ROUGH

Report On

California Research Project On
The Use of Fuel Containing X-105A

This report describes the results of an investigation undertaken to determine the concentrations of lead in the air of a garage, in which service of all types was provided for a fleet of taxicabs, related, during and after as resulting from the use of three different leaded fuels. period of time, and blended into three successive parts, in each of which a specific leaded fuel was being The initial observations, designated as Phase I, made with a part of the experimental fuel, while was in use, commercial gasoline containing 1.7 ml. of tetraethyl lead, were base-line observations were made used for comparison with those determined in subsequent observations to be made by Phase were continued into the second segment of time (Phase II), in association with the use of a blend of gasoline containing and still later Phase III, while 3 ml. of tetraethyl lead per gallon, (Phase III) and, subsequently, tetraethyl lead with still another blend (Phase III) containing X-105A in such concentration as to make its content of lead equivalent to that during Phase II. of the fuel used in the investigation with the Phase II fuel.

The observations with Phase I gasoline began at 3:45 p.m. on April 28 and continued until 12:00 noon on May 12. Tests with Phase II fuel were started immediately thereafter and continued through 4:00 p.m. on June 3, 1959. The final period of investigation with Phase III gasoline continued for the next six weeks and a period of was completed at 9:00 a.m. on July 13, 1959. This report, however,

considers the findings obtained during the period of the investigation with Phase III fuel in two periods each of three weeks duration so that they can be compared with those obtained during periods of time approximately equivalent to those used in the studies with the other two fuels.

Summary and Conclusions

The concentrations of lead in the air of the garage did not differ from each other significantly during the periods of investigation with Phase I and Phase II fuels. During the period of investigation with Phase III gasoline, the concentration of lead at the fueling island was approximately three times that present in the air during the periods when the other two fuels were used. The mean concentrations of lead in the air at the fueling station were 1.08, 1.23, and 3.35 micrograms per cubic foot of air respectively during the test periods with Phases I and II fuels and during the first three weeks of the investigation with Phase III fuel. These concentrations correspond to 38, 43.5 and 118 micrograms of lead per cubic meter of air. The mean concentration of lead in the air during the last three weeks of the investigation with

Phase III fuel was practically identical with that found to be present in the air during the first three-week period.

No relationship could be demonstrated between the concentration of lead and the temperature or the velocities of ~~air~~ the movements which were observed during the investigations with Phase I and Phase II fuels or during the first three weeks of the investigation with Phase III gasoline. During the last three weeks of tests with the latter fuel, the concentration of lead appeared to vary inversely with the velocity of the movement of air and to increase directly with the temperature. These variations, observed during one period of three weeks, possibly could be due to chance alone and need to be verified ~~with a long-term~~ over more prolonged periods of investigation particularly during periods of exceptionally warm weather.

Approximately 25% of the lead in the air during the periods of investigation with Phase I and Phase II fuels, was found to be particulate in nature. During the first three weeks of the investigation with Phase III fuel, 21% of the lead was in the particulate form. During the last three weeks (Phase III), 14% of the lead was found to be particulate in nature.

The mean concentrations of particulate lead in the air of the garage, as determined by the analysis of the dust deposited hourly on the tapes of an A.I.S.I. smoke sampler were 5.18, 6.35 and 7.02 micrograms per cubic meter of air during the respective periods of investigation with Phase I, Phase II and Phase III fuels. These concentrations do not differ significantly from the average concentration of 6.75 micrograms per cubic meter of air in the outside air at a downtown area in Los Angeles as observed during August through November in 1954. The patterns of the average hourly concentrations, during each period of investigation, show three peak concentrations, two that coincide with the periods of maximum fueling activity, from 10:00 p.m. to 2:00 a.m. and from 2:30 p.m. to 6:00 p.m., and still a greater peak between 8:00 and 9:00 a.m.

