Not a Known Carcinogen

UNDERSTANDING HEALTH AND SAFETY INFORMATION FOR CONSERVATION TREATMENT MATERIALS

Kerith Koss Schrager, Anne Kingery-Schwartz & Julie Sobelman CIH
Health & Safety Considerations for Conservators

WHY ARE WE SO SPECIAL?

1. UNUSUAL WORKPLACE SCENERIOS

Conservator Mimi Leveque cleans an Egyptian mummy at Mass General Hospital (AP Photo/Gretchen Ertl)

CHEMICALS ADAPTED FROM OTHER INDUSTRIES

Perchloroethylene for cleaning film

“Since the 1990’s...perchloroethylene or ‘perc’ (and more widely used in the dry cleaning of clothing), became the standard. Although it is not as destructive as its predecessors, it still has significant environmental and health dangers.”

Film Restoration: The Culture and Science of Audiovisual Heritage
Health & Safety Considerations for Conservators

WHY ARE WE SO SPECIAL?

3 LACK OF CONSERVATION EXPOSURE STUDIES
Health & Safety Considerations for Conservators

WHY ARE WE SO SPECIAL?

ACCESS TO HEALTH & SAFETY PROFESSIONALS

Survey conducted online of the American Institute for Conservation’s membership – February 2017
Do you feel you have adequate access to health & safety information and training at your place of work or school?

Yes 76%

Result consistent across all work environments (e.g. Large museum vs. private practice)

Are conservators aware of the Globally Harmonized System for Hazard Communication?

- Regulations for chemical labels and Safety Data Sheets
- Employers were required to train employees by 2015
- All purchasers and users of chemicals should know these systems
### Health & Safety Considerations for Conservators

**WHY ARE WE SO SPECIAL?**

<table>
<thead>
<tr>
<th>Question</th>
<th>Larger Institutions</th>
<th>Smaller Institutions &amp; Private Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you feel you have adequate access to health &amp; safety information and training at your place of work or school?</td>
<td>Yes 76%</td>
<td>Yes 55%</td>
</tr>
<tr>
<td>Are conservators aware of the Globally Harmonized System for Hazard Communication?</td>
<td>Yes 63%</td>
<td>Yes 40%</td>
</tr>
</tbody>
</table>

Result consistent across all work environments (e.g. Large museum vs. private practice)
Of the 35% of respondents who said they had access to health & safety professionals:

How did you find out about the GHS regulations?

- Did not know 37%
- From employer 40%
- Other Source 23%
Health & Safety Considerations for Conservators

WHY ARE WE SO SPECIAL?

5. CONSERVATORS ARE USED TO SOLVING COMPLEX PROBLEMS
   - Understand health and safety experts may be required to interpret issues correctly

6. PERCEPTIONS AND INTERPRETATIONS
   - Avoid making judgments based solely on personal experience
   - Understand chronic illness vs acute symptoms

7. HEALTH AND SAFETY CULTURE WITHIN CONSERVATION
   - Prioritize human safety along with object safety
   - Health and safety is learned by example
Why Cyclododecane?

**WHY IS IT SO SPECIAL?**

1 **VARIETY OF APPLICATION METHODS ACROSS ALL SPECIALTIES**

- British Postal Museum Digitization Project team members spray cyclododecane (Krystina Koscia).
- WUDPAC* Fellow, Jose Luis Lazarte applying cyclododecane using a kistka tool to temporarily secure the crack on the panel.
- Conservators from NMAI ** demonstrate various methods of applying cyclododecane to ceramics.

Why Cyclododecane?  
WHY IS IT SO SPECIAL?

2 CYCLODODECANE IN CONSERVATION IS OFF LABEL USE

“NIOSH has statistically estimated that 28 workers are potentially exposed to cyclododecane in the United States”

- NEOS Survey 1981-1983

“The direct exposure of general population is very unlikely as this substance is intended to be manufactured and handled in industrial settings under strictly controlled conditions only and as the substance is not intended for consumer uses.”

-Evonik Industries, Technical Information, GPS Safety Summary
Why Cyclododecane?
WHY IS IT SO SPECIAL?

