BS EN 12903:2009



# Products used for the treatment of water intended for human consumption — Powdered activated carbon

ICS 13.060.20; 71.100.80



BSI British Standards

# National foreword

This British Standard is the UK implementation of EN 12903:2009. It supersedes BS EN 12903:2003 which is withdrawn.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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English Version

# Products used for the treatment of water intended for human consumption - Powdered activated carbon

Produits utilisés pour le traitement de l'eau destinée à la consommation humaine - Charbon actif en poudre

Produkte zur Aufbereitung von Wasser für den menschlichen Gebrauch - Pulver-Aktivkohle

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# Contents

**Foreword** ..... 3

**Introduction** ..... 4

1 **Scope** ..... 5

2 **Normative references** ..... 5

3 **Terms and definitions** ..... 5

4 **Description** ..... 5
4.1 **Identification** ..... 5
4.2 **Commercial form** ..... 6

5 **Physical properties** ..... 6
5.1 **Appearance** ..... 6
5.2 **Particle size distribution** ..... 6
5.3 **Bulk density packed** ..... 6

6 **Chemical properties** ..... 6
6.1 **General** ..... 6
6.2 **Purity criteria** ..... 6

7 **Specific properties** ..... 8

8 **Test methods** ..... 8
8.1 **Sampling** ..... 8
8.2 **Analysis** ..... 8

9 **Labelling, transportation and storage** ..... 9
9.1 **Means of delivery** ..... 9
9.2 **Risk and safety labelling according to the EU directives** ..... 9
9.3 **Transportation regulations and labelling** ..... 10
9.4 **Marking** ..... 10
9.5 **Storage** ..... 10

**Annex A** (informative) **General information on powdered activated carbon** ..... 11
A.1 **Origin** ..... 11
A.2 **Properties** ..... 11
A.3 **Use** ..... 12
A.4 **Rules for safe handling and use** ..... 13
A.5 **Emergency procedures** ..... 13

**Bibliography** ..... 14

## Foreword

This document (EN 12903:2009) 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of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by September 2009.

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 12903:2003.

Differences between this edition and EN 12903:2003 are editorial to harmonize the text with other standards in this series.

Annex A is informative.

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

## 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 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 powdered activated carbon used for treatment of water intended for human consumption. It describes the characteristics of powdered activated carbon and specifies the requirements and the corresponding test methods for powdered activated carbon. It gives information on its use in water treatment.

# 2 Normative references

The following referenced documents are indispensable for the application 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 12901:1999, *Products used for treatment of water intended for human consumption - Inorganic supporting and filtering materials – Definitions*

EN 12902, *Products used for treatment of water intended for human consumption - Inorganic supporting and filtering materials - Methods of test*

EN ISO 787-11, *General methods of test for pigments and extenders - Part 11: Determination of tamped volume and apparent density after tamping (ISO 787-11:1981)*

# 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12901:1999 apply.

# 4 Description

## 4.1 Identification

### 4.1.1 Chemical name(s)

Carbon.

### 4.1.2 Synonym or common names

Activated coal, activated charcoal, active carbon.

### 4.1.3 Chemical formula

C (elementary).

### 4.1.4 CAS Registry Number [1)]

7440-44-0.

### 4.1.5 EINECS reference [2)]

231-153-3.

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1) Chemical Abstracts Service Registry Number.

2) European Inventory of Existing Commercial Chemical Substances.

### 4.2 Commercial form

Powdered activated carbon is available in many grades, differing in adsorption characteristics, porosity, particle size and purity.

## 5 Physical properties

### 5.1 Appearance

The product is a black powder.

### 5.2 Particle size distribution

#### 5.2.1 Particle size

At least a mass fraction of 95 % shall have a particle size less than 150 µm.

NOTE Other values can be necessary for certain applications. The particle size distribution is commonly specified as a mass fraction of 95 % less than a given particle size.

The particle size distribution shall be within the manufacturer's declared values.

#### 5.2.2 Oversize and undersize particles

The proportion of oversize and undersize particles shall be within the manufacturer's declared values.

### 5.3 Bulk density packed

The bulk density packed shall be within ± 10 % of the value specified by the manufacturer or supplier.

NOTE The bulk density packed of powdered activated carbon is typically in the range 200 kg/m$^3$ to 750 kg/m$^3$.

## 6 Chemical properties

### 6.1 General

Powdered activated carbon is manufactured by controlled oxidation, by means of steam or chemicals, from carbonaceous raw materials including coconut, wood, peat or coal. The raw materials shall be stated by the manufacturer.

High internal porosity results in adsorptive properties and, depending on the raw material and the manufacturing process, it can have acid or basic properties. It is a reducing agent with catalytic properties. Activated carbon can react with oxidants to form carbon dioxide.

The carbon content of the commercial product does not affect adsorption characteristics.

### 6.2 Purity criteria

#### 6.2.1 General

This European Standard specifies the minimum purity requirements for powdered activated carbon 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 the relevant authorities.

