BRITISH STANDARD

BS EN
12915-2:2009

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

Part 2: Reactivated granular activated carbon

ICS 13.060.20; 71.100.80

National foreword

This British Standard is the UK implementation of EN 12915-2:2009. It supersedes BS EN 12915-2:2003 which is withdrawn.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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Produkte zur Aufbereitung von Wasser für den menschlichen Gebrauch - Granulierte Aktivkohle - Teil 2: Reaktivierte granulierte Aktivkohle

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Contents

Foreword

This document (EN 12915-2:2009) 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of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by September 2009.

This document supersedes EN 12915-2:2003.

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.

Differences between this edition and EN 12915-2:2003 are editorial to harmonize the text with other standards in this series.

The note in Clause 6 concerning the purity of the product has been reworded.

This European Standard consists of two parts, Part 1 is concerned with virgin granular activated carbon and Part 2 gives requirements for reactivated granular activated carbon.

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 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 part of EN 12915 is applicable to reactivated granular activated carbon used for treatment of water intended for human consumption. It describes the characteristics of reactivated granular activated carbon and specifies the requirements and the corresponding test methods for reactivated granular 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 the treatment of water intended for human consumption - Inorganic supporting and filtering materials – Definitions*

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

EN 12915-1:2009, *Products used for the treatment of water intended for human consumption – Granular activated carbon - Part 1: Virgin granular activated carbon*

3 Terms and definitions

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

3.1
virgin activated carbon
freshly manufactured activated carbon that has not been used and has not been reactivated

[EN 12915-1:2009]

3.2
wettability
ability of granular activated carbon to be wetted when in contact with water, determined by measuring the quantity of material that sinks in water under specified conditions

[EN 12915-1:2009]

3.3
spent granular activated carbon
granular activated carbon with reduced adsorption capacity as a result of operational use

3.4
reactivation
process used to restore all or part of the adsorption capacity of spent granular activated carbon

NOTE The most common process is thermal reactivation but other methods can be used.

3.5
reactivated granular activated carbon.
spent granular activated carbon that has been subjected to reactivation

NOTE Usually, reactivated granular activated carbon is returned to the water treatment plant at which it was previously used. The delivered product can include make-up granular activated carbon and/or top-up granular activated carbon.

3.6
make-up granular activated carbon
virgin granular activated carbon, or reactivated granular activated carbon from the same water treatment plant, added to the reactivated granular activated carbon to compensate for losses during the operations of reactivation (handling, transportation and reactivation itself)

3.7
top-up granular activated carbon
virgin granular activated carbon, or reactivated granular activated carbon from the same water treatment plant, added to the reactivated granular activated carbon to compensate for losses due to operational (in-service) losses due to attrition and wash-out of granular activated carbon at the water treatment plant

4 Description

4.1 Identification

4.1.1 Chemical name(s)

Carbon.

4.1.2 Synonym or common names

Reactivated activated coal, reactivated activated charcoal, reactivated active carbon, regenerated granular activated carbon, regenerated activated coal, regenerated activated charcoal, regenerated 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.

4.2 Commercial forms

Granular activated carbon is a granular product; by convention not less than a mass fraction of 90 % is retained on a 180 µm aperture test sieve (see 5.3). The product can be either shaped (moulded/extruded) or irregular (non-moulded), and is available in many grades, differing in adsorption characteristics, hardness, porosity, granulometry, shape and purity.

5 Physical properties

5.1 General

The physical properties of reactivated granular activated carbon are dependent on the quality of the spent granular activated carbon as well as on the reactivation process.

[1] Chemical Abstracts Service Registry Number.

[2] European Inventory of Existing Commercial Chemical Substances.

5.2 Appearance

The commercial product consists of black, porous granules of irregular shape or, for moulded or extruded products, in forms such as uniform cylinders, pellets or spheres.

5.3 Particle size distribution

5.3.1 General

The particle size distribution shall be determined on samples taken at the point of reactivation. The particle size distribution shall be within the supplier's stated tolerance.

NOTE 1 Different applications can require different particle size ranges.

NOTE 2 The particle size can decrease during transportation and handling.

NOTE 3 The particle size distribution is dependent on that of the spent granular activated carbon. It can be impossible to guarantee a particular particle size distribution if the spent granular activated carbon has a substantially degraded particle size distribution.

