BS EN 878:2016

BSI Standards Publication

Chemicals used for treatment of water intended for human consumption — Aluminium sulfate

bsi.

National foreword

This British Standard is the UK implementation of EN 878:2016. It supersedes BS EN 878:2004 which is withdrawn.

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

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Chemicals used for treatment of water intended for human consumption - Aluminium sulfate

Produits chimiques utilisés pour le traitement de l'eau destinée à la consommation humaine - Sulfate d'aluminium

Produkte zur Aufbereitung von Wasser für den menschlichen Gebrauch - Aluminiumsulfat

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European foreword

This document (EN 878:2016) 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of an identical text or by endorsement, at the latest by September 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

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 878:2004.

Significant technical differences between this edition and EN 878:2004 are as follows:

a) addition of CAS Registry Number for tetradecahydrate;

b) information relating to the crystallization point added;

c) replacement of warning and safety precautions notes by labelling according to Regulation (EC) No 1272/2008;

d) modification of the concentration of the solutions used.

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

1) this 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;

2) 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.

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1 Scope

This European Standard is applicable to aluminium sulfate used for treatment of water intended for human consumption. It describes the characteristics of aluminium sulfate and specifies the requirements for aluminium sulfate and gives reference to the analytical methods. It gives information on its use in water treatment. It also determines the rules relating to safe handling and use of aluminium sulfate (see Annex B).

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 1302, *Chemicals used for treatment of water intended for human consumption - Aluminium-based coagulants - Analytical methods*

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

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

ISO 8213, *Chemical products for industrial use — Sampling techniques — Solid chemical products in the form of particles varying from powders to coarse lumps*

3 Description

3.1 Identification

3.1.1 Chemical name

Aluminium sulfate.

3.1.2 Synonym or common names

Aluminium sulfate, cake alum, alum.

NOTE In English the generic term “alum” is imprecise and is deprecated and in German the term “Alaun” is misleading.

3.1.3 Relative molecular mass

342,14 for $Al_2(SO_4)_3$.

3.1.4 Empirical formula

$Al_2(SO_4)_3$.

3.1.5 Chemical formula

$Al_2(SO_4)_3 \cdot n\ H_2O$.

3.1.6 CAS Registry Number [1)]

$Al_2(SO_4)_3$: 10043-01-3.

1) Chemical Abstracts Service Registry Number.

$Al_2(SO_4)_3 \cdot 14\ H_2O$: 16828-12-9.

$Al_2(SO_4)_3 \cdot 16\ H_2O$: 16828-11-8.

$Al_2(SO_4)_3 \cdot 18\ H_2O$: 7784-31-8

3.1.7 EINECS reference [2)]

$Al_2(SO_4)_3$: 233-135-0.

3.2 Commercial forms

Aluminium sulfate is available in solid hydrated forms, with different particle sizes (slabs, kibbled, ground, granulated) and as aqueous solutions.

3.3 Physical properties

3.3.1 Appearance

The product is a white solid or colourless to yellow, clear liquid.

3.3.2 Density

The density of a typical aluminium sulfate solution is given in Table 1 and varies depending on the concentration of the active matter (aluminium content), expressed in grams per kilogram of solution (Al g/kg).

Table 1 — Density of solution

Al g/kg of solution	Density at 15 °C g/ml
40,8	1,310
41,6	1,315
42,5	1,320
43,3	1,325
44,2	1,330
45,0	1,335

3.3.3 Solubility

The theoretical limit of active matter content for a typical solution is given in Table 2.

Table 2 — Solubility

Temperature °C	Active matter in Al g/kg of solution
- 1	44,7
24	44,8

The practical limit of solubility depends on the temperature and the device used for solubilization of the solid form (slabs, kibbled, ground or granulated).

2) European Inventory of Existing Commercial Chemical Substances.

An indication of practical limits is given in Table 3.

Table 3 — Indication of practical limits of solubility

Temperature °C	Active matter Al g/kg of solution	Solubility in grams solid form (containing Al 90 g/kg of solid) per kilogram of solution
15	37	410

3.3.4 Vapour pressure at 20 °C

Not known.