The ventilation in the garage was good during the periods of investigation with Phase I and Phase II fuels. The velocity of the movement of air throughout the lower garage area during these two periods averaged approximately 90 feet per minute. The velocity of the movement of air decreased significantly during the investigation with the Phase III fuel. The velocity averaged

57.6 feet per minute during the first three weeks and 65.8 feet per minute during the last three weeks of the latter test period.

The mean temperature increased slightly during each period of investigation. The respective mean temperatures during the periods of testing with Phase I, Phase II and during the first three weeks of the period of investigation with Phase III fuel were 60.7°, 62.2° and 64.8° F. During the last three weeks of the last test period, the mean temperature increased to 67.6° F., principally because of two days of unusually warm weather when a maximum of 84° F. was recorded.

The levels of concentration of carbon monoxide as observed, except for one value of 200 ppm on July 10, were ~~always~~ below the ~~threshold limits~~ of 100 ppm. All ~~concentrations~~ were less than 40 ppm during the period of the investigation with Phase I and Phase II fuels and during the first three weeks while Phase III fuel was being used. However, eight values greater than 40 ppm were observed during the last three weeks of the period of testing with Phase III fuel (Table 11, appendix). During this period, the

more unfavorably from the aspect of comfort, no doubt, with the relatively low ~~and a low velocity of the movement of air.~~ velocity of air movements associated with somewhat stuffy weather.

Procedures

The concentration of lead in the atmosphere was determined with the Ethyl Lead-In-Air Analyzer in the blending area and at the loading racks in Richmond and in the sales yard in San Francisco and at the fueling islands and other locations in the garage. Samples were collected in the garage in general only during the periods of maximum activity, which were said to occur between 3:00 p.m. and 5:00 p.m. and between 11:00 p.m. and 2:00 a.m.

During the period of investigation with Phase I gasoline, samples were collected only at the fueling island, but when, during the latter part of the investigation with Phase II gasoline, addition help became available, the concentration of lead in the air in other areas of the garage was also determined. The Lead-in - Air Analyzer was capable of determining all (or essentially all) of the organic lead and, in addition, a considerable, but unpredictable, proportion (dependent largely upon the size of the particles), of the particulate lead. The particulate lead in the air, and the

determination made by the Lead-In-Air Analyzer, was established from time to time, by equipping the analyzer with a sampling head in which a millipore filter could be placed. The millipore filter removed the particulate matter so that only the organic lead vapors reached the scrubber of the Analyzer.

A record of the particulate matter present in the atmosphere of the garage was obtained by operating an A.I.S.I. smoke sampler continuously during the entire period of time required to complete the investigations with the three types of fuel. In this equipment, air at a known rate was filtered through a paper tape and the small quantities of dust deposited on the tape were then analyzed to determine the fluctuations in the concentration of particulate lead in the air during each hour of the three periods of investigation.

On each day that the air was monitored at any of the four locations, a record was kept of the dry bulb temperature and of the velocity of the movement of air at each of the sampling sites. In addition, the concentrations of carbon monoxide in the atmosphere of the garage were determined with NBS carbon monoxide indicator tubes

The millipore filters and the paper tapes of the A.I.S.I. smoke sampler were mailed to the Kettering Laboratory for analysis. Lead was determined by a dithizone method used routinely in the Laboratory.

Results

The concentrations of lead in the air at a number of locations, while batches of the special blends of fuels used in these tests were being blended, are summarized in Table 1. The results of determination of the concentration of lead in the air at the breathing zone of the loader of tank trucks during the time he was stationed at the dome of the tank truck, as well as that ~~XXXXX~~ obtained at ground level while trucks were being loaded with the three types of gasoline, are summarized in Table 2. The dry-bub temperatures and the velocities of the movement of the air during the periods of sampling are also recorded in the two tables. The mean concentrations, their standard deviations and the frequency of occurence of certain levels of concentrations of lead, as determined with the Lead-In-Air Analyzer in the Yellow Cab Garage during the periods of maximum activity, are given in summarized form in Table 3. Data as to the temperature, the velocity

of ~~air~~ movement and the concentration of carbon monoxide within the garage are given in Table 4. The levels of concentration of organic and particulate lead in the air, as determined by the analysis of material separated by the train sampler so as to show the partition between organic and particulate lead, are recorded in Table 5. Table 6 gives the mean concentrations, their standard deviations and the frequencies of the occurrences of certain ranges of concentration of particulate lead in the samples of dust collected on the tapes of the A.I.S.I. smoke sampler during each hour of the three test periods.

