Occupational Hygiene: An Overview

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Hello!

- BSc in chemistry
- MSc in electro-analytical chemistry
- Chartered Chemist/CRSP
- R&D/Publications/Patents
- Consulting/Management
- Public sector/enforcement
What is Occupational Hygiene Anyway?

“...that science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the workplace, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community.”
Goals of Occupational Hygiene

- Anticipation
- Recognition
- Evaluation
- Control
Anticipation of Hazards

• Consider the following:
  – Raw materials
  – Intermediates formed
  – Final products
  – Toxicity of products and Possible Health Hazards

• Start to finish thought process
MB WSH Act and Regulations

- Manitoba Workplace Safety and Health Act and Regulation
  - Part 36 governs chemical and biological substances
Anticipation of Hazards

• American Council of Government Industrial Hygienists ("ACGIH") has established Threshold Limit Values ("TLV").

• TLVs are defined as:
  – Time weighted average ("TWA"), for most working conditions.
  – Short Term Exposure Limits ("STEL"), for 15 minute exposure.
  – Ceiling ("C"), for maximum allowable concentration.
### Anticipation of Hazards

- **Material Safety Data Sheets, MSDS (SDS)**

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**MATERIAL SAFETY DATA SHEET**

### I. General Information
- **CHEMICAL NAME & SYNONYM:** Synthetic Detergent
- **CHEMICAL FAMILY:** Cleaning Compound, Liquid
- **PROPER DOT SHIPPING NAME:** None
- **SUPPLIER:** ZEOLL INC.
  - 5041 11TH AVE
  - Mendota, CA 93534

### II. Ingredients

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>CAS No.</th>
<th>THRESHOLD LIMIT VALUE (UNITS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutant Bacteria</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Nonionic Surfactant</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Water</td>
<td>14.0</td>
<td>N/A</td>
</tr>
<tr>
<td>Fragrance</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### III. Physical Data
- **BOILING POINT (F):** 100
- **VAPOR PRESSURE (MM HG):** N/A
- **VAPOR DENSITY (AIR=1):** N/A
- **SOLUBILITY IN WATER:** Complete
- **APPEARANCE AND ODOR:** (Clear colorless liquid with a faint odor)

### IV. Fire & Explosion Hazard Data
- **Flash Point (Test Method):** None
- **Auto-Ignition Temperature:** None
- **Extinguishing Media:** Water, Dry Chemical, CO
- **Special Fire Fighting Procedures:** None
- **Unusual Fire & Explosion Hazards:** None
- **Lower Explosive Limit (LEL):** N/A
- **Upper Explosive Limit (UEL):** N/A

### V. Health Hazard Data
- **OSHA/ACGIH Threshold Limit Value:** N/A
- **Carcinogen - NTP Program:** None
- **Symptoms of Exposure:** Skin & Eye Irritation
- **Medical Conditions Aggravated by Exposure:** None
- **Primary Routes of Entry:** Skin, Eyes, Nose, Mouth
- **Emergency First Aid:**
  - **Skin:** Wash with water. See a physician.
  - **Eyes:** Wash with water for 15 minutes. See a physician.
  - **Ingestion:** Give large amounts of water. See a physician.
  - **Inhalation:** Remove to fresh air.
- **Carcinogen - IARC Program:** None

### VI. Reactivity Data
- **Stability:** Unstable
- **Incompatibility Material to Avoid:** None
- **Hazardous Polymerization:** May Occur
- **Hazardous Decomposition Products:** None
- **Dangerous Conditions to Avoid:** None

### VII. Environmental Protection Procedures
- **Spill Response:** Contain spill. Soak up in an absorbent material. Flush area with water.
- **Waste Disposal Method:** In accordance with Federal, State and Local regulations.

### VIII. Special Protection Information
- **Eye Protection:** Splash Goggles
- **Skin Protection:** None
- **Respiratory Protection:** None
- **Ventilation:** Recommended Local Exhaust
- **Other Precautions:** None

### IX. Special Precautions
- **Hygienic Practices in Handling & Storage:** Avoid skin or eye contact.
- **Precautions for Repair & Maintenance of Contaminated Equipment:** Flush with water and allow to air dry.
- **Other Precautions:** None
Goals of Occupational Hygiene

- Anticipation
- Recognition
- Evaluation
- Control
Hazard Recognition

- Chemical
- Physical
- Ergonomic
- Biological
Chemical Hazards

• Odors
  – Not all agents have detectable odor
• Frequent headaches
• Dermatitis
• Drowsiness
• Personality changes
• Clusters of problems
Chemical Hazards

