(b) Burning off a pipe section close to a flange which may have a Teflon gasket, or burning any metal containing a Teflon element, (i.e. pump, etc.) should be done under conditions with mechanical ventilation to disperse the fumes, if there is the possibility of the Teflon element being burned.

(c) Burning in highly confined spaces, such as valve pits, should be conducted only with local exhaust ventilation to remove the fumes.

5. Smoking

Smoking should be prohibited in areas where Teflon is cut, machined, or processed where dust or chips are produced.

6. Chemical Laboratory Use

Teflon labware, used under conditions of direct applied heat, such as hot plates or flames, should be placed in fume hoods.

7. Disposal

(a) Teflon scrap should not be disposed of by burning in incinerators, furnaces, etc. unless the fumes are vented to the outside and mechanical draft is provided.

(b) The disposal of Teflon scrap should preferably be done by burial in the ground when an appreciable quantity of scrap is involved.

8. Storage and Flammability

(a) Teflon is non-flammable and will not propagate a flame but will decompose under heat with development of noxious and toxic gases and fumes. This is characteristic of many non-flammable materials. Therefore, the only storage restriction which need be applied is to prevent storage with flammable materials, such as oils, gases, solvents, etc. This type of restriction applies equally well to rubber belting, insulated wires and plastics.

(b) Respiratory protective equipment used by fire fighting personnel, namely, the air supplied type, is adequate for entrance into burning areas where Teflon may be thermally decomposed.

(c) Because of the development of acid fumes from the thermal decomposition of Teflon, fire fighting personnel should be instructed to bathe and change clothes when the fire area involved considerable quantity of Teflon, unless protective clothing was worn.

Acknowledgements:

Evaluation conducted by: Melvin T. Okawa, Industrial Hygienist; Phillip L. Polakoff, M.D., Medical Officer; James B. Lucas, M.D., Medical Officer; Raymond L. Ruhe, Industrial Hygienist; Jerome P. Flesch, Industrial Hygienist; and Donald E. Richards, Research Chemist.

Occupational Health Case Report — No. 8

Monoisopropanolamine

Report prepared by Raymond L. Hervin, Industrial Hygienist, Project Officer and James B. Lucas, M.D., Principal Medical Officer, Hazard Evaluation Services Branch, Div. of Technical Services, NIOSH.

1. Introduction

The National Institute for Occupational Safety and Health (NIOSH) received a request from an authorized representative of employees to evaluate the potential hazards associated with the use of monoisopropanolamine (MIPA) and Titanium Dioxide (TiO_2) in the milling department of a large plant producing TiO_2. MIPA was replaced by triethanolamine (TEA) in early 1973; and TEA was eliminated from the process without substitution prior to our final site visit.

2. Health Hazard Evaluation

A. Plant Process — Conditions of Use

This plant produces titanium dioxide pigment from ilmenite ore and occupies an 80 acre site. Enriched ilmenite ore is digested by reacting it with sulfuric acid, steam, and water; producing TiO_2 which is further purified (99% pure) by precipitation, bleaching, washing, filtering, and calcining at extremely high temperatures. The pigment is then ground to specification in large vertical Raymond Mills located in the area covered by this Determination Report. These Mills and ancillary equipment are housed in a five story building; the bottom floor contains nine operational 50" mills; the second floor contains bagging facilities and four operational 60 in. mills; the third floor contains storage bins; the fourth floor contains the fan room with bag filters; and the fifth floor contains the platform and top of the "A" mill bin. Small quantities of MIPA (12-15 cc's per minute) were metered into the mills to reduce any caking tendency assuring that the product was ground to exact specification. Approximately 70 operators, cleanup, and maintenance employees were occasionally exposed to MIPA and TiO_2 (semisaturated with MIPA) during maintenance operations or when a leak occurs in the system. MIPA was replaced by TEA in early 1973, and TEA was discontinued without substitution prior to our final evaluation. Following particle sizing (submicron to several microns in size) for specific products, the TiO_2 is bagged for sale or sent to the wet mill area for further processing. The 60 in. mills were not operational at the time of our initial visit. There are four shifts which operate three shifts a day for seven days a week in the production areas. The main complaints were from the dusty conditions during operations, and more particularly from MIPA contact during maintenance operations.

