DRAFT TANZANIA STANDARD

Products used for the treatment of water intended for human consumption - Granular activated carbon - Part 1: Virgin granular activated carbon

TANZANIA BUREAU OF STANDARDS

1st Edition 2022

0 National Foreword

The Tanzania Bureau of standards is the statutory national standards body for Tanzania, established under the act.No.3 of 1975, amended by act.No.2 of 2009

This draft Tanzania Standard is being prepared by the BCDC 7 Sanitation Structures and Sanitary Appliances Technical Committee, under the supervision of the Building and Construction Standards Divisional Committee (BCDC)

In the preparation of this draft Tanzania Standard, assistance was adopted from:

EN 12915-1:2003 *Products used for the treatment of water intended for human consumption - Granular activated carbon - Part 1: Virgin granular activated carbon* published by British Standards Institution.

1. Scope

This draft Tanzania Standard describes the characteristics of virgin granular activated carbon and specifies the requirements and the corresponding test methods for virgin granular activated carbon. It gives information on its use in water treatment intended for human consumption.

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.

TZS 1443/ISO8213, Chemical Products for Industrial Use-Sampling Techniques-Solid chemical products in the form of particles varying from powders to coarse lumps.

TZS 1444/ISO 6206, Chemical products for industrial use-sampling-vocabulary.

1445/ISO3165, Sampling of chemical products for industrial use –Safety in sampling.

TZS 59:/ISO 3696, Water for analytical laboratory use – Specification and test methods.

TZS 658/ISO 565 Test sieves – Metal wire cloth, perforated metal plate and electroformed sheet – Nominal sizes of openings.

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

3. Terms and definitions

For the purposes of this Tanzania Standard, the terms and definitions of the following apply.

3.1
activated carbon
any form of carbon characterized by high adsorptive capacity for gases and vapours.

3.2
virgin activated carbon
freshly manufactured activated carbon that has not been used and has not been reactivated.

3.3
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.

3.4
water for human consumption
drinking water or potable process water

4. Description

4.1 Identification

4.1.1 Chemical name(s)

Carbon.

4.1.2 Synonym or common names

Virgin granular activated carbon, virgin activated coal, virgin activated charcoal, virgin active carbon.

4.1.3 Chemical formula

C (elementary).

4.1.4 CAS Registry Number[1])

7440-44-0.

Note 1: 1) Chemical Abstracts Service Registry Number.
Note 2: Any other international recognized number may be used.

4.2 Commercial forms

Granular activated carbon is a granular product; by convention not less than 90 percent by mass (% (m/m)) is retained on a 180 µm aperture test sieve (see 5.2). 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 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.

5.2 Particle size distribution

5.2.1 General

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

Note 3 Different applications can require different particle size ranges.

Note 4 The particle size can decrease during transportation and handling.

5.2.2 Irregular product

The particle size distribution shall be described by either:

a) effective size: (d_{10}) with a permitted tolerance of ± 5 %;

uniformity coefficient: (U) shall be less than 2.1;

minimum size: (d_1) with a permitted tolerance of ± 5 %;

or;

b) by particle size range and by mass of oversize and undersize particles according to application:

- the content of oversize plus undersize shall not exceed 15 % (*m/m*) and not more than 5 % *(m/m*) shall be undersize.

Note 5 Other values can be necessary for certain applications.

5.2.3 Moulded/extruded product

Not more than 3 % (m/m) shall pass a test sieve with an aperture size as close as possible to 0.75 times the nominal particle diameter.

5.3 Wettability

The wettability shall be greater than 99 % (*m/m*).

5.4 Bulk density packed

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

5.5 Mechanical strength

The ball-pan hardness shall be greater than 75.

Note 6 Products with a lower hardness are suitable for certain applications.

6. Chemical properties

6.1 General

Granular 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 draft Tanzania Standard specifies the minimum purity requirements for virgin granular 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 7 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 a change in the production process or raw materials leads to significant quantities of other impurities or by products 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)[a]
Ash	max.	15
Water[b] (at the time of packing)[c]	max.	5
Water-soluble material	max.	3
Zinc	max.	0.002

[a] Expressed on a dry basis except for water content.

[b] Higher or lower values can be necessary for certain applications.

