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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-160-285

CORHART REFRACTORIES
LOUISVILLE, KENTUCKY

MAY 1976

I. TOXICITY DETERMINATION

A Health Hazard Evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) in the no-bake mold department of Corhart Refractories' Louisville, Kentucky, plant on October 28-30, 1975, and on February 10, 1976. Breathing zone and general area air samples were taken to determine mold-room employees' exposure to formaldehyde, phenol, methylene diphenyl diisocyanate (MDI), phenylpropylpyridine, benzene, xylene, toluene, and petroleum distillates. In addition, sixteen employees were interviewed by the NIOSH medical officer.

Based on the analysis of environmental samples and the results of the medical investigation, it was determined that the employees working in the area in question have experienced transient, mild mucous membrane irritation due to fumes (probably of formaldehyde) emanating from the silica sand. However, based on currently available information, employee interviews, and physical examinations, there is no reason to suspect the development of any chronic conditions due to exposure to any of the substances in the concentrations found during this investigation.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH, Robert A. Taft Laboratories, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) Corhart Refractories Company
b) Authorized Representative of Employees
c) U. S. Department of Labor - Region IV
d) NIOSH - Region IV

For the purpose of informing the approximately 16 affected employees, the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees to evaluate potential hazards to employees in the no-bake mold department of the Corhart Refractories' Louisville, Kentucky, plant.

IV. HEALTH HAZARD EVALUATION

A. Process Description

The no-bake mold department is one of three areas in this plant that produce sand molds into which molten silica and alumina are poured to produce the refractory product sold by Corhart to the glass industry. Dry sand at approximately 90°F. is mixed with binders in an auger type mixer and dropped about four feet into the forms which shape the molds. In about five minutes the mold hardens due to the plasticizing of the phenol-formaldehyde resin. The molds are then separated from the forms, in some cases fitted with a top or core, and transported from the area. Until they are removed from the area, however, these fresh molds continue to off-gas into the atmosphere. Approximately sixteen men are involved in this operation.

B. Evaluation Design

1. Environmental

Environmental samples were collected from the breathing zone of the mold department employees by the use of battery operated personal sampling pumps worn by those employees. Two samples of approximately four hours duration were taken per employee per day. Similar pumps also were placed in fixed locations throughout the work area. Atmospheric contaminants were collected by adsorption onto charcoal or by absorption into a scrubbing solution. The charcoal and scrubbing solution samples were subsequently analyzed by gas chromatography for the various contaminants. Ventilation measurements were made with an Alnor "Senior" velometer. Detector tube measurements were taken at various times and locations during the survey for phenol and formaldehyde. Silica exposures were not measured since OSHA had previously addressed this problem at this plant, and since the addition of the binder reduced the amount of airborne dust resulting from this operation.

2. Medical

The medical investigation consisted of a thorough inspection of the no-bake area, medical interviews, and physical examinations if deemed necessary by the NIOSH medical officer. The medical interviews focused on the signs and symptoms associated with a toxic exposure to the agents discussed below.

C. Evaluation Criteria

1. Environmental

One of the criteria for this determination is the set of threshold limit values established by the American Conference of Governmental Industrial Hygienists (ACGIH).[1,2] The following table indicates the ACGIH maximum permissible exposure for various substances according to those TLV's:

Substance	Permissible Exposure 8 Hour Time-Weighted Average	
Formaldehyde	2.5 mg/M^3,*	2 ppm **
Phenol	19	5
MDI	0.2	0.02
Benzene	30	10
Toluene	375	100
Xylene	440	100

*Milligrams of contaminant per cubic meter of air.
**Parts of contaminant per million parts of air.

An approximate TLV can be calculated for petroleum distillates using a formula presented by the ACGIH. For the mixture of hydrocarbons grouped under the term "petroleum distillate" in this determination the TLV is calculated to be approximately 50 ppm or 300 mg/M^3.

Other criteria include the NIOSH recommended standards for occupational exposure to benzene[3], toluene[4], and xylene[5]. The maximum allowable concentration recommended by NIOSH for these substances is the same as those recommended by the ACGIH.

