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

National foreword

This British Standard is the UK implementation of EN 12123:2022. It supersedes BS EN 12123:2012, which is withdrawn.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 - Ammonium sulfate

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

Produkte zur Aufbereitung von Wasser für den menschlichen Gebrauch - Ammoniumsulfat

This European Standard was approved by CEN on 13 March 2022.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

European foreword	4
Introduction	5
1 Scope.....	6
2 Normative references.....	6
3 Terms and definitions	6
4 Description.....	6
4.1 Identification.....	6
4.1.1 Chemical name.....	6
4.1.2 Synonym or common name.....	6
4.1.3 Relative molecular mass	6
4.1.4 Empirical formula.....	7
4.1.5 Chemical formula.....	7
4.1.6 CAS-Registry Number	7
4.1.7 EINECS reference	7
4.2 Commercial form	7
4.3 Physical properties	7
4.3.1 Appearance	7
4.3.2 Density.....	7
4.3.3 Solubility in water	7
4.3.4 Vapour pressure.....	7
4.3.5 Boiling point at 100 kPa	7
4.3.6 Crystallization point	7
4.3.7 Specific heat.....	7
4.3.8 Viscosity dynamic	7
4.3.9 Critical temperature	7
4.3.10 Critical pressure.....	8
4.3.11 Physical hardness.....	8
4.4 Chemical properties.....	8
5 Purity criteria.....	8
5.1 General.....	8
5.2 Composition of commercial product	8
5.3 Impurities and main by-products	9
5.4 Chemical parameters.....	9
6 Test methods	9
6.1 Sampling.....	9
6.2 Analyses.....	10
6.2.1 Main product	10
6.2.2 Impurities	10
6.2.3 Chemical parameters.....	10
7 Labelling, transportation, storage	15
7.1 Means of delivery	15
7.2 Labelling according to the EU legislation	15
7.3 Transportation regulations and labelling	15
7.4 Marking	15

7.5	Storage	15
7.5.1	Long term stability	15
7.5.2	Storage incompatibilities	15
Annex A (informative) General information on ammonium sulfate		16
A.1	Origin	16
A.1.1	Raw materials	16
A.1.2	Manufacturing process	16
A.2	Use	16
A.2.1	Function	16
A.2.2	Form in which it is used	16
A.2.3	Treatment dose	16
A.2.4	Means of application	16
A.2.5	Secondary effects	16
A.2.6	Removal of excess product	16
Annex B (normative) General rules relating to safety		17
B.1	Rules for safe handling and use	17
B.2	Emergency procedures	17
B.2.1	First aid	17
B.2.2	Spillage	17
B.2.3	Fire	17
Bibliography		18

European foreword

This document (EN 12123:2022) 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 October 2022, and conflicting national standards shall be withdrawn at the latest by October 2022.

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 12123:2012.

In comparison with the previous edition EN 12123:2012, the following technical modifications have been made:

- a) modification of 7.3 on transportation regulations and labelling, adding the sentence “The user shall be aware of the incompatibilities between transported products.”;
- b) modification of 7.4 on marking. The requirements of marking are also applied to the accompanying documents.

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

In respect of 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 of 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 (see Annex A).

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1 Scope

This document is applicable to ammonium sulfate used for treatment of water intended for human consumption. It describes the characteristics and specifies the requirements of ammonium sulfate and refers to the corresponding analytical methods. It gives information on its use in water treatment.

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

ISO 760, *Determination of water — Karl Fischer method (General method)*

ISO 2992, *Ammonium sulphate for industrial use — Determination of iron content — 2,2'-Bipyridyl photometric method*

ISO 2993, *Ammonium sulphate for industrial use — Determination of free acidity — Titrimetric method*

ISO 3332, *Ammonium sulphate for industrial use — Determination of ammoniacal nitrogen content — Titrimetric method after distillation*

ISO 5993, *Sodium hydroxide for industrial use — Determination of mercury content — Flameless atomic absorption spectrometric method*

ISO 6353-1, *Reagents for chemical analysis — Part 1: General test methods*

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

3 Terms and definitions

No terms and definitions are listed in this document.

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

— ISO Online browsing platform: available at <https://www.iso.org/obp/ui>

— IEC Electropedia: available at <https://www.electropedia.org/>

4 Description

4.1 Identification

4.1.1 Chemical name

Ammonium sulfate.

4.1.2 Synonym or common name

Ammonium sulfate.

4.1.3 Relative molecular mass

132,14.

4.1.4 Empirical formula

$(\text{NH}_4)_2\text{SO}_4$.

4.1.5 Chemical formula

$(\text{NH}_4)_2\text{SO}_4$.

