KOPPERS INDUSTRIES, INC.

1991

Using Refined Coal Tar Emulsions Safely

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ABSTRACT

Occupational health issues involving sealcoating with refined coal tar emulsions are discussed including the results of air quality studies conducted during sealcoating, emulsion manufacturing and cure out. All data confirm that refined coal tar usage complies with health and safety regulations.

ACKNOWLEDGEMENT

Koppers Industries wishes to gratefully acknowledge the participation of Gem-Seal, Inc., Tampa, FL; Neyra Industries, Inc., Cincinnati, OH; and SealMaster, Inc., Sandusky OH.

Technical Assistance provided by Koppers Industries, Inc. employees Mr. James E. McFadden, Manager, Quality Control, Mr. Leo C. Whiteford and Ms. Mary Ann Deem was substantial and invaluable toward completion of this project.

INTRODUCTION

In response to continuing concerns from property owners, emulsion manufacturers and sealcoat contractors with regard to the potential for adverse effects of exposure to coal tar as well as asphalt products on health and the environment and coupled with a dearth of airborne data on pavement sealer manufacture/application, a series of field as well as laboratory studies were undertaken by Koppers Industries.

Koppers Industries, Inc. is a major distiller of crude coal tar into a variety of products including refined tars utilized in pavement maintenance and, as such, was positioned to undertake the necessary testing.

Crude coal tar is a by-product of making coke for the steel and foundry industries and constitutes a primary feedstock to the coal tar refining industry. Coal tars have been processed in the United States since Koppers Company completed the first by-product coke oven around 1912.

Crude coal tar is comprised of a complex mixture of naturally occurring compounds which are separated in the tar distillation plant into several fractions including refined tars, pitches, creosote and chemical oils. These fractions in turn have a multitude of end uses ranging from consumer products and industrial chemicals to construction materials. Industries utilizing coal tar derived products include wood treating, aluminum, steel, refractory, chemicals, protective coatings, reinforced plastics, roofing and road paving.

SCOPE OF STUDY

Study objectives included (1) characterizing any airborne emissions that might result from sealer manufacture, application and cure out, and (2) evaluating the regulatory status of refined coal tar sealer with respect to health and safety issues.

Air sampling was conducted during hand spray, squeegee machine and drag box sealer applications as well as batch milling utilizing a high speed shear mill, retail pail filling and bulk loading under what were considered representative operating and environmental conditions. In addition, emissions from the surface of sealed pavement immediately following sealer application were evaluated. Airborne emissions for all activities were characterized for those compounds listed in Table 1.

Since no specific Occupational Safety and Health Administration (OSHA) air standard exists for refined tar, the coal tar pitch volatiles (CTPVs) Standard as the benzene soluble fraction of collected dusts, fumes and mists has historically been employed to evaluate coal tar based products including refined tars. CTPVs (as benzene solubles) is utilized as an indicator of polynuclear aromatic hydrocarbons (PNAHs) where PNAHs are considered cancer causing compounds capable of producing skin tumors. Because many other non-PNAHs are soluble in benzene (i.e., aliphatics, resins, polymers), a CTPVs result can be misleading. To address this issue, selected samples were subjected to PNAH analyses where the CTPVs result approached or exceeded 0.1 milligram.

Table 1. AIR SAMPLE ANALYSES

COMPONENT	OSHA(1) Permissible Exposure Limit
Benzene	1.0 ppm(2)
Toluene	100 ppm(2)
Xylenes	100 ppm(2)
Cresols	5.0 ppm(2)
Phenol	5.0 ppm(2)
Naphthalene	10 ppm(2)
Coal Tar Pitch Volatiles (CTPVs)	0.2 mg/m3(3)
Polynuclear Aromatic Hydrocarbons (PNAHs)	where CTPVs approached or exceeded 0.1 milligram

(1) Occupational Safety and Health Administration.
(2) Parts of contaminant per million parts of air.
(3) Milligrams of benzene soluble particulate (including dust, fumes and mists) per cubic meter of air sampled.

Fifteen (15) PNAHs were evaluated using OSHA Analytical Method Number 58. These results serve as a true indicator of PNAH content and indirectly carcinogenicity. The 15 PNAHs were not arbitrarily selected, but represent those utilized by OSHA as an index of carcinogenicity.

A summary of study conditions as well as those sealer activities surveyed is provided in Table 2.

Table 2. STUDY CONDITIONS SUMMARY

Sealer Activities	Avg. Volume (gallons)	Avg. Area (sq. yds.)	# Samples	Ambient Temp. (°F)		Relative Humidity (%)	
				Avg.	Max.	Avg.	Max.
Hand Spray	1,300	9,300	12	84	94	82	95
Drag Box	1,500	10,000	4	82	94	85	89
Squeegee Machine	1,700	6,700	4	86	98	81	85
Pail Filling	3,000	603 pails	3	1041		67	82
Truck Loading	11,500	2 shifts	4	125-1332		67	82
Emulsion Manufacture (high shear batch mill)	20,200	15 batches	7	88	102	58	80
				230-2403			
Sealed Pavement - Head Space Tests		2 days	2	99-1044		81	85
Sealed Pavement - Fugitive Tests		2 days	2	114-1185		81	85

(1) Sealer tank filling temperature.
(2) Federal Material (RP355 E) loading temperature.
(3) Refined Tar (RT-12) storage tank temperature.
(4) Maximum enclosure temperature.
(5) Maximum pavement temperature.

