AIRBORNE LEAD-CONTAINING DUST AND FUME FROM THE USE OF LEADED CUT-OFF WHEELS

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INTRODUCTION

It is common practice in the abrasive industry to utilize materials called fillers as ingredients in organic-bonded abrasives. These filler materials usually are inorganic in nature. A general review of fillers and their principles of operation is provided by Robie[1].

It is generally believed that lead and its compounds impart desired performance characteristics to bonded abrasive articles. For example, U.S. Patent #2,258,774 dated October 14, 1941 discloses the use of powdered lead, lead alloys, and other low temperature metals as fillers for organic bonded abrasives. These fillers supposedly function as lubricants during the cutting or abrading process to reduce heat generation and to extend abrasive life. Widespread usage of lead and its compounds as fillers in bonded abrasives has not occurred, however; probably because of industrial hygiene problems, to the manufacturer as well as to the user, which are associated with handling of lead. The study described in this paper was undertaken to define the nature and extent of the health hazard

(1) N. P. Robie, "Why Resinoid Wheel Fillers", "Grinding and Finishing" Vol. 7, No. 12, December, 1961, pp.44-46.

presented during the use of leaded cut-off wheels under conditions of no ventilation, as occasionally occur in the field.

COMPOSITION OF TEST WHEELS

Several sets of resin-bonded cut-off wheels were prepared for the study. The wheels were all 16" in diameter by 1/8" thick. One set of wheels contained only cryolite as filler. In the other sets of wheels, either lead chloride ($PbCl_2$) or a lead-tin solder (75% Pb - 25% Sn) replaced part or all of the cryolite so that lead contents of 3%, 6%, and 12% of the total wheel composition were introduced. The cut-off wheel compositions which were investigated in this study are shown in Table I.

WHEEL IDENTIFICATION	WHEEL COMPOSITION - WT. %			
	Abrasive	Resin	Cryolite	Pb Cpd
No Lead	68	16	16	0
3 - $PbCl_2$	68	16	12	4
6 - $PbCl_2$	68	16	8	8
12 - $PbCl_2$	68	16	0	16
3 - Solder	68	16	12	4
6 - Solder	68	16	8	8
12 - Solder	68	16	0	16

TABLE I. CUT-OFF WHEEL COMPOSITION

TESTING PROCEDURE

All cutting off operations were conducted with a standard chopper-type cut-off machine as shown in Figure 1. No coolant was used. The wheels were operated at 3340 RPM or 14,000 SFPM when at 16" in diameter. The test bars were 1-1/8" in diameter and were composed of C1020 steel which had been certified by the vendor to contain no lead. With the exception of one run, all tests were conducted without ventilation of the machine. The cut-off machine was located in a room 62 feet by 31 feet by 14 feet. No general ventilation of the room occurred during a test run. Between tests, the doors to the room were opened and the fume exhaust system for the room was turned on to clear the air of accumulated dust and fume. As a further precaution against having residual dust and fume from a prior test affect the current run, the wheels were tested in order of increasing lead content.

Also shown in Figure 1 are the two electrostatic precipitator devices used to collect samples of dust and fume from room air. These devices draw air at a known rate through a metallic tube whereupon fume and dust are collected by electrostatic means. The fume and dust are subsequently analyzed to determine lead content according to procedures established by the American Conference of Governmental Hygienists[2].

(2) "Determination of Lead in Air - A Single Extraction, Mixed Color Dithiozone Method", Approved January 2, 1951 by the Committee on Standard Methods, American Conference of Governmental Industrial Hygienists.

The lead content of the sample is then expressed as milligrams of lead per cubic meter of air. The American Standards Association[3] established in 1943 that the maximum allowable concentration of lead in air which was breathed by human beings to be 0.15 milligrams per cubic meter. This figure was modified at the 1953 meeting of the American Conference of Governmental Industrial Hygienists which met in St. Louis to 0.20 milligrams per cubic meter.