NOTE 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, contents of other impurities and additives used in the products not stated in the 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 lead to significant quantities of impurities, by-products or additives being present, this shall be notified to the user.

### 6.2.2 Impurities and main by-products

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

**Table 1 - Main impurities and by-products**

| **Impurity** | | **Limit [a] in mass fraction** % |
|---|---|---|
| Ash [b] | max. | 15 |
| Water [c] (at the time of packing) [d] | max. | 5 |
| Water-soluble material | max. | 3 |
| Zinc | max. | 0,002 |

a) Expressed on a dry basis except for water content.

b) Some products incorporate minerals to reduce dust formation; for such products a higher limit for ash might be necessary.

c) Certain applications require a higher water content to avoid dust formation; for such products a higher limit might be necessary.

d) The water content can increase after packing; e.g. during transportation.

#### 6.2.3 Water-extractable substances

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

**Table 2 – Water-extractable substances**

| **Substance** | | **Limit of product (dry basis)** mg/kg |
|---|---|---|
| Arsenic (As) | max. | 10 |
| Cadmium (Cd) | max. | 5 |
| Chromium (Cr) | max. | 50 |
| Mercury (Hg) | max. | 1 |
| Nickel (Ni) | max. | 20 |
| Lead (Pb) | max. | 10 |
| Antimony (Sb) | max. | 5 |
| Selenium (Se) | max. | 10 |
| Cyanide (CN) | max. | 50 |
| PAH [a)] | max. | 0,2 |
| a) Polycyclic Aromatic Hydrocarbons: the sum of the detected concentrations of fluoranthene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene. | | |

## 7 Specific properties

The iodine number of the powdered activated carbon shall be not less than 600 mg/g.

NOTE In certain applications lower values are acceptable.

## 8 Test methods

### 8.1 Sampling

Prepare the laboratory sample(s) required by the relevant procedures described in EN 12902.

### 8.2 Analysis

#### 8.2.1 Particle size distribution

The particle size distribution shall be determined in accordance with EN 12902.

#### 8.2.2 Bulk density packed

##### 8.2.2.1 Apparatus

Drying oven capable of being controlled at (150 ± 5) °C.

##### 8.2.2.2 Procedure

Dry a sample of powdered activated carbon to constant mass at (150 ± 5) °C. Determine the bulk density packed in accordance with the method for apparent density after tamping described in EN ISO 787-11.

#### 8.2.3 Ash

The ash shall be determined in accordance with EN 12902.

#### 8.2.4 Water content

The water content shall be determined in accordance with EN 12902, drying the sample at 150 °C.

#### 8.2.5 Water-soluble material

The content of water-soluble material shall be determined in accordance with EN 12902.

#### 8.2.6 Content of zinc

The content of zinc shall be determined in accordance with EN 12902.

#### 8.2.7 Water-extractable substances

The content of water-extractable substances shall be determined in accordance with the method for powders in EN 12902.

#### 8.2.8 Iodine number

The iodine number shall be determined in accordance with EN 12902.

## 9 Labelling, transportation and storage

### 9.1 Means of delivery

Powdered activated carbon shall be delivered in paper sacks (10 kg to 25 kg), semi-bulk containers (polypropylene bags, metal or cardboard drums, or corrugated boxes containing 200 kg to 800 kg), or in bulk (up to 50 $m^3$).

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.

NOTE Local regulations could apply to electrical earthing of containers during transfer operations, to prevent discharge of static electricity.

### 9.2 Risk and safety labelling according to the EU directives [3)]

At the date of publication of this European Standard, powdered activated carbon was not listed as a dangerous substance.

3) See [1].

NOTE Annex I of the Directive 67/548/EEC on Classification, packaging and labelling of dangerous substances and its amendments and adaptations in the European Union contains a list of substances classified by the EU. Substances not in this Annex I should be classified on the basis of their intrinsic properties according to the criteria in the Directive by the person responsible for the marketing of the substance.

## 9.3 Transportation regulations and labelling

At the date of publication of this European Standard, steam activated carbon was not a dangerous cargo.

Chemically activated carbon is listed as:

— UN [4)] Number: 1362;

— RID [5)] /ADR [6)]: Class 4.2, S2, PGIII;

— IMDG [7)]: Class 4.2;

— IATA [8)]: Prohibited.

## 9.4 Marking

The marking shall include the following:

— the name "Powdered activated carbon", trade name and grade;

— the net mass;

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

— the statement "this product conforms to EN 12903".

## 9.5 Storage

### 9.5.1 Long term stability

The product is stable but hygroscopic. It can be stored for an unlimited time if kept dry and away from volatile materials.

### 9.5.2 Storage incompatibilities

The product shall be kept away from oxidants (e.g. hydrogen peroxide, potassium permanganate, chlorates, nitrates), volatile solvents and moisture.

NOTE Local regulations could apply to bulk storage (e.g. in silos).

4) United Nations Number.