3.3.5 Boiling point at 100 kPa [3)]

Not known.

3.3.6 Crystallization point

The crystallization point of aluminium sulfate varies, depending on the concentration of the active matter.

For example:

— - 7 °C for a typical solution of aluminium content of 42,4 g/kg of solution.

— Solution stored at low temperatures (below 0°C) can spontaneously form a solid mass of crystal hydrate.

3.3.7 Specific heat

Not known.

3.3.8 Viscosity (dynamic)

The viscosity of aluminium sulfate solution varies greatly, depending on the concentration of the active matter.

For a typical solution of aluminium content of 42,4 g/kg of solution, the viscosity is given in Table 4.

Table 4 — Viscosity

Temperature °C	Viscosity mPa.s
0	40,0
10	26,5
20	18,6
30	13,2
40	8,8

3.3.9 Critical temperature

Not applicable.

3.3.10 Critical pressure

Not applicable.

3) 100 kPa = 1 bar.

3.3.11 Physical hardness

Not applicable.

3.4 Chemical properties

Aluminium sulfate is an acidic hydrated salt or solution. Very dilute solutions hydrolyse and form a precipitate of aluminium hydroxide.

NOTE Since aluminium compounds are amphoteric in nature, the solubility of aluminium depends on the pH value and it is advised to use the product within an appropriate pH range.

4 Purity criteria

4.1 General

This European Standard specifies the minimum purity requirements for aluminium sulfate 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.

Users of the product should 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 the product standard, and other relevant factors.

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 a change in the production process or raw materials leads to significant quantities of impurities, by-products or additives being present, this shall be notified to the user.

4.2 Composition of commercial product

The concentration of active matter (aluminium content) in the product expressed as grams per kilogram of product shall be within ± 3 % of the manufacturer's declared values.

NOTE The concentration of water-soluble aluminium in commercial products varies. Typical values are given here below:

Commercial form	Al g/kg of product
Solid	72 to 91
Solution	32 to 44

4.3 Impurities and main by-products

The product shall conform to the requirements specified in Table 5.

Table 5 — Limits of impurities

Grade	Impurity		Limit g/kg of Al
Iron free	Iron (Fe)	max.	1,60
Low iron	Iron (Fe)	max.	1,60 < Fe ≤ 115
All grades	Insoluble matter	max.	23
NOTE The value quoted for iron is for both iron (II) and iron (III). Iron can be present as a component of the product and will usually be removed in the treatment process.			

4.4 Chemical parameters

The product shall conform to the requirements specified in Table 6.

Table 6 — Chemical parameters

Parameter		Limit mg/kg of Al		
		Type 1	Type 2	Type 3
Arsenic (As)	max.	14	40	100
Cadmium (Cd)	max.	3	50	100
Chromium (Cr)	max.	30	700	1 000
Mercury (Hg)	max.	4	10	20
Nickel (Ni)	max.	20	700	1 000
Lead (Pb)	max.	40	200	800
Antimony (Sb)	max.	20	40	120
Selenium (Se)	max.	20	40	120
NOTE 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. For maximum impact of these products on trace metal content in drinking water see A.2.				

5 Test methods

5.1 Sampling

5.1.1 Solid

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

Prepare the laboratory sample(s) required by the relevant procedure described in ISO 8213.

5.1.2 Liquid

5.1.2.1 Sampling from drums and bottles

5.1.2.1.1 General

5.1.2.1.1.1 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.

5.1.2.1.1.2 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 5.1.2.1.1.3.

5.1.2.1.1.3 Examine the surface of the liquid. If there are signs of surface contamination, take samples from the surface as described in 5.1.2.1.2; otherwise, take samples as described in 5.1.2.1.3.

5.1.2.1.2 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.

5.1.2.1.3 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.

5.1.2.2 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 5.1.2.1.2;

b) from the bottom of the tank or tanker, using a sampling tube as described in 5.1.2.1.3 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 Analyses

Use the relevant methods for analysis described in EN 1302.

