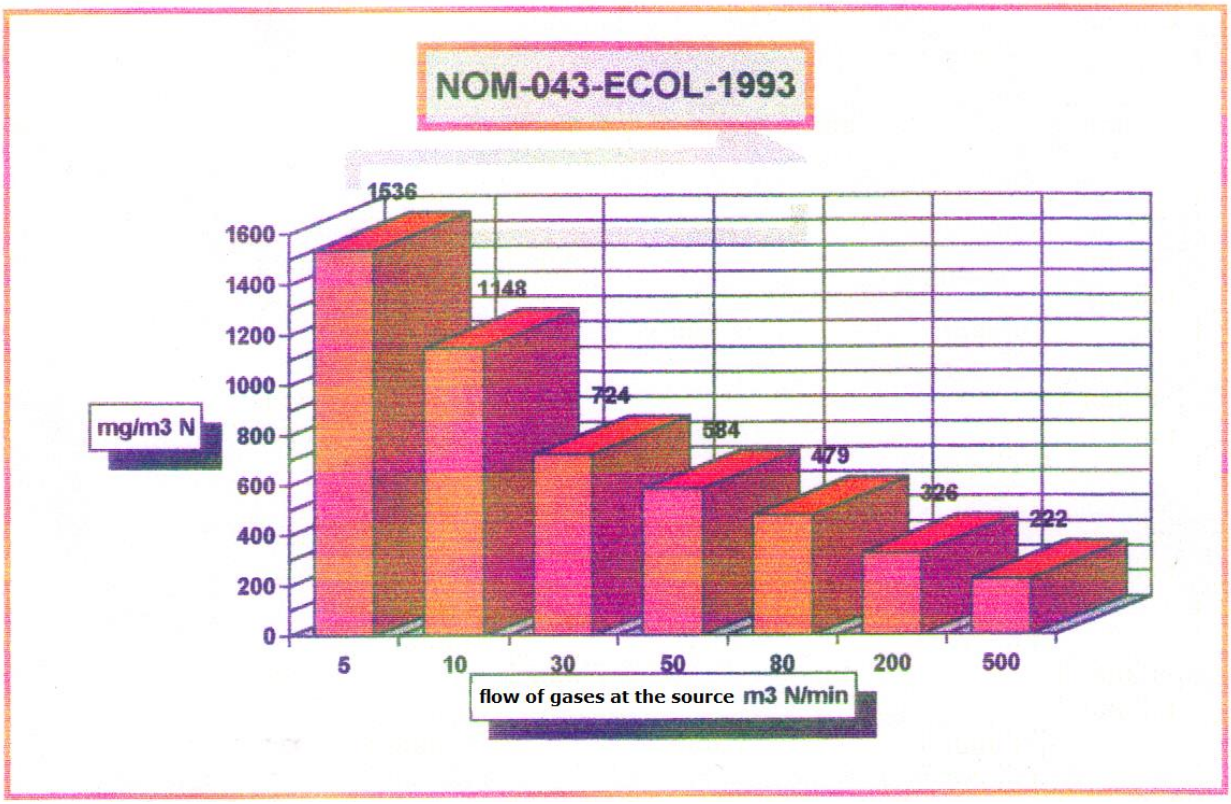
7 EMISSIONS AND POLLUTANTS

In tables 7 and 8 show the emissions values obtained based on the reported data for the determinations of particles present on first and second samples, both final, also shown are the comparisons against the norm NOM-043-ECOL-1993, see as reference the graphics. These comparisons are only made for the purposes of establishing indicators, and not as a normative elements.

Particulate emissions evidenced a significant variation with a tendency towards the reduction, in terms of emissions and concentrations, between the first and second evaluation, having standardized to normal conditions of temperature, and pressure base dry and corrected the difference in flow rates between assessments calculated in 0.84, up to 83% for both emission and concentration

8 INTERPRETATION OF RESULT

The maximum emission levels permitted by the Mexican Official Standard NOM-043-ECOL-1993, are calculated based on the flow of gases at the source, according to the mathematical relationship established to the critical region. For this reason each duct has a maximum of different emission level. The behavior of the cited standard appears schematized in the "Graphs" exhibit. Example of use of this graphic, if you have a 40 m3N/min flow, in the pipeline, the maximum emulsion permitted is 641 mg/m3N in the case of the critical region. This comparison for this particular single study is only presented as a mere indicator

