Application of Activated Carbon in Drinking Water Purification

Four methods for water purification: principles and purposes

Precipitation: Insoluble impurities are precipitated and separated from the aqueous phase; alternatively, the addition of alum can form a colloidal precipitate that adsorbs impurities, leading to their subsequent sedimentation.

Filtration: separates a liquid from solid substances that are poorly soluble in the liquid, thereby removing insoluble impurities.

Adsorption: By leveraging the adsorption properties of materials, this process removes poorly soluble impurities, odors, and pigments from water, including both poorly soluble and partially soluble impurities.

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Distillation involves heating water to convert it into water vapor, which is then condensed back into liquid water; this process removes soluble impurities and softens hard water.

Water purification methods:

Adsorption, precipitation, filtration, distillation

Adsorption: Commonly, alum and activated carbon are used; when alum dissolves in water, it forms a colloidal suspension that adsorbs suspended solids from the water.

Activated carbon can not only adsorb suspended solids from water, but also adsorb odor-causing substances and pigments present in water.

Precipitation: Suspended solids in the water are adsorbed to form denser particles, thereby causing the impurities to precipitate.

Filtration: removal of insoluble impurities from water

Distillation: a method for removing soluble impurities

Common disinfectants: bleach, chlorine, and novel chlorine dioxide, among others.

Among adsorption, precipitation, filtration, and distillation, distillation provides the highest degree of purification in a single operation.

When employing this integrated process, following the sequence of adsorption → precipitation → filtration → distillation yields optimal purification results.

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Water Purification Process

① Extract water from the reservoir.

② Add a flocculant (primarily alum) to adsorb and aggregate the suspended fine particulate impurities.

③ Perform sedimentation and separation in the reaction precipitation tank to achieve clarification of the water.

④ Direct the relatively clear water flowing from the sedimentation tank into a filtration tank to further remove insoluble impurities.

⑤ Next, the water is directed into an activated carbon adsorption tank to remove odors and residual fine insoluble impurities from the water.

⑥ Disinfection (commonly achieved by introducing chlorine gas). This is a chemical reaction process aimed at eliminating pathogens—specifically, the conversion of pathogens into other substances.

⑦ The disinfected water becomes clean, potable tap water, which is supplied to users via a water distribution pump; however, the water still contains certain soluble impurities and thus remains a mixture.

This activated carbon product for advanced purification of domestic drinking water (also known as bio-activated carbon) is particularly suitable for use in water treatment plants employing the ozone-bio-activated carbon technology. It complies with the standards GB/T7701.2-2008 and CJ 345-2010, and holds relevant qualifications, including the "Health Licensing Certificate."

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This product not only exhibits high adsorption capacity but also supports the growth and development of microorganisms. Its transition pores are significantly improved compared to conventional products, and its surface functional groups have been modified, transforming this activated carbon into a novel adsorbent that integrates multiple functionalities. In addition to adsorbing organic compounds dissolved in

water, it can rapidly decompose ozone to release dissolved oxygen, while also serving as a viable substrate for cultivating beneficial microorganisms, such as nitrifying bacteria. To date, this product has been successfully deployed in cities including Beijing, Shanghai, Guangzhou, and Shenzhen for the production of high-quality direct drinking water, achieving remarkable application success and providing essential support for ensuring critical water supply security.

The key features of this product are primarily reflected in the following aspects: (1) By utilizing anthracite as the primary raw material, the product exhibits reduced levels of water-soluble substances and ash content, thereby minimizing the risk of secondary contamination of tap water. (2) Through optimized coal blending, the proportion of transitional pores in the product has been adjusted; this enables the product to adsorb larger molecular organic pollutants more effectively than conventional anthracite activated carbon products, which in turn facilitates the proliferation and growth of microorganisms. (3) During the manufacturing process, rigorous control of the carbonization stage is implemented to prevent the formation of non-functional pores; this approach reduces the product's floating rate and minimizes waste during the backwashing phase. (4) In the pulverization stage, the selected raw coal is homogenized to disrupt its crystalline lattice structure, thereby achieving isotropic properties. This results in more uniform and

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homogeneous product performance, enhanced product strength, a uniform pore structure, fewer non-functional pores, a very low floating rate, and a high regeneration rate.

For the treatment of organic matter in water using different processes, the process flow diagram for the ozone–biological activated carbon treatment system is as follows:

The technical features of the product are primarily reflected in the following aspects:

1. Low ash content. This characteristic inherits the properties of Taixi anthracite in Ningxia as a raw material for coal-to-activated carbon production, serving as one of the foundational pillars of Ningxia's activated carbon industry. The low ash content enables multiple regeneration cycles of activated carbon used in advanced water purification processes.

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2. Low flotation rate. Due to the homogenization effects of coal powder preparation, stirring, and molding stages in the processing technology, the variations in ash content and microcrystalline structure of the raw coal during natural mineralization are reduced. Coupled with the control measures employed in the pre-oxidation carbonization process, the probability of localized expansion bubbles forming in the molded charge is significantly decreased. Consequently, the flotation rate of the

final product is extremely low, eliminating the need for water washing to reduce flotation. This characteristic is inherent to the processing technology used in Ningxia for activated carbon production. In contrast, the direct activation process for coal-to-crushed carbon using Datong coal lacks a homogenization stage; a prominent consequence of this approach is a high flotation rate, which necessitates water washing to lower the flotation rate. However, during water washing, issues such as excessive levels of *Escherichia coli* frequently arise due to water quality limitations, posing challenges for water purification in the initial operational phase.

3. Low water-soluble content. Due to the low ash content, as well as the even lower content of alkali and alkaline earth metal inorganic salts in the ash composition (generally less than 50% of the total ash content), and given that these inorganic salts consist primarily of calcium and magnesium oxides, the water-soluble content of the final activated carbon product is generally <0.2%.

4. High strength. The primary objective of carbonization is to enhance the strength of the molded material, extract light fractions from the molded material, and establish preliminary pathways for gas reactions during activation. When activation is performed on a semi-finished carbonized material that already possesses sufficiently high strength, the resulting product will naturally exhibit outstanding strength.

5. High water capacity. The purified activated carbon is prepared by blending a specific quantity of coal—distinct in quality characteristics from Taixi coal and optimized to promote the development of large, medium, and small micropores—during the pulverization and mixing stages. This approach differs from conventional coal-to-activated-carbon processes that primarily utilize Taixi coal as the sole raw material and are mainly employed for gas-phase adsorption. A key feature of this method is the ability to deliberately adjust the ratio of large, medium, and small micropores in the final product. Consequently, under otherwise comparable conditions—where other adsorption parameters, such as iodine value and CTC adsorption capacity, remain essentially consistent—this activated carbon exhibits relatively higher water capacity.

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