

**BS EN 15482:2012**



BSI Standards Publication

# **Chemicals used for treatment of water intended for human consumption — Sodium permanganate**

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**National foreword**

This British Standard is the UK implementation of EN 15482:2012. It supersedes BS EN 15482:2007 which is withdrawn.

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## Chemicals used for treatment of water intended for human consumption - Sodium permanganate

Produits chimiques utilisés pour le traitement de l'eau destinée à la consommation humaine - Permanganate de sodium

Produkte zur Aufbereitung von Wasser für den menschlichen Gebrauch - Natriumpermanganat

This European Standard was approved by CEN on 16 September 2012.

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**Management Centre: Avenue Marnix 17, B-1000 Brussels**



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## Foreword

This document (EN 15482:2012) has been prepared by Technical Committee CEN/TC 164 “Water supply”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2013, and conflicting national standards shall be withdrawn at the latest by May 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 15482:2007.

Significant technical differences between this edition and EN 15482:2007 are as follows:

- a) Modification of Table 2 to show consistent limits for chemical parameters.
- b) Modification of 6.2 on labelling, deletion of the reference to EU Directive 80/778/EEC of 15 July 1980 in order to take account of the latest Directive in force.

This document is largely based on EN 12672:2008 [3].

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



## Introduction

In respect of the potential adverse effects on the quality of water intended for human consumption caused by the product covered by this European Standard:

- a) this European Standard provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA;
- b) it should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

**NOTE** Conformity with this European Standard does not confer or imply acceptance or approval of the product in any of the Member States of the EU or EFTA. The use of the product covered by this European Standard is subject to regulation or control by National Authorities.

## 1 Scope

This European Standard is applicable to sodium permanganate used for the treatment of water intended for human consumption. It describes the characteristics of sodium permanganate and specifies the requirements and the corresponding test methods for sodium permanganate. It provides information on its use in water treatment.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1233, *Water quality — Determination of chromium — Atomic absorption spectrometric methods*

EN ISO 3696, *Water for analytical laboratory use — Specification and test methods (ISO 3696)*

EN ISO 11885, *Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885)*

EN ISO 11969, *Water quality — Determination of arsenic — Atomic absorption spectrometric method (hydride technique) (ISO 11969)*

EN ISO 12846, *Water quality — Determination of mercury — Method using atomic absorption spectrometry (AAS) with and without enrichment (ISO 12846)*

ISO 3165, *Sampling of chemical products for industrial use — Safety in sampling*

ISO 3856-2, *Paints and varnishes — Determination of "soluble" metal content — Part 2: Determination of antimony content — Flame atomic absorption spectrometric method and Rhodamine B spectrophotometric method*

ISO 6206, *Chemical products for industrial use — Sampling — Vocabulary*

ISO 8288, *Water quality — Determination of cobalt, nickel, copper, zinc, cadmium and lead — Flame atomic absorption spectrometric methods*

ISO 9965, *Water quality — Determination of selenium — Atomic absorption spectrometric method (hydride technique)*

## 3 Description

### 3.1 Identification

#### 3.1.1 Chemical name

Sodium permanganate

#### 3.1.2 Synonym or common name

Permanganate acid sodium salt

#### 3.1.3 Relative molecular mass



141,93

3.1.4 Empirical formula

NaMnO<sub>4</sub>

3.1.5 Chemical formula

NaMnO<sub>4</sub>

3.1.6 CAS Registry Number <sup>1)</sup>

10101-50-5

3.1.7 EINECS reference <sup>2)</sup>

233-251-1

3.2 Commercial forms

The sodium permanganate is usually available as a concentrated solution with a concentration within the range of mass fraction of 20 % to 40 %.

The density of sodium permanganate solutions is given in Table 1.

Table 1

Solution concentration Mass fraction in %	Density g/ml at 22 °C
10	1,076
15	1,116
20	1,164
25	1,216
30	1,266
35	1,316
40	1,374

3.3 Physical properties

3.3.1 Appearance

Sodium permanganate solution is a dark purple coloured solution.