- Irritants
- Asphyxiates
- CNS Agents
- Specific organ attack
- Genetic activity
- Corrosives
Chemical Hazards - Irritants

- Respiratory
- Skin
- Eye
Chemical Hazards - Irritants

• Primary/Secondary
  – Primary – at source of contact
  – Secondary – travels through blood to another area

• Reversible/Irreversible

• Sensitization
  – Irritant that has the ability to cause an allergic reaction in normal tissue after repeated exposure
Chemical Hazards

- Irritants
- Asphyxiants
- CNS Agents
- Specific organ attack
- Genetic activity
- Corrosives
Chemical Hazards - Asphyxiants

- Simple Asphyxiants
  - Nitrogen (N₂)
  - Carbon Dioxide (CO₂)
  - Helium (He)
  - Methane (CH₄)

- Chemical Asphyxiants
  - Carbon Monoxide (CO)
  - Hydrogen Cyanide (HCN)
  - Hydrogen Sulfide (H₂S)

- Dilute air so oxygen content is low

- Interact at cellular level to inhibit oxygen uptake.
Chemical Hazards

- Irritants
- Asphyxiates
- CNS Agents
- Specific organ attack
- Genetic activity
- Corrosives
Chemical Hazards – Central Nervous System Agents

- Narcotics
- Anesthetics
- Depressants
Chemical Hazards

- Irritants
- Asphyxiates
- CNS Agents
- Specific organ attack
- Genetic activity
- Corrosives
Chemical Hazards – Specific Organ Attack

- May be reversible or irreversible
  - Blood - Hemotoxic
  - Liver – Hepatotoxic
  - Lungs – Pulmonotoxic
  - Kidneys – Nephrotoxic
  - Skin – Dermatotoxic
  - Nerves & Brain - Neurotoxic
Chemical Hazards

- Irritants
- Asphyxiates
- CNS Agents
- Specific organ agents
- Genetic activity
- Corrosives
Chemical Hazards – Genetic Activity

- Typically is irreversible
  - Causes cancer – Carcinogen
  - Causes chromosome damage – Mutagen
  - Causes birth defects – Teratogen
  - Causes damage to reproductive system - Reproductive Hazard
Chemical Hazards

- Irritants
- Asphyxiates
- CNS Agents
- Specific organ agents
- Genetic activity
- Corrosives
Chemical Hazards – Corrosives

• Can be found on dip tanks, metal processing, equipment cleaners, battery maintenance.

• Concern for contact of workers with corrosives
  – Usually involves necrosis, the death of local tissue due to contact of agent
Hazard Recognition

• Chemical
• Physical
• Ergonomic
• Biological
Physical Hazards

- Dusts and Fibres
- Noise
- Thermal Stress
- Ionizing Radiation
- Non-Ionizing Radiation
Physical Hazards – Dusts and Fibres

• Concerned about particle size and penetration into pulmonary track
  – $D > 0.5$ micron – does not reach lungs (but may ingest)
  – $0.2 < D < 0.5$ micron – respirable and gets stuck in lungs
  – $D < 0.2$ micron – are exhaled
Physical Hazards

• Dusts and Fibres
• Noise
• Thermal Stress
• Ionizing Radiation
• Non-Ionizing Radiation
Physical Hazards – Noise

- Need to shout
- Ringing sensation
- Degraded hearing after work
- Auditory testing
## Physical Hazards – Noise

<table>
<thead>
<tr>
<th>Source</th>
<th>Sound Level (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocket</td>
<td>195</td>
</tr>
<tr>
<td>Jet Engine</td>
<td>160</td>
</tr>
<tr>
<td>Rock Band</td>
<td>115</td>
</tr>
<tr>
<td>Power Lawn Mower</td>
<td>95</td>
</tr>
<tr>
<td>Factory</td>
<td>90</td>
</tr>
<tr>
<td>Noisy Office</td>
<td>80</td>
</tr>
<tr>
<td>Conversation</td>
<td>65</td>
</tr>
<tr>
<td>Quiet Room</td>
<td>40</td>
</tr>
<tr>
<td>Whisper</td>
<td>20</td>
</tr>
</tbody>
</table>
Physical Hazards – Noise

Noise Control:

• Enclose equipment
• Enclose operator
• Slower rotational speed
• Intake/Exhaust mufflers
• Padded mountings
Physical Hazards

- Dusts and Fibres
- Noise
- Thermal Stress
- Ionizing Radiation
- Non-Ionizing Radiation
Physical Hazards – Thermal Stress