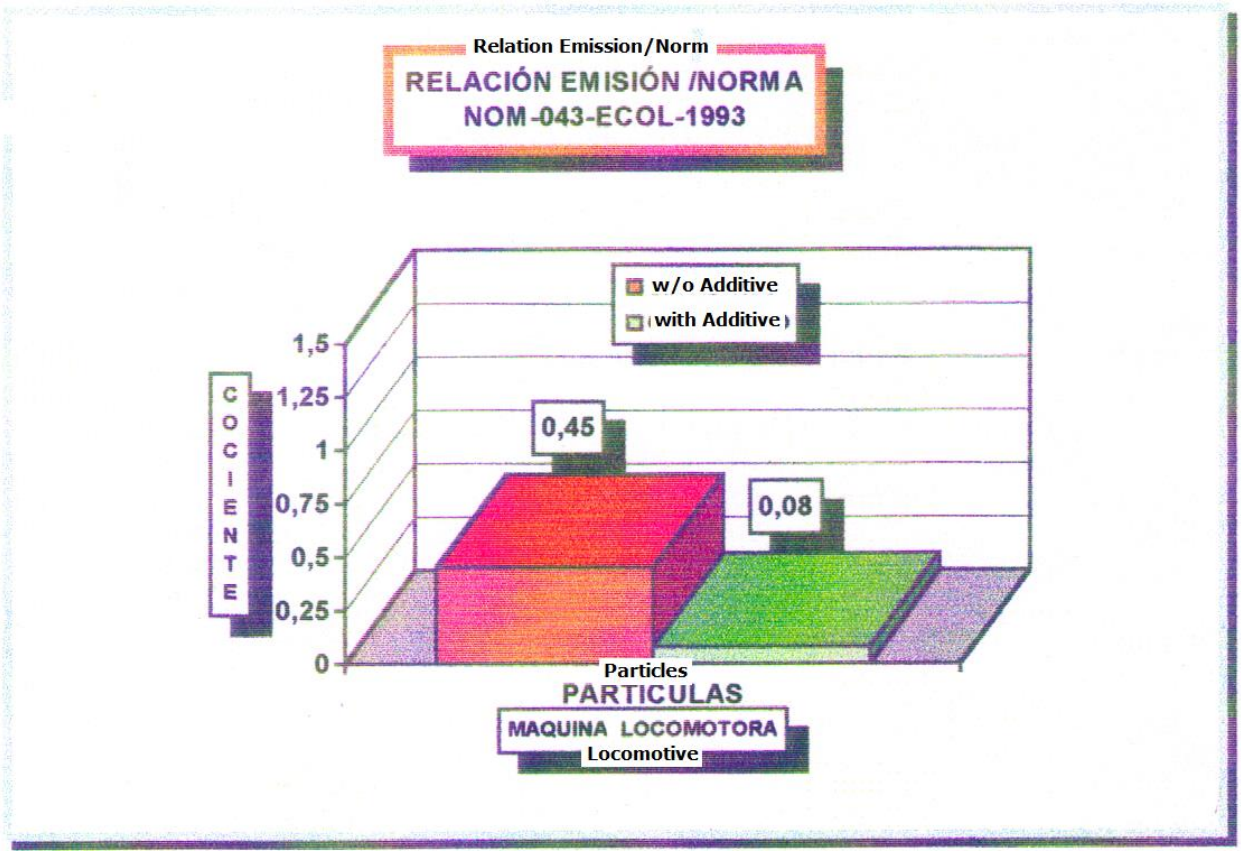


With regard to these levels, the results found in the field on the evaluations practiced to the pipelines, made twice showed that it did not exceeded its corresponding level, as shown in tables 7 and 8

None of the results of tests conducted, showed to exceed the limits set by the norm, however it is important to insist in the importance of maintaining optimal conditions of operation and maintenance of the combustion equipment to make obvious the impact in the formation of contaminants.

Regarding previous comments, the criteria for the interpretation of the emission ratios was based on, when it is below "1"it meets the standard, when it is "1" is equal to the permissible maximum and when
is above "1" it exceeds the norm, this analogy is presented in the graph's exhibits.

