Hydrogen Peroxide

General Information

Key Points

Fire
- Oxidising and flammable
- May explode from friction, heat or contamination producing oxygen which increases fire hazard. Reacts violently with combustibles, reducing agents, metals and organic materials such as wood or asbestos
- Rapidly decomposes to form water and oxygen
- In the event of a fire involving hydrogen peroxide, use fine water spray and liquid tight fire kit with breathing apparatus

Health
- Toxic via ingestion, inhalation, skin or eye contact
- Harmful and corrosive
- Ingestion may cause irritation of the gastrointestinal tract with vomiting which may contain blood, gastrointestinal bloating, tiredness and coma
- Inhalation of hydrogen peroxide may cause irritation of the nose, throat and respiratory tract. In severe cases an accumulation of fluid in the lungs may occur
- Skin contact can cause bleaching of skin, and at higher concentrations redness and swelling, blistering and burns
- Exposure to the eyes may result in pain, running of the eyes, conjunctivitis, and sensitivity to light

Environment
- Avoid release into the environment
- Inform Environment Agency of substantial incidents

Prepared by the Toxicology Department
CRCE, PHE
2009
Version 1
Hydrogen peroxide is a colourless liquid with a slightly sharp odour, which is unstable and flammable under heating, friction or when contaminated.

Hydrogen peroxide occurs naturally at very low levels in the air and water, in human and plant tissues and bacteria and in some food and drinks.

Hydrogen peroxide is produced industrially in large quantities. The main use of hydrogen peroxide is as a bleaching agent for wood pulp, as well as for bleaching textiles, paper and food. It is also used as a chemical intermediate in the production of a wide range of chemicals, plastics and pharmaceuticals.

Hydrogen peroxide is used to treat waste water and sewage from industrial and domestic sources and for detoxifying organic pollutants in the environment. It is also used as a commercial disinfectant and antimicrobial agent. Hydrogen peroxide is a component in some types of rocket fuel as it is extremely reactive. Hydrogen peroxide at low concentrations (around 3-6%) is used in peroxide-based hair dyes.

Exposure to large amounts of hydrogen peroxide is most likely to occur in an occupational setting. However, the general public may be exposed to small amounts due to its use in many domestic products.

Hydrogen peroxide is toxic at high concentrations by all routes of exposure, whether it is ingested, inhaled or comes into contact with the skin and eyes, producing effects at the site of contact.

Hydrogen peroxide is an irritant. Inhalation of hydrogen peroxide vapours causes irritation to the nose, throat and respiratory tract. In severe cases an accumulation of fluid in the lungs may occur, which can potentially be fatal. Ingestion may cause abdominal pain, foaming at the mouth, vomiting which may include blood, gastric bloating, fever, lethargy and unconsciousness. High concentrations will cause irritation and corrosion to the gastrointestinal tract and may cause death.

Skin contact with dilute solutions of hydrogen peroxide may cause whitening or bleaching of the skin. Contact with high concentrations of hydrogen peroxide can cause irritation and redness, corrosion, severe burns, blisters, ulcers and permanent scarring. Eye contact with high concentrations of hydrogen peroxide can cause pain, running of the eyes, conjunctivitis, sensitivity to light, severe eye burns and permanent injury including blindness.

Children exposed to hydrogen peroxide are expected to show similar effects to adults. Exposure to hydrogen peroxide during pregnancy is not likely to cause damage to the unborn child since it is rapidly detoxified with only a minimal amount getting into the blood.

The International Agency for Research on Cancer (IARC) has concluded that hydrogen peroxide is not classifiable as to its carcinogenicity to humans (group 3).
Frequently Asked Questions

What is hydrogen peroxide?
Hydrogen peroxide is a colourless liquid with a slightly sharp odour, which is unstable and flammable under heating, friction or when contaminated.

How does hydrogen peroxide get into the environment?
Hydrogen peroxide occurs naturally at very low levels in the air and water, in human and plant tissue and bacteria and in some food and drinks. It is produced industrially in large quantities and it may enter the environment from workplaces where it is manufactured or used.