6 Labelling - Transportation - Storage

6.1 Means of delivery

Solids: the product shall be delivered in suitable packages, paper or plastics bags, or by aluminium or mild steel tippers, or by rubber-lined or plastics-lined bulk truck (20 t to 35 t depending on transport regulations if applicable).

Bulk liquids: the product shall be delivered in tankers of corrosion-resistant materials.

NOTE The manufacturer can provide advice on suitable materials.

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.

6.2 Labelling in accordance with the EU legislation [4)]

One of the following labelling requirements shall apply to aluminium sulfate at the date of the publication of this document.

4) See [2].

For solids, hydrated forms:

 **Figure 1 - GHS05**	**Signal word:** Danger **Classification – Hazard statements:** H318: Causes serious eye damage

For solutions:

 **Figure 2 — GHS05**	**Signal word:** Danger **Classification – Hazard statements:** H290: May be corrosive to metals

The regulation [2], along with 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.

6.3 Transportation regulations and labelling

Aluminium sulfate is not classified as a dangerous product for road, rail, sea and air transportation.

Aluminium sulfate solution is corrosive class 8.

Aluminium sulfate should be transported under a UN number [5)] 3264.

Proper Shipping name:

CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. (Aluminium sulfate solution).

5) United Nations Number.

Packing Group: III

Hazard Class: 80

— RID [6]: as above;

— ADR [7]: as above;

— IMDG [8]: as above;

— IATA [9]: as above.

6.4 Marking

The marking shall include the following information:

— name: “aluminium sulfate” trade name and type;

— net mass;

— name and the address of the supplier and/or manufacturer;

— statement “This product conforms to EN 878”.

6.5 Storage

6.5.1 General

Storage tanks shall be of a corrosion-resistant material suitable for the purpose. Store at temperatures above 0 °C.

NOTE The manufacturer can provide advice on suitable materials and storage temperatures.

6.5.2 Long term stability

Solid aluminium sulfate is stable. The solution is stable depending on concentration and storage temperature.

6.5.3 Storage incompatibilities

Avoid contact with alkaline substances. Incompatible with other coagulants, such as polyaluminium chloride, and aluminium and iron chlorides salts. Special care shall be taken regarding mixing with other products used previously, in order to avoid gel formation or precipitation.

This product reacts aggressively with some metal surfaces (e.g. galvanised metal, aluminium, copper, zinc, and alloys of these metals). The reaction releases flammable hydrogen gas, which can be explosive in confined spaces. Seek manufacturer's advice.

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 Dangerous Goods Code.

9) International Air Transport Association.

Annex A
(informative)

General information on aluminium sulfate

A.1 Origin

A.1.1 Raw materials

The typical raw materials are:

a) sulfuric acid;

b) aluminium or aluminium oxide compounds such as:

— trihydrate;

— bauxite or clays of suitable composition;

— pickle liquors, purified if necessary;

— aluminium foundry residues, purified if necessary.