It should be pointed out that all data represent the use of sealer emulsions formulated with refined coal tar meeting ASTM D 490 Standard Specification for Road Tars - Grade RT-12 as well as Federal Material RP355 E requirements. While formulations varied depending on job specifications, the refined tar content of sealer emulsions involved in the discussed studies was judged to be representative. Bulk samples of Federal Material and "as applied" sealer were collected in conjunction with each survey and revealed refined tar contents for Federal Material and "as applied" sealer ranging from 29-37 wt. % and 12-17 wt. % respectively.

AIR SAMPLE COLLECTION/ANALYSES

Air samples were collected and analyzed in accordance with Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) procedures and methods. The various collection media utilized were placed in the breathing zones of workers (see Figure 1) to approximate inhalation exposure potentials.

Figure 1. Air Sampling Media — Inhalation Exposure Assessment

Similarly, air samplers were placed directly on the surface of sealed pavement within 15 minutes of sealer application to evaluate head space and fugitive emissions where air samplers were located inside a 2.5 cubic foot enclosure (head space emissions) effectively covering a 2 sq. ft. area of sealed pavement (see Figure 2) as well as in an unshielded (fugitive emissions) configuration (see Figure 3).

Figure 2. Head Space Test Configuration

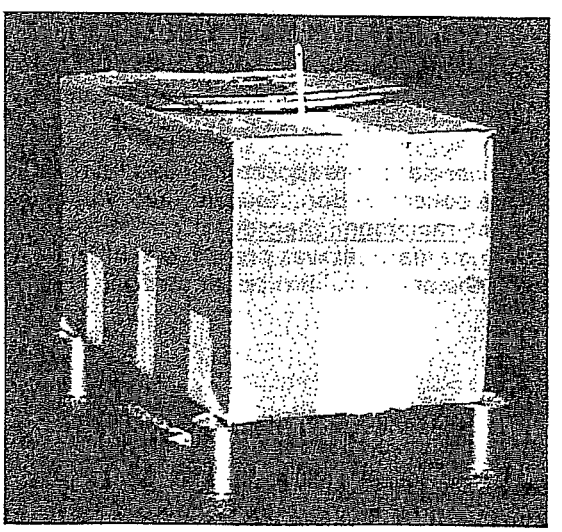
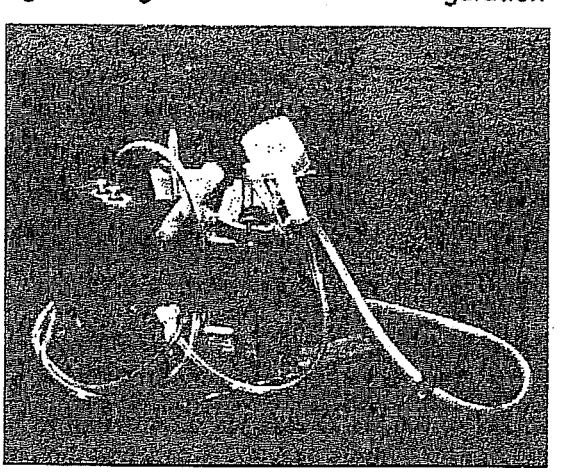


Figure 3. Fugitive Emission Test Configuration



Ambient air was drawn through the various collection media at predetermined flow rates via battery-powered portable sampling pumps.

All analytical work was contracted to an American Industrial Hygiene Association (AIHA) accredited laboratory.

RESULTS

General

Airborne concentrations of the various compounds tested were below the applicable OSHA Permissible Exposure Limits (PELs) in all cases. Most data were below the Analytical Limit of Detection and reported as the sample volume adjusted limit of detection for the analytical method employed. All data represent a full day of activity where sample durations generally ranged between 7-10 hours. This meets the OSHA sample duration requirements to determine compliance and assess exposure potentials.