How will I be exposed to hydrogen peroxide?
Hydrogen peroxide at high concentrations is toxic by all routes of exposure, whether it is ingested, inhaled or comes into contact with the skin and eyes. Exposure to large amounts of hydrogen peroxide is most likely to occur in an occupational setting. However, you may be exposed to small amounts of hydrogen peroxide at low concentrations due to its use in domestic products such as chlorine-free bleach and hair dye.

If there is hydrogen peroxide in the environment will I have any adverse health effects?
The presence of hydrogen peroxide in the environment does not always lead to exposure. Clearly, in order for it to cause any adverse health effects you must come into contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact. Following exposure to any chemical, the adverse health effects you may encounter depend on several factors, including the amount to which you are exposed (dose), the way you are exposed, the duration of exposure, the form of the chemical and if you were exposed to any other chemicals.

Hydrogen peroxide is an irritant. Inhalation of hydrogen peroxide will cause irritation to the nose, throat and respiratory tract. Ingestion of high concentrations will cause abdominal pain, foaming at the mouth, vomiting, bleeding of the gastrointestinal tract, gastric bloating, fever, lethargy, unconsciousness and in severe cases death. Skin contact with low concentrations of hydrogen peroxide cause a whitening of the skin. High concentrations of hydrogen peroxide can cause irritation and redness, corrosion, severe burns, blisters, ulcers and permanent scarring following skin contact. Eye contact with high concentrations of hydrogen peroxide can cause pain, running of the eyes, conjunctivitis, sensitivity to light, severe eye burns and permanent injury including blindness.

Can hydrogen peroxide cause cancer?
There is no evidence to suggest that exposure to hydrogen peroxide would cause cancer in humans.

Does hydrogen peroxide affect children or damage the unborn child?
Children exposed to hydrogen peroxide would be affected in the same way as adults. There is no evidence to suggest that exposure to hydrogen peroxide can affect the health of the unborn child.

What should I do if I am exposed to hydrogen peroxide?
If you have got hydrogen peroxide on your skin remove soiled clothing, wash the affected area with lukewarm water and soap for at least 10 – 15 minutes and seek medical advice.
If you have got hydrogen peroxide in your eyes remove contact lenses, wash the affected area with lukewarm water for at least 10 – 15 minutes and seek medical advice.

If you have ingested hydrogen peroxide seek medical advice.
Hydrogen Peroxide

Incident Management

Key Points

Fire
- Oxidising May explode from friction, heat or contamination producing oxygen which increases fire hazard. Reacts violently with combustibles, reducing materials causing fire and explosion hazard particularly in the presence of metals rapidly decomposes to form water and oxygen
- In the event of a fire involving hydrogen peroxide, use fine water spray and liquid tight fire kit with breathing apparatus

Health
- Exposure is via ingestion, inhalation dermal or ocular exposure
- Gas embolism may occur from ingestion, intravenous injection or wound irrigation.
- Ingestion may cause irritation of the gastrointestinal tract with vomiting and haematemesis. Concentrated solutions may cause blistering of the mucosae and oropharyngeal burns. Impaired consciousness, apnoea, stridor, cyanosis, convulsions and cardiac arrest may occur rapidly when concentrated solutions have been ingested.
- Inhalation may cause respiratory tract irritation
- Dermal exposure can cause whitening of the skin, inflammation, blistering and skin burns
- Eye contact may cause burning, redness and blurred vision. Exposure to stronger solutions (>10%) may cause corneal ulceration and perforation

Environment
- Avoid release into the environment
- Inform Environment Agency of substantial incidents

Prepared by the Toxicology Department
CRCE, PHE
02/2013
Version 2
### Hazard Identification

**Standard (UK) Dangerous Goods Emergency Action Codes**

<table>
<thead>
<tr>
<th>UN</th>
<th>2014</th>
<th>Hydrogen peroxide, aqueous solution (with not less than 20% but not more than 60% hydrogen peroxide (stabilised as necessary))</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAC</td>
<td>2P</td>
<td>Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must however still be exercised to avoid unnecessary pollution to watercourses.</td>
</tr>
<tr>
<td>APP</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class</th>
<th>Sub risks</th>
<th>Hazards</th>
<th></th>
<th>Sub risks</th>
<th>Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>8</td>
<td>Oxidising substances</td>
<td>58</td>
<td>Corrosive substances</td>
<td></td>
</tr>
</tbody>
</table>