100+ conservation publications about cyclododecane. Very few mention health and safety issues. Most information comes from the SDS/MSDS and suggest that it is not hazardous.
Why Cyclododecane?
WHY IS IT SO SPECIAL?

3 CONSERVATION LITERATURE AND WORKSHOPS

The uses of cyclododecane in conservation

Cyclododecane exposure in the field of conservation and restoration of art objects

Subliming Surfaces: Volatile Binding Media in Conservation
Cambridge, UK 15-17 April 2015
Why Cyclododecane?
WHY IS IT SO SPECIAL?

4 CHANGES IN AVAILABILITY
Why Cyclododecane?
WHY IS IT SO SPECIAL?

5 WHAT IS INNOVATION ANYWAY?

www.digg.com

MW2013: Museums and the Web 2013
S. Bruhin©HEAA Arc
Cyclododecane

IS IT SAFE?
Cyclododecane
IS IT SAFE? WHAT DO CONSERVATORS THINK?

NO 49%

YES 18%

DON’T KNOW 33%
Cyclododecane

IS IT SAFE? WHAT DO CONSERVATORS THINK?

- **No**: 49%
- **Yes**: 18%
- **Don’t Know**: 33%

**Why?**

- Information available on the Safety Data Sheet
  - or
- Seeing or reading about other conservators using it
  - or
- Not enough information
Cyclododecane
IS IT SAFE? WHAT DO CONSERVATORS THINK?

- **NO** 49%
  - SDS 17%
  - Other people 50%
  - No info 32%

- **YES** 18%
  - SDS 14%

- **DON’T KNOW** 33%
  - No info 33%
  - Never used 66%

- **Other people** 64%
  - No info 21%
Cyclododecane
IS IT SAFE? WHAT DO CONSERVATORS THINK?

- **NO** 49%
  - SDS 17%
  - Other people 50%
  - No info 32%

- **YES** 18%
  - SDS 14%
  - Other people 64%
  - No info 21%

- **DON'T KNOW** 33%
  - No info 33%
  - Never used 66%
# Cyclododecane

**IS IT HAZARDOUS?**

## CYCLODODECANE

*From Toxicological Literature*

<table>
<thead>
<tr>
<th>CAS [294-62-2]</th>
<th>Molecular Weight 168.32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Formula $\text{C}<em>{12}\text{H}</em>{24}$</td>
<td>Other names <strong>Dodecamethylene</strong></td>
</tr>
</tbody>
</table>

### Occ. Exp. Limits (TLV/PEL)
- None Available

### Biological Exposure Limits
- None Available

### LD50 Mouse sc
- >10.00 mg/kg bw

### LD50 Rat oral
- >10000 mg/kg bw

### LD50 Rat ip
- 1074-1398 mg/kg bw

### Neurological and Pulmonary
- CNS dep. and asp haz

### Skin Irritation
- Not a skin irritant

### Reproductive Toxicity
- None Available

### Carcinogenesis
- None Available

### Genetic & Rel. Cellular Effects
- None Available

### BCF range
- 1,100 to 14,400 (very high)

### Biodegradability
- Insufficient data

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**Material Safety Data Sheet**

According to regulation (EC) No. 1907/2006 (REACH)

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**87100 Cyclododecane**

- **Identification of the Substance/Mixture and of the Company/Undertaking**
  - **Product Identifier**
    - **Product Name:** Cyclododecane
    - **Article No.:** 87100

- **Relevant identified Uses of the Substance or Mixture and Uses advised against**
  - **Identified uses:** Not available.
  - **Uses advised against:** none

- **Details of the Supplier of the Safety Data Sheet**
  - **Company:** S. Kremmer Pigmemente GmbH & Co. KG
  - **Address:** Halleinstr. 41-47, 03317 Achstetten, Germany
  - **Phone:** +49 7565 914480
  - **Fax:** +49 7565 1660
  - **Internet:** [kremmer-pigmemente.de](http://kremmer-pigmemente.de)
  - **EMail:** info@kremmer-pigmemente.de

- **Emergency No.:**
  - **Emergency No.:** +49 7565 914480 (Mon.-Fri. 8:00 - 17:30)