3.3.2 Density

The density of 40,00 % sodium permanganate solution is 1,37 g/cm<sup>3</sup> at 20 °C.

\_\_\_\_\_

1) Chemicals Abstracts Service Registry Number.  
2) European Inventory of Existing Commercial Chemical Substances.



### 3.3.3 Solubility (in water)

Sodium permanganate solution is soluble up to 40 % and miscible with water in all proportions.

### 3.3.4 Vapour pressure

Not determined for sodium permanganate solution, however, very similar to water.

### 3.3.5 Boiling point at 100 kPa<sup>3)</sup>

Greater than 101 °C.

### 3.3.6 Melting point

Not applicable.

### 3.3.7 Specific heat

Not determined.

### 3.3.8 Viscosity (dynamic)

Less than 0,005 Pa·s for concentrations of 40 % or less

### 3.3.9 Critical temperature

Not determined.

### 3.3.10 Critical pressure

Not determined.

### 3.3.11 Physical hardness

Not applicable.

## 3.4 Chemical properties

Sodium permanganate is a very strong oxidising agent.

It is soluble in water and dissolves in various organic solvents (methanol, ethanol).

NOTE The reaction with organics can be violent and is not recommended.

It decomposes at a high temperature and also in the presence of concentrated acids, hydrogen peroxide and organic compounds in general.

It hydrolyses very slowly in contact with air, reducing to manganese dioxide (MnO<sub>2</sub>), a solid, brown to black colour product.

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3) 100 kPa = 1 bar.

## 4 Purity criteria

### 4.1 General

This European Standard specifies the minimum purity requirements for sodium permanganate used for the treatment of water intended for human consumption. Limits are given for impurities commonly present in the product. Depending on the raw material and the manufacturing process other impurities may be present and, if so, the user and when necessary relevant authorities shall be notified.

Users of this product should check the national regulations to clarify whether it is of appropriate purity for treatment of water intended for human consumption, taking into account raw water quality, required dosage, contents of other impurities and additives used in the product not stated in this product standard.

Limits have been given for impurities and chemical parameters where these are likely to be present in significant quantities from the current production process and raw materials. If the production process or raw materials leads to significant quantities of impurities, by-products or additives being present, the user shall be notified.

### 4.2 Composition of commercial product

The sodium permanganate is usually available in a concentrated solution with a concentration within the range of mass fraction of 20 % to 40 %.

The concentration of sodium permanganate solution shall be equal to or greater than the manufacturer specified value.

### 4.3 Impurities and main by-products

The content of manganese dioxide (insoluble matter) shall be no more than a mass fraction of 0,055 %.

NOTE The product can contain fluoride or hexafluorosilicate. At typical levels of dosing, the added fluoride would be less than 40 µg/l.

### 4.4 Chemical parameters

The content of chemical parameters shall conform to the requirements specified in Table 2.

Table 2 — Chemical parameters

Parameter		Limit mg/kg of NaMnO <sub>4</sub> (mass fraction 100 %)
Arsenic (As)	max.	20
Cadmium (Cd)	max.	50
Chromium (Cr)	max.	50
Mercury (Hg)	max.	10
Nickel (Ni)	max.	50
Lead (Pb)	max.	50
Antimony (Sb)	max.	50
Selenium (Se)	max.	50



## 5 Test methods

### 5.1 Sampling

#### 5.1.1 General

Observe the general recommendations of ISO 3165 and take account those of ISO 6206.

#### 5.1.2 Sampling from drums and bottles

##### 5.1.2.1 General

**5.1.2.1.1** Mix the contents of each container to be sampled by shaking the container, by rolling it or by rocking it from side to side, taking care not to damage the container or spill any of the liquid.

**5.1.2.1.2** If the design of the container is such (for example, a narrow-necked bottle) that it is impracticable to use a sampling implement, take a sample by pouring after the contents have been thoroughly mixed. Otherwise, proceed as described in 5.1.2.1.3.

**5.1.2.1.3** Examine the surface of the liquid. If there are signs of surface contamination, take samples from the surface as described in 5.1.2.2. Otherwise, take samples as described in 5.1.2.3.

