European Chemical Industry Council

Activated Carbon Producers Association (ACPA)

A Sector Group of Cefic

Guidelines for classification and measurement of spent activated carbon used in drinking water treatment.

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1.0 Introduction

Granular activated carbon is widely employed in the treatment of drinking water for the removal of organic compounds including pesticides and taste and odour forming contaminants. The adsorption capacity of the activated carbon is not unlimited and in most cases the spent activated carbon is regenerated by thermal reactivation. This involves removing the spent carbon from the adsorber and processing in a furnace at high temperature to remove and destroy the adsorbed organic components.

The ability of the spent activated carbon to be successfully reactivated will depend on a number of factors including:

- the original virgin activated carbon properties
- the loading and nature of adsorbed organic matter
- the service life of the activated carbon
- the deposition of metals, principally calcium on the spent carbon

The measurement of the quantity of spent activated carbon received for reactivation can be problematic. This can be for a number of reasons including:

- The activated carbon is installed in closed adsorbers and so can not be verified
- The adsorber is not completely emptied
- The volume can increase due to biomass and other factors

The objective of this document is to provide guidelines to Operators of Drinking Water Treatment Plants to monitor the condition of spent activated carbon by classifying according to a number of common parameters.

This standard also includes a procedure for the measurement of the quantity of spent activated carbon based on auditable results of weight and measured laboratory test parameters.

It is designed to complement the existing standard EN12915 – Products used for the treatment of water intended for human consumption – Granular activated carbon – Part 1 Virgin granular activated carbon and Part 2: Reactivated granular activated carbon.

2.0 Classification

The spent activated carbon is classified according to the following parameters:

Spent iodine
indicator of the residual activity of the spent carbon that is not saturated with adsorbed organics

Spent hardness
indicator of the mechanical strength of activated carbon and of potential losses during reactivation

Calcium content
measurement of the deposition of mineral calcium from the drinking water determined by acid soluble extraction of the spent carbon or ash. Calcium can act as a catalyst during reactivation resulting in higher losses.

Undersize
an indicator that the carbon has experienced conditions that have lead to mechanical breakdown. For irregular carbon, the undersize should be the mass fraction less than the lower test screen of the particle size range. For example, for a US Mesh 8x30 carbon, the undersize test screen should be US Mesh 30 (0.60mm aperture size). For an extruded carbon, the test sieve should have an aperture size as close as possible to 0.75 times the nominal particle diameter.

	Spent Iodine mg/g	Spent Hardness	Calcium Content %wt.	Undersize %wt.
Methods*	EN12902	EN12902	ASTM D6647**	EN12902
Class 1	> 600	> 90	< 1.0	< 5
Class 2	450 – 600	85 – 90	1.0 – 2.5	5 – 7
Class 3	< 450	< 85	> 2.5	> 7

* Alternative methods can be used if a good correlation has been identified.
**Extraction method for the ASTM 6647 (American Society for Testing and Materials) is used. Calcium is measured in place of iron by Atomic Absorption or similar method.

The Overall Class is determined by the average Class of the parameters.

Examples

	Sample A	Class	Sample B	Class	Sample C	Class	Sample D	Class
Residual Iodine mg/g	665	1	560	2	650	1	420	3
Spent Hardness	89	2	88	2	91	1	84	3
Calcium Content %wt.	0.7	1	0.7	1	4	3	4	3
Undersize %wt.	1.2	1	1.5	1	6.3	2	4.6	1
Average	-	1.25	-	1.50	-	1.75	-	2.50
Classification - Overall	-	1	-	2	-	2	-	3

3.0 Determination of received volume of spent activated carbon for drinking water.

3.1 Definitions

Custom Reactivation
a service to restore the adsorption capacity of activated carbon to an acceptable level by thermal processing in which spent carbons from individual customers are reactivated separately. All necessary precautions are taken to avoid mixing before, during and after processing.

Make up
virgin activated carbon added to compensate for thermal losses.

Nominal volume
the expected amount of activated carbon for reactivation and normally referred to in the contract.

Reactivated carbon
a blend of activated carbon produced by the reactivation furnaces and the amount of virgin make-up carbon required to compensate for thermal losses. The reactivated carbon excludes service losses.

Received volume
the volume of activated carbon received excluding solids and biomass. In some cases, this is lower than measured in the filter. The test method for this is described in the following section.

Service losses
activated carbon losses incurred at a Customer site owing to handling and use of the carbon.

Spent carbon
exhausted activated carbon.

Thermal losses
activated carbon that is lost during processing in the furnace.

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

Volume, backwashed and drained
the quantity of activated carbon normally measure in cubic metres (m^3) after a filter has been backwashed and drained and the bed is fully segregated.

3.2 Methods

Method to determine received volume (Virgin Carbon Equivalent)

$$\text{Received volume } (m^3, \text{ backwashed and drained}) = \frac{W(1 - M/100)}{(AD \times S)}$$

where:

W (kg) - The weight of spent carbon including moisture. This should be determined by weighing of the bulk tanker using weighbridge after drainage at the site of the Reactivator. The spent carbon should be drained until free water stops flowing from the bulk tanker.

M (%wt.) - The moisture content determined according to test method EN12902

AD – The apparent (bulk) density of the spent activated carbon after drying according to EN12915

S - The segregation factor which is the ratio of the apparent density to the backwashed and drained density. Backwashing activated carbon leads to segregation of the bed where smaller particles are pushed to the top and larger granules migrate to the bottom resulting in a lower density.

S = 0.85

This testing is based on a representative sample of spent activated carbon taken according to ISO 2309.