4.1.6 CAS-Registry Number ¹

7783-20-2.

4.1.7 EINECS reference ²

213-984-1.

4.2 Commercial form

The product is a powder.

4.3 Physical properties

4.3.1 Appearance

The product is a white, fine crystalline powder.

4.3.2 Density

The density of the product is 1,8 g/cm³ at 20 °C.

4.3.3 Solubility in water

The solubility of the product in water is 767 g/l at 25 °C.

4.3.4 Vapour pressure

Not applicable.

4.3.5 Boiling point at 100 kPa ³

Not applicable.

4.3.6 Crystallization point

The product decomposes above 235 °C.

4.3.7 Specific heat

Not known.

4.3.8 Viscosity dynamic

Not applicable.

4.3.9 Critical temperature

Not applicable.

¹ Chemical Abstracts Service Registry Number.

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

Not applicable.

4.4 Chemical properties

Ammonium sulfate easily dissolves in water. A saturated solution (200 g/l at 0 °C) has a pH value of approximately 6.

Upon heating with chlorates, nitrates or nitrites it reacts violently.

Above 235 °C the product decomposes with formation of ammonia vapour, sulfur oxides.

5 Purity criteria

5.1 General

This document specifies the minimum purity requirements for ammonium 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 this 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 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, this shall be notified to the user.

5.2 Composition of commercial product

The content of ammonium sulfate shall not be less than a mass fraction of 99 % corresponding to a mass fraction of 21 % of ammoniacal nitrogen.

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5.3 Impurities and main by-products

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

Table 1 — Impurities

Impurity	Limit in mg/kg of the product
Sulfuric acid (free) (H ₂ SO ₄) max.	10
Water (H ₂ O) max.	300
Iron (Fe) max.	10

5.4 Chemical parameters

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

Table 2 — Chemical parameters

Parameter	Limit mg/kg of commercial product
Antimony (Sb) max.	1
Arsenic (As) max.	5
Cadmium (Cd) max.	0,5
Chromium (Cr) max.	5
Lead (Pb) max.	5
Mercury (Hg) max.	0,1
Nickel (Ni) max.	5
Selenium (Se) max.	2

NOTE Pesticides and polycyclic aromatic hydrocarbons and cyanides (CN⁻) are not relevant in ammonium sulfate because the raw materials used in the manufacturing are free of them. For parametric values of ammonium sulfate on trace metal content in drinking water, see [1].

6 Test methods

6.1 Sampling

Observe the general recommendations of ISO 3165 [2] and take account of ISO 6206 [3]. Prepare the laboratory sample(s) required by the relevant procedure described in ISO 8213.

6.2 Analyses

6.2.1 Main product

The content of ammoniacal nitrogen (w_1), expressed as mass fraction in %, shall be determined in accordance with ISO 3332 (titrimetric method after distillation). The content of ammonium sulfate $((\text{NH}_4)_2\text{SO}_4)$ (w_2), expressed as mass fraction in %, is calculated from the formula:

$$w_2 = w_1 \times 4,72 \quad (1)$$

6.2.2 Impurities

6.2.2.1 Water

The content of water (H_2O) shall be determined in accordance with ISO 760 (Karl Fischer method).

6.2.2.2 Sulfuric acid

The content of free sulfuric acid (H_2SO_4) shall be determined in accordance with ISO 2993.

6.2.2.3 Iron (Fe)

The content of iron (Fe) shall be determined in accordance with ISO 2992.

6.2.3 Chemical parameters

6.2.3.1 General

The content of chemical parameters shall be determined using the procedures specified in Table 3:

Table 3 — Procedures for the determination of chemical parameters

Element	Reference	Method	Wavelength (nm)	Flame
As	see 6.2.3.3	Hydride AAS	193,7	n.a.
Sb	see 6.2.3.3	Hydride AAS	217,6	n.a.
Cd	ISO 6353-1 GM 29 see 6.2.3.2	AAS	228,8	air-acetylene
Cr	ISO 6353-1 GM 29 see 6.2.3.2	AAS	357,8	air-acetylene
Pb	ISO 6353-1 GM 29 see 6.2.3.2	AAS	217,0 or 283,3	air-acetylene
Ni	ISO 6353-1 GM 29 see 6.2.3.2	AAS	232,0	oxidising acetylene-air
Se	see 6.2.3.3	Hydride AAS	196,0	n.a.
Hg	in accordance with ISO 5993	Flameless AAS	253,6	n.a.

AAS = Atomic Absorption Spectroscopy.
n.a. = not applicable.