B. Evaluation - General

A medical-environmental team visited the facility on October 19-20, 1972 and May 30-31, 1973 to assess potential problem areas and to complete the evaluation. Conditions were very dusty (airborne dust and dust on floor, rafters, etc.) from visual observations made at the time of the initial visit.

Conditions were very much improved at the time of our final visit to the area covered by this request. Separate exit interviews were held with representatives of management and union at the completion of both visits to discuss preliminary findings.

C. Evaluation Criteria

The following is a brief resume of the pathologic effects of substances alleged to be hazardous:

Monoisopropanolamine (MIPA) and its vapor are not considered to be toxic in the usual industrial setting. High concentrations may be irritating to the upper respiratory tract and eyes. Splashes directly into the eye may result in serious injury. It is known to be a moderate skin irritant and may cause dermatitis as the result of a single direct exposure. Prolonged contact may result in more severe irritation. It is not thought to be a cutaneous sensitizer, i.e. allergenic. Our study confirmed the inability of this substance and TEA to cause cutaneous sensitization. It was noted that aqueous concentrations exceeding 25% produced primary irritation when directly applied to intact animal skin. Concentrations exceeding 1% were found to be capable of irritating previously abraded skin.

Triethanolamine (TEA) has properties very similar to MIPA but is considered to be less toxic. TEA was studied in an identical manner and found to be irritating in aqueous concentrations exceeding 10% for intact skin and 1% for abraded skin. These substances are no longer used in the workplace.

Titanium Dioxide (TiO_2). Titanium, its oxides, and salts are all regarded as being essentially innocuous. Titanium derivatives including the oxides have been used in treating various skin disorders and during World War II large amounts were used as a protective skin cream to prevent flash burns. Experience indicates that it is completely harmless when used as a constituent of cosmetic preparations. In man the hazard of lung fibrosis or "titanicosis" from chronic inhalation is regarded as very slight and no definite cases have been reported. Numerous investigators have reported no abnormal clinical, radiological or pulmonary function test findings among long-term operatives exposed to titanium dust.

Inert or Nuisance Dust

Total Dust — 15 mg/M³

Respirable Dust — 5 mg/M³

D. Evaluation Results and Discussion

1. Medical Evaluation. — During the initial survey 15 randomly-selected individuals were questioned regarding their general health. Attempts were then made to elicit present symptoms or a past history of respiratory or cutaneous disorders which might be considered occupational in origin. No one related complaints or knew of other men working in his area with health-related problems. Nine individuals reported by the Union as having past or present health complaints were individually interviewed and examined during the two survey periods. One individual was re-examined during the second visit. In three instances men were visited in their homes (one individual had been retired since 1968, another was on long-term disability, and the third worked the evening shift). Five of these men complained of present and three of past dermatitis. In four instances, all noted during the initial survey period, moderate cases of definite contact dermatitis traceable to direct contact with MIPA or MIPA contaminated dust were identified.

A single individual complained of headache, epigastric pain, sore throat, and eye irritation when working around MIPA. Another individual was noted during the second survey period to have a chronic eczematous eruption of the left wrist. This individual is atopic and it is felt that his dermatitis most likely represents nickel allergy due to his watchband. The retired worker gave a history of dermatitis definitely related to MIPA exposure, but he has had no further skin problem. The individual on disability was noted to have a chronic scaling (ichthyotic) process involving the legs, keratosis pilaris, and a mild furunculosis of the abdomen and thighs. The latter problem cleared between visits but his skin was still noted to be generally asteatotic (dry). His dermatitis is certainly not occupational in origin. A final individual was noted to have thickened and fissured skin on his finger tips probably largely attributable to pressure and the use of a harsh industrial cleaner.