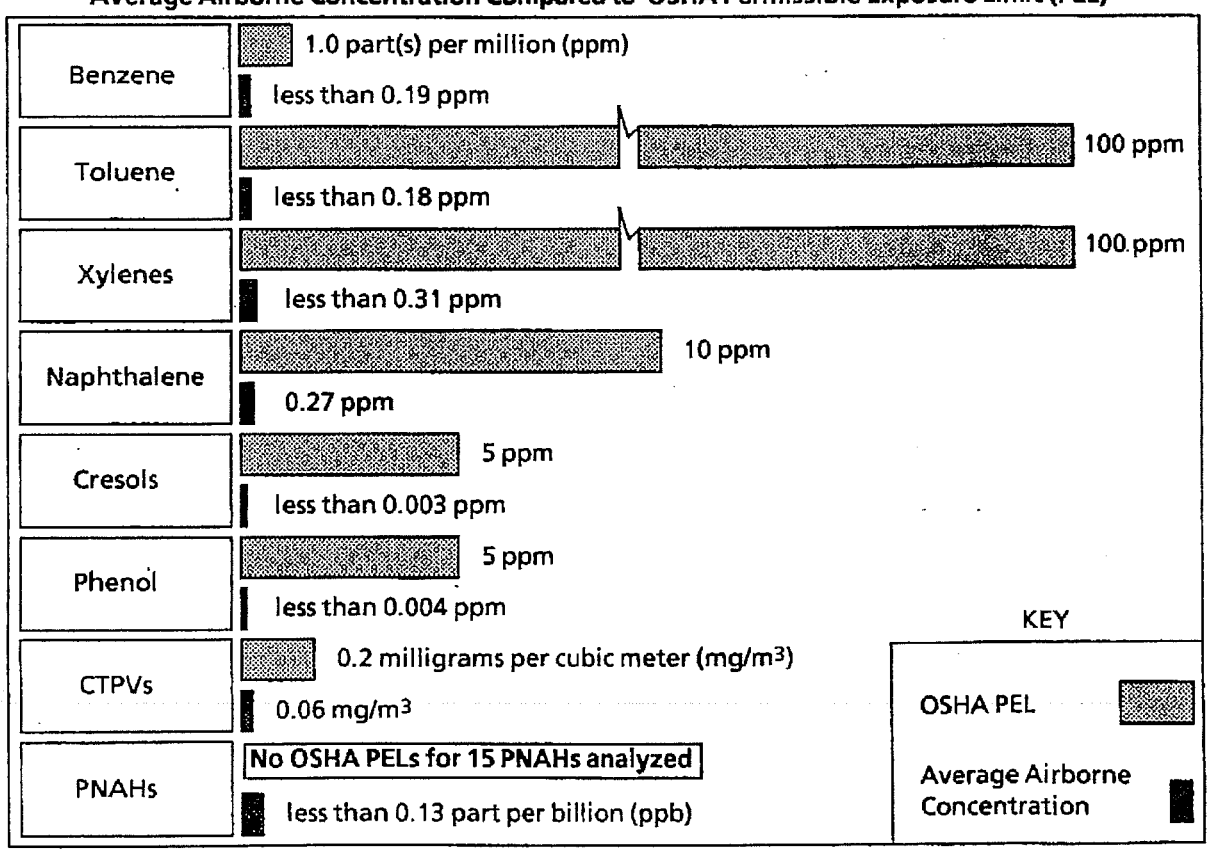
Where data are reported as less than a particular concentration, the involved values represent maximum theoretical concentrations where no material was present on the air sample at the analytical limit of detection.

Hand Spray Application

Airborne levels of volatile organics (benzene, toluene, xylenes and naphthalene) and semivolatile organics (cresols and phenol) were below detectable limits in all cases. CTPVs were detected on roughly 70% of the samples. However, the average concentration of those detectable levels was 0.07 mg/m^3 and the overall average for all samples including results below the limit of detection was 0.06 mg/m^3 where the OSHA PEL is 0.2 mg/m^3. While CTPVs levels were detectable, all data were well below the OSHA PEL. Analysis for 15 PNAHs was undertaken on the highest CTPVs samples (i.e., minimum of 0.1 milligram benzene soluble material). The resulting concentrations were below the analytical limits of detection (0.1-0.2 part per billion) for all 15 polynuclear aromatics.

Field survey air monitoring data are summarized in Figure 4.

Figure 4. HAND SPRAY APPLICATION MONITORING RESULTS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)



Drag Box and Squeegee Machine Application

All airborne concentrations of volatile and semivolatile organics as well as CTPVs were below the analytical limits of detection.

PNAH analyses were not undertaken due to less than detectable CTPVs results (i.e., low levels of benzene soluble material collected on filter samples). Because the levels of benzene solubles (i.e., CTPVs) were generally at or below the detection limit (i.e., 0.02-0.03 milligram), characterization for individual PNAHs was not feasible.

Field survey air monitoring data are summarized in Figures 5 and 6.

Figure 5. DRAG BOX MONITORING RESULTS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)