6.2.3.2 Determination of cadmium (Cd), chromium (Cr), lead (Pb) and nickel (Ni)

6.2.3.2.1 Principle

The elements cadmium (Cd), chromium (Cr), lead (Pb) and nickel (Ni) are determined using atomic absorption spectrometry with the standard additions technique.

6.2.3.2.2 Reagents

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

6.2.3.2.2.1 Standard solution (100 µg/l Cd, Cr, Pb or Ni)

The standard solution shall be freshly prepared on the day of use by individual dilution of a stock solution. This stock solution with a Cd, Cr, Pb or Ni content of at least 1 mg/l shall be made by dilution of standard solutions of Cd, Cr, Pb and Ni which are available from all major suppliers of laboratory chemicals. This stock solution shall be kept in containers of tetrafluoroethylene-hexafluoropropylene copolymer (FEP), polytetrafluoroethylene (PTFE) or polyethylene (PE).

The stock solution should not be kept for longer than four weeks.

6.2.3.2.3 Apparatus

Ordinary laboratory apparatus and the following:

6.2.3.2.3.1 Atomic absorption spectrometer with the measurement parameters specified in Table 3.

6.2.3.2.4 Procedure

6.2.3.2.4.1 Test portion

Weigh 1 g (*m*) to the nearest 0,01 mg of the laboratory sample into a 100 ml one-mark volumetric flask and make up to the mark at 20 °C with water.

6.2.3.2.4.2 Determination

The reference solutions shall be made by spiking the sample with the standard solutions, which contain stepwise increasing contents of the elements to be determined.

NOTE The amount of internal standard to be added can be estimated from a preliminary investigation, determining roughly the element content of the test sample from simple calibration.

The steps in which internal standards have to be added shall be at least as high as the estimated content of the test sample. With the spectrometer (6.2.3.2.3.1), carry out the measurement with the parameters specified in Table 3 in accordance with the manufacturer's instructions.

Repeat the procedure with all reagents and the same volume of standard solution to be added using water in place of the sample as a blank determination.

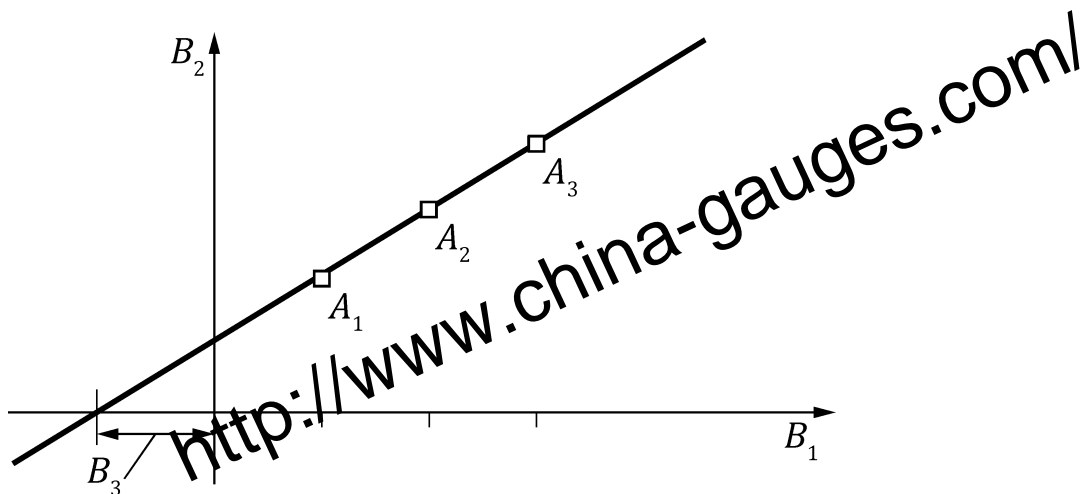
6.2.3.2.5 Expression of results

Prepare a calibration curve using the measured absorbencies of the spiked measurement solutions.

Read the concentration of each element in the test solution by extrapolation of the correlation line to absorbance $A = 0$ (see Figure 1). Similarly determine the element concentration of the blank solution (see Figure 2) and subtract from the result obtained for the test solution.

Alternatively, the evaluation can be carried out by linear regression. Additional dilution steps shall be compensated in the calculation.

The interim result (y) expressed in micrograms per litre is converted to give the final concentration according to 6.2.3.2.6.