[c] 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 µg/l in the extraction
Arsenic (As)	max.	10
Cadmium (Cd)	max.	0.5
Chromium (Cr)	max.	5
Mercury (Hg)	max.	0.3
Nickel (Ni)	max.	15
Lead (Pb)	max.	5
Antimony (Sb)	max.	3
Selenium (Se)	max.	3
Cyanide (CN)	max.	5
PAH[a]	max.	0.02

[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 granular activated carbon shall be not less than 600 mg/g.

8. Test methods

8.1 Sampling

Sampling shall be done as per TZS 1443/ISO8213 while observing the general recommendations as given in TZS 1445/ISO3165 and TZS 1444/ISO 6206.

8.2 Analysis

8.2.1 Particle size distribution

The particle size distribution shall be determined in accordance with TZS 658.

8.2.2 Wettability

8.2.2.1 Principle

Immersion of the product in boiling water. Cooling, sedimentation and filtration of the supernatant through a sieve to determine the quantity of material that is not wetted.

8.2.2.2 Reagents

All reagents shall be of a recognized analytical grade and the water used shall conform to grade 3 in accordance with TZS 59.

8.2.2.3 Apparatus

Ordinary laboratory apparatus and glassware together the following.

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

8.2.2.3.2 Hotplate.

8.2.2.3.3 Wire cloth sieve, with an aperture size as close as possible to the nominal undersize of the granular activated carbon (for moulded/extruded products, 0.75 times the nominal particle diameter).

8.2.2.3.4 Balance having an accuracy of 0,1 g.

8.2.2.4 Procedure

Take a test sample of approximately 500 ml of granular activated carbon, dry at (150±5)°C, and weigh (m_0). Bring 1 l of water to the boil in a 2 L glass beaker and add the granular activated carbon to the boiling water. Continue to boil for 10 min±30 s, swirling if necessary to remove carbon particles attached to the wall of the beaker. Remove from the hotplate (8.2.2.3.2) and cool to room temperature.

Carefully decant the supernatant water (approximately 500 ml), including any suspended or floating particles. Filter the supernatant through the sieve (8.2.2.3.3), collect the particles retained on the sieve and dry to constant mass at (150±5)°C (m_1).

8.2.2.5 Expression of results

The wettability, X_1, expressed as a percentage by mass (% (*m/m*)) of product, is given by the following equation:

$$X_1 = \frac{100 \times (m_0 - m_1)}{m_0}$$

Where

m_0 is the mass, in grams, of the test sample;

m_1 is the mass, in grams, of the test sample retained on the test sieve.

8.2.3 Bulk density packed

8.2.3.1 Principle

The bulk density packed of granular activated carbon is determined by measuring the volume packed by a free fall from a vibrating feeder into a 100 ml graduated cylinder and weighing the known volume.

8.2.3.2 Apparatus

8.2.3.2.1 Test apparatus, as shown in Figure 1, including:

- graduated cylinder, 100 ml capacity;
- reservoir funnel, glass or metal;
- feed funnel, glass or metal, with stem inside diameter of 23.8 mm;
- metal vibrator made of galvanized sheet metal.