**Hazard Identification**

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<table>
<thead>
<tr>
<th>UN</th>
<th>2015</th>
<th>Hydrogen peroxide, aqueous solution (with more than 60% hydrogen peroxide)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAC</td>
<td>2P</td>
<td>Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must however still be exercised to avoid unnecessary pollution to watercourses.</td>
</tr>
<tr>
<td>APP</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Hazards

<table>
<thead>
<tr>
<th>Class</th>
<th>Sub risks</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>8</td>
<td>Oxidising substances</td>
</tr>
<tr>
<td>5.1</td>
<td>-</td>
<td>Corrosive substances</td>
</tr>
</tbody>
</table>

| HIN   | 559 | Strongly oxidising (fire-intensifying) substance, which can spontaneously lead to violent reaction |

<table>
<thead>
<tr>
<th>UN</th>
<th>2984</th>
<th>Hydrogen peroxide, aqueous solution (with not less than 8% but not more than 20% hydrogen peroxide (stabilised as necessary))</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAC</td>
<td>2R</td>
<td>Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must however still be exercised to avoid unnecessary pollution to watercourses.</td>
</tr>
<tr>
<td>APP</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Hazards

<table>
<thead>
<tr>
<th>Class</th>
<th>Sub risks</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>-</td>
<td>Oxidising substances</td>
</tr>
</tbody>
</table>

| HIN   | 50   | Oxidising (fire-intensifying) substance |

UN – United Nations number; EAC – Emergency Action Code; APP – Additional Personal Protection; HIN - Hazard Identification Number
*Liquid-tight chemical protective clothing (BS 8428) in combination with self-contained open circuit positive pressure compressed air breathing apparatus (BS EN 137).
### Chemical Hazard Information and Packaging for Supply Classification\(^{(a)}\)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Oxidising</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5 Risk phrase</td>
<td>Heating may cause an explosion</td>
</tr>
<tr>
<td>R8 Risk phrase</td>
<td>Contact with combustible material may cause fire</td>
</tr>
<tr>
<td>R20/22 Risk phrase</td>
<td>Harmful by inhalation and if swallowed</td>
</tr>
<tr>
<td>R35 Safety phrase</td>
<td>Causes severe burns</td>
</tr>
<tr>
<td>S1/2 Safety phrase</td>
<td>Keep locked up and out of the reach of children</td>
</tr>
<tr>
<td>S17 Safety phrase</td>
<td>Keep away from combustible material</td>
</tr>
<tr>
<td>R26 Safety phrase</td>
<td>In case of contact with eyes, rinse immediately with plenty of water and seek medical advice</td>
</tr>
<tr>
<td>R28 Safety phrase</td>
<td>After contact with skin, wash immediately with plenty of ... (to be specified by the manufacturer)</td>
</tr>
<tr>
<td>R36/37/39 Safety phrase</td>
<td>Wear suitable protective clothing, gloves and eye/face protection</td>
</tr>
<tr>
<td>R45 Safety phrase</td>
<td>In case of accident or if you feel unwell seek medical advice immediately (show the label where possible)</td>
</tr>
</tbody>
</table>

### Specific Concentration Limits

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>C ≥ 50 %</td>
<td>Xn; R20</td>
</tr>
<tr>
<td>C ≥ 8 %</td>
<td>Xn; R22</td>
</tr>
<tr>
<td>C ≥ 70 %</td>
<td>C; R35</td>
</tr>
<tr>
<td>50 % ≤ C &lt; 70 %</td>
<td>C; R34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concentration Range</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 % ≤ C &lt; 50 %</td>
<td>Xi; R37/38</td>
</tr>
<tr>
<td>8 % ≤ C &lt; 50 %</td>
<td>Xi; R41</td>
</tr>
<tr>
<td>5 % ≤ C &lt; 8 %</td>
<td>Xi; R36</td>
</tr>
<tr>
<td>C ≥ 50%</td>
<td>Footnote O; R8</td>
</tr>
<tr>
<td>C ≥ 70 %</td>
<td>R5</td>
</tr>
</tbody>
</table>
Globally Harmonised System of Classification and Labelling of Chemicals (GHS)\(^{(a)}\)