Figure 1 portrays the average daily fluctuation in the concentrations of particulate lead and of the Coh value, an empirically derived index of the soiling property of the dust in the air, for each of the three periods of investigation. All concentrations of lead, except those in Table 5 and Figure 1, are expressed as micrograms per cubic foot of air. The concentration of lead ~~as~~ micrograms per cubic meter of air can be calculated by multiplying the micrograms per cubic foot value by 35.3, the number of cubic feet in a volume of one cubic meter.

Table 7, in the appendix, summarizes the concentrations of carbon monoxide and lead, the temperatures and the wind velocities as observed during the last three weeks of the investigation with Phase III fuel. Tables 8, 9, 10 and 11 record, respectively, the frequencies of the occurrence of certain concentrations of lead during the second part of the investigation with Phase III fuel, the temperatures, the velocities of air movement and the concentrations of carbon monoxide observed during the three periods of investigation. Table 12 gives the average number of cars serviced with fuel during the intervals of time as observed on five different days.

Discussion

The exposure of operators to lead during the blending of Chevron gasoline (1.7 ml. TEL per gallon) was not determined since the fuel came from regular blended stock. Many observations elsewhere have shown that this exposure, under normal conditions of operations, is negligible.

The concentration of lead in the air, while batches of fuel were specially blended to be used in the Phase II and Phase III programs of the investigation, were at levels generally considered safe. The highest concentrations of lead were present in the air

at the thiefing station of the storage tank while samples were being drawn. The concentration of lead in the air during the blending of the batches of the special fuels used in this investigation cannot be considered as representative of ~~several~~ normal blending operations since the preparation of these blends required practices and equipment not used normally.

Loading Areas

The concentration of lead in the air at the breathing zone of the loader, while he worked at the dome of the tank truck, was slight (Table 2), the highest mean concentration being 1.5 micrograms of lead per cubic foot of air.

Yellow Cab Garage

The concentration of lead in the air at the fueling islands in the garage during periods of peak activity averaged ~~1.08~~ 1.23 and 3.35 micrograms per cubic foot of air respectively during the periods of investigation with Phase I, Phase II and Phase III fuels. These mean concentrations, when expressed as milligrams of lead per cubic meter of air, were ~~38~~ 22, 43.5 and 118 micrograms of lead during the periods of maximum activity at a location where

~~For~~ all areas ~~in~~ the garage were considered, the mean concentrations were 0.98 microgram/ft.^{3} (35.3 micrograms/cubic meter) and 2.77 (98 micrograms/M^3) respectively, during the period of testing with Phase II and Phase III fuels.

The particulate lead in the air averaged 43, 42 and 21 per cent of the lead ~~present~~ in the air respectively during ~~the periods of~~ investigation with the three fuels. These calculations include all of the ~~zero lead in air~~ and all of the concentrations of particulate lead associated with these particular findings. The quantities of lead on the millipore filters in these cases were generally near the limit detectable by the analytical method and, therefore, their accuracy is questionable. When these questionable ~~concentrations~~ were omitted from the calculation, the particulate matter was found to be 25% of the lead present in the air. A comparison of the quantities of lead found in the samples recorded in Table 5 with the mean concentrations recorded in Table 3, indicates that the lead-in-air analyzer trapped 90 per cent, or more, of the lead present in the air. (The efficiency of this instrument will not always be in this range since the size and the uniformity of the particles dispersed in the atmosphere

Particulate lead was present in comparatively low concentrations in the dust removed from the air of the garage by the tapes of the A.I.S.I. smoke sampler, the mean concentrations being 5.18, 6.35 and 7.02 respectively during the periods of investigation with Phase I, Phase II and Phase III fuels. ~~During two periods, the~~ mean concentrations were lower and, during the other period, slightly higher than the 6.75 micrograms per cubic meter found at a downtown station in Los Angeles during the period August - November of 1954 (Cholak, J., Schafer, L. J., Yeager, D. and Kehoe, R. A.: Report on the nature of suspended matter, Report for Air Pollution Foundation, Los Angeles, California, July 1, 1955).