Xp Lab, Inc.
946 Hawthorn St. San Diego, CA 92101
Tel. (619) 233-3111 Fax: (619)233-3112
Xp3@xplab.com http://www.xp3.com



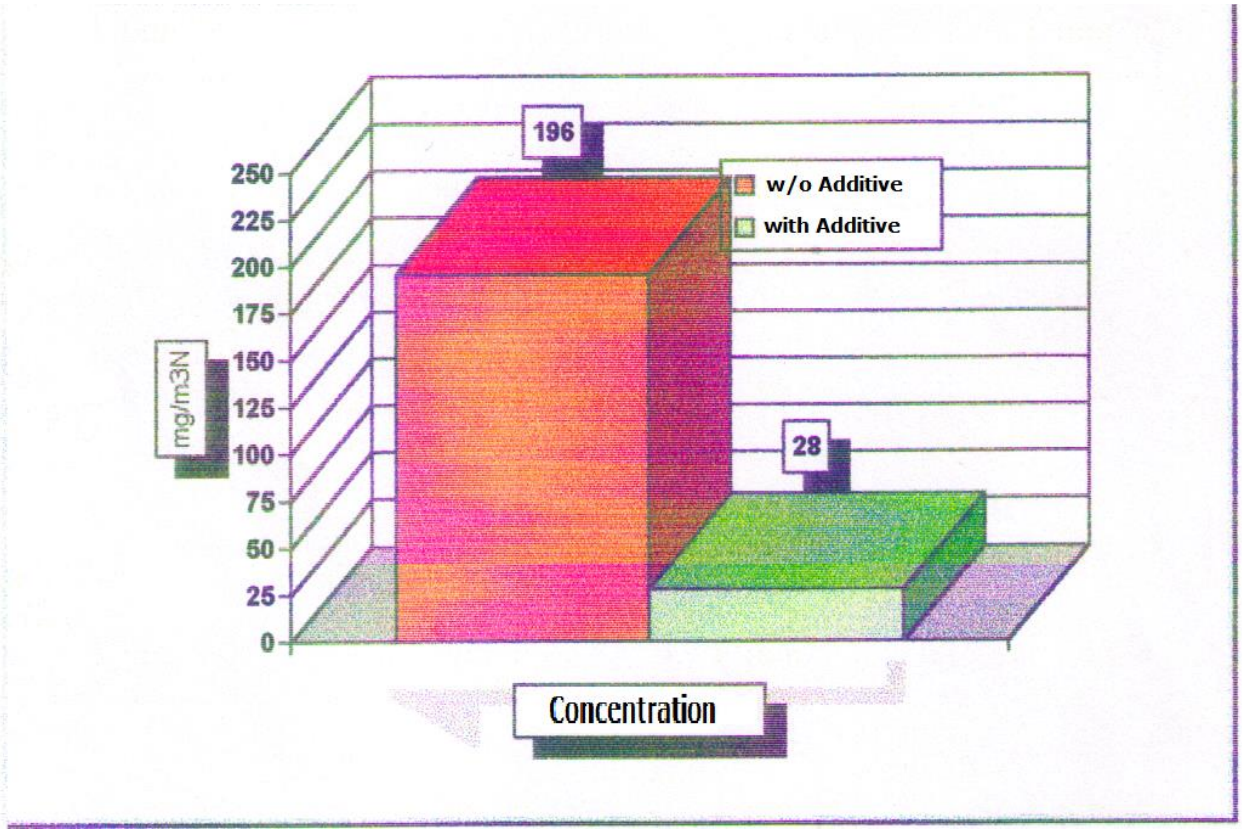
The following variables may affect these typical behaviors

- Lack of cleaning of soot discharge pipelines, causing accumulation that do not necessarily represent the normal behavior of the equipment, causing in consequence a false impression of dirt or pollutant emissions, specially soot.

- Ash susceptible of being thrown into the environment or change in the fuel quality that produces a greater amount of contaminant material

- Modifications to the combustion systems that do not ensure the representativeness of the results expressed, or lack of preventive and corrective maintenance

Xp Lab, Inc.
946 Hawthorn St. San Diego, CA 92101
Tel. (619) 233-3111 Fax: (619)233-3112
Xp3@xplab.com http://www.xp3.com



In summary these values indicate mainly the following:

- It was found evidence of the reduction in the formation of particles between two conducted evaluations, without additives and additive. In the same conditions of operation and maintenance on both cases there was an approximately 83% reduction on the results when the product XP3, additive for diesel, was used.

9. CONCLUSIONS AND RECOMMENDATIONS contain

- The results information of particles emissions and the comparison between the tests without additive and with additive are shown in tables 7 and 8

Note: As experimental work the results presented only represent the particular conditions in which the determinations were made, and does not establish the generalization of behavior of the experimental system, for such effect any research should be subject to the relative establish protocols.

Xp Lab, Inc.
946 Hawthorn St. San Diego, CA 92101
Tel. (619) 233-3111 Fax: (619)233-3112
Xp3@xplab.com http://www.xp3.com