<table>
<thead>
<tr>
<th>Hazard Class and Category</th>
<th>Oxidising liquid, category 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Tox. 4</td>
<td>Acute toxicity (oral and inhalation) category 4</td>
</tr>
<tr>
<td>Skin. Corr. 1A</td>
<td>Skin corrosive, category 1A</td>
</tr>
</tbody>
</table>

### Hazard Statement

- **H271** May cause fire or explosion; strong oxidiser.
- **H332** Harmful if inhaled.
- **H302** Harmful if swallowed.
- **H314** Causes severe skin burns and eye damage.

### Signal Words

- DANGER

### Specific concentration limits

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Hazard Class and Category</th>
<th>Hazard Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C \geq 70 % )</td>
<td>Ox. Liq. 1</td>
<td>H271 May cause fire or explosion; strong oxidiser.</td>
</tr>
<tr>
<td>50 % ( \leq ) ( C &lt; 70 % )</td>
<td>Ox. Liq. 2</td>
<td>H272 May intensify fire; oxidiser</td>
</tr>
<tr>
<td>( C \geq 70 % )</td>
<td>Skin Corr. 1A</td>
<td>H314 Causes severe skin burns and eye damage.</td>
</tr>
<tr>
<td>50 % ( \leq ) ( C &lt; 70 % )</td>
<td>Skin Corr. 1B</td>
<td>H314 Causes severe skin burns and eye damage.</td>
</tr>
<tr>
<td>35 % ( \leq ) ( C &lt; 50 % )</td>
<td>Skin Irrit. 2</td>
<td>H315 Causes skin irritation</td>
</tr>
<tr>
<td>8 % ( \leq ) ( C &lt; 50 % )</td>
<td>Eye Dam. 1</td>
<td>H318 Causes serious eye damage</td>
</tr>
</tbody>
</table>

\(^{(a)}\) Annex VI to Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures- Table 3.1.
<table>
<thead>
<tr>
<th>Concentration Range</th>
<th>Effect</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 % ≤ C &lt; 8 %</td>
<td>Eye Irrit. 2</td>
<td>H319</td>
<td>Causes serious eye irritation</td>
</tr>
<tr>
<td>C ≥ 35 %</td>
<td>STOT SE 3</td>
<td>H335</td>
<td>May cause respiratory irritation</td>
</tr>
</tbody>
</table>

* Implemented in the EU on 20 January 2009.
Physicochemical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS number</td>
<td>7722-84-1</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>34.0</td>
</tr>
<tr>
<td>Empirical formula</td>
<td>(\text{H}_2\text{O}_2)</td>
</tr>
<tr>
<td>Common synonyms</td>
<td>Dihydrogen dioxide, Hydrogen dioxide, Hydroperoxide</td>
</tr>
<tr>
<td>State at room temperature</td>
<td>Colourless liquid</td>
</tr>
<tr>
<td>Volatility</td>
<td>Vapour pressure = 1.5 mmHg (90%) 0.75 mmHg (70%)</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.4 (90%) 1.3 (70%) (water=1)</td>
</tr>
<tr>
<td>Flammability</td>
<td>When heated, shocked, or contaminated, the concentrated forms of hydrogen peroxide can explode or start fires</td>
</tr>
<tr>
<td>Lower explosive limit</td>
<td>Data not available</td>
</tr>
<tr>
<td>Upper explosive limit</td>
<td>Data not available</td>
</tr>
<tr>
<td>Water solubility</td>
<td>Miscible with water. Soluble in ether, insoluble in petroleum ether and is decomposed by many organic solvents</td>
</tr>
<tr>
<td>Reactivity</td>
<td>Unstable. May explode from friction, heat or contamination producing oxygen, which increases fire hazard. Will accelerate burning when involved in a fire. It is a strong oxidant and reacts violently with combustible and reducing materials causing fire and explosion hazard particularly in the presence of metals. Attacks many organic substances, e.g., textile and paper.</td>
</tr>
<tr>
<td>Reaction or degradation products</td>
<td>Readily decomposes to form water and oxygen. Decomposition is accelerated by agitation or contact with rough surfaces, metals, alkalis and finely divided metals.</td>
</tr>
<tr>
<td>Odour</td>
<td>Slightly sharp odour</td>
</tr>
<tr>
<td>Structure</td>
<td>(\text{HO—OH})</td>
</tr>
</tbody>
</table>

