EMISSION TESTING

OF

CIUDAD JUAREZ, CHIHUAHUA BRICK KILNS

For

FEMAP

By

American Environmental Testing Co.

Sponsored by

El Paso Natural Gas Company

March 30-31, 1993

EXECUTIVE SUMMARY: EMISSION TESTING OF JUAREZ BRICK KILNS

1.1 Introduction

Federacion Mexicana de Asociaciones Privadas de Salud y Desarrollo Comunitario (FEMAP) requested assistance from El Paso Natural Gas Company (EPNG) to assess the emissions from brick kiln operations in Juarez, Chihuahua, Mexico. Therefore, on March 30 and 31, 1993, American Environmental Testing Company (AET), with assistance from EPNG personnel, conducted preliminary emission testing at five small brick kilns in Juarez. Also present during the testing were representatives of FEMAP, Comite Municipal de Ecologia Area Atmosfera, Secretaria de Ecologia del Estado de Mexico, and Empresas de Solidaridad.

Because of time constraints, this preliminary study was not exhaustive, but the focus was limited to identification of chemical compounds present and the approximate percent composition of the fuels, raw materials and products of combustion. Thus, detailed material balances or emission rates were not included in this initial study.

The sampling and analytical work done are described briefly below and will be described in more detail when AET's final report is available.

The scope of this initial study included:

- Minor modification of the kilns so that testing could be conducted.
- Measurement of temperature and sampling combustion gases for analysis.
- Sampling and analysis of the raw clay, unfired bricks, and each fuel used.

1.2 Testing and Analytical Methodology

As stated, the preliminary scope of work was confined to *qualitative* (not quantitative) analysis of the fuel and unfired brick components and emissions from the kilns. That is, this study identified the concentrations of "generic" pollutants (e.g., CO, NOx, etc.), but only the relative percent concentrations of the organic compounds present in the combustion gases. No attempt was made to close detailed material balances or to quantify emissions. This was due to the fact that standards were not immediately available for some of the trace compounds detected in the effluent gases.

Because the five brick kilns are open-topped and have no stacks, it was necessary to build and provide a ceramic cover, fitted with a stack and a sample port and placed temporarily over each kiln top during the testing.

U.S. Environmental Protection Agency test methods were used to obtain the samples and analyze them for the compounds and operating conditions listed in the tables below.

1.3 Results

Table 1 lists the concentrations of "generic" air pollutants (CO, NOx, etc.) and operating conditions during the testing. Information on the compositions of fuels burned and of raw materials will be included in the final AET report. Table 2 provides the *relative percent concentrations* of organic compounds detected in the combustion gases. It should be noted that these relative numbers should be compared only from kiln to kiln--not compound to compound.

1.4 Conclusions Based on the Analytical Results

- High concentrations of CO were emitted by all the kilns except kiln 5 (the "Ecological" kiln).
- Kiln 5, equipped with a naturally aspirated propane burner, produced the lowest concentrations of CO.
- Kiln 5 produced the most consistent emission results of all the kilns tested; that is, the ranges were narrowest of all. This indicates the most stable, dependable operation among the kilns tested.
- Used motor oil and contaminated sawdust produced the greatest numbers of organic compounds, especially air toxics.
- Some organic compounds appeared in all effluent gases regardless of which fuel was used; this is due to the fact that those organics evolved from straw and other organics in the raw clay mixture.

1.5 Other Observations Inferred from the Results and Technical Experience

Used Motor Oil - The used motor oil contained large quantities of hazardous metals, including lead, arsenic, chromium, cadmium, selenium and mercury. Burning of used motor oil results in emissions of these hazardous metals to the air, contamination of the bricks, and contamination of the kiln and the area around the kiln. Additionally, relatively large amounts (approximately 50 times as much as detected with propane fuel) of methylene chloride, an air toxin, were emitted while burning the used oil.

Contaminated Sawdust - The contaminated sawdust contained the following hazardous metals: molybdenum, barium, chromium, and mercury. Burning of the contaminated sawdust results in emissions of these hazardous metals to the air, contamination of the bricks, and contamination of the kiln and the area around the kiln. Relatively large amounts (from 5 to 50 times as much as detected with propane fuel) of the following toxins were emitted while burning the contaminated sawdust: Benzene, toluene, xylene and ethylbenzene. Additionally, poor control of the fuel-air mixture resulted in very high levels of carbon monoxide emissions, which were detected several times while burning the contaminated sawdust, approximately 10 times as high as detected with any of the other fuels.