2. Medical

A brief description is given here of known pathophysiological effects of suspected agents. The medical interviews focused on these signs and symptoms.

a. Formaldehyde: Exposure to formaldehyde may product irritation of the mucous membranes of the eyes, nose, throat and respiratory tract. Its odor is detectable at 1 ppm and at 4-5 ppm lachrymation and

burning of the nose and throat occurs. At concentrations greater than 10 ppm, difficulty in breathing, intolerable burning of nose and throat as well as substernal discomfort occurs. These symptoms may persist for several hours after high exposures have terminated. Dermal sensitization to formaldehyde may occur following repeated, direct contact with the skin. Skin sensitization to formaldehyde vapor is rare. Formaldehyde is not currently considered a carcinogen.

b. Phenol

With rare exceptions, human exposure, in industry, has been limited to contact of phenol with the skin and to inhalation of phenol vapors. Intermittent industrial exposure has been reported to result in marked irritation of the mucous membranes of the eyes, nose, and throat. Chronic phenol poisoning has been infrequently reported. Severe chronic poisoning has been characterized by nausea, vomiting, difficulty swallowing, diarrhea, anorexia, headache, vertigo, and possibly by a skin eruption. The disease is usually fatal when there is extensive kidney and liver damage.

c. Methylene Diphenyl Diisocyanate (MDI): Exposure to high concentrations of MDI may produce symptoms of irritation of the skin and the mucous membranes of the eyes, nose, throat and respiratory tract, as well as a chemical pneumonia. In certain individuals, respiratory tract sensitization to low levels of MDI may occur so that once sensitization has occurred, exposure to even minimal concentrations may provoke a severe asthmatic reaction. Individual susceptibility to developing sensitization is variable but does not appear to be related to atopic status; however, sensitization may follow several episodes of severe irritation.

In summary, MDI may cause the clinical features of primary irritation of the mucous membranes or of sensitization.

d. Phenylpropylpyridine: As a member of the pyridine family, phenylpropylpyridine is a primary irritant which may produce intense irritation of the eyes and skin. Prolonged and excessive exposure to this family of compounds may produce headache, dizziness, fatigue, gastrointestinal upset, nausea and vomiting.

e. Petroleum Distillates: This term applies to a mixture of hydrocarbons, in this case aromatic hydrocarbons with a mean boiling point of approximately 165^{o}C, including benzene, xylene, and toluene. Mucous membrane irritation might be expected from vapors of these hydrocarbons, along with drowsiness, stuporous feeling, loss of appetite, and central nervous system damage.

D. Evaluation Results

1. Environmental

Table 1 gives the concentration of formaldehyde, benzene, petroleum distillates and MDI found in the breathing zones of the workers identified by job title. Table 2 shows the concentration of these substances at various locations in the work area as determined by area

samples. These concentrations were measured on October 29 and 30, 1975. Table 3 shows the concentration of formaldehyde and petroleum distillates found on February 10, 1976. Concentrations of phenylpropylpyridine, phenol, toluene, and xylene were below levels measurable by currently available techniques. Detector tube measurements of formaldehyde indicated concentrations around a half part per million near the roll-over machine, and generally less in other areas. Ventilation measurements showed general air movement to be approximately 100 feet per minute through most of the work area, although some locations showed no measurable air movement.

2. Medical

Sixteen persons were interviewed by the NIOSH medical officer during the February visit. Working conditions were considered normal. Eleven persons work in the no-bake area and five persons are former no-bake employees. The mean age of the employees interviewed is 31 years with a range of 25 to 45 years. The mean duration of employment in the no-bake area is three years with a range of three months to five years.

All persons interviewed related that they had occasionally developed transient irritation of eyes, nose and throat which they related to the fumes, smelling-like formaldehyde which emanated from the molds. No person noted cough, shortness of breath, wheezing or skin problems. All noted that the symptoms were self-limited, of a mild nature, and several workers related they had to go into another area or outside into fresh air for a few minutes to obtain relief. Many workers reported that operating the mixer was the job with the greatest exposure to the fumes and they related that symptoms of mucous membrane irritation occurred more frequently on this job than other jobs. Most employees thought the job with the lowest exposure was the mold topper (or capper). The workers felt that the fumes emanate from the sand as it drops from the mixer into the molds and from the molds on the rolling rack. Some workers said the conditions were worse in the hot, humid summer; others said conditions were worse in the winter when the doors were closed. Some said the overhead fan helped to improve conditions; others were not certain and some said it had made no substantial difference. As one worker concluded, the fumes were a nuisance; they occurred occasionally on all the jobs in the area and were something you got used to.

On the day of this investigation, two of the 11 employees in the no-bake area reported transient irritation of the eyes and nose. Physical examinations were unremarkable. It is noteworthy that the medical investigator on entering the area noted an odor suggestive of formaldehyde and after remaining in the no-bake area for several minutes, noted the onset of eye and throat irritation lasting 15-20 minutes which gradually subsided.

