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TITLE: ACTIVATED CARBON,ITS PROPERTIES AND ITS APPLICATIONS

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Abstract

As we all know that in this era of technology, the demands of the human race are increasing very rapidly. So it is very important to meet these demands without harming the nature. In these situation, the use of activated carbon for various purposes can be one of the most efficient method to perform, as this form of carbon has a huge applications in small scale as well as in large scale industries. This form of carbon can be used in many purposes ranging from daily use cosmetics to huge filter and purifiers. This is beneficial to both human and nature, due to its easy availability and eco-friendly property.

Keywords: *Activated carbon/charcoal, adsorption, industrial applications, eco-friendly.*

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1. Introduction

What is activated carbon/charcoal?
So, basically charcoal that has been heated or treated otherwise to increase its adsorption power is called activated carbon which is also called as activated charcoal. It is a form of carbon processed to generate small volume pores that increases the surface area available for adsorption or chemical reaction. Due to its high degree of microporosity, one gram of activated carbon has a surface area in excess of 3,000 m2 (32,000 sq ft) as determined by gas adsorption. An activation level sufficient for useful application may be obtained solely from high surface area. Further chemical treatment often enhances adsorption properties. Activated carbon is usually derived from charcoal and is sometimes used as biochar. When derived from coal or corn it is referred to as activated coal. Activated coke is derived from coke.

2. Types of charcoal on the basis of origin.

There are as such not many types of charcoal.

Lump charcoal: One type of charcoal is lump charcoal in which pure burning of wood takes place in which trees or bark of trees are burned to obtain charcoal.
Coconut charcoal: Another is coconut charcoal. This is the most commonly used and most efficient type of charcoal. As this is partially a non-conventional form of charcoal because of the abundant and hardly ending supply of it. This type of charcoal is obtained from burning the shells of coconut.
Bone charcoal: This type of charcoal is made from the bones of animals. These are generally given to chickens to reduce the chances of infection by microorganisms and protect them from diseases and also increase their productivity due to which they may also give eggs that are larger than they usually give.

3. Classification of activated charcoal on the basis of operations performed on it:

- Powdered activated carbon

A micrograph of activated carbon (R1) below bright field illumination on a lightweight magnifier. Notice the fractal-like form of the particles hinting at their monumental area. Each particle during this image, despite being only around 0.1 mm across, can have a surface area of several square centimeters. The entire image covers an area of roughly one.1 by 0.7 mm, and the full resolution version is at a scale of 6.236 pixels/µm. Normally, activated carbons (R one) square measure created

in particulate kind as powders or fine granules but 1.0 mm in size with an average diameter between 0.15 and 0.25 mm. Thus they provide a large surface to volume ratio with a small diffusion distance. Activated carbon (R 1) is outlined because the atomic number 6 particles maintained on a 50-mesh sieve (0.297 mm). PAC material is finer material. PAC is formed from crushed or ground carbon particles, 95–100% of which will pass through a designated mesh sieve. The ASTM classifies particles passing through associate 80-mesh sieve (0.177 mm) and smaller as PAC. It is not common to use political action committee during a dedicated vessel, due to the high head loss that would occur. Instead, political action committee is usually superimposed on to different method units, such as raw water intakes, rapid mix basins, clarifiers, and gravity filters.

- Granular activated carbon

A micrograph of activated carbon (GAC) below scanning microscope. Granular atomic number 6 (GAC) incorporates a comparatively larger particle size compared to pulverized atomic number 6 and consequently, presents a smaller external surface. Diffusion of the adsorbate is an important factor. These carbons are suitable for adsorption of gases and vapours, because they diffuse rapidly. Granulated carbons square measure used for water treatment, deodorization and separation of parts of flow system and is additionally utilized in speedy combine basins. GAC will be either in granular or extruded kind. GAC is selected by sizes like 8×20, 20×40, or 8×30 for liquid section applications and 4×6, 4×8 or 4×10 for vapour phase applications. A 20×40 carbon is formed of particles that may suffer a U.S. Standard Mesh Size No. 20 sieve (0.84 mm) (generally such as as eighty fifth passing) however be maintained on a U.S. Standard Mesh Size No. 40 sieve (0.42 mm) (generally such as as ninety fifth retained). AWWA (1992) B604 uses the 50-mesh sieve (0.297 mm) because the minimum GAC size. The most in style binary compound section carbons square measure the 12×40 and 8×30 sizes as a result of they need an honest balance of size, area, and head loss characteristics.

- Extruded activated carbon

Extruded atomic number 6 (EAC) combines pulverized atomic number 6 with a binder, which are fused together and extruded into a cylindrical shaped activated carbon block with diameters from 0.8 to 130 mm. These square measure principally used for gas section applications thanks to their air mass drop, high mechanical strength and low dirt content. Also sold as CTO filter (Chlorine, Taste and Odour).

- Bead activated carbon (BAC)

Bead atomic number 6 (BAC) is formed from oil pitch and provided in diameters from some zero.35 to 0.80 mm. Similar to EAC, it's conjointly noted for its air mass drop, high mechanical strength and low dust content, but with a smaller grain size. Its spherical form makes it most well-liked for fluidized bed applications like water filtration.

- Impregnated carbon

Porous carbons containing many styles of inorganic impregnate like iodine, silver, cat-ions such as Al, Mn, Zn, Fe, Li, Ca have also been prepared for specific application in air pollution control especially in museums and galleries. Due to its antimicrobial and antiseptic properties, silver loaded C is employed as associate adsorbent for purification of domestic water. Drinking water will be obtained from natural water by treating the natural water with a combination of atomic number 6 and Al(OH)3, a flocculating agent. Impregnated carbons are used for the sorption of element Sulfide(H2S) and thiols. Adsorption rates for H2S as high as five hundredth by weight are reported .

