

Potassium permanganate (KMnO₄)

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1. Identification and classification

KMnO₄ (CAS no. 7722-64-7; EC no. 231-760-3) is the potassium salt of permanganic acid, HMnO₄, which is unknown in the free state. It is a deep reddish-purple crystalline solid with a metallic sheen. Potassium permanganate is a powerful oxidising agent (1).

It is used in industrial and agricultural processes and in chemical synthesis. Because of its powerful oxidising effect it is used in a variety of industrial processes including decontamination/disinfection of water, as an algicide and as a bleaching agent in textile finishing (2).

2. Existing regulations

In the European Union, harmonised classification of KMnO₄ under the CLP Regulation (1272/2008, Annex VI) is required in order to ensure appropriate risk management throughout the Community (3).

The substance is currently being reassessed by France under the Community Rolling Action Plan (CoRAP). The ECHA and member states are developing risk-based criteria for the selection of substances for inclusion in CoRAP. KMnO₄ has been selected because of its suspected reproductive toxicity and because of the exposure of certain populations (4).

3. Use in wet textile production processes



In textile finishing KMnO₄ acts as a bleaching agent that is used to produce ‘used-look’ effects on jeans and denim articles. The substance is sprayed or brushed on in a watery solution and then neutralised, giving the jeans a light ‘used-look’ appearance. Suitable personal protective equipment must be worn by operatives performing open finishing processes in which potassium permanganate is used: the substance has a pronounced irritant effect on living tissue (e.g. mucous membranes and skin) and can easily cause chemical burns and eye damage.

Under the bluesign® criteria, the use of KMnO₄ as an active substance is not permitted (‘Substances with usage restrictions but no consumer safety limits’) (7). Compliance is monitored as part of the certification process.

Use is also not permitted under the Global Organic Textile Standard (GOTS), because chemical inputs classed as ‘Very toxic to aquatic life with long-lasting effects’ are prohibited (8). Compliance is monitored as part of the certification process.


4. Hazard potential

Current harmonised classification under CLP with regard to acute and chronic human toxicity

GHS pictogram	Harmonised classification (CLP)	Examples of effects	Safety
GHS03 	H272: May intensify fire; oxidiser.	Oxidising effect, intensifies fire. Produces potentially explosive compounds when mixed with flammable substances.	Keep away from flammable substances and do not mix with them; store in a clean environment.
GHS07 	H302: Harmful if swallowed. H314: Causes severe skin burns and eye damage.	Harmful to health; irritates eyes, skin or respiratory organs. Fatal in large quantities.	As above; if skin irritation or eye contact occurs, rinse with water or other suitable medium. Wear protective clothing and gloves, eye and mouth protection or respiratory protection.

Current harmonised classification under CLP with regard to environmental toxicity

GHS pictogram	Harmonised classification (CLP)	Examples of effects	Safety
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<p>GHS09</p> 	<p>H410: Very toxic to aquatic life with long-lasting effects.</p>	<p>Harmful to aquatic life, toxic or very toxic, acute or with long-lasting effects.</p>	<p>Must be disposed of in hazardous waste; must not be released into the environment.</p>
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5. Environmental behaviour

Potassium permanganate is in German Water Hazard Class (WGK) 3 (severe hazard to waters) (5); this, as well as its oxidative effect, must be borne in mind when disposing of permanganate residues. The substance must not be allowed to enter open water, soil, or the sewage system (5).

6. Possible substitutes

To create a 'used-effect' look on denim articles, there are some chemical/physical and mechanical processes that produce effects that are similar, but not identical, to those of potassium permanganate.

Sandblasting with quartz sand is a mechanical alternative that cannot necessarily be recommended on account of the health and safety risks associated with open processes and because compliance with proper procedures in closed processes is difficult to monitor.

A better substitution option in connection with the 'used look' on denim clothing is mechanical treatment with sandpaper, sandstone or pumice stone, or physical treatment with lasers.

When searching for chemical substitutes it is particularly important to ensure that sufficient information is available on the human and environmental toxicity and environmental behaviour of the substitute. Care should be taken to ensure that KMnO_4 is replaced by a verifiably less hazardous alternative. Chlorine-based oxidising agents such as HClO and HClO_2 cannot be recommended because they create similar problems in connection with occupational health and safety as well as wastewater problems.

7. Summary

KMnO_4 is used as a bleaching agent to produce 'used-look' effects on jeans and denim articles. It is hazardous to human health mainly on account of its use in open industrial processes (spraying and blasting), especially when the personal protective equipment worn is inadequate. Reclassification of the substance by CoRAP would further highlight the risks associated with use of the chemical.

When replacing KMnO_4 with alternative substances or processes, care should be taken to ensure that the chosen chemical alternatives do not have properties that give equal or greater cause for concern and that alternative (mechanical or physical) processes have verifiably fewer risks.

8. References

- (1) <http://www.chemie.de/lexikon/Kaliumpermanganat.html>
- (2) <https://echa.europa.eu/de/registration-dossier/-/registered-dossier/14531>
- (3) <https://echa.europa.eu/de/information-on-chemicals/annex-vi-to-clp>
- (4) <https://echa.europa.eu/documents/10162/eadc7f1f-0f58-ef78-a64f-82004e142129>
- (5) http://gestis.itrust.de/nxt/gateway.dll/gestis_de/000000.xml?f=templates&fn=default.htm&vid=gestis_deu:sdbdeu
- (6) <http://www.bmub.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/vwwws.pdf>
- (7) <https://www.bluesign.com/industry/infocenter/downloads>
- (8) <http://global-standard.org/de/information-centre/downloads.html#gb>