5.3.2 Irregular product

The particle size distribution shall be described by particle size range and by mass of oversize and undersize particles according to application:

— the content of oversize plus undersize shall not exceed a mass fraction of 15 % and not more than a mass fraction of 5 % shall be undersize.

NOTE 1 Other values can be necessary for certain applications.

NOTE 2 Alternatively, particle size distribution can be described by:

— effective size: (d_{10});

— uniformity coefficient: (U);

— minimum size: (d_1).

5.3.3 Moulded/extruded product

Not more than a mass fraction of 3 % shall pass a test sieve with an aperture size as close as possible to 0,75 times the nominal particle diameter.

5.4 Wettability

The wettability shall be greater than a mass fraction of 99 %.

5.5 Bulk density packed

The bulk density packed shall be greater than or equal to 180 kg/m^3.

5.6 Mechanical strength

The ball-pan hardness shall be greater than or equal to the supplier's declared value.

6 Chemical properties

The chemical properties of reactivated granular activated carbon are dependent on the quality of the spent granular activated carbon as well as on the reactivation process. See A.2.3.

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.

7 Specific properties

The iodine number of the reactivated granular activated carbon shall be not less than 600 mg/g when tested according to 8.2.2. The supplier shall state the iodine numbers of the spent and reactivated granular activated carbon.

NOTE 1 The iodine number of reactivated granular activated carbon is dependent on the quality of the spent granular activated carbon as well as on the reactivation process. See A.2.4.

NOTE 2 The purchaser should notify the supplier if data for other adsorption indices are required.

NOTE 3 It should be stated whether the iodine number determination was carried out on product including make-up and/or top-up granular activated carbon.

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 Wettability

The wettability shall be determined in accordance with EN 12915-1.

8.2.3 Bulk density packed

The bulk density packed shall be determined in accordance with EN 12915-1.

8.2.4 Ball-pan hardness

The ball-pan hardness shall be determined in accordance with EN 12915-1.

8.2.5 Iodine number

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

9 Labelling, transportation and storage

9.1 Means of delivery

Reactivated granular 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 of 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.

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

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

NOTE EU regulations apply to the transport of spent granular activated carbon – see [2] and [3].

9.4 Marking

The marking shall include the following:

— the name "reactivated granular activated carbon" and batch identity;

— the net mass;

— the name and the address of the reactivator;

— the statement "this product conforms to EN 12915-2".

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).

[3] See [1]

Annex A
(informative)

General information on reactivated granular activated carbon

A.1 Reactivation

Reactivation is a process used to restore the adsorption capacity of granular activated carbon. The most widely used method for removing contaminants from spent granular activated carbon is thermal reactivation. This involves removing the spent granular activated carbon from an adsorber, processing it in a special furnace, making up any losses with virgin granular activated carbon and returning the reactivated granular activated carbon to the adsorber.

The main stages in the thermal reactivation process are:

a) drying at 150°C to remove water;

b) thermal evaporation at up to 250°C to physically desorbs volatile adsorbed compounds;

c) heating to 200°C to 700°C to pyrolyze and carbonize non-volatile organics;

d) gasification at 800°C to 1 000°C in a controlled atmosphere, in the presence of steam or carbon dioxide, to remove the char that is formed in the pores and to prevent the granular activated carbon from burning.

The most common types of reactivation furnace are the multiple hearth furnace and the rotary kiln.

The reactivation process involves many variables, most important of which are the operating temperature, composition and flowrate of gases in the furnace and the time during the various stages in the furnace. The conditions required depend on the base material of the granular activated carbon (coal, peat, wood, …) and the nature and amount of inorganic and organic chemicals adsorbed on the spent granular activated carbon. Small-scale furnaces can be used to determine optimum conditions experimentally.

Non-thermal reactivation can be carried out using chemicals such as sodium hydroxide but this is not used to any appreciable extent for drinking water applications.

It is important to maintain segregation of a batch of granular activated carbon throughout the stages of removal and handling of the spent granular activated carbon, transportation, storage, reactivation and re-installation of the reactivated product. The reactivated granular activated carbon should consist only of the reactivated granular activated carbon from the purchaser's facility plus any make-up granular activated carbon. The plant used to reactivate granular activated carbon used to treat drinking water should be used exclusively for reactivation of potable water grade or food grade product.