No evidence or cases were found suggesting that titanium dioxide dust represents any pulmonary or other hazard to employees working in the area covered by this report.

2. Environmental Evaluation. — During the initial visit five of the nine 50 in. mills were operational with major maintenance work being performed on two mills. It is during major maintenance work or during spills or leaks in the MIPA lines that the possibility of major exposure occurs. No environmental sampling was accomplished initially since no appropriate sampling or analytical technique was then available for MIPA. The environmental survey was scheduled after the sampling the analytical techniques were developed for MIPA or TEA. Visual observations during both visits noted that clouds of dust were generated during equipment breakdowns, for example, holes in the gasket of a mill, leaks in the ventilation or bagging system, etc. One particularly dusty operation was noted when an operator opened an "A" bin top on the 5th floor to measure the level of TiO_2. With the exception of the "A" bin, housekeeping was considerably improved on the final visit. Certain jobs such as maintenance, checking levels of certain bins, operation of equipment (e.g., ventilation, bagger, etc.) needing repair and the use of a broom and shovel for routine housekeeping generate undue amounts of airborne dust.

The environmental survey was conducted on May 30, 1973 while three of the four 60" mills were operational and five of the nine 50 in. mills were operational; and on the following day while two 60 in. mills and no 50" mills were operational. No operations using MIPA or TEA were noted, and no major maintenance operations were observed during the survey. Hence, no air samples were obtained for MIPA or TEA. Vinylmetracel filters were used for obtaining Respirable Dust (Dorr-Oliver cyclone and filter cassett) and Total Dust (Millipore Field Monitor) in conjunction with an MSA Model G Vacuum Pump and analyzed by gravimetric (weight) methods. All of the personal samples were used to measure Respirable Dust since the average size of the two products consist of dust in the 0.5 and 8.0 micron range. General Area samples were obtained for Respirable Dust and for Total Dust to obtain data on the amount of respirable and total dust loading in a particular area. All of the samples were collected over long periods of the work day and are assumed to represent an 8-hour time-weighted average. The Table presents all air sample results for Total and Respirable Dust in the Milling area.

Thirteen personal air samples were obtained for Respirable Dust representing various exposures for Mill Operators, Packers, Maintenance Men, and Laborers. Sample results varied from 0.6 mg/M³ to 3.7 mg/M³ the highest being at least 20% below the federal standard for Respirable Dust.

Twelve general area samples were obtained at representative locations in the facility. Where possible, side-by-side samples were obtained for Respirable Dust and Total Dust. The maximum results for Respirable Dust and Total Dust occurred

Air Sample Results for Total Dust and Respirable Dust in Milling Area

Location and/or Operation	Type of Sample	mg/M³ Concentrations
Laborer-50" Bottom Mills	P-RD	0.6
Operator-50" Bottom Mills	P-RD	3.2
Operator-50" Top Mills	P-RD	1.1
Laborer-50" Bottom Mills	P-RD	0.7
Operator-50" Bottom Mills	P-RD	1.1
Operator-50" Top Mills	P-RD	1.2
Laborer-50" Top Mills	P-RD	1.1
Maintenance Man	P-RD	1.2
Operator-60" Mills	P-RD	1.6
Operator-60" Mills	P-RD	0.6
Packer-60" Mills	P-RD	1.5
No. 54 Packer	P-RD	1.8
No. 35 Packer	P-RD	3.7
1st Floor-No. 6 50" Mill	GA-TD	2.3
1st Floor-No. 6 50" Mill	GA-RD	1.5
2nd Floor-No. 5 50" Mill	GA-RD	1.4
2nd Floor-No. 5 50" Mill	GA-TD	4.5
3/4 Fan Floor-No. 5 50" Mill	GA-RD	0.7
5th Floor-A 50" Mill Bin	GA-TD	16.0
5th Floor-A 50" Mill Bin	GA-RD	10.5
No. 54 Packing 60" Mill Area	GA-TD	3.5
No. 54 Packing 60" Mill Area	GA-RD	0.7
No. 35 Packing 60" Mill Area	GA-TD	4.9
No. 54 Packing 60" Mill Area	GA-TD	1.2
No. 54 Packing 60" Mill Area	GA-RD	0.6