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**Excerpts**

*Cyclohexane and other volatile cycloalkanes are CNS depressants and have been used in combusted.
Vernez, D., et al.
Cyclododecane exposure in the field of conservation and restoration of art objects
International Archives of Occupational Environmental Health (2011) 84:371-374

**Table 1 Exposure levels to CDD during typical activities**

<table>
<thead>
<tr>
<th>Location</th>
<th>Application method</th>
<th>CDD concentration a (mg/m³)</th>
<th>Mean (n = 3)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor</td>
<td>Brush, ventilated hood off</td>
<td>15.5</td>
<td>0.55–40.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brush, ventilated hood on</td>
<td>0.85</td>
<td>0.53–1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spray gun, ventilated hood on</td>
<td>0.75</td>
<td>0.06–1.6</td>
<td></td>
</tr>
<tr>
<td>Outdoor</td>
<td>Brush, open area b</td>
<td>23.3</td>
<td>10.2–40.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spray gun, open area b</td>
<td>24.2</td>
<td>12.1–40.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spray gun, vertical wall b</td>
<td>19.5</td>
<td>12.7–24.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spray gun, open ditch</td>
<td>53.9</td>
<td>30.9–74.4</td>
<td></td>
</tr>
</tbody>
</table>

a Total (aerosol + vapor)
b Ground level measurements

- Indoor and outdoor exposure levels
- Field work and work in confined and unventilated spaces are of particular concern
- Reported respiratory and central nervous system effects following exposure
# Cyclododecane

**IS IT SAFE?**

## Rowe, S. and C. Rozeik.

**The uses of cyclododecane in conservation**


---

**Table 1 Physical properties of cyclododecane, taken from Material Safety Data Sheets and technical information provided by manufacturers and suppliers**

<table>
<thead>
<tr>
<th>Source name</th>
<th>Manufacturers</th>
<th>Suppliers</th>
<th>Databases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dupont</td>
<td>Merck</td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td>[6]</td>
<td>[7]</td>
<td></td>
</tr>
<tr>
<td>Melting point (°C)</td>
<td>60.7</td>
<td>58–61</td>
<td></td>
</tr>
<tr>
<td>Boiling point (°C)</td>
<td>247 at 760 mm Hg</td>
<td>243</td>
<td>239</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>&gt;93</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Ignition temperature (°C)</td>
<td>175 at 500 psig</td>
<td>225</td>
<td>230</td>
</tr>
<tr>
<td>Vapour pressure</td>
<td>10 mm Hg at 100°C</td>
<td>approx 0.1 hPa</td>
<td>0.03 mm Hg</td>
</tr>
<tr>
<td>Specific gravity (g/cm³)</td>
<td>0.82 at 80°C</td>
<td>0.83</td>
<td>0.83</td>
</tr>
<tr>
<td>(at 65°C unless stated otherwise)</td>
<td>0.82 at 80°C</td>
<td>0.83</td>
<td>0.83</td>
</tr>
<tr>
<td>Viscosity</td>
<td>–</td>
<td>2.21 mPa.s</td>
<td>76.50 cP at 146.9°C</td>
</tr>
<tr>
<td>(at 65°C unless stated otherwise)</td>
<td>2.21 mPa.s</td>
<td>2.21 mPa.s</td>
<td>2.21 mPa.s</td>
</tr>
</tbody>
</table>

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Industrial Hygiene Approach

Evaluate the marriage of material hazards and use to propose safe work practices that mitigate negative outcomes.
Understanding Resources
WHERE TO START?

- Product Manufacturer/Supplier
- Regulatory Entities
- Peer-Reviewed Literature

“ASK THE GOOGLE”
Understanding Resources
GLOBALLY HARMOIZED SYSTEM (GHS) FOR HAZARD COMMUNICATION

• Identification and review of relevant data
• No requirement for testing or required testing methodology
• Classification considerations may include:
  • Previously used classifications
  • Biological availability of the substance
  • Animal welfare
  • Evidence from humans
  • Expert judgement
  • Weight of evidence
Understanding Resources

LABELS AND SAFETY DATA SHEETS

Material Safety Data Sheet
According to regulations (EC) No. 1907/2006 (REACH)