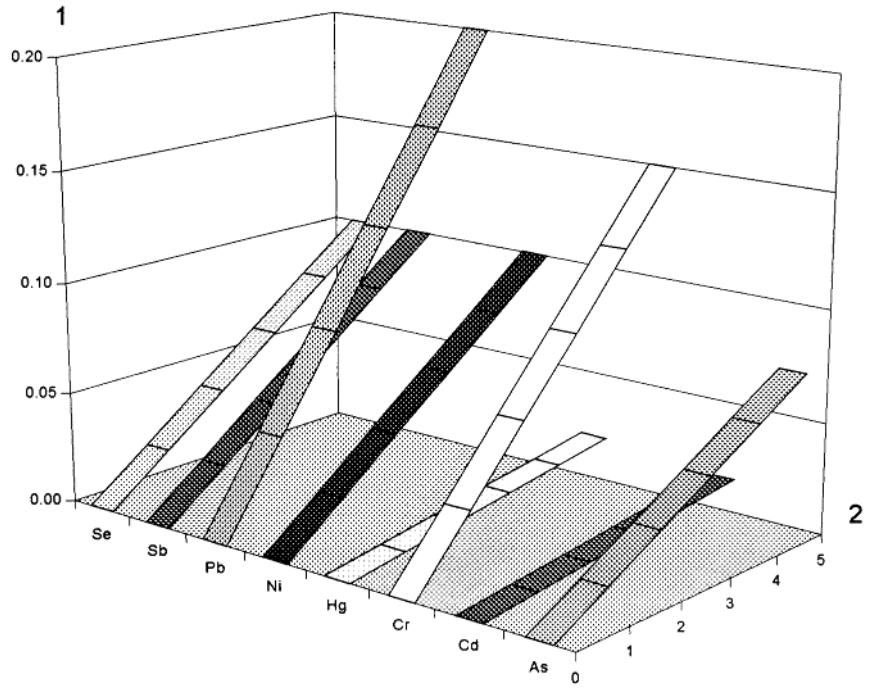
A.1.2 Manufacturing process

Aluminium sulfate is a synthetically manufactured product.

The typical manufacturing process is the reaction of a raw material containing aluminium or aluminium compounds with sulfuric acid.

A.2 Quality of commercial product

The three types of aluminium sulfate specified in Table 6 reflect the quality of commercially available products. Figures 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 6. It can be seen that the concentrations of metal added are well below the Parametric Values given in the EU Directive 98/83/EC (see [1]) at typical product doses. Furthermore, the figures overstate the concentrations 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.

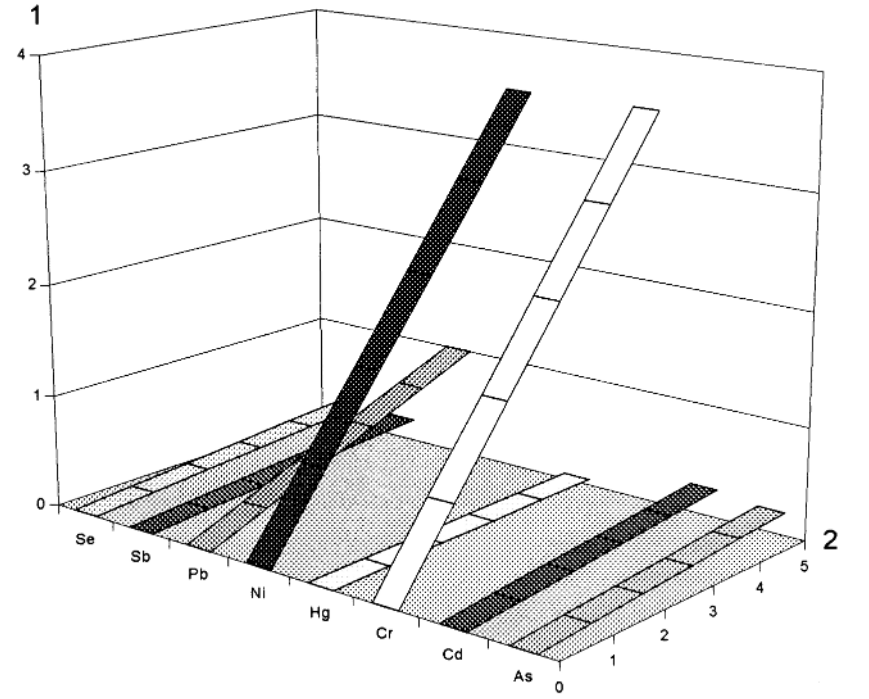


Key

1 maximum addition to water µg/l metal

2 product dosage mg/l Al - Typical dose

Figure A.1 — Maximum impact of aluminium sulfate, Type 1, on trace metal content of water