Key

- B_1 concentration of added standard in micrograms per litre
- B_2 absorbance A
- B_3 concentration in the test solution in micrograms per litre
- $A_1; A_2; A_3$ spiking

Figure 1 — Calculation of the element concentration in the test solution

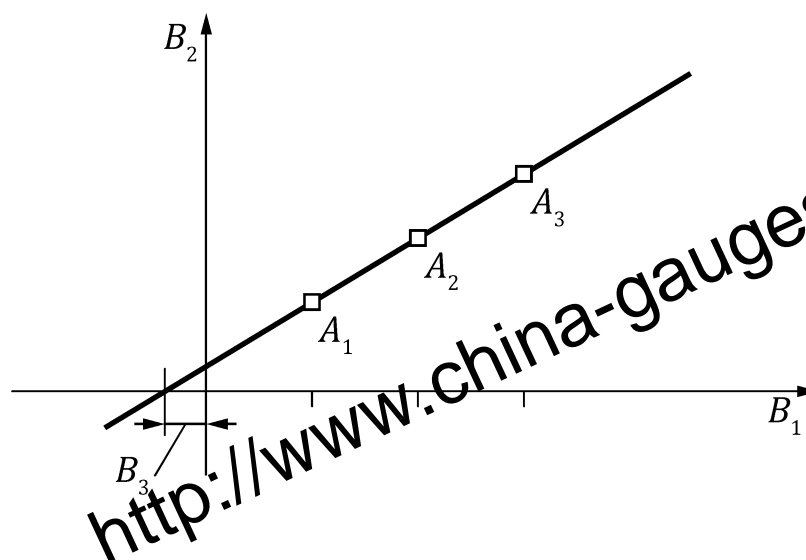
6.2.3.2.6 Calculation

From the interim result (y) (see 6.2.3.2.5), the content, w_3 , of each element in the laboratory sample, expressed in milligram per kilogram of a mass fraction of 100 % ammonium sulfate is given by the following formula:

$$w_3 = \frac{y \times V \times 100 \times 1000}{m \times w_2} \tag{2}$$

where

- y is the interim result (6.2.3.2.5);
- V is the volume, expressed in millilitres, of the test solution;
- m is the mass, expressed in grams, of the test portion;
- w_2 is the concentration, expressed in mass fraction in %, of ammonium sulfate (see 6.2.1).

**Key**

B_1	concentration of added standard in micrograms per litre
B_2	absorbance A
B_3	concentration in the blank solution in micrograms per litre
$A_1; A_2; A_3$	spiking

Figure 2 — Calculation of the element concentration in the blank solution

6.2.3.3 Determination of arsenic (As), antimony (Sb) and selenium (Se)

6.2.3.3.1 Principle

The elements arsenic, antimony, and selenium are determined by hydride-atomic absorption spectrometry. The elements are reduced by reducing agents (sodium borohydride (NaBH_4)) to form the hydrides. These volatile compounds flow through the heated measuring cuvette of an atomic absorption spectrometer where the content of the individual element is determined.

6.2.3.3.2 Reagents

6.2.3.3.2.1 Hydrochloric acid, high purity analytical grade, mass fraction of 30 %, density $\rho = 1,15 \text{ g/ml}$.

6.2.3.3.2.2 Preliminary reduction agent

Dissolve 10 g sodium iodide and 100 g *L*-ascorbic acid in 1 000 ml of water.

6.2.3.3.2.3 Reduction agent

Dissolve with water NaBH_4 and NaOH in concentrations specified in the manufacturer's handbook for the spectrometer.

6.2.3.3.2.4 Standard solution (100 $\mu\text{g/l}$ As, Sb or Se)

The standard solution shall be freshly prepared on the day of use by individual dilution of a stock solution. This stock solution with an As, Sb or Se content of at least 1 mg/l shall be made by dilution of standard solutions of Se, As and Sb which are available from all major suppliers of laboratory chemicals. This stock solution shall be kept in containers of tetrafluoroethylene-hexafluoropropylene copolymer (FEP), polytetrafluoroethylene (PTFE) or polyethylene (PE).

The stock solution should not be kept for longer than four weeks.

6.2.3.3.3 Apparatus

- 6.2.3.3.3.1 **One one-mark volumetric flask**, 100 ml.
- 6.2.3.3.3.2 **Nine one-mark volumetric flasks**, 10 ml.
- 6.2.3.3.3.3 **Pipettes**, 5 ml, 10 ml and 20 ml.
- 6.2.3.3.3.4 **Three one-mark volumetric flasks**, 50 ml.
- 6.2.3.3.3.5 **Micropipettes**, volume adjustable to a maximum 500 µl.
- 6.2.3.3.3.6 **Atomic absorption spectrometer** with the measurement parameters specified in Table 3.