Two electrostatic precipitator air sampling devices are shown in Figure 1. The data reported in this paper are from samples collected from the device located within 6" to 8" of the operator's nose. The second device was used to collect air samples at a point approximately 6 feet from the cut-off wheel to determine general room contamination from the tests. The intake to the device located near the operator was positioned to prevent large particles from flying directly into the collector tube.

RESULTS AND DISCUSSION

The data on air contamination resulting from the testing of leaded cut-off wheels are summarized in Table II. As can be seen in the table, most of the test results were confirmed by running the wheels again during the second day of testing. Variation in testing time occurred because of electrical difficulties. The lead concentration of 0.24 milligrams per

(3) American Standard "Allowable Concentration of Lead and Certain of its Inorganic Compounds" Z37.11-1943, Approved September 16, 1943.

cubic meter of air which occurred during the second test of the unleaded wheel cannot be readily explained. It is supposed that this high value occurred because of residual leaded dust lying in the vicinity of the cut-off machine from the previous day's run. Otherwise, the data seem logical.

WHEEL IDENTIFICATION		TEST TIME IN MINUTES	TEST CONDITIONS	AIRBORNE LEAD IN MG./M^3
None		30	Background Sample	0.002
No Lead	(1st Day	18	120 Cuts-No Ventilation	0.04
	(2nd Day	26	120 Cuts-No Ventilation	0.24
3-$PbCl_2$	(1st Day	21	120 Cuts-No Ventilation	1.16
	(2nd Day	21	120 Cuts-No Ventilation	1.26
3-Solder	(1st Day	17	120 Cuts-No Ventilation	0.68
	(2nd Day	25	120 Cuts-No Ventilation	0.98
6-$PbCl_2$	(1st Day	34	120 Cuts-No Ventilation	1.70
	(2nd Day	0	-	-
6-Solder	(1st Day	21	120 Cuts-No Ventilation	2.01
	(2nd Day	22	120 Cuts-No Ventilation	2.25
12-$PbCl_2$	(1st Day	20	120 Cuts-No Ventilation	7.57
	(2nd Day	15	120 Cuts-No Ventilation	6.45
12-Solder	(1st Day	28	120 Cuts-No Ventilation	5.32
	(2nd Day	0	-	-
12-Solder		7.5	80 Cuts-Ventilation On	0.100

TABLE II. SUMMARY OF TEST RESULTS

In addition to the concentration of lead in air, consideration must be given to the particle size of leaded dust when evaluating its significance as a health hazard. Particles larger than 5-10 microns are not readily ingested into the human body, and normally are expelled in expectorant or by other means. The fine particles of lead materials constitute the health hazard. A second test series was run to determine particle size of the leaded dust and fume emitted during the testing of cut-off wheels, Twelve runs were conducted in a manner similar to that described above. Dusts from these tests were analyzed to determine particle size. On the average, 84% of all dust from these tests was less than 10 microns in size. Furthermore, analysis of this fine material revealed that most of the lead was in this portion of the sample, and relatively little occurred as particles larger than 10 microns.

These tests clearly demonstrate that the use of leaded cut-off wheels with unventilated machines results in hazardous amounts of lead-bearing dust and fume in the vicinity of the operator. Furthermore, the preponderance of this dust and fume is of a particle size to permit ingestion and absorption of the lead in the human body. The individual test shown at the bottom of Table II indicates that proper ventilation reduces airborne lead content below the maximum allowable concentration of 0.20 milligrams per cubic meter.

CONCLUSIONS

1. Leaded cut-off wheels are a health hazard, especially to the operator.
2. Proper ventilation can reduce the health hazard, probably to within safe limits.
3. Manufacturers of leaded cut-off wheels should inform their customers of the health hazards involved and should instruct them in the use of proper ventilation and other industrial hygiene measures to avoid adverse health effects to operating personnel.