Table references\(^{(a,b,c)}\)


Threshold Toxicity Values

<table>
<thead>
<tr>
<th>%</th>
<th>SIGNS AND SYMPTOMS</th>
<th>REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 30 – 40</td>
<td>Serious – risk of severe irritation and death</td>
<td>a</td>
</tr>
</tbody>
</table>

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**Published Emergency Response Guidelines**

*Emergency Response Planning Guideline (ERPG) Values*(a)

<table>
<thead>
<tr>
<th>ERPG-1*</th>
<th>Listed value (ppm)</th>
<th>Calculated value (mg m⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>13.91</td>
</tr>
<tr>
<td>ERPG-2**</td>
<td>50</td>
<td>69.53</td>
</tr>
<tr>
<td>ERPG-3***</td>
<td>100</td>
<td>139.06</td>
</tr>
</tbody>
</table>

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.
** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
*** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.

**Acute Exposure Guideline Levels (AEGLs)**

<table>
<thead>
<tr>
<th>Interim values</th>
<th>ppm</th>
<th>10 min</th>
<th>30 min</th>
<th>60 min</th>
<th>4 hr</th>
<th>8 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEGL-1†</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AEGL-2††</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Data not available</td>
</tr>
<tr>
<td>AEGL-3†††</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† The level of the chemical in air at or above which the general population could experience notable discomfort.
†† The level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape.
††† The level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

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## Exposure Standards, Guidelines or Regulations

### Occupational Standards

<table>
<thead>
<tr>
<th>WEL&lt;sup&gt;(a)&lt;/sup&gt;</th>
<th>LTEL (8 hour reference period): 1 ppm (1.4 mg m&lt;sup&gt;-3&lt;/sup&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STEL (15 min reference period): 2 ppm (2.8 mg m&lt;sup&gt;-3&lt;/sup&gt;)</td>
</tr>
</tbody>
</table>

### Public Health Guidelines

<table>
<thead>
<tr>
<th>DRINKING WATER QUALITY GUIDELINE</th>
<th>Data not available</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR QUALITY GUIDELINE</td>
<td>Data not available</td>
</tr>
<tr>
<td>SOIL GUIDELINE VALUE AND HEALTH CRITERIA VALUES</td>
<td>Data not available</td>
</tr>
</tbody>
</table>

WEL – Workplace exposure limit; LTEL - Long-term exposure limit; STEL – Short-term exposure limit

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<sup>(a)</sup> EH40/2005 Workplace Exposure Limits (second edition, published 2011).
Health Effects

Major Route of Exposure\(^{(a)}\)

- Main route of exposure is via ingestion, dermal or ocular exposure

Immediate Signs or Symptoms of Acute Exposure\(^{(b)}\)

- Gas embolism may occur from ingestion, intravenous injection or wound irrigation. Hepatic and cerebral gas emboli have been reported.
- Ingestion may cause nausea, vomiting and haematemesis. Concentrated solutions may cause blistering of the mucosae and oropharyngeal burns. Foaming at the mouth may occur with a risk of obstruction to the respiratory tract and pulmonary aspiration. Impaired consciousness, apnoea, stridor, cyanosis, convulsions and cardiac arrest may occur rapidly when concentrated solutions have been ingested. Release of oxygen gas may cause belching and painful gastric distension.
- Inhalation may cause respiratory tract irritation. Coughing and dyspnœa may occur but will be mild and transient unless a concentrated solution is involved. Irritation may be severe, leading to pulmonary oedema 24 to 72 hours after exposure.
- Skin contact may cause a whitening of the skin, inflammation, blistering and skin burns. Symptoms are expected to be mild when dilute solutions are involved. Exposure may be greater when used for wound irrigation.
- Eye contact with weak solutions may cause burning, redness and blurred vision. Stronger solutions (10% or more) may cause corneal ulceration or perforation.