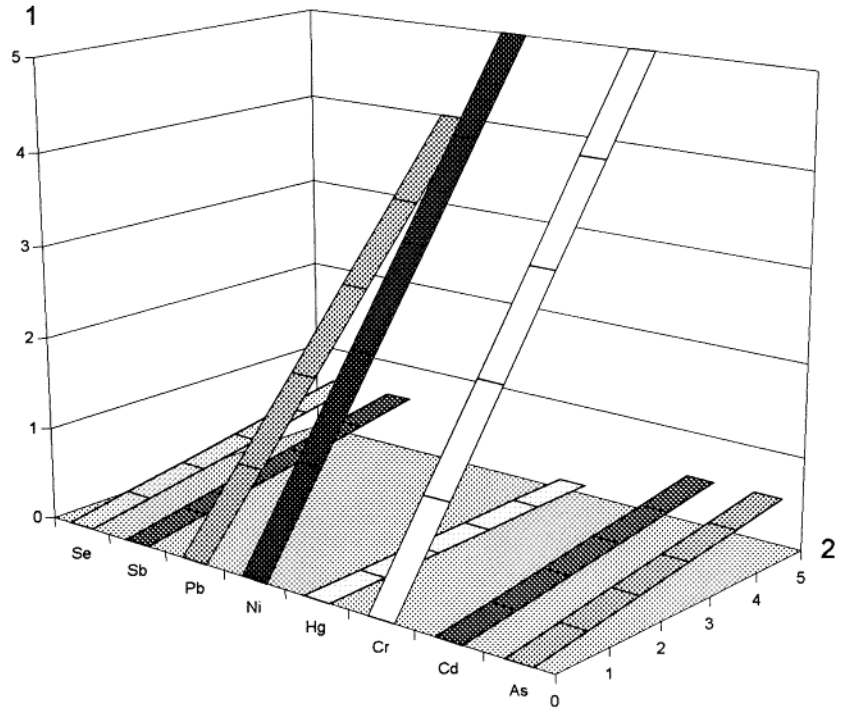


Key

1 maximum addition to water µg/l metal

2 product dosage mg/l Al - Typical dose

Figure A.2 — Maximum impact of aluminium sulfate, Type 2, on trace metal content of water



Key

1 maximum addition to water µg/l metal

2 product dosage mg/l Al - Typical dose

Figure A.3 — Maximum impact of aluminium sulfate, Type 3, on trace metal content of water

A.3 Use

A.3.1 Function

Aluminium sulfate is used as a coagulant.

A.3.2 Form in which it is used

For a liquid product, the concentration of the solution used, expressed as Al, is generally about 10 g/l to 55 g/l (typically 10 g/kg to 44 g/kg).

NOTE Very dilute solutions hydrolyse and form a precipitate.

A.3.3 Treatment dose

The treatment dose is generally 1 mg/l or more, expressed as Al, depending on raw water quality.

A.3.4 Means of application

Solutions are usually applied using a positive displacement metering pump. Sufficient turbulence should be provided at the point of addition to promote rapid dispersion.

A.3.5 Secondary effects

— reduction of pH value;

— reduction of alkalinity;

— increase in sulfate concentration.

A.3.6 Removal of excess product

The coagulation process should be operated under conditions (e.g. pH) in which the aluminium ions in the system are precipitated and reduced below the maximum allowable concentration.

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 wash thoroughly with cold water and seek medical advice if irritation persists.

In case of contact with eyes rinse thoroughly with cold water and seek medical advice.

In case of inhalation remove to fresh air, loosen clothing and seek medical advice.

In case of ingestion seek medical advice immediately.

NOTE In general, it is advised to treat the product as a weak acid.

B.2.2 Spillage

Refer to 6.5.3 for incompatibilities.

Put on protective clothing. Collect and dispose of spillages carefully.

Dilute small spillages of liquid with water and flush to sewer.

Neutralize and dispose of large spillages of liquid.

NOTE 1 Local regulations might apply to the disposal of this product.

NOTE 2 Suitable neutralizing chemicals are diluted sodium hydroxide or sodium carbonate.

B.2.3 Fire

The product is non-flammable. Any extinguishing media can be used. The product can liberate toxic and corrosive fumes of sulfur dioxide and trioxide under extreme conditions when boiled to dryness or heated above 600 °C.

Bibliography

[1] 98/83/EC: Council Directive of 3 November 1998 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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