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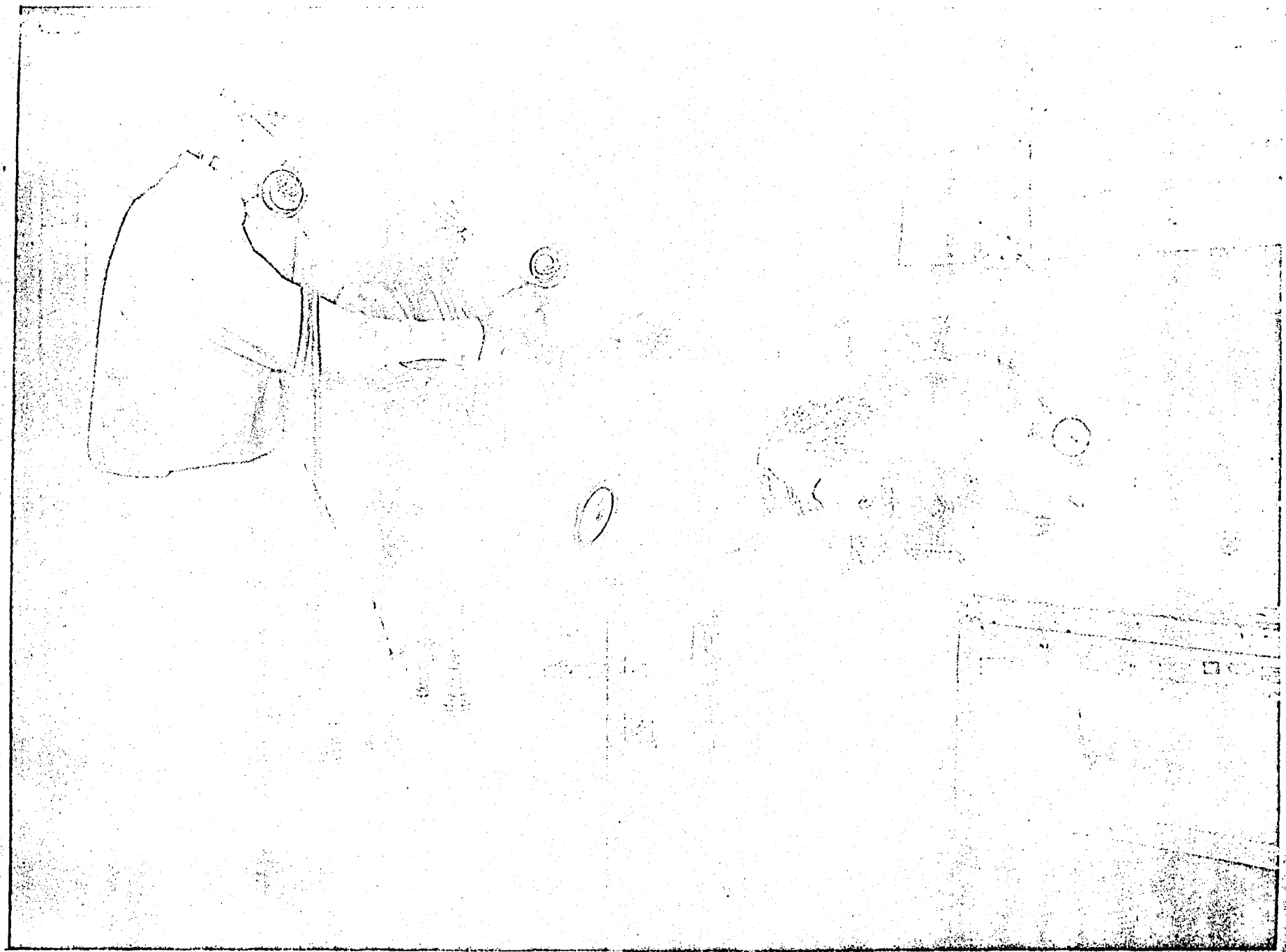

FIGURE 1 GENERAL TEST ARRANGEMENT