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Chemicals used for treatment of water intended for human consumption — Iron (III) sulfate, solid

National foreword

This British Standard is the UK implementation of EN 14664:2023. It supersedes BS EN 14664:2004, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CII/59, Chemicals and filtering media for water treatment.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

**Chemicals used for treatment of water intended for human
consumption - Iron (III) sulfate, solid**

Produits chimiques utilisés pour le traitement de l'eau
destinée à la consommation humaine - Sulfate de fer
(III), solide

Produkte zur Aufbereitung von Wasser für den
menschlichen Gebrauch - Eisen(III)sulfat, fest

This European Standard was approved by CEN on 2 January 2023.

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European foreword

This document (EN 14664:2023) 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of an identical text or by endorsement, at the latest by December 2023, and conflicting national standards shall be withdrawn at the latest by December 2023.

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

This document supersedes EN 14664:2004.

The main changes compared to the previous edition are listed below:

- removal of the analytical methods from this document and addition of reference to EN 17215 as analytical method standard;
- update of the information on risk and safety labelling of the product to comply with the new regulations (see 7.2 and [2]);
- update of the information related to the Drinking Water Directive.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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Introduction

With respect to potential adverse effects on the quality of water intended for human consumption, caused by the product covered by this document:

- a) this document 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 document does not confer or imply acceptance or approval of the product in any or the Member States of the EU or EFTA. The use of the product covered by this document is subject to regulation or control by National Authorities.

1 Scope

This document is applicable to iron (III) sulfate solid used for treatment of water intended for human consumption. It describes the characteristics of iron (III) sulfate solid and specifies the requirements and the corresponding analytical methods for iron (III) sulfate solid and gives information on its use in water treatment. It also determines the rules relating to safe handling and use of iron (III) sulfate solid.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 17215, *Chemicals used for treatment of water intended for human consumption - Iron-based coagulants - Analytical methods*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Description

4.1 Identification

4.1.1 Chemical name

Iron (III) sulfate, solid.

4.1.2 Synonym or common names

Ferric sulfate, solid.

4.1.3 Relative molecular mass

499,0 g/mol.

4.1.4 Empirical formula

$\text{Fe}_2(\text{SO}_4)_3 \cdot x \text{H}_2\text{O}$ where x is approximately 5,5.

4.1.5 Chemical formula

$\text{Fe}_2(\text{SO}_4)_3 \cdot x \text{H}_2\text{O}$ where x is approximately 5,5.

4.1.6 CAS Registry Number® ¹

10028-22-5.

4.1.7 EINECS reference ²

233-072-9.

4.2 Commercial forms

Iron (III) sulfate solid is available as free flowing granules or powder in different particle size ranges.

4.3 Physical properties

4.3.1 Appearance

The iron (III) sulfate solid consists of greyish or yellowish granules.

4.3.2 Density

The bulk density is approximately equal to 1 300 kg/m³ for granules and 1 000 kg/m³ for powders at 20 °C.

4.3.3 Solubility (in water)

Iron (III) sulfate solid dissolves rapidly in water. The solubility is approximately 550 g/dm³, corresponding to approximately mass fraction 12,3 % of Fe at 20 °C (see A.3.2).

4.3.4 Vapour pressure

Not known.

4.3.5 Boiling point at 100 kPa ³

Not applicable.

4.3.6 Melting point

Iron (III) sulfate solid decomposes when heated.

4.3.7 Specific heat

Not known.

4.3.8 Viscosity (dynamic)

Not applicable.

4.3.9 Critical temperature

Not applicable.

¹ Chemical Abstract Service Registry Number. CAS Registry Number® is a trademark of CAS corporation. This information is given for the convenience of users of this document and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same results.

² European Inventory of Existing Commercial Chemical Substances.

³ 100 kPa = 1 bar.

4.3.10 Critical pressure

Not applicable.

4.3.11 Physical hardness

The granule strength is higher than 50 N/mm².

4.4 Chemical properties

Iron (III) sulfate solid is slightly hygroscopic at relative humidity higher than 50 %.

Iron (III) sulfate solutions are acidic.

5 Purity criteria

5.1 General

This document specifies the minimum purity requirements for iron (III) sulfate solid 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 can be present and, if so, this shall be notified to the user and when necessary to relevant authorities.

NOTE Users of this product can check the national regulations in order 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 document.

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 lead to significant quantities of impurities, by-products or additives being present, this shall be notified to the user.

5.2 Composition of commercial product

The product typically contains not less than mass fraction of 64 % of Fe₂(SO₄)₃ or not less than a mass fraction of 18 % of Fe and shall be within ± 3 % of the manufacturer's declared values.