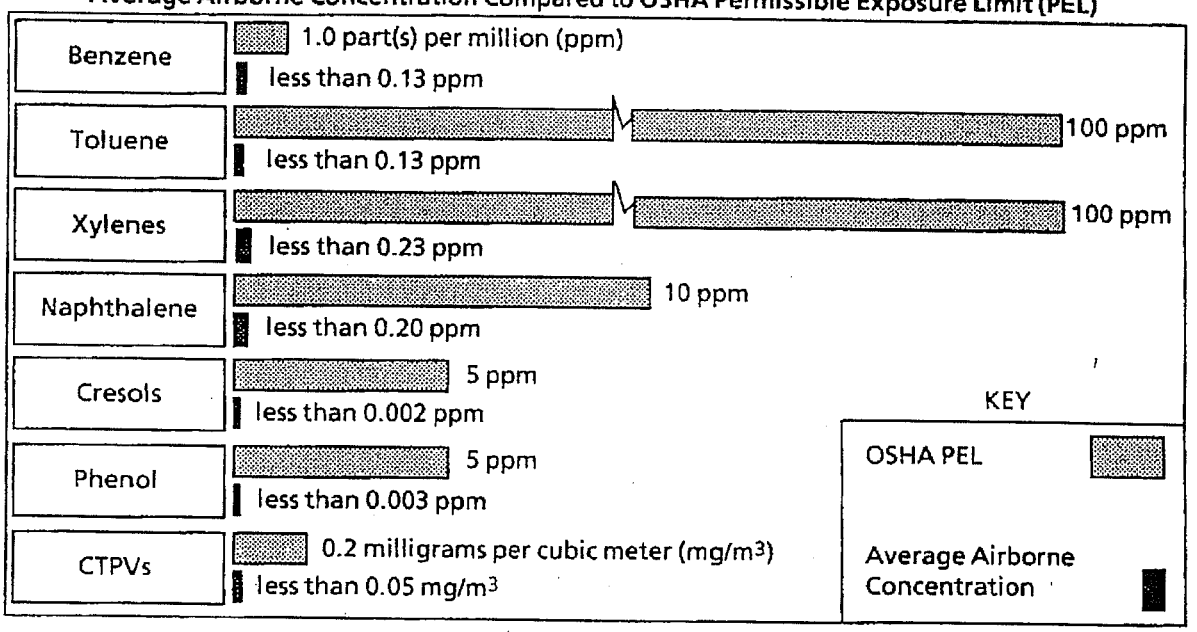
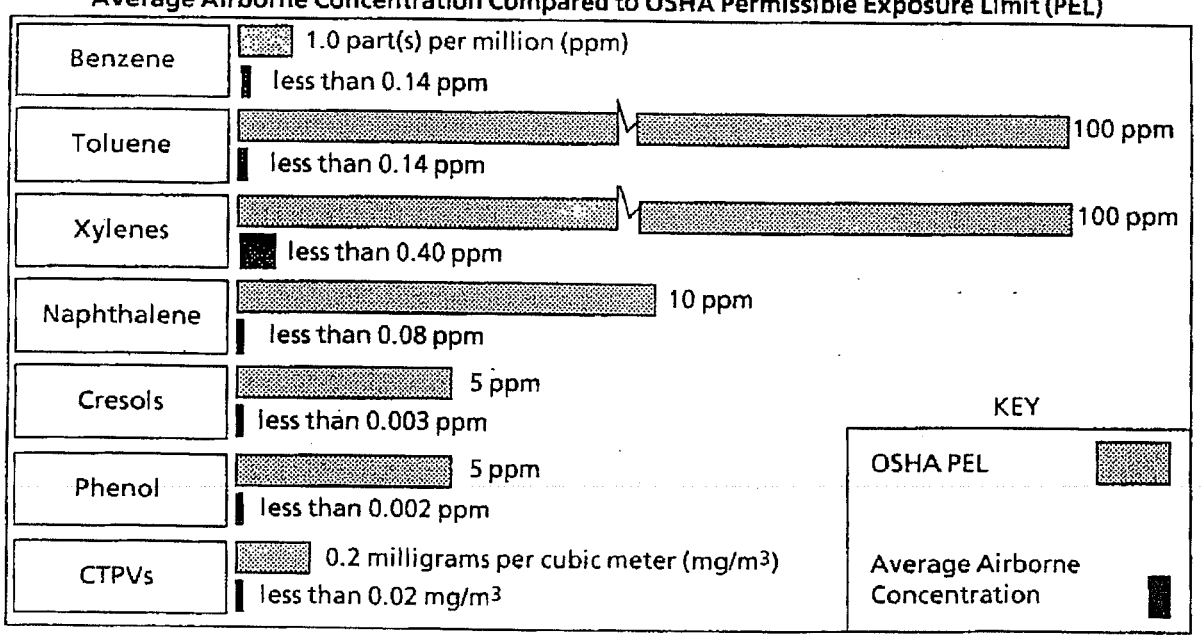


Figure 6. SQUEEGEE MACHINE MONITORING RESULTS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)



Pail Filling and Truck Loading

With the exception of two benzene results (0.15 ppm - during pail filling) and (0.1 ppm - during truck loading), all airborne data for volatile and semivolatile organics as well as CTPVs were at or below the analytical limits of detection. PNAH analyses were not undertaken due to negligible CTPVs results (i.e., low levels of benzene soluble material collected on filter samples). Because the levels of benzene solubles (i.e., CTPVs) were generally at or below the detection limit (i.e., 0.02-0.03 milligram), characterization for individual PNAHs was not feasible.

The two detectable benzene levels were less than 20% of the permissible limit and were not corroborated by area sample results obtained above the pail filling and bulk loading stations.

All area samples (pail filling station and bulk loading platform) were nondetectable for benzene where these area samples would be expected to represent worst-case conditions.

Because the personal samples in question were collected on employees with access to other areas of the plant where solvents and various hydrocarbon additives were being handled/repackaged as part of other coating systems, it is postulated that benzene most likely was present as a trace contaminant in a raw material(s) utilized for coatings other than pavement sealer.

All other data, including application results, support the contention of a non-tar and non-pavement sealer trace source of benzene.

Field survey air monitoring data are summarized in Figures 7 & 8.