##### 5.1.2.2 Surface sampling

Take a sample using a suitable ladle. Lower the ladle into the liquid until the rim is just below the surface, so that the surface layer runs into it. Withdraw the ladle just before it fills completely and allow any liquid adhering to the ladle to drain off. If necessary, repeat this operation so that, when the other selected containers have been sampled in a similar manner, the total volume of sample required for subsequent analysis is obtained.

##### 5.1.2.3 Bottom sampling

Take a sample using an open sampling tube, or a bottom-valve sampling tube, suited to the size of container and the viscosity of the liquid.

When using an open sampling tube, close it at the top and then lower the bottom end to the bottom of the container. Open the tube and move it rapidly so that the bottom of the tube traverses the bottom of the container before the tube is filled. Close the tube, withdraw it from the container and allow any liquid adhering to the outside of the tube to drain off.

When using a bottom-valve sampling tube, close the valve before lowering the tube into the container and then proceed in a similar manner to that when using an open sampling tube.

#### 5.1.3 Sampling from tanks and tankers

From each access point, take samples as follows:

- a) from the surface of the liquid, using a ladle as described in 5.1.2.2;
- b) from the bottom of the tank or tanker, using a sampling tube as described in 5.1.2.3 or using a specially designed bottom-sampling apparatus;
- c) from one or more positions, depending on the overall depth, between the bottom and the surface using a weighted sampling can.



5.2 Analysis

5.2.1 Determination of sodium permanganate

5.2.1.1 Principle

Reduction of sodium permanganate Mn(VII) to Mn(II) with sodium oxalate under acidic conditions. The excess of sodium oxalate is titrated with a standard volumetric solution of potassium permanganate.

5.2.1.2 Reagents

All reagents shall be of a recognised analytical grade and the water used shall conform to grade 3 in accordance with EN ISO 3696.

5.2.1.2.1 Potassium permanganate.

5.2.1.2.2 Sodium oxalate.

5.2.1.2.3 Sulfuric acid solution, mass fraction 20 %.

5.2.1.2.4 Potassium permanganate standard volumetric solution  $c(\text{KMnO}_4) = 1,000 \text{ g/l}$ .

— Weigh 1,000 g of the potassium permanganate (5.2.1.2.1), transfer to a 1 l volumetric flask and make up to the volume with water. Allow to stand with occasional mixing for 15 min.

Calibration:

— Weigh 2,120 g of the sodium oxalate (5.2.1.2.2) and transfer to a 1 l volumetric flask. Add 20 ml of  $\text{H}_2\text{SO}_4$  (5.2.1.2.3) to the 1 l volumetric flask containing the oxalate, dissolve and allow to stand for 5 min.

Transfer 40 ml of the sodium oxalate solution by pipette into a small conical flask, heat to 70 °C to 80 °C and titrate with the prepared potassium permanganate solution to a faint pink end-point that persists for 20 s to 30 s.

The standardization factor ( $F$ ) is given by the following formula:

$$F = \frac{40}{V} \tag{1}$$

where

$V$  is the volume, in millilitres, of potassium permanganate ( $\text{KMnO}_4$ ) solution used for the titration.

5.2.1.3 Apparatus

Ordinary laboratory apparatus and glassware.

5.2.1.4 Procedure

Tare a weighing bottle and cap. Carefully add sample to the weighing bottle with a disposable pipette to a mass between 1,0 g and 1,5 g.

Cap the bottle and record the exact mass ( $m_1$ ).

Pour the contents of the bottle into a 500 ml conical flask that contains a stirrer bar, and reweigh the empty bottle ( $m_2$ ). Rinse down the sides of the flask with water.

Calculate the actual sample mass as ( $m_1 - m_2$ ). Record this mass ( $m_3$ ).



Weigh an amount of sodium oxalate (5.2.1.2.2) that is equal to or slightly less than the mass of sodium permanganate solution ( $m_3$ ) onto a tarred weighing paper. The mass shall be weighed to the nearest 0,001 g. Record this mass ( $m_4$ ).

