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AIR QUALITY IN BALTIMORE AND OHIO TRAINS DESCENDING THE ALLEGHENY - PIEDMONT GRADE IN WEST VIRGINIA

An investigation for the Federal Railroad Administration conducted by the FAA Aeronautical Center Industrial Hygiene Section, Oklahoma City, Oklahoma

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SUBMITTED BY Robert N. Thompson

ROBERT N. THOMPSON, Ph.D.
Chief, Industrial Hygiene Section

INTRODUCTION

On 28-29 November 1972, acting upon a request from the Federal Railroad Administration's Office of Safety, air quality tests were made by the FAA, Aeronautical Center, Industrial Hygiene Section, in Baltimore and Ohio (B&O) Railroad caboose cars near Cumberland, Maryland. This investigation was conducted in response to a complaint filed with the State of Maryland, Department of Mental Health and Hygiene alleging that smoke produced during prolonged braking of railroad cars may be hazardous to the health of employees riding in caboose cars. The air in the cars was sampled in an attempt to identify and quantify the particulate and vapor fractions of the subjectively detectable material and to assess the effect that such products might have on the occupants.

PROCEDURE

The site selected for the tests is on the B&O line between Altamont, W. Virginia and Piedmont, a seventeen mile section of track descending on an approximate 2.0% grade. Trains negotiating this grade apply brakes for virtually the entire distance and apparently in the process create considerable smoke which is readily visible outside the trains. There was speculation by some that the smoke may have been caused wholly or in part by burning flange lubricant on the tracks.

Tests were performed on four trains; a manifest train, two coal drags, and a grain train in that order. The first two trains were boarded at Altamont and the last two at Mountain Lake Park, Md. Air sampling inside the caboose cars began at Altamont and ended at Piedmont on each run.

SAMPLING

In conversations with brake shoe manufacturer's representatives, we learned something of the probable contents of the composition shoes. Though general due to its proprietary nature, the information did provide some clues to the pyrolysis products we might expect to find in our sampling activities.

One obvious requirement in this type of investigation is that all of the sampling equipment must be portable and battery or hand powered. Consequently, we resorted to the use of (1) direct reading gas detector tubes and (2) personal samplers for vapor and particulate collection.

(1) Direct reading gas detector tubes were used to measure sulfur dioxide (SO_2), carbon monoxide (CO) ammonia (NH_3) and styrene ($C_6H_5CH{:}CH_2$) any or all of which could have been present in the caboose air. In this sampling method, a metered quantity of air is aspirated through a glass tube containing a chemical selected to react with a specific gas or vapor. The reaction produces a color change in the tube contents, the length of which is proportional to the concentration of the gas in the sample of air.

(2) Personal samplers are small battery operated pumps which attach to the wearers clothing and aspirate air from his breathing zone at a constant flow rate throughout the sampling period.

One sampler was used to draw air through a tared membrane filter having a pore size of 0.45 micron (μ). The particulates trapped on the filter surface were returned to the FAA, Aeronautical Center, Industrial Hygiene Laboratory where they were weighed and then examined with a light microscope for identification and sizing.

Another sampler was used for vapor collection by drawing air through a 127mm x 6mm glass tube containing activated charcoal. These tubes were sealed after sampling and returned to the laboratory where they were desorbed with carbon disulfide and analyzed on a gas-liquid chromatograph using a flame ionization detector.

RESULTS

On the first run, a manifest train, we detected no contamination in the caboose either subjectively or by test.

On the second run, the smoke became very dense and visibility in the caboose was severely restricted. Although it was certainly an annoying condition, we did not find it irritating or restrictive to our breathing throughout the fifty minute sampling period.

We would classify smoke concentrations on the third and fourth runs as medium and light respectively when compared with the conditions encountered in the second run.

On the basis of our observations and tests, we conclude that the smoke arises from the "burning" of the brake shoes and that little, if any, comes from burning flange lubricant.

The gas, vapor and particulate sampling results are recorded on page 8.

GASES AND VAPORS

The only contaminant present in measurable amounts using the direct reading gas detector tubes was carbon monoxide. It was detected during each run, but only in trace (T) quantities, less than 10 parts per million parts of air sampled (ppm). The other gases i.e. SO_2, NH_3 and styrene, if present, were in concentrations too low to measure by this method.

The activated charcoal - gas chromatography method used for collection and analysis of vapor contaminants is extremely sensitive to low concentrations. Only during the second run did we collect any measureable, though minute, quantity of material. A chromatographic "fingerprint" of this sample bore a strong resemblance to a similar chromatogram of pyrolyzed brake shoe material. Although the components of the sample represent physiologically insignificant air-borne concentrations of contaminants that could be emitted from the brake shoes, we are continuing with tests to identify and quantify each.

PARTICULATES

Particulate concentrations ranged from 0 milligrams per cubic meter (mg/M^3) of air sampled on the first run to 19.75 mg/M^3 on the second run. Microscopic examination of the filters revealed that virtually all of the collected material was black smoke particles (soot) ranging in size from < 1 micron (1/25,000 inch) to 6 micron. We saw no asbestos fibers on any of the filters.

CONCLUSIONS

Air quality standards of the Occupational Safety and Health Administration (OSHA) established by the Federal Occupational Safety and Health Act of 1970 contain air-borne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day (8 hr), week after week (5 days) without adverse effect. They are time-weighted concentrations which means that excursions above the limit may be permitted provided they are compensated by equivalent excursions below the limit during the work day. These threshold limit values (TLV's) are based on the best available information from industrial experience, from experimental human and experimental animal studies, or possibly combinations of the three.

Threshold limit values for all air-borne substances sampled directly on the trains are included in the table on page 8. Only the TLV for nuisance particulates of $10mg/M^3$ was exceeded during the 50 minutes of sampling on run number two when the concentration reached 19.75 mg/M^3. However, a time-weighted average for an 8 hour

period which included only one such exposure, or even two, would fall far below the TLV. The 50 minute excursion above the TLV would be easily compensated by the much longer exposure to air not contaminated with the smoke. This sample which was collected in the caboose of a long coal drag probably represents the worst condition of this particular smoke problem that would be encountered on this line.

Asbestos, which is an important ingredient in brake shoes, was not detected in its hazardous (fibrous) form in any of the air samples. When subjected to temperatures of 900°F, fibrous asbestos is reduced to a relatively inocuous powder.

Carbon monoxide, traces of which were detected on each run, is probably traceable to the heaters used in the cars.

We have checked TLV's for other substances which may be degradation products of pyrolyzed composition brake shoes such as phenols and formaldehyde and find that the concentrations of our chromatographically separated charcoal tube sample components are far below such limits.

In summary, air sampling in caboose cars of four B&O trains descending the grade from Altamont, W. Virginia to Piedmont, W. Virginia revealed only traces of CO and no measurable amount of SO_2, NH_3 and styrene. During one run the TLV for nuisance particulates was exceeded briefly but not significantly when the period of exposure was considered. Other collected vapor components of the brake shoe smoke were present in only trace quantities and not physiolegically significant.