P-Personal Sample
GA-General Area Sample
RD-Respirable Dust Sample (Dorr-Oliver Cyclone with filter cassett)
TD-Total Dust Sample (Millipore Field Monitor)
"-Inch

on the 5th floor (50" mill) directly over the "A" Mill Bin and were 10.5 mg/M³ for Respirable Dust and 15 mg/M³ for Total Dust. Although the standards were exceeded, general area samples cannot be considered to represent continuous exposure levels since personnel are not exposed to this particular atmosphere except for brief periods of time. All other general area samples were well below the federal standards for Respirable Dust and Total Dust.

Bulk samples of the products were obtained during both visits and analyzed for trace impurities. No impurities were detected in amounts which could be considered as a health hazard to employees.

For completeness, we conducted a limited noise survey. No 8-hour evaluation of any employee's total integrated exposure to noise was performed. Noise levels exceeding the current federal standard of 90 dBA were noted in the Raymond Mills, 105 dBA near the shakers, etc. Management was aware of this problem and is implementing a more comprehensive hearing conservation program including hearing protective devices, audiometric exams, and where possible, engineering-out (replacing noisy electrical shakers with mechanical shakers) the noise problem.

3. Summary

Based upon the results of the medical evaluation, it has been determined that Monoisopropanolamine (MIPA) was toxic and represented a definite cutaneous hazard upon direct contact with the skin to those workmen failing to utilize proper protective clothing, gloves, and good work practices. Five instances of primary irritant contact dermatitis due to direct skin exposure to MIPA were identified. Most employees working with the substance recognized its irritant properties, but were not wearing appropriate protective clothing at the time of contact. Another individual also noted upper respiratory tract and eye irritation due to this substance. No new cases of irritation or dermatitis have appeared since the discontinuance of this substance. Proper protective measures should eliminate this problem if MIPA or Triethanolamine (TEA) is reintroduced into the workplace.

It is further determined that a toxic condition to workers from exposure to Titanium Dioxide (TiO_2) dust does not exist at concentrations found in this work environment. This finding is based upon: (1) personal air sample results which were well below those levels reported to cause abnormal effects in exposed workers; and (2) the lack of pulmonary or other noncutaneous health problems identified during the course of this investigation.

4. Recommendations

In view of the above information, the following recommendations are made to provide a more desirable environment for employees in the area covered by this report. It is felt these recommendations are consistent with good industrial hygiene practices. No recommendations are made concerning safety as this is not the purpose of this report.

(a) If MIPA or TEA is reintroduced into the process, appropriate protective clothing should be provided and worn by all employees during operations where there is a possibility of direct contact with these substances.

(b) Complete implementation of the hearing conservation program should be accomplished.

(c) The mills and ancillary equipment (e.g., ventilation system, filter bags, etc.) warrant the institution of a preventive maintenance program. Prompt attention should be given to maintenance problems (e.g., leak in ventilation system, gasket, etc.) which give rise to airborne dust, and employees should report such problems to supervisors immediately. To retard the unnecessary accumulation of dust, further installation of walking surface floor gratings should be considered.

(d) The use of a vacuum cleaner or vacuum system for cleanup operations would preclude dust from becoming airborne as is now the case with the broom and shovel housekeeping. Serious considerations should be given to reactivate and modify as appropriate the vacuum system which was previously used in the milling area.

(e) Respirators for inert or nuisance dust should be provided and worn by employees during those operations which involve exposure to obviously excessive amounts of airborne dust.

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