Figure 7. PAIL FILLING MONITORING RESULTS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)

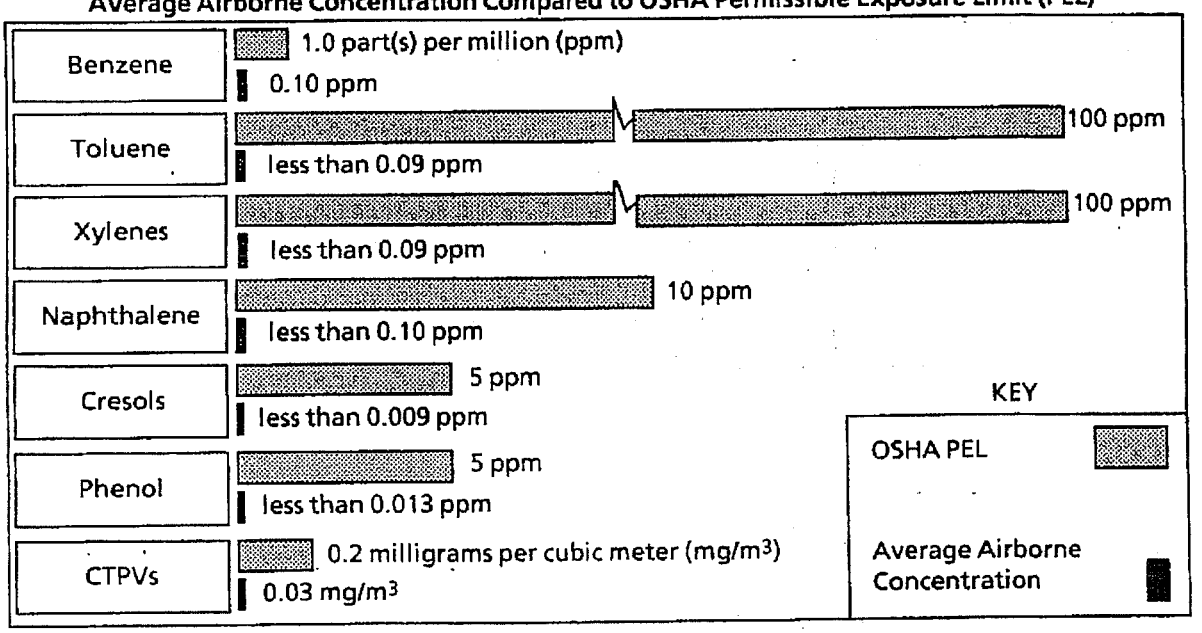
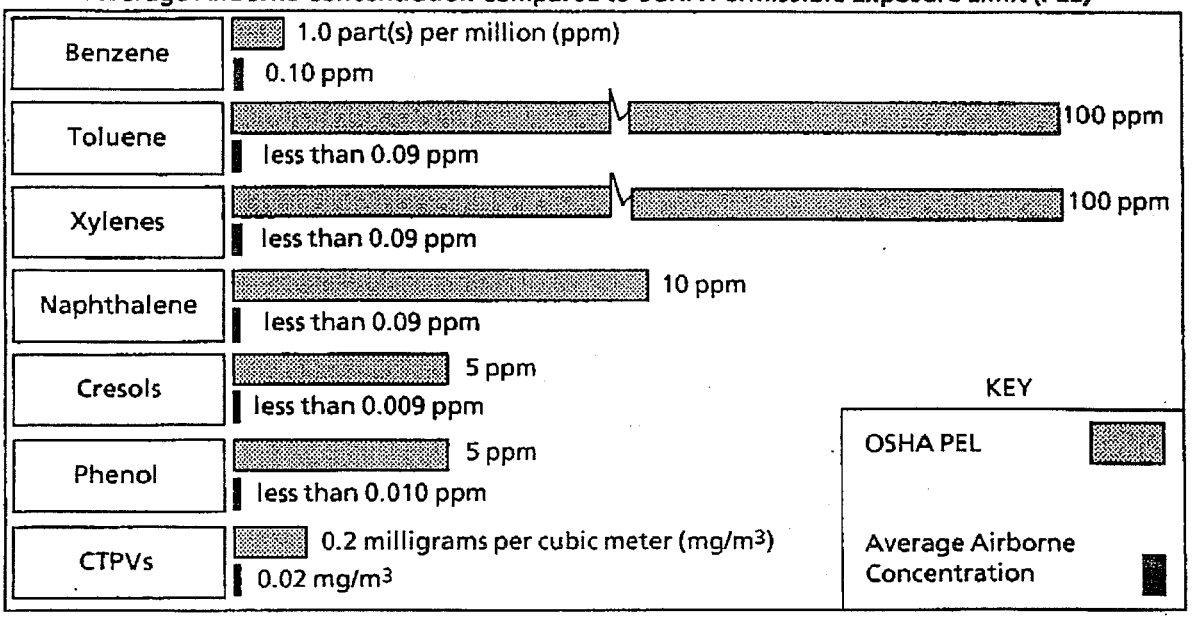


Figure 8. TRUCK LOADING MONITORING RESULTS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)



Emulsion Manufacture (high shear batch mill)

Seventy-five percent (75%) of volatile organic samples were below the analytical limits of detection. Detectable values were reported for benzene, toluene, xylenes and naphthalene ranging from 0.3% to 1.0% of the permissible levels and were not corroborated by area sample results obtained above the batch mill. All area (batch mill) samples were nondetectable for the involved organics where these area samples would be expected to represent worst-case conditions. Given the proximity and simultaneous operation of other coating and patching product manufacturing equipment to the batch emulsion mill, where these other products involved solvents and various hydrocarbon additives, it is felt that the detected volatile organics more than likely originated from raw materials utilized for these aligned products and not pavement sealer. All airborne data, including application results, support the contention of a non-tar and non-pavement sealer source of volatile organics.

