

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

The European Standard EN 12903:2003 has the status of a  
British Standard

ICS 71.100.80

## National foreword

This British Standard is the official English language version of EN 12903:2003. It supersedes BS EN 12903:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CII/59, Chemicals for drinking water treatment, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

### Additional information

Article 10 of the Council of the European Community Directive 98/83/EC on the quality of water intended for human consumption requires Member States to ensure that substances and materials (including associated impurities) used in the preparation of drinking water do not remain in treated water at concentrations that are higher than necessary or that would reduce the protection of public health provided for in the Directive.

This requirement is given effect in England and Wales by regulation 25 of the Water Supply (Water Quality) Regulations 1989 (similar provisions apply in Scotland and Northern Ireland). Regulation 25 makes provision for attaching conditions of use to chemicals and filter media that are authorized for use in public water supplies.

Details of conditions of use are contained in the *List of Products and Processes Approved Under Regulations 25 and 26 For Use In Connection With The Supply of Water For Drinking, Washing, Cooking and Food Production Purposes* published by the Drinking Water Inspectorate, Floor 2/A1, Ashdown House, 123 Victoria Street, London SW1 6DE ([www.dwi.gov.uk](http://www.dwi.gov.uk)).

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### Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 14, an inside back cover and a back cover.

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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

This European Standard was approved by CEN on 20 February 2003.

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## Foreword

This document (EN 12903:2003) 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 2003, and conflicting national standards shall be withdrawn at the latest by October 2003.

**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.

This document supersedes EN 12903:1999.

Significant technical differences between this edition and EN 12903:1999 are as follows:

- a) modifications of limit values for As, Ni, Pb and Sb in line with the EU Directive 98/83/EC (see [1]);
- b) deletion of reference to EU Directive 80/778/EEC of 15 July 1980.

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, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, 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.

## 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

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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 European Standard, 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 <sup>1)</sup>

7440-44-0.

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1) Chemical Abstracts Service Registry Number.

**4.1.5 EINECS reference <sup>2)</sup>**

231-153-3.

**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 95 percent by mass (% (*m/m*)) 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 95 % (*m/m*) 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  $\pm 10\%$  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<sup>3</sup> to 750 kg/m<sup>3</sup>.

**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.

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2) European Inventory of Existing Commercial Chemical Substances.



## 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 relevant authorities.

NOTE Users of this product should satisfy themselves that 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 products not stated in the product standard, and other relevant factors.

Limits have been given for impurities and water-extractable substances 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 in % (m/m) <sup>a)</sup>
Ash <sup>b)</sup>	max.	15
Water <sup>c)</sup> (at the time of packing) <sup>d)</sup>	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 in mg/kg of product (dry basis)
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  $(150 \pm 5)^\circ\text{C}$ .

### 8.2.2.2 Procedure

Dry a sample of powdered activated carbon to constant mass at  $(150 \pm 5)^\circ\text{C}$ . 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  $150^\circ\text{C}$ .

### 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  $50\text{ m}^3$ ).

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 <sup>3)</sup>

Powdered activated carbon is not listed as a dangerous substance.

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 1 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.

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3) See [2].

### **9.3 Transportation regulations and labelling**

Steam activated carbon is not a dangerous cargo.

Chemically activated carbon is listed as:

- UN <sup>4)</sup> Number: 1362 ;
- RID <sup>5)</sup> /ADR <sup>6)</sup> / IMDG <sup>7)</sup>: Class 4.2 ;
- IATA <sup>8)</sup>: 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).

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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 95 % (*m/m*) 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<sup>3</sup>.

##### A.2.3 Chemical composition

The content of carbon is generally not less than 75 % (*m/m*) on a water-free basis; the carbon content is not an indicator of adsorption properties. Other major components are ash (up to 15 % (*m/m*)), water (up to 5 % (*m/m*)) 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 small proportion of the total metals content is water-extractable.

Table A.1 - Total content of metals

Element	Typical content mg/kg of the product		
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).

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 may 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] 98/83/EC, Council Directive of 3<sup>d</sup> November 1998 on the quality of water intended for human consumption.
- [2] 67/548/EEC, Council Directive of 27<sup>th</sup> 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.



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