

DRINKING WATER TREATMENT CHEMICALS – FACT SHEETS

Carbon, powdered activated

(endorsed 2005)

Powdered activated carbon is used in drinking water treatment to adsorb dissolved organic matter, pesticides, algal toxins and compounds causing taste or odour problems. Adding activated carbon before disinfection reduces the formation of disinfection by-products, by reducing the amount and reactivity of organic precursors of these by-products.

GENERAL DESCRIPTION

Powdered activated carbon (PAC) is a black, solid, extremely porous material that can adsorb impurities and contaminants from air and water. It has a complex, porous internal structure, with internal surface areas averaging about 900 m²/g and a bulk density of 250–600 kg/m³. Activated carbon is insoluble in water and organic solvents.

The properties of activated carbon depend on its degree of activation and the raw material from which it is produced. Coal, wood and coconut-based activated carbons each have different pore structures and different characteristics.

Dry activated carbon can be stored in cast iron or steel silos. Wet activated carbon can be stored in plastic, rubber, or silicon-lined containers, or in stainless steel (type 316), monel or bronze.

CHEMISTRY

Carbon is 'activated' by heating carbonaceous material such as wood, coal or coconut husks to high temperatures in a controlled atmosphere of steam, or at moderate temperatures in the presence of chemicals such as acid.

The adsorptive properties of PAC vary with particle size, pore size, pore-size distribution, internal surface area of the pores and surface properties. The properties of the PAC available in the market are variable. In selecting an activated carbon product, it is important to take into account factors such as the adsorptive capacity of the activated carbon, the desired application and the cost. The quality of the activated carbon can be determined by its ability to remove contaminants such as 2-methylisoborneol (MIB), geosmin, toxins and pesticides, and by a number of other factors that are listed below, together with typical ranges (actual values will depend on the raw material and the activation processes):

- iodine number: 800–1400 mg/g carbon
- apparent density: 0.2–0.6 g/cc
- moisture content: 3–8%
- particle size distribution: 90% minimum through 100 µm mesh
95% minimum through 200 µm mesh
- ash content: 3–15%

The adsorptive capacity of activated carbon can be inferred from the iodine number, methylene blue number or molasses number.

Effective sizes of PAC are typically 20–50 µm.

TYPICAL USE IN AUSTRALIAN DRINKING WATER TREATMENT

In drinking water treatment, PAC can be added as a powder by dry-feed equipment; for higher dosing, it can be added as a slurry by metering pumps or feeders. It is important to add PAC early in the treatment process, before addition of chemicals such as chlorine, to ensure sufficient contact time and to avoid chemicals being adsorbed onto the carbon. For intermittent or low dosing, Ideally, PAC is added 30 minutes before coagulation; often near the raw water source. Care should be taken to avoid areas where PAC may build up (e.g. low-velocity pipes). The carbon is mixed for a short time before being removed by settling or filtration.

If PAC is added in the coagulation zone, additional PAC may be required, because the carbon can become bound in flocs, diminishing its effectiveness. Jar testing reflecting the operating conditions can determine the effective dose rate and contact time for optimal performance of PAC.

Occasionally, PAC is dosed immediately before filtration, where it reacts with organics above and within the filter bed. Care should be taken to avoid breakthrough of PAC caused by normal sludge removal processes (e.g. clarifier sludge blowdowns, flotation or filter backwashing).

The amount of PAC required will depend on the type and concentration of organics in the water. Typical values range from 2 to 60 mg/L, but can be as high as 100 mg/L. A contact time of 10–30 minutes between the PAC and the water generally removes most taste and odour compounds, but a longer time may be needed for removal of MIB and geosmin (the compounds most often linked with tastes and odours — see the fact sheet on taste and odour).

CONTAMINANTS

The purity of chemicals used in Australia for the treatment of drinking water varies, depending on the manufacturing process. The following chemical contaminants may be present in the ash that may be found in activated carbon:

- aluminium
- arsenic
- chromium
- copper
- iron
- lead
- manganese
- mercury
- phosphorus
- zinc

RESIDUAL AND BY-PRODUCT FORMATION IN DRINKING WATER

When employed in drinking water treatment, PAC should be used in such a way that any contaminant or by-product formed by the use of the chemical does not exceed guideline values in the *Australian Drinking Water Guidelines*.

Powdered carbon slurry applied to raw water is easily removed by other water treatment processes (e.g. by settled sludge, floated sludge or filtration). PAC can pass through a water treatment plant, causing black specks and deposits in the distribution system, although it is unlikely that significant quantities of carbon residues will be present in finished water.

STATUS

Activated carbon was endorsed by the NHMRC for use as a drinking water treatment chemical in 1983. The revision undertaken in 2003 did not change the status of this chemical for the treatment of drinking water.

REFERENCES

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