5.3 The grade of the product

The product shall conform to the requirements specified in Table 1.

The concentration limits refer to Fe (III).

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Table 1 — Limit values for the grades 1, 2 and 3

Limit values in mass fraction in % of Fe (III) content

Parameter	Limit value		
	Grade 1	Grade 2	Grade 3
Manganese max.	0,5	1	1
Iron (II) ^a max.	3,5	3,5	3,5
Insoluble matters ^b max.	10	10	10

^a Fe (II) has a lower coagulant efficiency compared to Fe (III). Also hydrolysis of Fe (II) starts at pH value 8, and therefore Fe (II) can remain in the water at lower pH values.

^b An excess of insoluble matters indicates the presence of foreign matter. Iron as a component of the product will usually be removed in the treatment process.

5.4 The type of the product

The product shall conform to the requirements specified in Table 2.

The concentration limits are specified in milligrams per kilogram of Fe (III).

Table 2 — Limit values for types 1, 2 and 3

Limit values in mg/kg of Fe (III)

Parameter	Limit		
	Type 1	Type 2	Type 3
Arsenic (As) max.	1	20	50
Cadmium (Cd) max.	1	25	50
Chromium (Cr) max.	100	350	500
Mercury (Hg) max.	2,5	5	10
Nickel (Ni) max.	300	350	500
Lead (Pb) max.	2,5	100	400
Antimony (Sb) max.	10	20	60
Selenium (Se) max.	5	20	60

NOTE 1 Cyanide (CN⁻) is usually not relevant because of the acidity of the product. Pesticides and polycyclic aromatic hydrocarbons are not relevant since the raw materials used in the manufacturing process are free of them.

NOTE 2 For maximum impact of iron (III) sulfate on trace metal content in drinking water, see A.2.

6 Test methods

6.1 Sampling

Use the relevant method described in EN 17215.

6.2 Analyses

Use the relevant methods described in EN 17215.

7 Labelling - Transportation - Storage

7.1 Means of delivery

The product shall be delivered in suitable packages, paper or plastics bags, or by rubber-lined or plastics-lined bulk truck.



In order that the purity of the product is not affected, the means of delivery shall not have been used previously for any different product or it shall have been specially cleaned and prepared before use.

7.2 Risk and safety labelling according to the EU Directives ⁴

The following Table 3 is an example of labelling. The manufacturer should confirm the classifications for their product. Users are instructed to read the manufactures data sheet.

⁴ See [2].

Table 3 — Labelling example

Hazard pictograms	Hazard statements	Signal word
 <p>Figure 1 — GHS05</p>  <p>Figure 2 — GHS07</p>	<p>H302: Harmful if swallowed. H315: Causes skin irritation. H317: May cause an allergic skin reaction. NOTE H317 depends on the content. H318: Causes serious eye damage.</p>	<p>Danger</p>

Precautionary statements ('P statements') should be provided by the company responsible for the marketing of the substance. They should be indicated on the packaging label and in the extended safety data sheet (eSDS) of the substance.

NOTE The legislation [2] contains a list of substances classified by the EU. Substances not listed in this regulation can 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. Classification and labelling can be carried out in compliance with [2].

7.3 Transportation regulations and labelling

Iron (III) sulfate solid is not listed under a UN number ⁵.

Iron (III) sulfate solid is not classified as a dangerous product for road, rail, sea and air transportation.

⁵ United Nations Number.

7.4 Marking

The marking shall include the following information:

- the name “Iron (III) sulfate solid”, trade name, grade and type;
- the net mass;
- the name and the address of the supplier and/or manufacturer;
- the statement “This product conforms to EN 14664”.

7.5 Storage

7.5.1 General

Iron (III) sulfate solid is not corrosive.

7.5.2 Long term stability

Iron (III) sulfate solid is stable at relative humidity lower than 50 %.

7.5.3 Storage incompatibilities

Avoid contact with water because iron (III) sulfate solution formed is acidic and corrosive.

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Annex A
(informative)

General information on iron (III) sulfate solid

A.1 Origin

A.1.1 Raw materials

The product is manufactured from sulfuric acid, iron (II) sulfate and oxygen.

A.1.2 Manufacturing process

Iron (III) sulfate solid is produced by dissolving iron (II) sulfate in sulfuric acid with oxygen as oxidant at elevated temperature followed by granulation or as powder produced by atomized drier of liquid iron (III) sulfate.