\(^{(a)}\) TOXBASE: Hydrogen peroxide, 2009
Decontamination and First Aid

**Important Notes**

- Ambulance staff, paramedics and emergency department staff treating chemically-contaminated casualties should be equipped with Department of Health approved, gas-tight (Respirex) decontamination suits based on EN466:1995, EN12941:1998 and prEN943-1:2001, where appropriate.
- Decontamination should be performed using local protocols in designated areas such as a decontamination cubicle with adequate ventilation.

**Dermal Exposure**\(^{a}\)

- Do **NOT** apply neutralising chemicals as heat produced during neutralisation reactions may cause thermal burns and increase injury.
- Contaminated clothing should be removed, double bagged, sealed and stored safely.
- Decontaminate open wounds first and avoid contamination of unexposed skin.
- Any particulate matter adherent to skin should be removed and the patient washed with copious amounts of water under low pressure for at least 10 – 15 minutes or until pH of the skin is normal (pH of the skin is 4.5 – 6 although it may be closer to 7 in children, or after irrigation.
- **The earlier the irrigation begins, the greater the benefit.**
- Pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears.
- Recheck pH of affected areas after a period of 15-20 minutes and repeat irrigation if abnormal. Burns with strong solutions may require irrigation for several hours or more.
- Once the pH is normal and stabilised, treat as per a thermal injury.
- Burns totalling more than 15% of body surface area in adults (more than 10% in children) will require standard fluid resuscitation as for thermal burns.
- Moderate/severe chemical burns should be reviewed by a burns specialist.
- Other measures as indicated by the patient’s clinical condition

**Ocular Exposure**\(^{b}\)

- Remove patient from exposure.
- Remove contact lenses if present and immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10 – 15 minutes. Continue until the conjunctival scale pH is normal (7.5 – 8.0). Retest after 20 minutes and use further irrigation if necessary.
- Any particles lodged in the conjunctival recesses should be removed.
- Patients with corneal damage and those whose symptoms do not resolve rapidly should be referred for urgent ophthalmological assessment.

**Inhalation**\(^{c}\)

- Maintain a clear airway and ensure adequate ventilation.
- Give oxygen if required.
- If appropriate remove from exposure and decontaminate the patient.
- All patients with abnormal vital signs, chest pain, respiratory symptoms or hypoxia should have a 12 lead ECG performed.

\(^{a}\) TOXBASE: Skin decontamination – corrosives, 2010
\(^{b}\) TOXBASE: Chemicals Splashed or Sprayed into the Eyes, 2012
\(^{c}\) TOXBASE: Corrosives – Inhalation, 2012.
- If the patient has clinical features of bronchospasm treat conventionally with nebulised bronchodilators and steroids.
- Other measures as indicated by the patient's clinical condition.

**Ingestion**

- Gut decontamination is contraindicated. Hydrogen peroxide is rapidly decomposed, releasing oxygen gas. If a concentrated solution has been ingested, oral fluids should not be given since an exothermic reaction will occur.
- Monitor cardiac rhythm and respiration rate.
- Other measures as indicated by the patient's clinical condition.
Hydrogen Peroxide

Toxicological Overview

Key Points

Kinetics and metabolism

- Hydrogen peroxide may only cause toxicity at the site of contact but not systemic toxicity
- Hydrogen peroxide generates hydroxyl radicals that induce lipid peroxidation within exposed cells which can lead to DNA damage and cell death

Health effects of acute exposure

- The main toxic effect of exposure to hydrogen peroxide is irritation at the site of contact
- Acute inhalation of hydrogen peroxide causes irritation to the nose, throat and respiratory tract. In very severe cases bronchitis or pulmonary oedema may occur, which can potentially be fatal
- Ingestion of hydrogen peroxide results in gastrointestinal irritation, abdominal pain, foaming at the mouth, vomiting and haematemesis, gastric distension, gas embolism, fever, lethargy unconsciousness and in severe cases, can result in death
- Dermal exposure to dilute solutions may cause whitening of the skin, whilst more concentrated solutions can cause severe irritation and corrosion, severe burns, blisters, ulcers and permanent scarring
- Ocular exposure to hydrogen peroxide may cause corrosion, corneal burns, lacrimation, photophobia and permanent injury including blindness

