Evaluation of particulate emissions when using Xp3D-Bunker fuel additive in a boiler

TEST LAB

Mexican Petroleum Institute
Environmental Protection Coordination
Environmental Protection and Industrial Safety Office
Energy Control Division
Work no. Eoe-4330

BACKGROUND

Xp Lab requested the Mexican Petroleum Institute to conduct a combustion comparative test in heavy fuels treated with and without Xp3 additive.

OBJECTIVES

To perform combustion tests of heavy fuel with and without Xp3 additive to assess the efficiency of the combustion, quantify their emissions, and compare results against the values established by the standard NOM-085-ECOL-1994.

SCOPE

The combustion tests will allow to experimentally determine the behavior of the fuel with and without additive subject to different excesses of air (3, 5 and 7 % of oxygen in the stack gases). In addition, from the fuel flow values and steam produced in each combustion condition, the boiler efficiency will be obtained.

Evaluation of pollutant emissions S02, NOx, CO and Total Suspended Particles (PST), will be obtained during the fuel burning, comparing these emissions against the values of the same norm.

DEVELOPMENT

This work was done with the tests and equipment described as follows.

METHODS AND MEASUREMENTS

The stack measurements were done using as a basis the current Mexican official Norms and the EPA Methods.

1. NOM-AA-9-1973: Flue gas determination through the Pitot tube.
2. NOM-AA-54-1978: Humidity content in the gases flowing through a pipe.
3. DGN.AA.35-1975: Carbon dioxide, carbon monoxide, and oxygen specification in the combustion gases.
4. NOM-085-ECOL-1994: For fixed sources that use solid fossil fuels, liquid or gas in any combinations, that establish the maximum emissions levels of smoke allowed to the atmosphere, total suspended particles, sulfur dioxide, nitrogen oxides, and requirements for indirect combustion heating equipment operation requirements, as well as the maximum levels of sulfur dioxide emissions allowed on direct heating by combustion equipment.
5. EPA-Method 1: "Definition of sampling point and stack gases velocity on fixed sources. Federal Register, Title 40, Part 60, App. A, page 348."
6. EPA-Method 2: "Definition of stack gases velocity and volumetric flow (Pitot tube type "S"). Federal Register, Title 40, Protection of Environmental Part 60, App. A, pages 354-372."
7. EPA-Method 3: Gas analysis for carbon dioxide, oxygen, carbon monoxide, air excess, and molecular weight. Federal Register, Title 40, Protection of Environmental, part 60, App A, page 372.
8. EPA-method 3A: Definition of oxygen concentrations and carbon dioxide emissions from fixed sources. Protection of Environmental, Part 60, App A, page 372 (Procedure for Instrumental Analysis).
9. EPA-Method 4: Definition of humidity content in stack gases Federal Register, vol. 36, no. 247, December 1971.
10. EPA-Method 5: Definition of particles emission from fixed sources. Title 40, Environmental Protection, Part. 60, App A, Page 387.

RESULTS

SUSPENDED PARTICULATES (1)

	w/o	w/ Xp3	Reduction
Particulate Concentration (mg/m3 N)	**230.09**	**161.65**	**29.74%**
Particulate Emissions (kg/h)	**0.2925**	**0.1799**	**38.50%**
Opacity	**5**	**3**	**40.00%**

(1) Results with 5% oxygen on chimney gases

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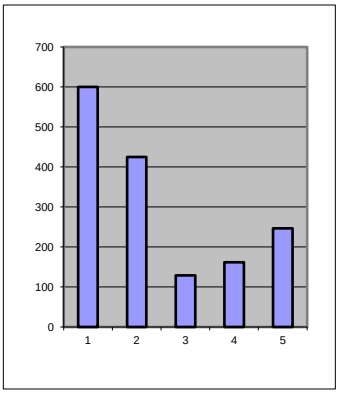
LAB TEST RESULTS

TOTAL SUSPENDED PARTICULATES



1) 600 Ecological Norms for the Mexican Republic

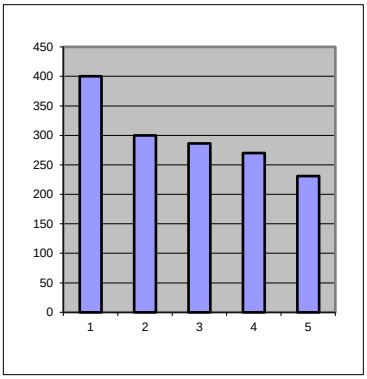
2) 425 Ecological Norms for Critical Zone in Mexico

3) 129.32 With Xp3 (7% of O2 in combustion gases)

4) 161.65 With Xp3 (5% of O2 in combustion gases)

5) 246.35 With Xp3 (3% of O2 in combustion gases)

NOx EMISSIONS CORRECTED AT 5% OF O2



1) 400 Ecological Norms for the Mexican Republic

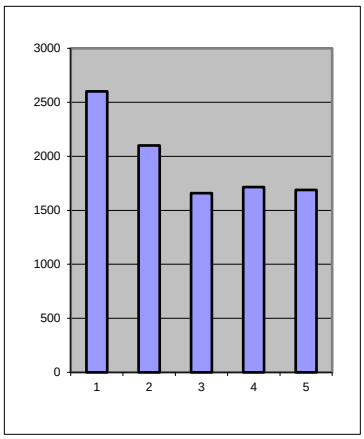
2) 300 Ecological Norms for Critical Zone in Mexico

3) 286.1 With Xp3 (7% of O2 in combustion gases)

4) 270 With Xp3 (5% of O2 in combustion gases)

5) 230.8 With Xp3 (3% of O2 in combustion gases)

SO2 EMISSIONS CORRECTED AT 5% OF O2



1) 2600 Ecological Norms for the Mexican Republic

2) 2100 Ecological Norms for Critical Zone in Mexico

3) 1659 With Xp3 (7% of O2 in combustion gases)

4) 1716 With Xp3 (5% of O2 in combustion gases)

5) 1688 With Xp3 (3% of O2 in combustion gases)

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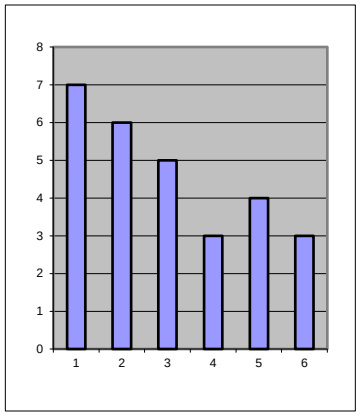
LAB TEST RESULTS

OPACITY



1) 7 With Xp3 (3% of O2 in combustion gases)

2) 6 W/O Xp3 (3% of O2 in combustion gases)

3) 5 With Xp3 (5% of O2 in combustion gases)

4) 3 W/O Xp3 (5% of O2 in combustion gases)

5) 4 With Xp3 (7% of O2 in combustion gases)

6) 3 W/O Xp3 (7% of O2 in combustion gases)

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