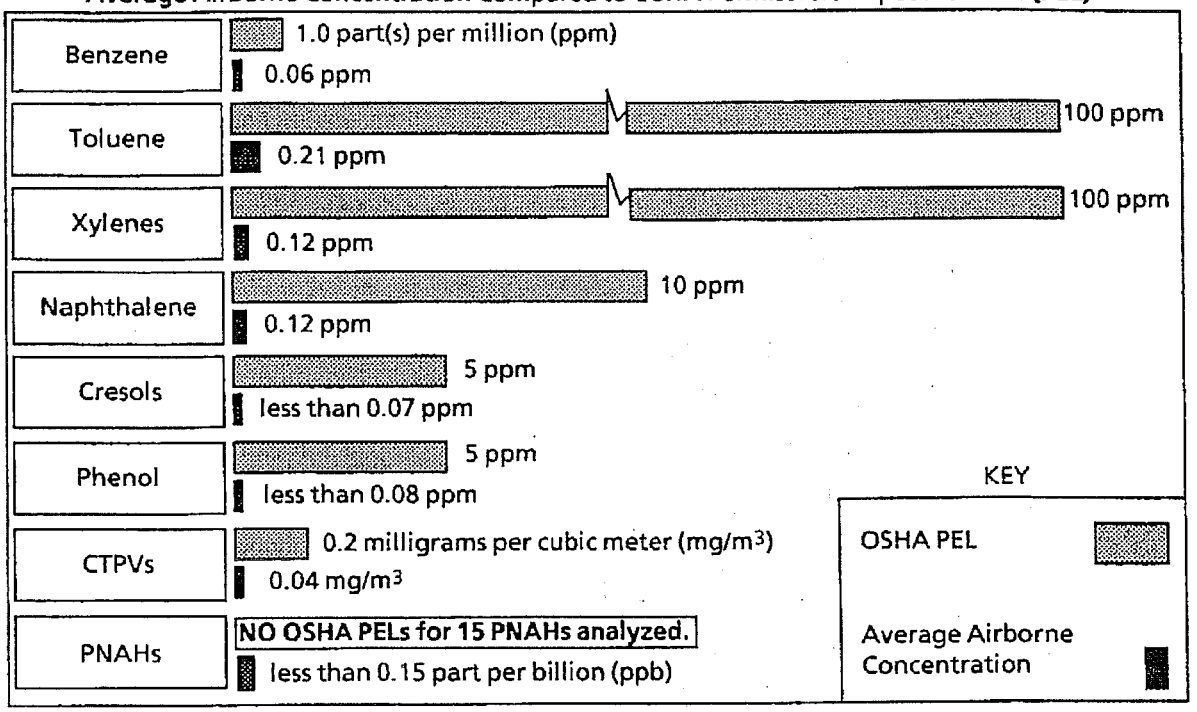
All airborne levels of semivolatile organics were below detectable levels and well below the OSHA PELs.

CTPVs were detected on 70% of the samples. The average concentration of those detectable levels was 0.05 mg/m^3 and the overall average for all samples including results below the limit of detection was 0.04 mg/m^3 where the OSHA PEL is 0.2 mg/m^3. While detectable levels of CTPVs were reported, all concentrations were well below the OSHA PEL.

PNAH analyses were undertaken on the highest CTPVs samples (i.e., minimum of 0.1 milligram benzene soluble material). The resulting concentrations were below the average analytical limits of detection (0.15 part per billion) for all 15 polynuclear aromatics.

Field survey air monitoring data are summarized in Figure 9.

Figure 9. EMULSION MANUFACTURE (HIGH SHEAR BATCH MILL) MONITORING RESULTS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)



Sealed Pavement Emissions

Head Space Emissions

With the exception of naphthalene, all airborne data for volatile and semivolatile organics were at or below the analytical limits of detection.

Detectable naphthalene levels were less than 2% of the permissible limit where the average concentration was 0.12 ppm compared to the OSHA PEL of 10 ppm.

CTPVs were present at roughly the limit of detection where the average concentration was 0.03 mg/m^3 and the OSHA PEL is 0.2 mg/m^3. While detectable levels of CTPVs were reported, concentrations were well below the OSHA PEL. PNAH analyses were not undertaken due to negligible CTPVs results (i.e., low levels of benzene soluble material collected on filter samples). Because the levels of benzene solubles (i.e.,CTPVs) were generally at the detection limit (i.e., 0.02-0.03 milligram), characterization for individual PNAHs was not feasible.

Field survey air monitoring data are summarized in Figure 10.

Fugitive Emissions

With the exception of naphthalene, all airborne data for volatile and semivolatile organics as well as CTPVs were at or below the analytical limits of detection.

