

BS EN 12123:2012



BSI Standards Publication

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

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**National foreword**

This British Standard is the UK implementation of EN 12123:2012. It supersedes BS EN 12123:2005 which is withdrawn.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.

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EUROPEAN STANDARD

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November 2012

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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 23 September 2012.

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

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## Foreword

This document (EN 12123:2012) 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of an identical text or by endorsement, at the latest by May 2013, and conflicting national standards shall be withdrawn at the latest by May 2013.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 12123:2005.

Significant technical differences between this edition and EN 12123:2005 are as follows:

- 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.

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

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

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 Description

### 3.1 Identification

#### 3.1.1 Chemical name

Ammonium sulfate.

#### 3.1.2 Synonym or common name

Ammonium sulfate.

#### 3.1.3 Relative molecular mass

132,14.

### 3.1.4 Empirical formula

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

### 3.1.5 Chemical formula

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

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

7783-20-2.

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

213-984-1.

## 3.2 Commercial form

The product is a powder.

## 3.3 Physical properties

### 3.3.1 Appearance

The product is a white, fine crystalline powder.

### 3.3.2 Density

The density of the product is 1,8 g/cm<sup>3</sup> at 20 °C.

### 3.3.3 Solubility in water

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

### 3.3.4 Vapour pressure

Not applicable.

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

Not applicable.

### 3.3.6 Crystallisation point

The product decomposes above 235 °C.

### 3.3.7 Specific heat

Not known.

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1) Chemical Abstracts Service Registry Number.

2) European Inventory of Existing Commercial Chemical Substances.

3) 100 kPa = 1 bar.



### **3.3.8 Viscosity, dynamic**

Not applicable.

### **3.3.9 Critical temperature**

Not applicable.

### **3.3.10 Critical pressure**

Not applicable.

### **3.3.11 Physical hardness**

Not applicable.

## **3.4 Chemical properties**

Ammonium sulfate easily dissolves in water. A saturated solution (706 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.

## **4 Purity criteria**

### **4.1 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 may 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.

### **4.2 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.

### **4.3 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 <sub>2</sub> SO <sub>4</sub>	max	200
Water	max	300
Iron (Fe)	max	10

#### 4.4 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<sup>-</sup>) 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].

## 5 Test methods

### 5.1 Sampling

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

### 5.2 Analyses

#### 5.2.1 Main product

The content of ammoniacal nitrogen (C<sub>1</sub>), expressed as mass fraction in %, shall be determined in accordance with ISO 3332 (titrimetric method after distillation). The content of ammonium sulfate ((NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>) (C<sub>2</sub>), expressed as mass fraction in %, is calculated from the formula:

$$C_2 = C_1 \times 4,72 \quad (1)$$

## 5.2.2 Impurities

### 5.2.2.1 Water

The content of water (H<sub>2</sub>O) shall be determined in accordance with ISO 760 (Karl Fischer method).

### 5.2.2.2 Sulfuric acid

The content of free sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) shall be determined in accordance with ISO 2993.

### 5.2.2.3 Iron (Fe)

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

## 5.2.3 Chemical parameters

### 5.2.3.1 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 5.2.3.3	Hydride AAS	193,7	n.a.
Sb	see 5.2.3.3	Hydride AAS	217,6	n.a.
Cd	ISO 6353-1 GM 29 see 5.2.3.2	AAS	228,8	air- acetylene
Cr	ISO 6353-1 GM 29 see 5.2.3.2	AAS	357,8	air- acetylene
Pb	ISO 6353-1 GM 29 see 5.2.3.2	AAS	217,0 or 283,3	air- acetylene
Ni	ISO 6353-1 GM 29 see 5.2.3.2	AAS	232,0	oxidising acetylene- air
Se	see 5.2.3.3	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.

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

#### 5.2.3.2.1 Principle

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

#### 5.2.3.2.2 Reagents

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

##### 5.2.3.2.2.1 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.

#### 5.2.3.2.3 Apparatus

Ordinary laboratory apparatus and the following:

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

#### 5.2.3.2.4 Procedure

##### 5.2.3.2.4.1 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.

##### 5.2.3.2.4.2 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 (5.2.3.2.3.1), 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.

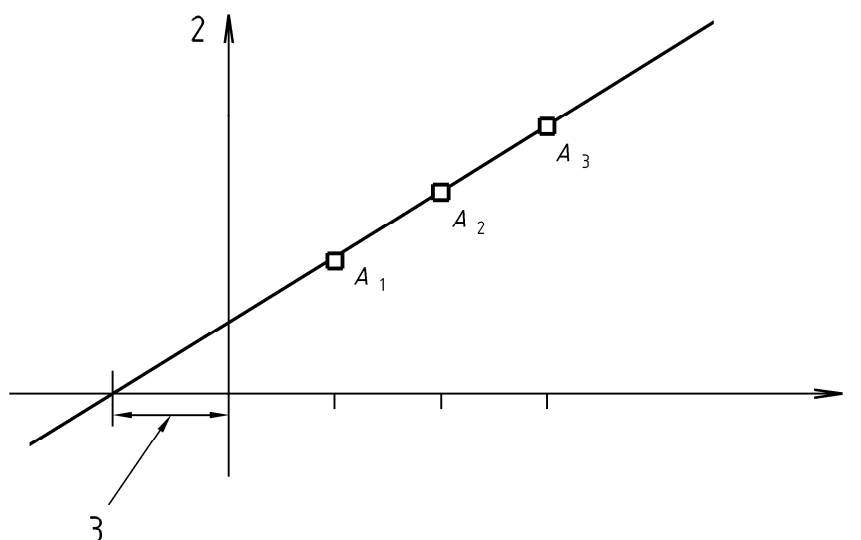
#### 5.2.3.2.5 Expression of results

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 5.2.3.2.6.



