

Minera Real de Angeles
S.A. de C.V.
Noria de Angeles, Zacateca
Mexico

Fuel: Diesel

Machine/Type: Truck/Motor

Test: Gas (CO) Emissions Control

Xp Lab, Inc.

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November 15, 1996

N/REF: TS-1103/96

Dear Sirs,

A test was conducted to determine the emissions generated by heavy duty trucks used in the mine **MINERA REAL DE ANGELES S.A. DE C.V.**, located in Noria de Angeles, Zacatecas, Mexico.

The test was conducted on October 29 and November 13. The exact purpose of test was:

- a) To determine the sulfur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO) emissions and opacity # produced by the trucks Caterpillar numbers ECAT-15 and ECAT-13, and the trucks DRESSER numbers EDRE-34, with and without Xp³)

Thank you for your help and access during our visit, it facilitated our work. We hope we could be of help in future projects. We remain yours truly,

ASESORIA EN CONTROL AMBIENTAL

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1. INTRODUCTION

A test was conducted to determine the emissions generated by heavy duty trucks used in the mine **MINERA REAL DE ANGELES S.A. DE C.V.**, located in Noria de Angeles, Zacatecas, Mexico.

The test was conducted on October 29 and November 13. The purpose of the test was:

- A) Determine the sulfur dioxide (SO₂), nitrogen oxides (NO_x), carbon monoxide (CO) emissions and opacity # produced by the trucks Caterpillar numbers ECAT-15 and ECAT-13, and the trucks DRESSER numbers EDRE-34, with and without Xp³)

Emissions were compared to the Mexican Official Norms.

2.1. PROCEDURE AND EQUIPMENT

The following procedure and equipment was used to measure the emissions:

1. We measured the stack gas temperature with a Testo-Term 342-1.
2. We measured the Carbon Monoxide (CO) emissions with a Testo-Term 342-1.
3. We measured sulfur dioxide (SO₂) emissions with a Testo-Term 350.
4. We measured the black spot test with a Bacharach 10-7012 unit.
5. We measured nitrogen oxides (NO_x) with a hermo Environmental 10-AR emission test equipment.

2.2. EQUIPMENT USED

The following equipment was used: "TESTO-TERM 342-1, TESTO-TERM 350, THERMO ENVIRONMENTAL AND OPACIMETER", All the equipment metes the Mexican Official Norms.

NOM-AA-35-1976	Carbon Dioxide, Monoxide and Oxygen emissions produced during combustion.
NOM-O85-ECOL-1994	Established the maximum of the following allowed emissions: smoke, particles, dioxide sulfur and oxides of nitrogen. It contains the requirements and operation limits
NOM-AA-114-1991	Stack gas smoke density test by the Spot Smoke Test.

The variables measured in the stack gases were:

- a. Stack gas temperature
- b. Stack gas composition
- c. Gas density
- d. SO₂ concentration
- e. CO concentration
- f. NO_x concentration
- g. Smoke opacity

Emission Reductions with the use of Xp³

TRUCK EVALUATED (YUCLE)		
PARAMETERS	CATERPILLA R.13	DRESSER-34
Nitrogen Oxides(NOx) ppm	23.87%	17.53%
Sulfur Dioxide (SO ₂) ppm	N.A	N.A
Carbon Monoxide (CO) ppm	20.54%	29.05%
Opacity (# SPOT) %	33.33%	25.00%

NOTES

- *The measurements of sulfur dioxide (SO₂), nitrogen oxides (NOx) and carbon monoxide (CO) are reported in ppm. They have been converted to normal conditions on dry base.*
- *The opacity (# spot) is produced by the soot particles. They are expressed here in percentage.*

RESULTS

TRUCK (YUCLE) CATERPILLAR.13				
PARAMETER	EMISSIONS WITHOUT Xp3		EMISSIONS WITH Xp3	
	TRIP 1(M-3)	TRIP 2(M-4)	TRIP 1(M10)	TRIP 2(M-9)
Nitrogen Oxides(NOx) ppm	1389.08	1645.11	1206.23	1 550.85
Sulfur Dioxide (SO2) ppm	()	0	0	0
Carbon Monoxide (CO) ppm	783.36	766.35	585.2	646.23
Opacity (# SPOT) %	60	60	40	40

TRUCK (YUCLE) DRESSER-34				
PARAMETERS	EMISSIONS WITHOUT Xp3		EMISSIONS WITH Xp3	
	TRIP 1(M-5)	TRIP 2(M-6)	TRIP 1(M-11)	TRIP 2(M-12)
Nitrogen Oxides(NOx) ppm	389.29	648.09	417.48	438.03
Sulfur Dioxide (SO2) ppm	()	0	0	0
Carbon Monoxide (CO) ppm	584.41	606.32	410.96	433.81
Opacity (# SPOT) %	40	40	30	30

TRUCK (YUCLE) CATERPILLAR-15				
PARAMETERS	EMISSIONS WITHOUT Xp3		EMISSIONS WITH Xp3	
	TRIP 1	TRIP 2	TRIP 1 (M-1)	TRIP 2 (M-2)
Nitrogen Oxides(NOx) ppm			417.48	438.03
Sulfur Dioxide (SO2) ppm			0	0
Carbon Monoxide (CO) ppm			410.96	433.81
Opacity (# SPOT) %			30	30

NOTES

- The measurements of sulfur dioxide (SO2), nitrogen oxides (NOx) and carbon monoxide (CO) are reported in ppm. They have been converted to normal conditions on dry base.
- The opacity (# spot) is produced by the soot particles. They are expressed here in percentage.

RESULTS (CONTINUATION)

TRUCK (YUCLE) CATERPILLAR-15				
PARAMETERS	EMISSIONS WITHOUT Xp3		EMISSIONS WITH Xp3	
	TRIP 1	TRIP 2	TRIP 1 (M-1)	TRIP 2 (M-2)
Nitrogen Oxides(NOx) ppm			446.09	385.57
Sulfur Dioxide (SO2) ppm			0	0
Carbon Monoxide (CO) ppm			512.56	497.09
Opacity (# SPOT) %			30	50

NOTES

- *The measurements of sulfur dioxide (SO₂), nitrogen oxides (NO_x) and carbon monoxide (CO) are reported in ppm. They have been converted to normal conditions on dry base.*
- *The opacity (# spot) is produced by the soot particles. They are expressed here in percentage.*