Detectable naphthalene levels were less than 2% of the permissible limit where the average concentration was 0.12 ppm compared to the OSHA PEL of 10 ppm. PNAH analyses were not undertaken due to negligible CTPVs results (i.e., low levels of benzene soluble material collected on filter samples). Because the levels of benzene solubles (i.e., CTPVs) were below the detection limit (i.e., 0.02-0.03 milligram), characterization for individual PNAHs was not feasible.

Field survey air monitoring data are summarized in Figure 11.

Figure 10. SEALED PAVEMENT MONITORING RESULTS - HEAD SPACE EMISSIONS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)

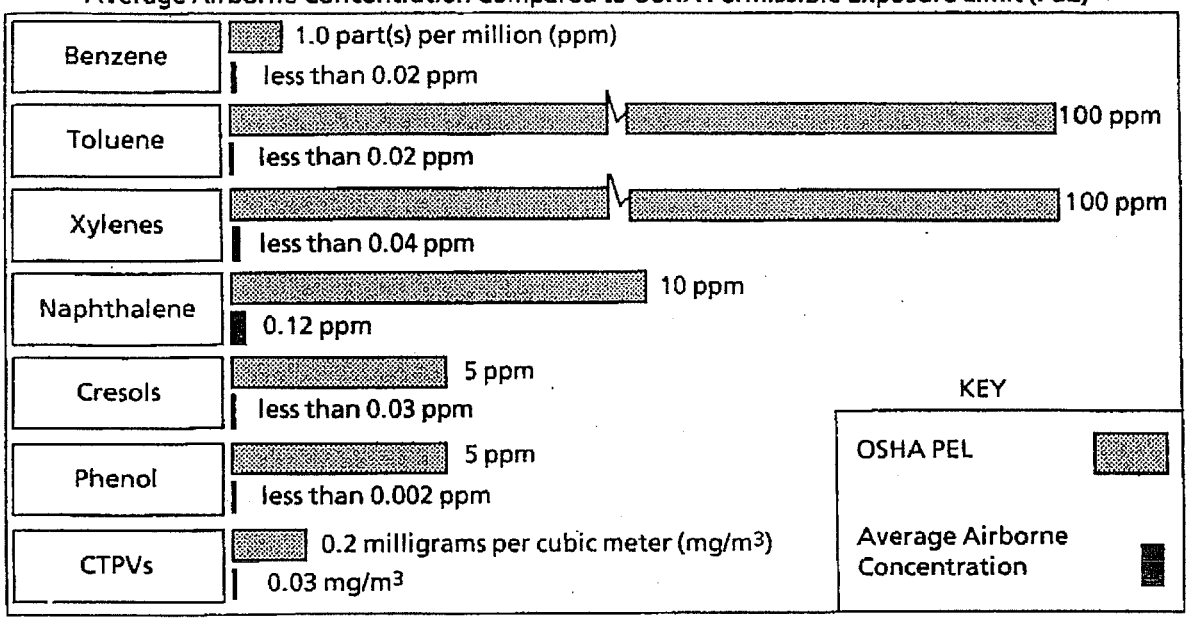
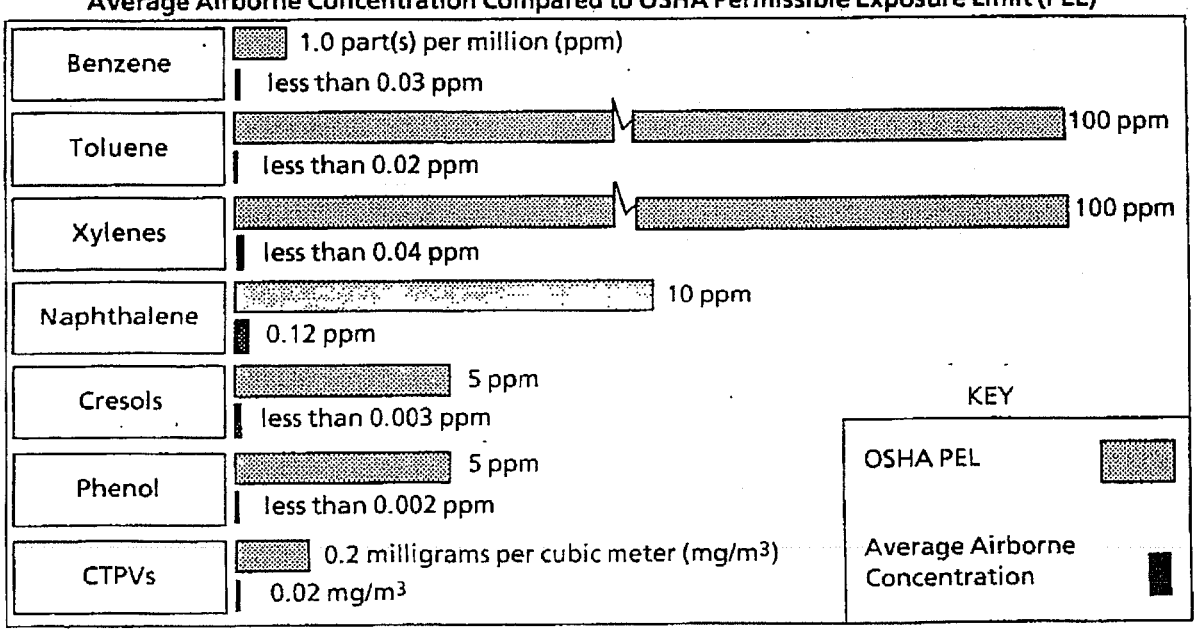


Figure 11. SEALED PAVEMENT MONITORING RESULTS - FUGITIVE EMISSIONS
Average Airborne Concentration Compared to OSHA Permissible Exposure Limit (PEL)



CONCLUSIONS

Air monitoring data collected under representative field conditions involving a variety of refined coal tar sealer application and handling scenarios indicate emissions during sealer application and manufacture are negligible and well below occupational health exposure limits. Similarly, emissions from sealed pavement during cure out are negligible and of no health consequence for applicators or the general public, including pedestrians and property owners.