5) Regulations concerning international carriage of dangerous goods by rail.

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

7) International Maritime transport of Dangerous Goods.

8) International Air Transport Association.

# Annex A
(informative)

# General information on powdered activated carbon

## A.1 Origin

### A.1.1 Raw materials

Powdered activated carbon can be produced from virtually any carbonaceous material, e.g. coal, lignite, peat, coconut shell and wood.

### A.1.2 Manufacturing process

The carbonaceous material is subjected to controlled oxidation during which a highly porous structure is developed.

The raw material is activated, thermally (most common) or chemically. Thermal activation involves heating to between 800 °C and 1 100 °C in the presence of an oxidizing gas (usually steam) under carefully controlled conditions for several hours. Chemical activation involves heating to between 400 °C and 700 °C in the presence of a dehydrating agent (e.g. phosphoric acid). After activation the material is cooled, then prepared, e.g. by pulverizing and sieving to extract the desired particle size, and packaged.

## A.2 Properties

### A.2.1 Particle size range

Powdered activated carbon commonly has a mean particle size in the range 10 µm to 50 µm and more than a mass fraction of 95 % is in the size range 0 µm to 150 µm.

### A.2.2 Density

The absolute density of the material is approximately 2,1 g/cm$^3$.

### A.2.3 Chemical composition

The content of carbon is generally not less than a mass fraction of 75 % on a water-free basis; the carbon content is not an indicator of adsorption properties. Other major components are ash (up to a mass fraction of 15 %), water (up to a mass fraction of 5 %) and impurities volatile at activation temperatures.

Indicative values for the total concentrations of metals in powdered activated carbon are given in Table A.1. The actual concentrations will depend on the type and source of raw material, manufacturing conditions and methods of sampling and analysis. Only a fraction of the total metal content is water-extractable.

**Table A.1 - Total content of metals**

| Element | Typical content of the product mg/kg | | |
|---|---|---|---|
| Arsenic (As) | 1 | to | 35 |
| Cadmium (Cd) | < 0,1 | to | 0,5 |
| Chromium (Cr) | 1 | to | 30 |
| Mercury (Hg) | < 0,1 | | |
| Nickel (Ni) | 2 | to | 20 |
| Lead (Pb) | 0,1 | to | 10 |
| Antimony (Sb) | < 0,5 | to | 4 |
| Selenium (Se) | 0,1 | to | 2 |

#### A.2.4 Adsorption properties

Powdered activated carbon removes contaminants from water by adsorption. A number of indices are used as surrogates for or measures of the adsorptive capacity of powdered activated carbon under specific conditions.

In addition to Iodine Number (Clause 7), indices which may be specified include:

— specific surface area (BET isotherm);

— phenol number;

— molasses number;

— tannin number;

— methylene blue number.

Specifications for such properties can be the subject of agreement between the customer and the manufacturer/supplier and the latter should make test methods available, if requested, so that quality checks can be performed by the customer.

## A.3 Use

### A.3.1 Function

Powdered activated carbon is used as an adsorbent for the removal of trace organic contaminants (e.g. pesticides, chlorinated solvents, oils), taste- and odour- producing compounds and trihalomethane precursors. It may be used in preference to granular activated carbon particularly to deal with seasonal or intermittent problems.

### A.3.2 Treatment dose

The treatment dose is typically in the range 5 mg/l to 50 mg/l (normally less than 20 mg/l) dependent on water quality and treatment objectives.

### A.3.3 Method of use

Powdered activated carbon is dosed as a slurry into the water and removed by subsequent treatment processes (coagulation/flocculation, sedimentation, filtration). It can be necessary to prepare the slurry using softened water in order to avoid precipitation of calcium carbonate which would reduce adsorption efficiency.

Dosing equipment should be selected so as to avoid the possibility of overdosing.

## A.4 Rules for safe handling and use

It is recommended to handle the product so as to avoid dust formation.

Powdered activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion can reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low-oxygen areas should be followed.

Certain types of chemically activated carbon might have special requirements for transport and storage in bulk; advice should be sought from the manufacturer.

Local regulations can require transfer equipment to be electrically grounded to avoid ignition/explosion of dust by discharge of static electricity.

## A.5 Emergency procedures

### A.5.1 First aid

In case of skin contact, it is recommended to wash with soap and water.

In case of eye contact, it is recommended to flush with plenty of water for 15 min.

In case of inhalation, it is recommended to move to fresh air.

### A.5.2 Spillage

It is recommended to sweep or to vacuum unused carbon and to discard in a refuse container or repackage.

### A.5.3 Fire

Any extinguishing media can be used; it is recommended to use foam extinguishers.

Self-contained breathing apparatus should be worn because carbon dioxide and carbon monoxide can be produced during combustion.

# Bibliography

[1] 67/548/EEC, *Council Directive of 27th June 1967 on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances and its amendments and adaptations*

[2] 98/83/EC, *Council Directive of 25th December 1998 on the quality of water intended for human consumption*

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