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

8.2.3.2.3 Desiccator.

8.2.3.2.4 Balance having an accuracy of 0.1 g.

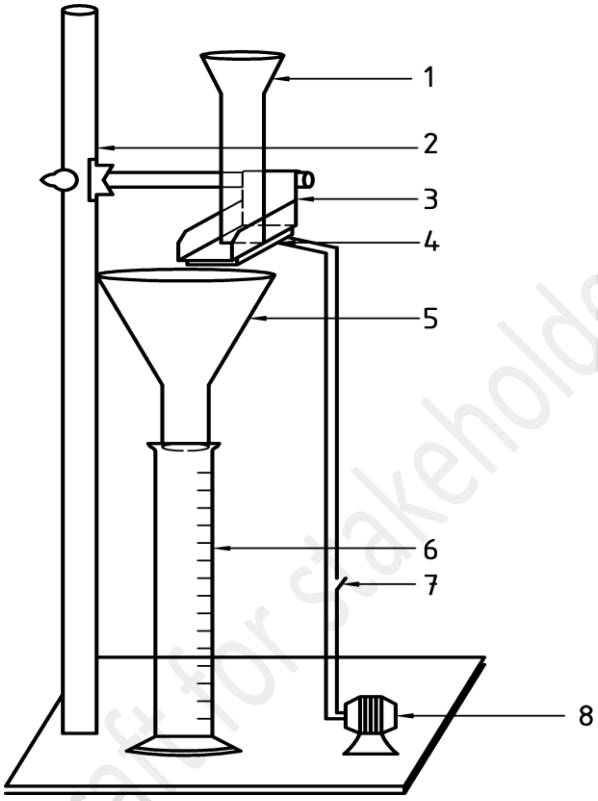

Figure 1a — Assembly of apparatus (not to scale)

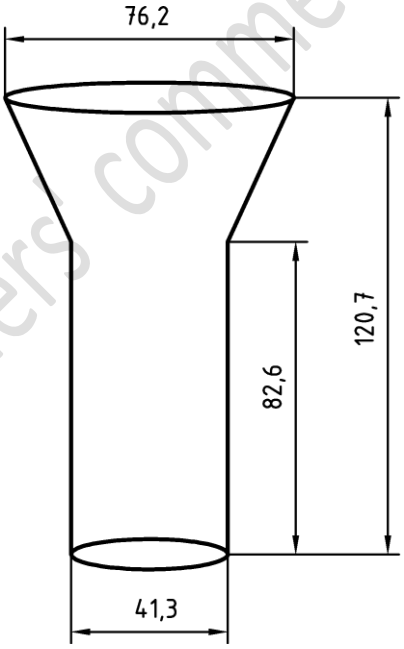

Figure 1c — Reservoir Funnel

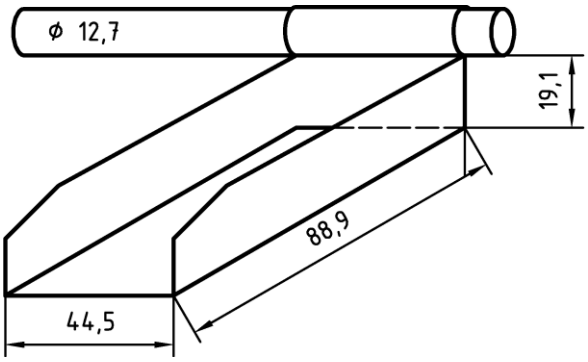

Figure 1b — Metal Vibrator

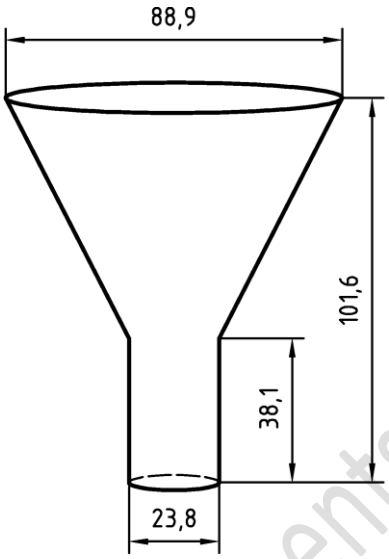

Figure 1d — Feed Funnel

Key

1 Reservoir funnel clamped to ring stand
2 Ring stand
3 Metal vibrator
4 Door bell « buzzer »
5 Feed funnel clamped to ring stand
6 100 ml graduated cylinder
7 Toggle switch
8 Transformer

Figure 1 — Bulk density packed test apparatus

8.2.3.3 Procedure

Dry an adequate test sample of granular activated carbon to constant mass at 150°C.

Note 8 Products that exhibit shrinkage upon oven drying should have the density determined on an as-received basis with a correction made for water content.

Carefully place a representative sample of the granular activated carbon into the reservoir funnel so that the material does not flow prematurely into the graduated cylinder (if this occurs return the material to the reservoir funnel). Add the sample to the cylinder using the vibrator feeder through the feed funnel. Fill the cylinder at a uniform rate between 0.75 ml/s and 1.0 ml/s up to the 100 ml mark; the rate can be adjusted by changing the slope of the metal vibrator or raising or lowering the reservoir funnel, or both. Transfer the contents of the cylinder to a balance pan and weigh to the nearest 0.1g.