The width of the slit, the measuring time, rinsing with argon before and after the measurement and the reaction time shall be adjusted in accordance with the manufacturer's instructions. The background compensation shall be activated for the measurement of As and Sb, but not for the measurement of Se.

6.2.3.3.4 Procedure

For As (procedure for Sb and Se in parentheses if different from As procedure): weigh a test portion of 1 g to the nearest 0,01 mg and transfer it to a 100 ml one-mark volumetric flask (6.2.3.3.3.1) and make up to the mark at 20 °C with water. Pipette 10 ml (Sb: 10 ml; Se: 30 ml) of this solution into a 50 ml one-mark volumetric flask (6.2.3.3.3.4) and add 10 ml HCl (6.2.3.3.2.1) and 5 ml preliminary reduction agent (6.2.3.3.2.3). Do not add preliminary reduction agent to the flasks for Sb and Se determination. Allow 3 h for reaction to occur and fill to the mark with water. Pipette 5 ml of this solution into three 10 ml one-mark volumetric flasks (6.2.3.3.3.2) labelled A, B, C. For the purpose of internal calibration, add those quantities of standard solutions (6.2.3.3.2.4) as given in Table 4 to the flasks B and C. With the spectrometer (6.2.3.3.3.6), carry out the measurement with the addition of the reduction agent (6.2.3.3.2.3) and the parameters of measurement in accordance with the manufacturer's instructions for the spectrometer.

Repeat the procedure with all reagents and the same volume of standard solution to be added using water in place of the sample as a blank determination.

Table 4 — Standard solution

	Volume of standard solution to be added		
	As	Sb	Se
Flask B	50 µl	100 µl	200 µl
Flask C	100 µl	200 µl	500 µl

6.2.3.3.5 Expression of results

See 6.2.3.2.5.

6.2.3.3.6 Calculation

See 6.2.3.2.6.

7 Labelling, transportation, storage ⁴

7.1 Means of delivery

Ammonium sulfate shall be delivered in plastics bags or in bulk.

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 Labelling according to the EU legislation ⁵

At the date of the publication of this document no labelling requirements apply to ammonium sulfate.

The legislation [4], 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.

7.3 Transportation regulations and labelling

Ammonium sulfate is not classified as a dangerous product for road, rail, sea and air transportation. The user shall be aware of the incompatibilities between transported products.

7.4 Marking

The marking and the accompanying documents shall include the following:

- name “ammonium sulfate”, trade name and grade;
- net mass;
- name and the address of supplier and/or manufacturer;
- statement “this product conforms to EN 12123”.

7.5 Storage

7.5.1 Long term stability

The product is stable indefinitely when stored under dry, cool conditions.

7.5.2 Storage incompatibilities

The product shall be kept away from alkalis, hypochlorites, chlorates, nitrates and high temperature sources.

⁴ See Annex B.

⁵ See [4].

Annex A (informative)

General information on ammonium sulfate

A.1 Origin

A.1.1 Raw materials

Ammonium sulfate is manufactured from aqueous ammonia solution and sulfuric acid.

A.1.2 Manufacturing process

The production of ammonium sulfate is in many cases related to other production processes where sulfuric acid waste streams are produced. By mixing these waste streams with aqueous ammonia solutions followed by subsequent evaporation and crystallization, solid ammonium sulfate is recovered as a co-product.

A.2 Use

A.2.1 Function

Ammonium sulfate is used for *in situ* bacteriostatic treatment by formation of chloramines using the reaction of chlorine and ammonium sulfate.

A.2.2 Form in which it is used

Ammonium sulfate is used as an aqueous solution.

A.2.3 Treatment dose

A typical treatment dose is 0,5 mg/l - calculated as concentration of NH_3 (= 3,85 mg/l of ammonium sulfate).

Maximum admissible concentration should not be exceeded.

A.2.4 Means of application

It is usually applied using a metering pump.

A.2.5 Secondary effects

There are no secondary effects under normal conditions.

A.2.6 Removal of excess product

Not applicable.

Annex B
(normative)

General rules relating to safety

B.1 Rules for safe handling and use

The supplier will provide current safety instructions.

B.2 Emergency procedures

B.2.1 First aid

In case of any contact, it is recommended to rinse with water.

B.2.2 Spillage

It is recommended to collect spillage and to rinse any residue with water.

B.2.3 Fire

There are no restrictions on extinguishing media in fire situations.

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Bibliography

- [1] 98/83/EC: Council Directive of 3 November 1998 on the quality of water intended for human consumption
- [2] ISO 3165, *Sampling of chemical products for industrial use — Safety in sampling*
- [3] ISO 6206, *Chemical products for industrial use — Sampling — Vocabulary*
- [4] 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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