E. Summary and Conclusions

Based upon an inspection of the processes in the no-bake area, medical interviews and physical examinations, it is concluded that employees have experienced transient, mild mucous membrane irritation due to fumes

(probably of formaldehyde). Neither medical symptomology exhibited by these employees, nor atmospheric concentrations or contaminants measured in the work area, when compared to existing criteria would appear to indicate the development of chronic adverse effects on employees. However, only a long-term study with periodic examinations would confirm or disprove the development of chronic adverse effects.

According to Patty[6], formaldehyde can be detected by most people below 1 ppm due to its strong odor, and discomfort of the eyes and nose is noted at about 2-3 ppm (3 mg/M^3). People working with low levels (below 5 ppm) of formaldehyde seem to become acclimated to it.

V. RECOMMENDATIONS

Additional general area ventilation in the no-bake area would be helpful to further reduce employee irritation from vapors. This is especially true on warm days when the increased vapor pressure of the contaminants could cause higher atmospheric vapor concentrations. In addition to lowering atmospheric vapor concentrations, the added ventilation would have a cooling effect and there would be no additional cost for heating make-up air. From the information obtained during this study, it appears that the most advantageous position for an inlet or exhaust is through the wall or roof near the southeast corner of the conveyor room. Care should be taken, however, in the design of additional air flow so as not to negate air flow through the remainder of the operation.

Means of allowing fresh molds to off-gas in a manner so as not to add to vapor concentrations in the work area should be explored. These could include local exhaust ventilation near the molds, moving the molds to a remote area for a period of time, or other solutions.

Also, employees should be encouraged to eat and take breaks in areas other than their work area, for example, outside or in the lunch room.

VI. REFERENCES

1. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1975, American Conference of Governmental Industrial Hygienists.

2. Documentation of the Threshold Limit Values for Substances in Workroom Air, 1971, ACGIH.

3. Criteria for a Recommended Standard, Occupational Exposure to Benzene, 1974, NIOSH.

4. Criteria for a Recommended Standard, Occupational Exposure to Toluene, 1973, NIOSH.

5. Criteria for a Recommended Standard, Occupational Exposure to Xylene, 1975, NIOSH.

6. Patty, F.A., Ed., Industrial Hygiene and Toxicology, Vol. II., Interscience Pub., 1963.

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Table 1

Results of Personal Environmental Sampling

October 29-30, 1975

Corhart Refractories
Louisville, Kentucky

Job Title	Time Period	Concentration mg/M^3			
		Formaldehyde	Benzene	Petroleum Distillates*	MDI
Roll Over	Oct. 29 A.M.	0.6	-	-	N.D.**
	Oct. 29 P.M.	0.4	-	-	N.D.
	Oct. 30 A.M.	0.4	-	-	-
	Oct. 30 P.M.	0.7	-	-	-
Mold Filler	Oct. 29 A.M.	0.1	-	-	N.D.
	Oct. 29 P.M.	0.1	-	-	N.D.
	Oct. 30 A.M.	0.3	-	-	-
	Oct. 30 P.M.	0.4	-	-	-
Off Bearer	Oct. 29 A.M.	0.3	-	-	N.D.
	Oct. 29 P.M.	0.3	-	-	N.D.
	Oct. 30 A.M.	-	0.2	31	-
	Oct. 30 P.M.	-	N.D.	36	-
Mold Waxer	Oct. 29 A.M.	0.1	1.7	17	-
	Oct. 29 P.M.	0.2	1.5	29	-
	Oct. 30 A.M.	-	N.D.	12	-
	Oct. 30 P.M.	-	0.4	8	-
VF Strike Off	Oct. 29 A.M.	0.1	-	-	0.006
	Oct. 29 P.M.	0.2	-	-	N.D.
	Oct. 30 A.M.	-	-	-	N.D.
	Oct. 30 P.M.	-	-	-	0.010
VF Form Assembly	Oct. 29 A.M.	0.2	-	-	N.D.
	Oct. 29 P.M.	0.2	-	-	N.D.
	Oct. 30 A.M.	-	0.2	22	-
	Oct. 30 P.M.	-	N.D.	18	-
Strike Off Man	Oct. 29 A.M.	0.1	-	-	0.007
	Oct. 29 P.M.	0.1	-	-	N.D.
	Oct. 30 A.M.	-	-	-	0.030
	Oct. 30 P.M.	-	-	-	0.020

Table 1 (contd)