Health effects of chronic exposure

- Chronic exposure to hydrogen peroxide is likely to cause similar adverse health effects to those seen following acute exposure, as it does not give rise to systemic toxicity
- Hydrogen peroxide is not considered to be a carcinogen

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Summary of Health Effects

Hydrogen peroxide may cause toxicity from all routes of exposure. Exposure to large quantities of hydrogen peroxide is most likely to occur in an occupational setting, due to its use at high concentrations (typically above 35%) in many industrial applications.

The main toxic effect resulting from exposure to hydrogen peroxide is irritation at the site of contact.

Inhalation of hydrogen peroxide causes irritation to the nose, throat and respiratory tract. In very severe cases bronchitis or pulmonary oedema may occur, which can potentially be fatal.

Ingestion of hydrogen peroxide results in gastrointestinal irritation, abdominal pain, foaming at the mouth, vomiting and haematemesis, gastric distension, gas embolism, fever, lethargy unconsciousness and in severe cases, can result in death.

Dermal exposure to dilute solutions of hydrogen peroxide can cause whitening or bleaching of the skin. Solutions of 35% hydrogen peroxide cause mild irritation and concentrations above 50% cause severe irritation and corrosion, severe burns, blisters, ulcers and permanent scarring. Ocular exposure to hydrogen peroxide solutions of greater than 35% are expected to cause corrosion, corneal burns, lacrimation, photophobia and permanent injury including blindness.

Chronic exposure to hydrogen peroxide is likely to cause similar adverse health effects to those seen following acute exposure, as it does not give rise to systemic toxicity.

There is no evidence to suggest that hydrogen peroxide causes reproductive or developmental toxicity in humans.

The International Agency for Research on Cancer (IARC) has noted that there is inadequate evidence in humans for the carcinogenicity of hydrogen peroxide. The overall conclusion of IARC was that hydrogen peroxide is not classifiable as to its carcinogenicity to humans (group 3). Hydrogen peroxide has some mutagenic potential in in vitro systems, but it is not possible to conclude whether it has mutagenic potential in vivo.
**Kinetics and Metabolism**

Few data are available regarding the kinetics of hydrogen peroxide.

Absorbed hydrogen peroxide is very rapidly broken down by enzymes, including glutathione peroxidise or catalase in tissue and hence does not give rise to systemic toxicity [1, 2]. Formation of hydroxyl radicals in cells of tissues of first contact may induce lipid peroxidation, DNA damage and cell death [1].

**Sources and Route of Human Exposure**

Hydrogen peroxide may cause toxicity from all routes of exposure.

Exposure to large quantities of hydrogen peroxide is most likely to occur in an occupational setting, due to its use at high concentrations (typically above 35%) in many industrial applications [3]. In occupations where hydrogen peroxide is used, personal protective equipment is recommended [4].

The general public may be exposed to small amounts due to its use at low concentration (approximately 3-6%) in many domestic products such as chlorine-free bleach and in peroxide-based hair dyes. Small amounts are also formed in the body as a by-product of normal enzymatic processes [5].
Health Effects of Acute / Single Exposure

**Human Data**

**General toxicity**

The main toxic effect resulting from exposure to hydrogen peroxide is irritation at the site of contact [3].

**Inhalation**

Hydrogen peroxide does not readily form a vapour at room temperature. However, if heated or misted, acute inhalation of hydrogen peroxide will cause irritation to the nose, throat and respiratory tract. Dyspnoea and cough have also been reported [6]. In very severe cases bronchitis or pulmonary oedema may occur, which can potentially be fatal [3]. In human volunteers exposed to an aerosol of hydrogen peroxide for 4 hours, the threshold for respiratory tract irritation was 10 mg m$^{-3}$ [3].