Transfer the sodium oxalate to the conical flask containing the sample of sodium permanganate and add sufficient water to cover the stirrer bar.

Add 25 ml of  $H_2SO_4$  (5.2.1.2.3) to the conical flask and rinse the sides with water.

Heat while stirring to 70 °C to 80 °C and then titrate with the potassium permanganate standard volumetric solution (5.2.1.2.4) to a faint pink end-point that persists for 20 s to 30 s. Record this volume  $V_1$ .

#### 5.2.1.5 Expression of results

The content ( $P_1$ ) in mass fraction in (%) of sodium permanganate in the sample is given by the following formula:

$$P_1 = \frac{(0,4718 \times m_4) - (F \times V_1) \times 89,8}{m_3} \quad (2)$$

where

$m_3$  is the mass, in milligrams, of sodium permanganate;

$m_4$  is the mass, in milligrams, of sodium oxalate;

$V_1$  is the volume, in millilitres, of the potassium permanganate standard volumetric solution used for the titration;

$F$  is the standardization factor obtained in 5.2.1.2.4.

### 5.2.2 Impurities

#### 5.2.2.1 Manganese dioxide (insoluble matter)

##### 5.2.2.1.1 Principle

Determination of mass fraction in (%) of manganese dioxide ( $MnO_2$ ) in a sample of sodium permanganate, by spectrometric analysis of  $Mn(II)$ .  $MnO_2$  is separated from an aqueous solution of  $NaMnO_4$  by filtration and subsequently reduced to  $Mn(II)$ . The resulting solution is analysed according to EN ISO 11885.

##### 5.2.2.1.2 Reagents

All reagents shall be of a recognised analytical grade and the water used shall conform to grade 3 in accordance with EN ISO 3696.

##### 5.2.2.1.2.1 Hydrochloric acid (HCl), concentrated solution.

##### 5.2.2.1.2.2 Hydrogen peroxide solution, mass fraction 30 %.

##### 5.2.2.1.3 Apparatus

Ordinary laboratory apparatus and glassware together with the following:

ICP emission spectrometer.



5.2.2.1.4 Procedure

5.2.2.1.4.1 Separation and dissolution of MnO<sub>2</sub>

Weigh to the nearest milligram a sample of sodium permanganate solution containing about 5 g of NaMnO<sub>4</sub>. Filter through a glass filter (porosity P10 (4µm to 10 µm)) and wash the sample repeatedly with water until the filtrate water is free from NaMnO<sub>4</sub> (colourless). Dissolve the residue on the filter with 10 ml of HCl (5.2.2.1.2.1) and of H<sub>2</sub>O<sub>2</sub> (5.2.2.1.2.2). After repeated washing of the filter, transfer to a 50 ml volumetric flask and make up to volume with water.

5.2.2.1.4.2 Determination of MnO<sub>2</sub> content

The MnO<sub>2</sub> content shall be determined by measuring the emission of the dissolved Mn(II) by ICP spectrometry according to EN ISO 11885.

The method will provide the interim result (*y*) expressed in milligrams per litre of MnO<sub>2</sub> which needs to be converted to give the final concentration according to 5.2.2.1.5.

5.2.2.1.5 Expression of results

From the interim result (*y*) determined (see 5.2.2.1.4.2), the content of MnO<sub>2</sub> (*C*<sub>1</sub>) in the sample expressed as a mass fraction in (%) is given by the following formula:

$$C_1 = y \times \frac{5}{m \times 1000} \tag{3}$$

where

- y* is the interim result (5.2.2.1.4.2);
- m* is the mass, in grams, of the initial sample.

5.2.3 Chemical parameters

5.2.3.1 Principle

The elements arsenic, antimony, cadmium, chromium, lead, mercury, nickel and selenium are determined by atomic absorption spectrometry.

5.2.3.2 Reagents

All reagents shall be of a recognised analytical grade and the water used shall conform to the appropriate grade specified in EN ISO 3696.