A.2 Quality of commercial product

The three types of iron (III) sulfate solid specified in Table 2 reflect the quality of commercially available products. Tables A.1 to A.3 show the maximum concentrations of trace metals that would be added to the raw water by the addition of products corresponding to the purity levels specified in Table 2. It can be seen that the concentrations of metal added are well below the Parametric Values given in the EU Directive 2020/2184/EC (see [1]) at typical product doses. Furthermore, the tables overstate the concentration of metals that would be present in the treated water since a substantial proportion of the trace metals will be incorporated in the sludge. Users of this product should select an appropriate grade and type to enable them to achieve treated water quality targets taking into account raw water characteristics, required dosage, process plant conditions and other relevant factors.

**Table A.1 — Maximum impact of iron (III) sulfate, Type 1, on trace metal content of water.
Drinking water limit value is based on Drinking Water Directive**

	The max. concentration of trace metal (mg/m ³ = µg/l) with different dosing		Drinking water limit value
	Dosing 4 g Fe/m ³	Dosing 10 g Fe/m ³	
	µg/l	µg/l	µg/l
Arsenic (As)	0,004	0,01	10
Cadmium (Cd)	0,004	0,01	5
Chromium (Cr)	0,4	1	25
Mercury (Hg)	0,01	0,025	1
Nickel (Ni)	1,2	3	20
Lead (Pb)	0,01	0,025	10
Antimony (Sb)	0,04	0,1	10
Selenium (Se)	0,02	0,05	20

**Table A.2 — Maximum impact of iron (III) sulfate, Type 2, on trace metal content of water.
Drinking water limit value is based on Drinking Water Directive**

	The max. concentration of trace metal (mg/m ³ = µg/l) with different dosing		Drinking water limit value
	Dosing 4 g Fe/m ³	Dosing 10 g Fe/m ³	
	µg/l	µg/l	µg/l
Arsenic (As)	0,08	0,2	10
Cadmium (Cd)	0,1	0,25	5
Chromium (Cr)	1,4	3,5	25
Mercury (Hg)	0,02	0,05	1
Nickel (Ni)		3,5	20
Lead (Pb)	0,4	1,0	10
Antimony (Sb)	0,08	0,2	10
Selenium (Se)	0,08	0,2	20

**Table A.3 — Maximum impact of iron (III) sulfate, Type 3, on trace metal content of water.
Drinking water limit value is based on Drinking Water Directive**

	The max. concentration of trace metal (mg/m ³ = µg/l) with different dosing		Drinking water limit value
	Dosing 4 g Fe/m ³	Dosing 10 g Fe/m ³	
	µg/l	µg/l	µg/l
Arsenic (As)	0,2	0,5	10
Cadmium (Cd)	0,2	0,5	5
Chromium (Cr)	2	5	25
Mercury (Hg)	0,04	0,1	1
Nickel (Ni)	1,6	5,0	20
Lead (Pb)	0,6	4,0	10
Antimony (Sb)	0,24	0,6	10
Selenium (Se)	0,24	0,6	20

A.3 Use

A.3.1 Function

The product is used as primary coagulant.

A.3.2 Form in which it is used

The product is used as delivered or dissolved in water. At concentrations lower than mass fraction of 0,3 % Fe, hydrolysis and formation of iron (III) hydroxide will occur.

A.3.3 Treatment dose

The treatment dose is variable depending on raw water quality and corresponds to a treatment dose between 4 g/m³ and 10 g/m³ expressed as Fe.

A.3.4 Means of application

Product can be dosed continuously from a silo by a dry feeder into a solution tank for continuously overflowing into the raw water. To promote a rapid dispersion a high turbulence at the point of addition is desirable. Iron (III) sulfate solution is acidic and equipment in contact with the solution therefore should be made of corrosion resistant materials (stainless, plastics, rubber, lead, etc.).

A.3.5 Secondary effects

- Reduction of pH value;
- Reduction of alkalinity
- Increase of the sulfate content.

A.3.6 Removal of excess product

The coagulation process includes the hydrolysis of the ferric ions to ferric hydroxide. This precipitate is removed by sedimentation, flotation and/or finally filtration.

Annex B
(normative)

General rules relating to safety

B.1 Rules for safe handling and use

The supplier shall provide current safety instructions. The user shall read the safety data sheet.

B.2 Emergency procedures

B.2.1 First aid

In case of contact with skin, wash with plenty of water.

In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

If swallowed, provided patient is conscious, wash out the mouth with water and seek medical advice immediately.

B.2.2 Spillage

As much solid product as possible should be removed. Then it should be rinsed with water.

If in dissolved form, remove with liquid binder as much of the concentrated product as possible, then rinse with water.

B.2.3 Fire

Product is not combustible.

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Bibliography

- [1] Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the Quality of Water intended for Human Consumption
- [2] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 (REACH)

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