

Occupational Health Guideline for Titanium Dioxide

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: TiO_2
- Synonyms: Rutile; anatase; brookite
- Appearance and odor: White powder with no odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for titanium dioxide is 15 milligrams of titanium dioxide (total dust) per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists has recommended for titanium dioxide a Threshold Limit Value of $10 mg/m^3$.

HEALTH HAZARD INFORMATION

• Routes of exposure

Titanium dioxide can affect the body if it is inhaled.

• Effects of overexposure

Slight change in the lungs may occur.

• Reporting signs and symptoms

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to titanium dioxide.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to titanium dioxide at potentially hazardous levels:

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from titanium dioxide exposure.

—Chronic respiratory disease: Titanium dioxide is a nuisance dust. In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of titanium dioxide might cause exacerbation of symptoms due to its irritant properties.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

• Summary of toxicology

Titanium dioxide dust is a mild pulmonary irritant. Rats repeatedly exposed to concentrations of 10 to 328 million particles per cubic foot of air for as long as 13 months showed small focal areas of emphysema, which were attributed to large deposits of dust; there was no evidence of any specific lesion being produced by titanium dioxide. Three of 15 workers who had been exposed to titanium dioxide dust showed radiographic signs in the lungs resembling "slight fibrosis," but disabling injury did not occur; the magnitude and duration of exposure were not specified. In the lungs of three workers involved in processing titanium dioxide pigments, deposits of the dust in the pulmonary interstitium were associated with cell destruction and slight fibrosis; the findings indicated that titanium dioxide is a mild pulmonary irritant.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 79.9
2. Boiling point (760 mm Hg): Less than 3000 C (less than 5432 F)
3. Specific gravity (water = 1): 3.9–4.2
4. Vapor density (air = 1 at boiling point of titanium dioxide): Not applicable
5. Melting point: 1640 C (2984 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

- **Reactivity**
 1. Conditions contributing to instability: None
 2. Incompatibilities: None
 3. Hazardous decomposition products: None
 4. Special precautions: None
- **Flammability**
 1. Not combustible
- **Warning properties**

According to Grant, titanium dioxide "is a white pigment which is insoluble in water and very inert. It has been introduced by tattooing into the corneas of rabbits and patients having corneal scars, and has caused permanent white coloration but no irritation." For the purposes of this guideline, therefore, titanium dioxide is not treated as an eye irritant.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

Sampling and analyses may be performed by collection of titanium dioxide on a filter, followed by treatment with nitric acid, solution by heating with sulfuric acid and ammonium sulfate, and atomic desorption spectrophotometric analysis. An analytical method for titanium dioxide is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to titanium dioxide may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during mining, purification, packaging, and distribution	General dilution ventilation; personal protective equipment
Use as a pigment in manufacture of paints, varnishes, and lacquers to impart whiteness, opacity, and brightness	General dilution ventilation; personal protective equipment
Use in manufacture of paper used in coatings and fillers to improve opacity and brightness; manufacture of paper, photographic papers, paper packaging, and cellophane coatings	General dilution ventilation; personal protective equipment
Use as a white pigment in manufacture of plastics; blow-molded plastic containers	General dilution ventilation; personal protective equipment
Use in manufacture of elastomers for use in tire sidewalls, footwear, floor mats, gloves, rainwear, and wall coverings; use in manufacture of floor coverings	General dilution ventilation; personal protective equipment
Use in manufacture of ceramics and glass for capacitors, electromechanical transducers, welding-rod coatings, and glass fibers	General dilution ventilation; personal protective equipment
Use in manufacture of printing inks for flexographic, gravure, and letter press inks; packaging, publication, offset, and screen processing inks	General dilution ventilation; personal protective equipment

Use in manufacture of coated fabrics and textiles on natural/artificial leather, oilcloth, upholstery materials, and wall coverings; as a delustrant for acrylic, nylon, and spandex fibers

General dilution ventilation; personal protective equipment

Use in manufacture of building materials in roofing granules, ceiling tiles, cement-curing aids, and titanium carbide cutting tools

General dilution ventilation; personal protective equipment

Use in manufacture of cosmetics, food color additives, and synthetic diamonds

General dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Breathing

If a person breathes in large amounts of titanium dioxide, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If titanium dioxide is spilled, the following steps should be taken:

1. Ventilate area of spill.

2. Collect spilled material in the most convenient and safe manner for reclamation or for disposal in a secured sanitary landfill. Liquid containing titanium dioxide should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Titanium dioxide may be disposed of in a secured sanitary landfill.

REFERENCES

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RESPIRATORY PROTECTION FOR TITANIUM DIOXIDE

Condition	Minimum Respiratory Protection* Required Above 15 mg/m³
Dust or Mist Concentration	
75 mg/m ³ or less	Any dust and mist respirator.
150 mg/m ³ or less	Any dust and mist respirator, except single-use or quarter-mask respirator.
Dust, Mist, or Fume Concentration	
150 mg/m ³ or less	Any fume respirator or high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
750 mg/m ³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
7,500 mg/m ³ or less	A powered air-purifying respirator with a high efficiency particulate filter. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 7,5000 mg/m ³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

*Only NIOSH-approved or MSHA-approved equipment should be used.