- **Heat Stress**
  - Heat Stroke
  - Heat Exhaustion

- **Cold Stress**
  - Frostbite
  - Hypothermia
Physical Hazards – Thermal Stress

Heat Stress

- Body’s Energy Balance
  - Metabolic rate
  - Radiation
  - Convection
  - Sweating

- External Conditions
  - Temperature
  - Humidity
  - Air movement
  - Radiation

In a typical healthy individual the internal core body temperature may rise as much as 3°C during heat stress
Physical Hazards – Thermal Stress

Cold Stress

• Less Common in Industrial Situations
  – Cold climates
  – Refrigerated space
  – Wind chill

• Responses to Cold Stress
  – Body core temperature is typically 37°C
  – Shivering when body $T_c < 36°C$
  – Lose Consciousness at $T_c < 34°C$
Physical Hazards – Thermal Stress

Control Measures

- **Hot Stress**
  - Air movement
  - Periodic rest
  - Remove to cooler location

- **Cold Stress**
  - Limit exposure time
  - Protective clothing
Physical Hazards

• Dusts and Fibres
• Noise
• Thermal Stress
• Ionizing Radiation
• Non-Ionizing Radiation
Physical Hazards – Ionizing Radiation

- Physical damage to cells
- Possible genetic damage
- Types of Radiation
  - Alpha – emitted from nuclei of radioactive particles
  - Beta – similar to α but with more penetrating (~ 1 cm)
  - X-ray – produced from high speed electrons striking material
  - Gamma – originates from nucleus, produces burns
  - Neutrons – emitted from disintegration of isotopes, very penetrating
Physical Hazards – Ionizing Radiation

• Alpha, Beta - Little protection required

• X-ray, Gamma - Extensive high density shielding

• Neutrons - Special shielding techniques
Physical Hazards

- Dusts and Fibres
- Noise
- Corrosives
- Thermal Stress
- Ionizing Radiation
- Non-Ionizing Radiation
Physical Hazards – Non-Ionizing Radiation

- Low frequency: ~ 3 m wavelength
- Microwaves: 3 m to 3 mm
- Infrared: 3 mm to 750 nm
- Visible light: 750 nm to 400 nm
Chemical Hazards – Non-Ionizing Radiation

• Ultraviolet Radiation
  – UV-A  400 to 320 nm
    • Harmful only to eyes, causes sun tan
  – UV-B  320 to 280 nm
    • Causes skin damage (sun burn), source arc welding
  – UV-C  280 to 220 nm
    • Severe damage, source germicidal lamps
Chemical Hazards – Non-Ionizing Radiation

Lasers

• Especially dangerous for eyes
• Retinal burns
• Corneal burns
Goals of Occupational Hygiene

• Anticipation
• Recognition
• Evaluation
• Control
Typical Questions Asked By Hygienists

- How many people are potentially exposed at work?
- Where do they work (industry); what do they do (occupation)?
- What are the working environmental conditions?
- What levels are they exposed to?
Occupational Hygiene Monitoring
Sound Level Meter

• Measures sound pressure levels
• Useful for construction of noise maps
Noise Dosimeter

- Personal noise exposure measurements
- CSA Z107.56
- Typically used when sound level meter indicates elevated noise levels (>85 dBA)
- Gives an 8 hour dBA LEX
- **LEXposure vs. LEQuivalent**
Particulate Monitor

• For use in office, industrial or outdoor workplaces

• Detects airborne dust, smoke, fumes and mists

• Non-specific
Direct Reading Monitor

- For use in office, industrial or outdoor workplaces
- Detects specific chemicals
- Possible interferences/false positives
- Able to easily measure STEL and day-to-day/hour-to-hour variations in exposure levels
Comprehensive Air Monitoring

- Used for samples where quantitative measurements are required
- Typically done for welding studies, acid/base studies, VOC compositions
- Media attached to end of pump and then sent off to the lab for analysis
- Requires methodology such as NIOSH and understanding of the results
Goals of Occupational Hygiene

• Anticipation
• Recognition
• Evaluation
• Control
Hazard Control

1. Elimination / Substitution: Eliminates the exposure before it can occur.
2. Engineering Controls: Requires a physical change to the workplace.
3. Administrative & Work Practice Controls: Requires worker or employer to DO something.
4. Personal Protective Equipment (including respirators): Requires worker to WEAR something.
Hazard Control

• Consider the following:
  – What is being controlled?
  – What are the concentrations of the hazard?
  – Will the control being undertaken have a positive effect?
  – Alternative control measures?
Questions?

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