87100 Cyclododecane

Material Safety Data Sheet

KREMER Pigmente GmbH & Co. KG
Hauptstr. 41-47, 88717 Achstetten, Germany
Tel/Fax: Tel +49 7565 914460, Fax +49 7565 1606
Internet: www.kremer-pigmente.de - info@kremer-pigmente.de
Email: kremer@kremer-pigmente.de

1. Identification of the Substance/Mixture and of the Company/Undertaking
1.1. Product Identifier
Product Name: Cyclododecane

87100

1.2. Relevant Identified Uses of the Substance or Mixture and Uses Advised against
Identified uses: Not available.
Uses advised against: none

3. Details of the Supplier of the Safety Data Sheet
Company: Kremer Pigmente GmbH & Co. KG
Address: Hauptstr. 41-47, 88717 Achstetten, Germany
Tel/Fax: Tel +49 7565 914460, Fax +49 7565 1606
Email: kremer@kremer-pigmente.de

1. Emergency No:
Emergency No: +49 7565 914460 (Mon-Fri 8:00 - 17:00)

1.1. Product Identifier
Product Name: Cyclododecane

1.2. Relevant Identified Uses of the Substance or Mixture and Uses Advised against
Identified uses: Laboratory chemicals, Manufacture of substances
Uses advised against: none

1.3. Details of the Supplier of the Safety Data Sheet
Company: Sigma-Aldrich
Address: 3001 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone: +1 800-323-3302
Fax: +1 800-323-3302

1.4. Emergency telephone number:
Emergency Phone #: +1-703-527-2677 (CHEMTREC)

1.2. Hazards Identification
1.2.1. Classification of the substance or mixture
Classification according to EC Regulation 1272/2008: This product is not classified as hazardous according to the CLP/HS Directive.
Classification according to EC Regulation No. 67/548 or No. 1907/2006: The material is not subject to classification according to EC data.

Safety phrases:
Possible Environmental Effects:

1.2.2. Label elements
Classification according to EC Regulation 1272/2008:
Hazard designation: Not applicable.

Signal word:
Hazard designation:
Safety designation:
Hazardous components for labelling:

1.2.3. Other hazards

2. Composition/Information on Ingredients

SIGMA-ALDORICH
SAFETY DATA SHEET
Version 8.8
Revised Date 06/26/2014
First Date 05/16/2017

1. PRODUCT AND COMPANY IDENTIFICATION
1.1. Product Identifier
Product name: Cyclododecane
Product Number: 5436402
Brand: Aldrich
CAS-No.: 294-02-2

1.2. Relevant identified uses of the substance or mixture and uses advised against
Identified uses: Laboratory chemicals, Manufacture of substances
Uses advised against: none

1.3. Details of the supplier of the safety data sheet
Company: Sigma-Aldrich
Address: 3001 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone: +1 800-323-3302
Fax: +1 800-323-3302

1.4. Emergency telephone number:
Emergency Phone #: +1-703-527-2677 (CHEMTREC)

2. HAZARDS IDENTIFICATION
2.1. Classification of the substance or mixture
GHS Classification in accordance with 29 CFR 1910 (OSHA HCS): Acute aquatic toxicity (Category 3), H412
Chronic aquatic toxicity (Category 3), H412
For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2. GHS Label elements, including precautionary statements
Signal word: none
Signal word: none
Hazard statement(s): H412: Harmful to aquatic life with long lasting effects.
Precautionary statement(s): P273: Avoid release to the environment.
P601: Dispose of content/container to an approved waste disposal plant.

2.3. Hazards not otherwise classified (INOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS
3.1. Substances
Formule: CT2424
Molecular Weight: 163.20 g/mol
CAS-No.: 784-62-2
BC-No.: 254-033-9
No ingredients are hazardous according to OSHA criteria.
Aldrich: 5436402
Understanding Toxicology Resources

EPA Chemview

CDC/NIOSH International Chemical Safety Cards

National Library of Medicine
  - PubChem
  - TOXNET
“...low acute and chronic toxicity overall, but still able to induce many toxic responses...including central nervous system (CNS) depression, dizziness, and headache.”

“...the margin of safety between CNS depression and death is very narrow and...barely recognizable. . .”