Corhart Refractories

Job Title	Time Period	Concentration mg/M^3 Formaldehyde	Benzene	Petroleum Distillates*	MDI
VF Form Assembly	Oct. 29 A.M.	0.1	-	-	0.01
	Oct. 29 P.M.	0.2	-	-	N.D.
	Oct. 30 A.M.	-	-	-	-
	Oct. 30 P.M.	-	N.D.	24	-
VF Form Assembly	Oct. 29 A.M.	-	0.7	39	N.D.
	Oct. 29 P.M.	-	0.3	35	N.D.
	Oct. 30 A.M.	0.4	-	-	N.D.
	Oct. 30 P.M.	0.6	-	-	N.D.
Roll-Over	Oct. 29 A.M.	-	0.8	25	N.D.
	Oct. 29 P.M.	-	0.9	27	N.D.
	Oct. 30 A.M.	0.4	-	-	-
	Oct. 30 P.M.	0.6	-	-	-
VF Mold Filler	Oct. 29 A.M.	-	0.4	35	0.008/ 0.030
	Oct. 29 P.M.	-	0.5	31	0.008
	Oct. 30 A.M.	0.2/1.3	-	-	N.D.
	Oct. 30 P.M.	0.3	-	-	N.D.
V.F. Form Assembly	Oct. 29 A.M.	-	0.3	25	N.D.
	Oct. 29 P.M.	-	0.3	19	N.D.
	Oct. 30 A.M.	-	-	-	N.D.
	Oct. 30 P.M.	-	-	-	N.D.
Off-Bearer	Oct. 29 A.M.	-	0.9	36	N.D.
	Oct. 29 P.M.	-	2.6	26	N.D.
	Oct. 30 A.M.	-	N.D.	28	N.D.
	Oct. 30 P.M.	-	N.D.	46	N.D.
Mold Topper	Oct. 29 A.M.	-	-	-	N.D.
	Oct. 29 P.M.	-	-	-	N.D.
	Oct. 30 A.M.	0.3	-	-	-
	Oct. 30 P.M.	0.3	-	-	-
Fork Lift Driver	Oct. 29 A.M.	-	2.0	10	N.D.
	Oct. 29 P.M.	-	2.4	12	N.D.
	Oct. 30 A.M.	-	-	-	-
	Oct. 30 P.M.	-	-	-	-

*Analysis of petroleum distillate concentrations is semi-quantitative.
**"N.D." indicates concentration is not detectable by current methods.
Blank indicates no measurement was made.

Table 2

Results of Area Environmental Sampling

October 29-30, 1975

Corhart Refractories
Louisville, Kentucky

Area	Time Period	Concentration mg/M^3			
		Formaldehyde	Benzene	Petroleum Distillates	MDI
Near Mold Filling	Oct. 29 A.M.	-	N.D.	22	-
	Oct. 29 P.M.	-	1.3	26	-
	Oct. 30 A.M.	-	N.D.	24	-
	Oct. 30 P.M.	-	N.D.	19	-
Between Mixers	Oct. 29 A.M.	0.2	-	-	-
	Oct. 29 P.M.	0.2	-	-	-
	Oct. 30 A.M.	0.2	N.D.	26	0.003
	Oct. 30 P.M.	-	N.D.	29	-
Mold Topping Area	Oct. 29 A.M.	0.2	-	-	-
	Oct. 29 P.M.	0.2	-	-	-
Near Roll-Over	Oct. 30 A.M.	0.5	-	-	N.D.

Table 3

Results of Environmental Sampling

February 10, 1976

Corhart Refractories
Louisville, Kentucky

Job Title	Time Period	Concentration mg/M^3 Formaldehyde	Concentration mg/M^3 Petroleum Distillates
Mold Topper	A.M.	0.05	64
	P.M.	0.38	87
Mold Topper	A.M.	0.06	52
	P.M.	0.38	107
Mold Topper	A.M.	N.D.	35
	P.M.	1.1	73
Mixer Operator	A.M.	N.D.	93
	P.M.	N.D.	161
Strike-Off	A.M.	N.D.	56
	P.M.	0.2	67
Roll-Over	A.M.	0.1	66
	P.M.	0.1	56
Roll-Over	A.M.	0.2	67
	P.M.	0.1	112
Off-Bearer	A.M.	0.1	51
	P.M.	N.D.	69
VF Form Assembly	A.M.	0.05	39
	P.M.	0.2	42
VF Form Assembly	A.M.	N.D.	58
	P.M.	N.D.	55
VF Form Assembly	A.M.	0.2	33
	P.M.	0.3	63
Area Sample Near Roll-Over Machine	A.M. & P.M.	-	52
Area Sample Near VF Roll-Over Machine	A.M. & P.M.	N.D.	33