8.2.3.4 Expression of results

The bulk density (packed), X_2, expressed in kilograms per cubic metre, is given by the following equation:

$$X_2 = 10 \times m_1$$

Where

m_1 is the mass, in grams of dried test sample in the cylinder;

Note 8 If density is determined on an as-received basis, it is recommended to correct m_1 for water content using the formula:

$$\frac{m_1 \times (100 - X_4)}{100}$$

Where

X_4 is the water content determined in 8.2.6, in percent by mass (% (*m/m*)) of product.

8.2.3.5 Precision

8.2.3.5.1 Repeatability limit

The absolute difference between two single results, obtained under repeatability conditions, shall not exceed 2 % of the mean value.

8.2.3.5.2 Reproducibility limit

The absolute difference between two single results, obtained under reproducibility conditions, shall not exceed 4 % of the mean value.

8.2.4 Ball-pan hardness

8.2.4.1 Principle

A screened and weighed sample of granular activated carbon is placed in a special hardness pan with a number of stainless steel balls, then subjected to a combined rotating and tapping action for 30 min. Degradation of particle size is determined by measuring the mass of granular activated carbon retained by a sieve whose aperture is closest to half the aperture of the sieve that defines the minimum particle size of the original sample.

8.2.4.2 Apparatus

8.2.4.2.1 Mechanical sieve shaker, to produce from (140 to 160) taps and (280 to 320) rotating motions per minute in a stack of standard 200 mm diameter sieves.

8.2.4.2.2 Wire cloth sieves, 200 mm diameter, 50 mm tall. A set of six sieves is required, at least two of which shall have an aperture greater than the expected nominal size of the sample and at least two of which shall have an aperture less than the expected nominal particle size of the sample. One of the sieves, the "Hardness Test Sieve", shall have an aperture size as close as possible to half the aperture of the test sieve that defines the minimum particle size of the original sample. A bottom receiver pan and a sieve cover are also required.

8.2.4.2.3 Hardness test pan, specially constructed, consisting of a standard 200 mm x 50 mm round sieve frame with a solid metal plate instead of sieve wire. The metal plate shall be of 3,2 mm thickness half-hard cartridge brass or soft temper aluminium bronze, soldered into position in the sieve frame.

8.2.4.2.4 Adjustable interval timer, with a precision of at least 5 s and duration at least 600 s.

8.2.4.2.5 Soft brass-wire sieve brush.

8.2.4.2.6 Balance having an accuracy of 0.1 g.

8.2.4.2.7 Steel balls: fifteen (12.7±0.1) mm in diameter and fifteen (9.5±0.1) mm in diameter.

8.2.4.3 Procedure

8.2.4.3.1 Determination of test particle size range

From the particle size distribution (determined in 8.2.1), determine the test particle size range, expressed in sieve aperture sizes: the smaller size allowing not more than 5 % (*m/m*) of the particles to pass through, and the larger size retaining not more than 5 % (*m/m*) of the particles.

8.2.4.3.2 Hardness test

Screen a 125 ml sample of granular activated carbon to the test particle size range. Discard the fraction below the smaller sieve aperture size and the fraction above the larger sieve aperture size. Screen further material if necessary to obtain at least 100 ml within the test particle size range.

Measure out 100 ml of screened sample into a tared graduated cylinder (using the method described in 8.2.3 for determination of bulk density packed). Weigh to the nearest 0.1 g (m_0).

Place the hardness pan (8.2.4.2.3) on the bottom receiver pan. Pour the screened and weighed sample into the hardness pan and add the steel balls (8.2.4.2.7).

Complete the stack of sieves by stacking five full-height sieves and the sieve cover on top of the hardness pan.

Note 9 The extra sieves serve only to form a stack which fills the shaker, avoiding changes in tapping action and readjustment of the sieve stack retainer.

Place the sieve stack in the sieve shaker (8.2.4.2.1) and shake for (30±0.5) min, with the tapping hammer operating. At the end of the shaking period, remove the sieve stack from the sieve shaker and remove the hardness pan from the sieve stack.