5.2.3.2.1 Hydrochloric acid (HCl), concentrated solution.

5.2.3.2.2 Hydroxylamine hydrochloride, NH<sub>2</sub>OH.HCl, mass fraction 99 %.

5.2.3.3 Test solution

**SAFETY PRECAUTIONS:** Addition of HCl to NaMnO<sub>4</sub> will evolve chlorine gas. Hydroxylamine and sodium permanganate can react violently. Add carefully and use adequate personal protection/goggles.

Weigh to the nearest 10 mg a sample of the product containing about 2,5 g of NaMnO<sub>4</sub>. Dilute with 100 ml of water in a 150 ml acid-washed beaker. Under a hood, acidify the solution with concentrated HCl (5.2.3.2.1) to a pH value of less than 2. Add hydroxylamine hydrochloride (5.2.3.2.2) until the solution turns clear. Heat the



solution gently to reduce the volume below 100 ml, making sure that it does not boil. Quantitatively transfer to a 100 ml acid-washed volumetric flask and make up to volume with water.

#### 5.2.3.4 Blank test solution

Prepare a blank test solution as in 5.2.3.3 without the sample.

#### 5.2.3.5 Determination

Determine the content of elements in the test solution (5.2.3.3) and in the blank test solution (5.2.3.4) in accordance with the following methods:

- Arsenic, in accordance with EN ISO 11969;
- Nickel, cadmium and lead, in accordance with ISO 8288, Method A;
- Chromium, in accordance with EN 1233;
- Mercury, in accordance with EN ISO 12846 (FAAS method);
- Selenium, in accordance with ISO 9965;
- Antimony, in accordance with ISO 3856-2 (FAAS method).

The method will give an interim result ( $y$ ) expressed in milligrams per litre which needs to be converted to give the final concentration according to 5.2.3.6.

#### 5.2.3.6 Expression of results

From the interim result ( $y$ ) determined (see 5.2.3.5), the content,  $C_2$ , expressed in milligrams per kilogram of each element in the laboratory sample, is given by the following formula:

$$C_2 = y \times \frac{V_1}{m_1} \quad (4)$$

where

$y$  is the interim result (5.2.3.5);

$V_1$  is the volume, expressed in millilitres, of the sample solution (5.2.3.3) (= 100 ml);

$m_1$  is the mass, expressed in grams, of the initial sample.

## 6 Labelling - Transportation - Storage

### 6.1 Means of delivery

The product shall be delivered in steel drums or HDPE containers. To ensure that the purity of the product is not affected, the means of delivery shall not have been previously used for any different product or it shall have been specially cleaned and prepared before use.

6.2 Labelling according to the EU legislation <sup>4)</sup>

Sodium Permanganate is not listed within Annex VI of Regulation (EC) No 1272/2008 at the date of publication of this European Standard.

The regulation [2], and its amendments for the purposes of its adaptation to technical and scientific progress contains a list of substances classified by the EU. Substances not listed in this regulation should be classified on the basis of their intrinsic properties according to the criteria in the regulation by the person responsible for the marketing of the substance.

NOTE        Notifications to the Classification & Labelling Inventory established at the European Chemicals Agency (ECHA) returned variable classification and labelling for sodium permanganate solutions depending on the concentration of the solution

6.3 Transportation regulations and labelling

Sodium permanganate solution is listed as UN Number <sup>5)</sup>: 3214.

RID <sup>6)</sup>/ADR <sup>7)</sup>: Class 5.1, classification code O1; packing group II.

IMDG <sup>8)</sup>: Class 5.1, packing group II.

IATA <sup>9)</sup>: Class 5.1, packing group II.

6.4 Marking

The marking shall include the following information:

- name "sodium permanganate solution", the trade name and the grade;
- net mass;
- name and the address of supplier and/or manufacturer;
- statement "this product conforms to EN 15482".

6.5 Storage

6.5.1 Long term stability

The product is stable when stored in a cool, dry area in closed containers.

6.5.2 Storage incompatibilities

Sodium permanganate can produce spontaneous combustion in contact with products such as glycerine and ethylene glycol.