**Ingestion**

Acute ingestion of hydrogen peroxide results in gastrointestinal irritation, and possible gas embolism. Concentrations greater than 30 – 40 % cause severe irritation, with signs and symptoms including abdominal pain, foaming at the mouth, vomiting and haematemesis, and gastric distension. Fever, lethargy, shock, unconsciousness and respiratory arrest may also occur. Concentrated solutions may cause gas embolism, and in severe cases, death may occur within minutes of ingestion [3, 6]. However, most cases of acute ingestion of hydrogen peroxide result only in mild adverse effects [6].

**Dermal / ocular exposure**

Dermal exposure to dilute solutions of hydrogen peroxide cause whitening or bleaching of the skin due to microembolism caused by oxygen bubbles in the capillaries [1, 3]. Dermal contact with solutions of 35 % hydrogen peroxide cause mild skin irritation. Solutions of 50 % hydrogen peroxide and above cause severe irritation and corrosion, severe burns, blisters, ulcers and permanent scarring [3, 6].

Ocular exposure to hydrogen peroxide solutions of greater than 35 % are expected to cause corrosion, corneal burns, lacrimation, photophobia, conjunctivitis and permanent injury including blindness [3].

**Animal and In-Vitro Data**

**Inhalation**

No data on acute toxicity in animals following acute inhalation were available.

**Ingestion**

No data on acute toxicity in animals following acute ingestion were available.
Dermal / ocular exposure

No data on acute toxicity in animals following acute dermal or ocular were available.
Health Effects of Chronic / Repeated Exposure

**Human Data**

**General toxicity**

As hydrogen peroxide does not cause systemic toxicity, any adverse health effects observed following a chronic or repeated exposure would be expected to be similar to those observed following an acute exposure.

**Inhalation**

A case study in which seven workers occupationally exposed to 12 – 41 mg m\(^{-3}\) hydrogen peroxide aerosols for one year reported eye and throat irritation and a gradual bleaching of their hair [3].

**Ingestion**

No data on chronic toxicity in humans following chronic ingestion were available. Ingestion is not a typical route of exposure to hydrogen peroxide [3].

**Genotoxicity**

No data was available regarding the genotoxicity or mutagenicity of hydrogen peroxide in humans [1, 3].

**Carcinogenicity**

IARC noted that there was inadequate evidence in humans for the carcinogenicity of hydrogen peroxide and concluded that, overall, it is not classifiable as to its carcinogenicity to humans (group 3) [1].

**Reproductive and developmental toxicity**

No data were located regarding the reproductive or developmental toxicity of hydrogen peroxide in humans [3].

**Animal and In-Vitro Data**

**Inhalation**

No data on chronic toxicity in animals following chronic inhalation were available.

**Ingestion**

Long-term oral administration of 0.1 - 0.15% hydrogen peroxide to mice gave rise to an inflammatory response in the gastro-duodenal tissue [3].
**Genotoxicity**

Hydrogen peroxide has been shown to cause DNA damage in bacteria and in cultured mammalian cells. Hydrogen peroxide was also positive for mutation in *Salmonella typhimurium* and *Escherischia coli* in the absence of metabolic activation. There is also evidence that it can cause mutations in Chinese hamster V79 cells and mouse lymphoma L5178Y cells at the *hprt* locus. Chromosomal aberrations and sister chromatid exchanges were induced in human and other mammalian cells *in vitro*. These positive results are believed to be due to generation of reactive oxygen species that would be rapidly detoxified *in vivo*. There was no evidence of chromosomal aberrations in the bone marrow cells of rats exposed to hydrogen peroxide *in vivo* [1].

Hydrogen peroxide has the potential for mutagenicity in *in vitro* systems, however, it is not possible to conclude that hydrogen peroxide is mutagenic *in vivo* [3].

**Carcinogenicity**

IARC have concluded that there was limited evidence in experimental animals for the carcinogenicity of hydrogen peroxide. This is based on an oral study in mice in which adenomas and carcinomas of the duodenum were observed. Other studies were considered inadequate for evaluation. Overall, it is not classifiable as to its carcinogenicity to humans (group 3) [1].

**Reproductive and developmental toxicity**

Only limited data are available on the reproductive and developmental toxicity of hydrogen peroxide from which it is not possible to draw any conclusions [3].
References