Place the hardness test sieve (defined in 8.2.4.2.2) on top of the receiving pan. Remove the steel balls from the hardness pan and transfer the sample to the hardness test sieve, brushing adhering particles into the sieve. Stack the five sieves and sieve cover on top of the hardness test sieve and receiving pan, and replace the stack in the sieve shaker. Shake with the hammer operating for 10 min±10 s.

At the end of the shaking period, remove the sieve stack from the sieve shaker and transfer the remainder of the sample on the hardness test sieve to a tared weighing pan. Weigh to the nearest 0.1 g (m_1). Sweep the contents of the receiver pan into a tared weighing dish and weigh to the nearest 0.1 g (m_2).

8.2.4.4 Expression of results

The ball-pan hardness number, X_3, is given by the following equation:

$$X_3 = \frac{100 \times m_1}{m_0}$$

where

m_0 is the mass, in grams, of the test sample loaded onto the hardness pan;

m_1 is the mass, in grams, of the test sample retained on the hardness test sieve.

As a check on the accuracy of the test, calculate the check hardness number, X_c, using the following equation:

$$X_c = 100 \times (1 - \frac{m_2}{m_0})$$

where

m_0 is the mass, in grams of test sample loaded onto the hardness pan;

m_2 is the mass, in grams of test sample retained on the receiver pan.

If X_c differs from X_3 by more than 2%, a significant amount of carbon is not accounted for, and the test shall be repeated.

8.2.4.5 Precision

Repeatability limit

For samples with hardness numbers near 100, the absolute difference between two single results, obtained under repeatability conditions, shall not exceed the repeatability limit, *r*, in more than 1 in 20 cases.

$$r = 0.4 \times X_3$$

Note 10 It is difficult to evaluate the precision of the method, owing to the substantial variation in hardness within a batch of granular activated carbon.

8.2.5 Ash

The ash shall be determined in accordance with EN 12902.

8.2.6 Water content

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

8.2.7 Water-soluble material

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

8.2.8 Content of zinc

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

8.2.9 Water-extractable substances

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

8.2.10 Iodine number

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

9. Labelling, transportation and storage

9.1 Means of delivery

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

Granular activated carbon is not listed as a dangerous substance.

9.3 Transportation regulations and labelling

Steam activated granular activated carbon is not a dangerous cargo. Chemically activated granular

activated carbon is listed as:

- UN Number[4]): 1362;

-RID[5])/ ADR[6])/ IMDG[7]): class 4.2;

-IATA[8]): Prohibited.

9.4 Marking

The marking shall include the following:

- the name "Virgin granular activated carbon", trade name and commercial grade;

- the net mass;

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

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 11 National regulations could apply to bulk storage (e.g. in silos).

Annex A

(informative)

General information on granular activated carbon

A.1 Origin

A.1.1 Raw materials

Granular 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 prepared, e.g. by pulverizing, mixing with a binder, compression into briquettes, crushing and sieving, to extract the desired particle size. This is then activated, thermally (most common) or chemically. Thermal activation involves heating to between 800°C and 1100°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). The resulting granular activated carbon is then cooled and packaged.

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.

A.2.2 Density

The absolute density of the material is approximately 2.1 g/cm3.

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 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 granular 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 metals content is water-extractable.

Table A.1 — Total content of metals

Metal	Typical content in 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

6.2.3 specifies the maximum quantities of water-extractable substances determined according to EN 12902. Studies have shown that metals concentrations decrease over the operational life of a granular activated carbon filter [2]. In the test method concentrations are determined on the third bed volume of water treated whereas the practical life of a filter is commonly 50,000 to 100,000 bed volumes. In addition, when commissioning a granular activated carbon filter it is common practice to divert the filtrate to waste for a sufficient period to ensure that leachable impurity concentrations are acceptably low. In practice, therefore, the concentrations of these substances in water treated using granular activated carbon are substantially lower than the maximum concentrations specified in 6.2.3.

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.

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 0.4 volume per volume (*V/V*).

A.3.2 Head loss during filtration

Headloss depends on size, shape and roughness of particles, filtration rate, filter bed depth, and water temperature.

A.3.3 Expansion during up-flow washing

Expansion during washing depends on flow rate, effective size, density, shape and roughness, 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 may need 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:

$$E = \frac{M \times 10^6}{L}$$

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.