The relationship between the concentrations of particulate lead and the total particulate matter present in the air, generally, as indicated by the empirical "Coh" unit for the three periods of investigation, is shown graphically in Figure 1. It may be seen that there were similarities in the fluctuations in the average hourly concentrations of lead and of the Coh values. The peaks in the graph for Phase I did not appear to bear any relationship to the times of peak activity within the garage. The dust spots on the tapes during the period of investigation with Phase I fuel

could not always be related to a definite period of time because of frequent power failures and some inadequacy in marking the tapes daily. Some of the deficiencies in marking were corrected during the periods of investigation with Phase II and Phase III fuel but, as can be seen, with little change in the form of the graphs. The maxima in the concentrations of lead and in the Coh values between 10:00 P.M. and 2:00 A.M. and 2:30 P.M. and 6:00 P.M. are associated with the hours of maximum activity and are more pronounced in the graphs for the period of investigation with Phase II and Phase III fuels than was the case for Phase I. The highest concentration of lead and of Coh value, however, were obtained not during the hours of maximum fueling activity, but in the morning hours between 6:00 and 9:00 A.M. This peak was evident in the graphs for all three periods and was said to be caused by general housecleaning activities which were carried out principally between these hours each day.

The concentrations of carbon monoxide in the garage were satisfactory at all times during the periods of investigation with the Phase I and Phase II fuels and during the initial three weeks of fueling with Phase III gasoline, there being only a few values

as high as 40 ppm. These low concentrations, during the periods when Phase I and Phase II fuels were used and during the first three weeks of the period during the use of Phase III fuel, showed no relationship to temperature or velocity of the movement of the air. However, during the last three weeks of the test period when gasoline provided with X-105A was being used, seven values of 80 ppm and one of 200 ppm were recorded. (Table 5, appendix). The concentrations of carbon monoxide in the air during the period of the last three weeks were examined along with temperatures and velocites of the air at the time of sampling. The higher carbon monoxide concentrations were found to be associated with elevated temperatures and the low velocities of air movement (Figure 4, Appendix).

The dry-bulb temperatures were not significantly different during the periods of investigation with Phase I and Phase II gasolines. During the period of investigation with Phase III fuel, there were several days of unusually warm weather and the mean temperature was significantly higher during this period than was the case during the periods of fueling with Phase I and Phase II fuels. An extremely hot July 10, when the temperature reached 84°, raised

temperature observed during the first three weeks of the period of investigation with Phase III fuel. During the latter three weeks, the concentration of lead in the air at the fueling island increased with increase in temperature (Figure 2, Appendix). This relationship was not observed during the other times and may be due to chance alone, but should be investigated further to establish its authenticity.

The velocities of the movement of air within the garage were not different statistically for the periods of investigation with Phase I and Phase II fuels and averaged 87 and 92 feet per minute, respectively. During the entire six weeks of the test with Phase III fuel, there were many occasions where the air moved at velocities less than 25 feet per minute, and the mean velocity during the entire period was significantly lower than was the case during the periods of investigation with Phase I or Phase II fuel. Except for the last three weeks of the investigation with Phase III gasoline, there was no relationship between the velocity of the movement of the air and the concentration of lead in the air of the fueling island. The scatter diagram in Figure 3 of the Appendix appears

velocity of the air decreased. This observation may also be due to chance alone and should be verified with further air studies.

Acknowledgement

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