<u>Clean Sawdust</u> - The clean sawdust contained the hazardous metals molybdenum and barium. Burning of the clean sawdust results in emissions of the hazardous metals to the air, contamination of the bricks, and contamination of the kiln and the area around the kiln. Additionally, relatively large amounts of methylene chloride (approximately 50 times as much as detected with propane fuel) was emitted while burning the clean sawdust. The use of the blower improved the fuel-to-air mixture resulted in much reduced carbon monoxide emissions as compared to contaminated sawdust without the blower; however, the carbon monoxide levels detected were still measurably higher than those detected using propane with a properly designed burner (approximately 2 to 6 times higher). Additionally, use of the blower significantly reduced the visual emissions (soot), however, visual emissions are still detectable early in the firing process.

1.6 Recommendations

- Further research should be done to quantify emissions from brick kilns.
- Further research should be done to determine optimum burner configuration. (EPNG has plans to conduct burner tests on kiln 5.)
- Optimize kiln design to be more energy efficient. In turn, this will reduce overall emissions to the air.
- Consider the use of a two-phased process for brick making: Slowly dry the raw materials in an open system over low heat, then fire the dried bricks with more intense heat in a closed kiln.
- Revert to the use of clean fuels, such as propane. Combustion of sawdust, especially contaminated blends, and used motor oil should be discontinued.

Table 1: "Generic Emissions" And Operating Conditions (See Note 1)								
Kiln	Fuel	Temp, F.	CO, ppmv	CO_2, %	NO, ppmv	NO_2, ppmv	SO_2, ppmv	O_2, %
1	Clean sawdust	103-116	649-1915	4.3-5.3	12-16	0	1-11	15.2-16.2
2	Used motor oil	120-154	329-1987	3.7-11.1	12-29	0-1	2-54	7.0-16.3
3	Propane	99-130	1853-4683	6.9-9.5	40-103	0	3-60	7.0-12.3
4	Contaminated sawdust	64-134	2671-29267	4.9-13.3	36-80	0	18-226	6.6-15.6
5 (See Note 2)	Propane	115-124	255-331	6.9-7.6	19-22	0	0-9	12.7-13.5

Notes:
1. Organic constituents of the products of combustion were identified, but not quantified. See Table 2.
2. This kiln was FEMAP "Ecological" kiln and was equipped with a naturally aspirated propane burner.

Table 2 Relative Percent Concentration of Organic Components of Combustion Products[1]

Component Detected	TWA,[6] ppm	Kiln 1 Sawdust		Kiln 2 Used Oil		Kiln 3 Propane		Kiln 4 Waste Sawdust		Kiln 5 Propane
		1-hr	5-hr	1-hr	5-hr	1-hr	5-hr	1-hr	5-hr	1-hr[3]
Acetaldehyde[4,5] and Methanol	100 200	63		71		100		84		
Acetamides[4,5]	10	X	X	X	X	X	X	X	X	X
Acetone[4,5]	750	X	X	X	X	X	X	X	X	X
Benzene[4,5]	10	<1	<1	2	X	<1	3	<1	100	2
Butanal/Other alkanal	N/A						X	X		
Ethylbenzene[4,5]	100								100	20
Ethynyl Benzene	N/A								X	
Formaldehyde[2,4]	0.3					X				
Furan	N/A						X		X	X
Heavy Siloxanes	N/A	X	X	X	X	X	X	X	X	X
Iodomethane[5]	2						X			
Ketone[4,5]/acetate	200						X			
Methylene Cl[4]	50	55		X	46	X		100		
Nitromethane	N/A							X		
Propane	1000				X					
Propenenitrile	N/A								X	
Terpenes[5]	N/A	X	X	X	X			X	X	X
Thiophene	N/A								X	
Toluene[4,5]	50			<1		<1	2	1	100	5
Xylenes[4,5]	100								100	23

NOTES:

1 Legend: X = detected but no relative concentration determined; 100 = largest concentration of the compound detected during any test; smaller numbers are relative percentages detected. Blank space means not detected. NOTE: Compare only one kiln to another -- not one compound to another.
2 Relative formaldehyde concentrations to be determined.
3 Only one 1-hr sample was analyzed for Kiln #5
4 Chemical included in the 189 Air Toxics List regulated under Title III of the 1990 Clean Air Act Amendments
5 Potential ozone precursor chemical
6 TWA - Time Weighted Average - Is defined as the acceptable exposure concentration for a normal 8-hr workday. Obtained from the 1992-1993 ACGIH publication.