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4) See [2].

5) United Nations Number.

6) Regulations concerning International carriage of Dangerous goods by rail.

7) European Agreement concerning the international carriage of Dangerous goods by Road.

8) International Maritime transport of Dangerous Goods.

9) International Air Transport Association.



Also, sodium permanganate reacts violently with acetic acid, sulfuric acid, finely divided organic materials, charcoal, iron (II) salts, sulfites and peroxides. With hydrochloric acid it releases toxic gas (chlorine).

## **Annex A** (informative)

### **General information on sodium permanganate**

#### **A.1 Origin**

##### **A.1.1 Raw materials**

The raw materials for the production of sodium permanganate are:

- potassium hydroxide (KOH);
- pyrolusite (manganese ore, manganese dioxide ( $\text{MnO}_2$ ));
- sodium hexafluorosilicate ( $\text{NaSiF}_6$ ).

##### **A.1.2 Manufacturing process**

The principal manufacturing process of sodium permanganate is an oxidation of manganese dioxide in the presence of potassium hydroxide. The oxidation process consists of two stages; one chemical which yields potassium manganate ( $\text{K}_2\text{MnO}_4$ ) and another electrochemical which oxidises potassium manganate to potassium permanganate. The sodium permanganate is obtained by the conversion of potassium permanganate through an ion exchange of potassium with sodium using sodium hexafluorosilicate.

#### **A.2 Use**

##### **A.2.1 Function**

The main applications of sodium permanganate include taste and odour control, removal of iron (Fe) and manganese (Mn) by oxidation to insoluble oxides and regeneration of filtering material.

##### **A.2.2 Form in which the product is used**

The product is used as delivered or diluted with water.

##### **A.2.3 Treatment dose**

The treatment dose depends on the water quality to be treated. Effective oxidation of contaminants in water is achieved at dose rates under 10 mg of  $\text{NaMnO}_4$  per litre of water.

##### **A.2.4 Means of application**

It is applied using a metering-pump, an injection feeder or a constant head gravity feeder.



### **A.2.5 Secondary effects**

There are no secondary effects because although the oxidation process yields a by-product, namely manganese dioxide, this by-product is insoluble in water at pH values between 2 and 11,5, biologically inert and removable by settling and filtration.

### **A.2.6 Removal of excess product**

The excess product is removed with a water solution of sodium thiosulfate or sodium bisulfite.

## **Annex B** (normative)

### **General rules relating to safety**

#### **B.1 Rules for safe handling and use**

The supplier shall provide current safety instructions.

#### **B.2 Emergency procedures**

##### **B.2.1 First aid**

In case of contact with skin, rinse immediately with plenty of water and remove and wash the contaminated clothing.

In the case of contact with the eyes, rinse immediately with plenty of water for at least 15 min and seek medical advice.

In the case of ingestion, drink sugared milk, orange juice or lemon juice; if not possible, drink plenty of water. Seek medical advice.

##### **B.2.2 Spillage**

Contain the liquid by diking or collecting in a pit or holding area. Dilute the solution to make sure the concentration is approximately 6 % ( $\text{MnO}_4^-$ ). Neutralise the permanganate using a solution of sodium thiosulfate, bisulfite, or an iron (II) salt.

To clean contaminated floors, flush with large quantities of water and discharge in accordance with the requirements/approval of the relevant authority.

These products can ignite wood, cloth, and paper. If clothing becomes contaminated, it is recommended to wash off immediately. They can cause a fire if left on dirty rags or paper towels that have been thrown into the garbage. Any of these materials should be diluted and neutralised prior to disposal.

##### **B.2.3 Fire**

These products are not flammable, but they favour combustion.

Cool fire-endangered containers with water.

Use water to extinguish fires.

Sodium permanganate decomposes spontaneously if exposed to high temperatures, releasing oxygen. In closed places this decomposition can lead to an explosion.



## Bibliography

- [1] 98/83/EC, *Council Directive of 3rd November 1998 on the Quality of Water intended for Human Consumption*
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