**Key**

- 1 concentration of added standard in micrograms per litre
- 2 absorbance  $A$
- 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**

**5.2.3.2.6 Calculation**

From the interim result ( $y$ ) (see 5.2.3.2.5), the content,  $C_3$ , of each element in the laboratory sample, expressed in milligrams per kilogram of a mass fraction of 100 % ammonium sulfate is given by the following formula:

$$C_3 = \frac{y \times V \times 100 \times 1\,000}{m \times C_2} \quad (2)$$

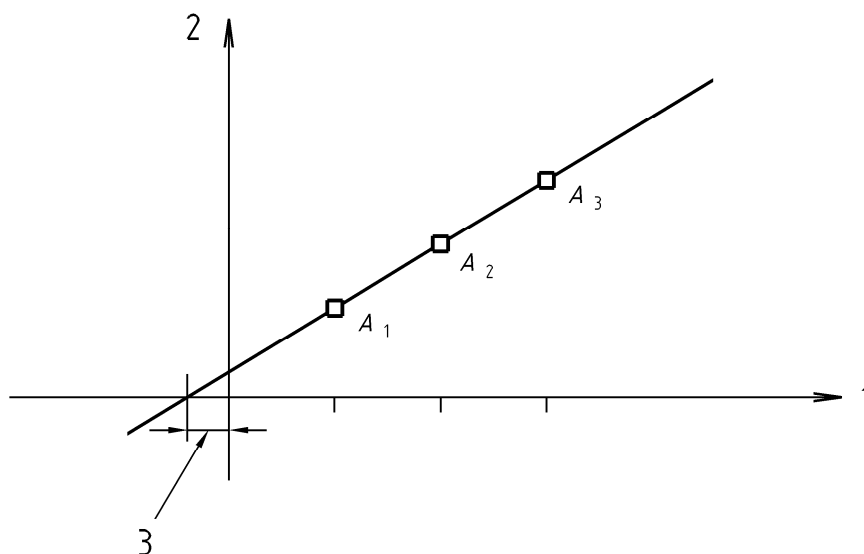
where

$y$  is the interim result (5.2.3.2.5);

$V$  is the volume, expressed in millilitres, of the test solution;

$m$  is the mass, expressed in grams, of the test portion;

$C_2$  is the concentration, expressed in mass fraction in %, of ammonium sulfate (see 5.2.1).



### Key

- 1 concentration of added standard in micrograms per litre
- 2 absorbance A
- 3 concentration in the blank solution in micrograms per litre
- A<sub>1</sub>; A<sub>2</sub>; A<sub>3</sub> spiking

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

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

#### 5.2.3.3.1 Principle

The elements arsenic, antimony, and selenium are determined by hydride-atomic absorption spectrometry. The elements are reduced by reducing agents (sodium borohydride (NaBH<sub>4</sub>)) 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.

#### 5.2.3.3.2 Reagents

**5.2.3.3.2.1 Hydrochloric acid**, high purity analytical grade, mass fraction of 30 %, density  $\rho = 1,15$  g/ml.

**5.2.3.3.2.2 Preliminary reduction agent.**

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

**5.2.3.3.2.3 Reduction agent.**

Dissolve with water NaBH<sub>4</sub> and NaOH in concentrations specified in the manufacturer's handbook for the spectrometer.

**5.2.3.3.2.4 Standard solution (100 µg/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.

### 5.2.3.3.3 Apparatus

5.2.3.3.3.1 One one-mark volumetric flask, 100 ml.

5.2.3.3.3.2 Nine one-mark volumetric flasks, 10 ml.

5.2.3.3.3.3 Pipettes, 5 ml, 10 ml and 20 ml.

5.2.3.3.3.4 Three one-mark volumetric flasks, 50 ml.

5.2.3.3.3.5 Micropipettes, volume adjustable to maximum 500 µl.

5.2.3.3.3.6 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.

### 5.2.3.3.4 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 (5.2.3.3.3.1) 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 (5.2.3.3.3.4) and add 10 ml HCl (5.2.3.3.2.1) and 5 ml preliminary reduction agent (5.2.3.3.2.3). 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 (5.2.3.3.3.2) labelled A, B, C. For the purpose of internal calibration, add those quantities of standard solutions (5.2.3.3.2.4) as given in Table 4 to the flasks B and C. With the spectrometer (5.2.3.3.3.6), carry out the measurement with the addition of the reduction agent (5.2.3.3.2.3) 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

### 5.2.3.3.5 Expression of results

See 5.2.3.2.5.

### 5.2.3.3.6 Calculation

See 5.2.3.2.6.

## **6 Labelling – Transportation – Storage**

### **6.1 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.

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

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

The legislation [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.

### **6.3 Transportation regulations and labelling**

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

### **6.4 Marking**

The marking 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".

### **6.5 Storage**

#### **6.5.1 Long term stability**

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

#### **6.5.2 Storage incompatibilities**

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

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4) See [2].



## **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 crystallisation, solid ammonium sulfate is recovered as a co-product.

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

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

Ammonium 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  $\text{NH}_3$  (= 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.

### **A.3 General rules relating to safety**

#### **A.3.1 Rules for safe handling and use**

The supplier will provide current safety instructions.

#### **A.3.2 Emergency procedures**

##### **A.3.2.1 First aid**

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

##### **A.3.2.2 Spillage**

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

#### **A.3.3 Fire**

There are no restrictions on extinguishing media in fire situations.

## 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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