Operation of a granular activated carbon filter and handling operations can affect the volume. Therefore the method and location of volume determinations should be stated in the contract documents.

A.2 Composition

A.2.1 Particle size grading

Irregular (non-moulded) granular activated carbon commonly has a mean particle size in the range 0,25 mm to 4,0 mm; for example available grades include 0,315 mm to 1,0 mm, 0,8 mm to 2,0 mm, 0,4 mm to 1,7 mm, 1,0 mm to 3,15 mm.

Moulded/extruded products typically consist of particles of diameter 0,5 mm to 1,5 mm and length 0,5 mm to more than 4,0 mm.

The particle size distribution should be indexed to that of the virgin granular activated carbon.

A.2.2 Density

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

The bed density (backwashed and drained) is usually in the range of 85 % to 93 % of the bulk density packed.

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, water and impurities volatile at activation temperatures.

The chemical composition of reactivated granular activated carbon depends heavily on the quality of the spent granular activated carbon, which is influenced by the quality of the water treated, history and method of use and other factors. Consequently it is not possible to establish meaningful requirements for the chemical composition of reactivated granular activated carbon. The purchaser should provide at least the following to assist in determining required reactivation conditions and likely quality of the reactivated granular activated carbon.

a) granular activated carbon manufacturer, trade name and grade;

b) particle size distribution;

c) reactivation history;

d) time in service and volume of water treated;

e) means of application (gravity filter, pressure adsorber, …) and process flowsheet;

f) influent water quality;

g) representative sample of the spent granular activated carbon.

Granular activated carbon can be chemically treated, e.g. by acid washing, before or after reactivation to remove potentially leachable impurities.

After filling, washing and commissioning of a filter system producing drinking water the reactivated granular activated carbon should not increase the content of water-extractable substances to undesirable levels. The method for granular materials given in EN 12902 can be used to determine water-extractable substances.

A.2.4 Adsorption properties

Granular activated carbon removes contaminants from water by adsorption. A number of indices are used as surrogates for or measures of the adsorptive capacity of granular activated carbon under specific conditions. The iodine number is commonly used for this purpose.

Reactivation should increase the iodine number towards that of the virgin material. However, the extent to which the iodine number can be restored will depend on the quality of the spent granular activated carbon.

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 Hydraulic characteristics

A.3.1 Interstitial volume

The interstitial volume of granular activated carbon is approximately a volume fraction of 0,4.

A.3.2 Headloss in filtration

Headloss depends on particle size, shape, filtration velocity and temperature.

A.3.3 Expansion in backwashing

Bed expansion depends on washing rate, size, density and shape of particles, and water temperature.

A.4 Use

A.4.1 Function

The primary function of granular activated carbon is 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 can be used for the removal of excess oxidants such as chlorine, ozone and permanganate. Granular activated carbon can be used to prevent fouling of resins and/or membranes. It can also be used as a support for active biomass ("Biological Activated Carbon").

If granular activated carbon is used as a filter medium for removal of suspended solids, specific tests related to the performance of filter media might have to be carried out.

A.4.2 Treatment dose

The usage of granular activated carbon is usually expressed as bed life; i.e. volume of water treated between reactivations. The effective dose, *E*, expressed in milligrams per litre, of granular activated carbon can be calculated from the following equation:

$$E = \frac{M \times 10^6}{L} \qquad (1)$$

where:

M is the mass, in tonnes, of granular activated carbon in the filter bed;

L is the bed life, expressed as volume, in cubic metres, of water treated.

The bed life depends on several factors including water quality and treatment objectives, filter design, filtration velocity and contact time.

A.4.3 Method of use

Granular activated carbon is used either in purpose built adsorbers or in existing filters. Water flows through the bed and dissolved impurities are removed by adsorption within the pores of the material. Physical filtration of suspended solids also occurs; trapped solids can be removed by backwashing at intervals. Once the concentration of the parameter(s) to be removed reaches some predetermined level in the treated water, the granular activated carbon is removed, reactivated, and replaced.

A.5 Rules for safe handling and use

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

Granular 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.

A.6 Emergency procedures

A.6.1 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.6.2 Spillage

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

A.6.3 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] 259/93/EEC, *Council regulation on the supervision and control of shipments of waste within, into and out of the European Community*.

[3] Commission Decision 98/368/EC. Official Journal of the European Communities, No L165, 16 June 1998, p20.

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