“Oral administration of high doses to animals...resulted in severe diarrhea, vascular collapse, and heart, lung, liver, and brain degeneration.”

Toxicology studies are from the 1960s -1990s.

Toxicology warnings involve similar compounds not specifically cyclododecane

Some discrepancies in reported results
EXPOSURE
the opportunity for the body to receive a dose substantial enough to result in an adverse health effect

Inhalation
Ingestion
Absorption

TLV/PEL
LC 50

LD50

Air Samples
Wipe Samples

Bio-Monitoring

DETECTION
How dangerous is CDD? (according to the industrial literature)

**CDD is not poisonous** - CDD has been tested by subcutaneous injection into populations of mice and by feeding it to populations of rats, to determine the lethal dose (LD) required to kill half the population. These are the results:

- **LD 50, subcutaneous mouse > 10,000 mg/Kg**
- **LD 50, oral rat > 10,000 mg/Kg**

Scaled up to the weight of a human being, this is the equivalent of around 700 grams.

**CDD is not corrosive** - Testing using artificial skin has shown no evidence of corrosive or irritant properties

**CDD is not mutagenic** - CDD had a negative Ames test. Testing for mutagens are done on insects

**CDD has a high likelihood of bioaccumulation** - CDD is hydrophobic (one of its many useful properties) and conversely, lipophilic (fat-loving). It will absorb through the skin and through the lungs. Once CDD has entered the body it is not eliminated but is absorbed into the fat cells. Testing has indicated that there is a high likelihood of bioaccumulation in fish.

**Other Health & Safety Tips**

- Double boilers are recommended for melting due to low flash-point.
- Nitrile gloves are recommended for working with CDD.
What should we do??

**ALARA [As Low As Reasonably Achievable]**
Based on radiation exposure—even if there is a recommended limit, best practice is to minimize all exposure

**UNIVERSAL PRECAUTIONS**
Based on the OSHA standard on blood borne pathogens, which means treating all blood/body fluid as if it were infectious.

If you don’t know, treat it all as if it can harm you (which in reality it might)
But, really, what should we do?

- **Assume lowest values**
  - Use the lowest values for flashpoint, exposure limits, etc. if data is inconsistent

- ** Appropriately monitor exposure**
  - Don’t use smell as a measure of toxicity
  - If equipment is available to you take measurements to document exposure levels

- **Select the correct Personal Protective Equipment (PPE)**
  - PPE is specific to the hazard
  - Understand how to properly select a respirator and cartridges
    - For cyclododecane use both an organic vapor and particulate filters

- **Use environmental controls**
  - Avoid working in confined spaces
  - Work with proper ventilation
  - Consider exposure scenarios beyond yourself
    - For example, consider long term exposure controls during sublimation

- **Follow basic Hazard Communication protocols**

- **Make health & safety a priority**
ACKNOWLEDGEMENTS

MICHAEL HUNT, CIH, Industrial Hygienist, Office of Safety, Health & Environmental Management Smithsonian
MARTIN J ADLEM, BSC TECH IOSH, Health & Safety Advisor
KATHRYN MAKOS, MPH, CIH, Industrial Hygienist, Smithsonian (retired)
RICK KERSCHNER, Conservator, Kerschner Museum Conservation Services
RACHAEL PERKINS ARENSTEIN, Conservator, AM Art Conservation, LLC
AMY DAVIDSON, Senior Principal Preparator, American Museum of Natural History
TARA FRASER, Conservator, Fraser Spafford Ricci Art & Archival Conservation Inc.
REBECCA KACZKOWSKI, Preventative Conservator, Museum Conservation Institute, Smithsonian
CHRISTINA ROZEIK, Conservator, Christina Rozeik Conservation
DAVID KREMER, Kremer Pigmente GmbH & Co. KG
BONNIE NAUGLE, Communications Director, AIC
MEMBERS OF THE AIC HEALTH & SAFETY COMMITTEE
ARTS, CRAFT & THEATER SAFETY and MONONA ROSSOL

For Resources, General Health and Safety Information and the Full Results of our Survey:

HEALTH & SAFETY COMMITTEE WIKI