Refined coal tar (Grade RT-12) as well as refined coal tar emulsions will continue to be available and are not the subject of any regulatory reviews or bans.

Like most industrial chemicals, coal tar has potentially hazardous properties. These potential hazards are well known and can be controlled by following some simple work practices and using good personal hygiene. Refined coal tar sealer can be used safely by following these simple rules:

- Read the manufacturer's Material Safety Data Sheet and follow the recommendations.
- Avoid prolonged direct contact with skin and eyes. If refined tar or sealer does get on your skin or saturates work clothing, the affected garments should be removed and involved skin areas washed with soap or waterless cleaners.
- Full-length clothing should be worn at all times (i.e., long-sleeved shirts buttoned over the glove cuff, long pants with close fitting cuffs extending below the top of work boots).
- Chemical resistant or liquid repellent gloves should be worn. Cloth gloves will absorb sealer.
- For highly sensitive individuals or where there is the possibility of skin contact and exposure to sunlight, a protective cream formulated for coal tar products or a general purpose protective cream applied in conjunction with a No. 15 sun lotion should be used.

GLOSSARY OF TERMS

American Industrial Hygiene Association — Professional organization charged with ensuring all aspects of occupational health evaluation are conducted in a scientific, ethical and professional manner.

Analytical Limit of Detection — The smallest amount of a substance that can be determined by a specific analytical method. When a material cannot be detected at this lower limit, values are reported as less than (<) the limit of detection divided by the air sample volume or what is called the volume-adjusted limit of detection. Values reported in this manner should be considered maximum theoretical concentrations and representative of a worst-case value.

ASTM — American Society for Testing and Materials; a scientific and technical organization for the development of standards on characteristics and performance of materials, products, systems, and services.

CTPVs — Coal tar pitch volatiles; a measure of dusts, fumes, mists that are soluble in benzene (i.e., PNAHs) and an index of carcinogenicity. Historically used to evaluate exposure to coke oven emissions, now applied to all coal tar-derived products.

Distillation — A separation process that consists of driving vapors from a hydrocarbon solution by heating, then condensing to a liquid product. Is used for purification and/or fractionation.

Material Safety Data Sheet (MSDS) — A summary document required by law for all chemicals. Provides health, safety and environmental information as well as physical properties.

mg — milligram; a metric unit of weight, in this case, the amount of a material trapped on a specific collection media. There are 1,000 milligrams in one gram (g) of a substance.

m^3 — cubic meter; a metric unit of volume, in this case the volume of air passed through a specific collection media. The volume of air contained in an enclosed space roughly 40 inches on all sides.

mg/m^3 — Milligrams per cubic meter; a unit for measuring concentrations of particulates or gases in the air [a weight (in milligrams of contaminant) per unit of volume (in cubic meters of air sampled)].

NIOSH — National Institute for Occupational Safety and Health of the Public Health Service, U. S. Department of Health and Human Services (DHHS); federal agency which, in addition to other activities, tests and certifies respiratory protective devices, air sampling and analytical methods/procedures, recommends occupational exposure limits for various substances and assists OSHA in occupational safety and health investigations and research.

OSHA — Occupational Safety and Health Administration of the U. S. Department of Labor; a federal agency with safety and health regulatory and enforcement authority for most of U. S. industry and business.

PEL — Permissible exposure limit; an exposure limit established by OSHA's regulatory authority. Airborne concentration at which workers would not experience health effects.

PNAHs — Polynuclear Aromatic Hydrocarbons; organic compounds usually composed of three or more carbon rings. It is believed that some of these compounds are capable of causing skin tumor formation upon repeated and prolonged exposure.

ppb — Parts per billion; a unit for measuring the concentration of a gas or vapor in air; parts (by volume) of the gas or vapor in a billion parts of air. Equal to one inch in 16,000 miles or one second in 32 years.

ppm — Parts per million; a unit for measuring the concentration of a gas or vapor in air; parts (by volume) of a gas or vapor in a million parts of air. Equal to one inch in 16 miles or one minute in two years.

Protective Cream — A protective skin cream provides an invisible, flexible protection for the hands from soils, solvents, dusts, powders, oils, greases, paints, epoxies, resins, inks and irritants. It can be easily removed by washing with any cleansing product.

Semivolatile Organics — For purpose of this study, semivolatile organics refers to cresols and phenols.

Volatile Organics — For purposes of this study, volatile organics refers to benzene, toluene, xylenes and naphthalene.