Chromium VI

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Chromium IV vs. Chromium III

- Oxidation states range from –2 to +6
- Most Common forms Cr III and Cr VI
- +3 Oxidation state less hazardous
- Common Chromium IV compounds
  - Sodium dichromate
  - Potassium dichromate
  - Chromic acid

Characteristics

- Heavy Metal
- Oxidizing Agent
- Color: dark red flakes or crystals
- Melting Point: 196 ^{o}C
- Boiling Point: Decomposes at 250 ^{o}C
- Flash Point: Noncombustible
  - Strong oxidizing agent- accelerate the burning rate of combustible materials.
- No known taste or odor

Exposure

- **Occupational** 305,000 workers exposed
  - Stainless steel welding; chromate production; chrome plating; manufacture of dyes, pigments, fungicides, and glass; leather tanning; wood preserving; rust and corrosion inhibitors, textiles and toner for copying machines
- **Environmental**
  - Released into air, soil and water
  - Occurs naturally in rare mineral crocoite

Routes of Exposure- 1

- Ingestion
  - **Occupational**
    - Accidental ingestion in workplace or poor work practices
  - **Environmental-** Concentration generally low
    - 18% of US population exposed to drinking water levels between 2 and 60 μg/L
    - Less than 0.1% of US population exposed to drinking water level between 60 and 120 μg/L

Routes of Exposure-2

- Absorption
  - **Occupational**- Chromium +6 readily crosses cell membranes with skin contact
  - **Environmental**- No significant exposures

Routes of Exposure-3

- Inhalation
  - **Occupational**
    - Dusts, fumes and mists generated in the manufacture of Chromium +6 or processing of Chromium +6 containing products
  - **Environmental-** concentration of dust particles generally low
    - Mean levels below 300 ng/m^3
    - Median levels less than 20ng/ m^3
    - Concentrations in urban areas 2-4 times higher

Toxicokinetics

- Absorption
  - Particles deposited in lungs
  - Penetrates the skin through sweat glands
  - Readily passes through cell membranes in GI tract
- Distribution
  - Reduced to +3 Chromium
  - Induces oxidative stress that results in oxidative deterioration of biological macromolecules
  - Found in both RBC and plasma
- Excretion
  - Eliminated in Urine

Health Outcomes-1

- Strong oxidizing agent
- Reproductive- no consistent data
- Ingestion
  - 1-15 g may be a fatal dose in humans
  - Non-lethal dose
    - Stomach, liver, kidney damage
    - Symptoms- clammy, cyanotic skin, sore throat, gastric burning, vomiting, diarrhea

Health Outcomes -2

- Absorption
  - Ulceration- due to corrosive action
  - Dermatitis
  - Allergic Reactions

Health Outcomes -3

- Inhalation
  - Irritation of the nose, throat, bronchial tubes and lungs
  - Symptoms- coughing, running nose, sneezing, itching, nosebleeds, ulcers and holes in nasal septum
  - Lung cancer

Health Outcomes-Carcinogencity

- WHO lists as “IARC Group 1” (Carcinogenic to Humans)
- OSHA categorizes as a “Select Carcinogens”

Critical Thresholds

- **Occupational**
  - Total Chromium
  - Chromium VI compounds
- **Environmental**
  - EPA set maximum level of total Chromium allowed in the drinking water at 100 microgram/L

Chromium (Cr)

- Cr Metal and insoluble salts
  - TWA OSHA 1 mg/m^3
  - IDLH 500 mg/m^3
- Cr as soluble chromic and chromous salts
  - TWA OSHA 0.5 mg/m^3
  - IDLH 250 mg/m^3

Sodium Dichromate and Potassium Dichromate

- TWA NIOSH
  - 0.025 mg/m^3/10 hr day
  - 0.05 mg/m^3/15 min ceiling
- TLV ACGIH (water soluble Cr ^{VI} compounds)
  - 0.05 mg/m^3

Chromium Trioxide

- TWA OSHA
  - 0.1 mg/m^3
- TWA NIOSH
  - 0.025 mg/m^3/10 h day
  - 0.05 mg/m^3/15 min ceiling
- TLV ACGIH
  - 0.05 mg/m^3
- IDLH
  - 30 mg/m^3

Prevention/Appropriate Treatment

- Substitution, Engineering Controls, Administrative Controls, Personal Protective Equipment
- Education emphasizing personal hygiene
- 10 % $CaNa^2$ EDTA ointment

Medical Supervision

- Medical Examination
- Chest Radiography
- Nasal cytology- unconfirmed value
- Urine/Blood Biomarkers- not diagnostic nor confirmation of disease

References