- Polymer coated carbon

This is a method by that a porous carbon will be coated with a biocompatible chemical compound to present a sleek and porous coat while not obstruction the pores. The resulting carbon is useful for hemoperfusion. Hemoperfusion could be a treatment technique during which giant volumes of the patient's blood square measure disregarded AN adsorbent substance so as to get rid of noxious substances from the blood.

- Woven activated carbon cloth

There is a technology of process technical textile fiber into atomic number 6 fabric for carbon filtering. Adsorption capability of activated fabric is larger than that of activated carbon (BET theory surface area: 500–1500 m2/g, pore volume: 0.3–0.8 cm3/g). Thanks to the various types of activated material, it will be utilized in a large vary of applications (super capacitors, odour-absorbers, CBRN defense trade etc.).

4. Properties

A gram of atomic number 6 will have a extent in way over five hundred M2 (5,400 sq ft), with 3,000 m2 (32,000 sq ft) being pronto doable. Carbon aerogels, whereas dearer, have even higher surface areas, and area unit utilized in special applications.

Under associate microscope, the high surface-area structures of atomic number 6 area unit discovered. Individual particles area unit intensely convoluted and show numerous forms of porosity; there could also be several areas wherever flat surfaces of graphite-like material run parallel to every different, separated by only a few nanometers or so. These micropores give excellent conditions for surface assimilation to occur, since sorb material will move with several surfaces at the same time. Tests of surface assimilation behaviour area unit typically through with N gas at seventy seven K underneath high vacuum, however in everyday terms atomic number 6 is dead capable of manufacturing the equivalent, by surface assimilation from its setting, liquid water from steam at a hundred °C (212 °F) and a pressure of 1/10,000 of an environment.

James Dewar, the human once whom the Dewar (vacuum flask) is called, spent a lot of time learning atomic number 6 and printed a paper concerning its surface assimilation capability with respect to gases. In this paper, he discovered that cooling the carbon to atomic number 7 temperatures allowed it to sorb important quantities of diverse air gases,

among others, that could then be recollected by merely permitting the carbon to heat once more which coconut based mostly carbon was superior for the result. He uses gas as associate example, whereby the atomic number 6 would usually sorb the atmospherical concentration (21%) underneath commonplace conditions, however unharness over eightieth gas if the carbon was first cooled to low temperatures.

Physically, atomic number 6 binds materials by van der Waals force or London dispersion force.

Activated carbon does not bind well to certain chemicals, including alcohols, diols, strong acids and bases, metals and most inorganics, such as lithium, sodium, iron, lead, arsenic, fluorine, and boric acid.

Activated carbon adsorbs iodine very well. The iodine capability, mg/g, (ASTM D28 commonplace methodology test) could also be used as a sign of total extent.

Carbon monoxide isn't well adsorbate by atomic number 6. This should be of explicit concern to those exploitation the fabric in filters for respirators, fume hoods or different gas management systems because the gas is undetectable to the human senses, toxic to metabolism and neurotoxic.

Substantial lists of the common industrial and agricultural gases adsorbate by atomic number 6 are often found on-line.

Activated carbon are often used as a substrate for the appliance of assorted chemicals to enhance the chemosorptive capability for a few inorganic (and problematic organic) compounds like sulphide (H2S), ammonia (NH3), gas (HCOH), mercury (Hg) and radioactive iodine-131(131I). This property is known as chemisorption.

Iodine number

Many carbons preferentially adsorb small molecules. Iodine range is that the most basic parameter accustomed characterize atomic number 6 performance. It is a live of activity level (higher range indicates higher degree of activation,[citation needed]) typically reported in mg/g (typical vary 500–1200 mg/g). It is a live of the micropore content of the atomic number 6 (0 to twenty Å, or up to a pair of nm) by surface assimilation of iodine from answer. It is such as extent of carbon between 900 and 1100 m2/g. It is the standard measure for liquid-phase applications.

Iodine number is defined as the milligrams of iodine adsorbed by one gram of carbon when the iodine concentration in the residual filtrate is at a concentration of 0.02 normal (i.e. 0.02N). Basically, iodine range may be a live of the iodine adsorbate within the pores and, as such, is a sign of the pore volume offered within the atomic number 6 of interest. Typically, water-treatment carbons have iodine numbers starting from 600 to 1100. Frequently, this parameter is employed to work out the degree of exhaustion of a carbon in use. However, this observe ought to be viewed with caution, as chemical interactions with the adsorbate might have an effect on the iodine uptake, giving false results. Thus, the utilization of iodine range as a live of the degree of exhaustion of a carbon bed will solely be counseled if it's been shown to be free of chemical interactions with adsorbates associated if an experimental correlation between iodine range and therefore the degree of exhaustion has been determined for the actual application.

Molasses

Some carbons are more adept at adsorbing large molecules. Molasses number or molasses efficiency is a measure of the mesopore content of the activated carbon (greater than 20 Å, or larger than 2 nm) by adsorption of molasses from solution. A high sirup range indicates a high surface assimilation of huge molecules (range 95–600). Caramel displaced person (decolorizing performance) is analogous to sirup range. Molasses potency is reported as a proportion (range 40%–185%) and parallels sirup range (600 = decennary, 425 = 85%). The European sirup range (range 525–110) is reciprocally associated with the North yank sirup range.

Molasses variety could be a live of the degree of decolorization of a customary syrup resolution that has been diluted and standardized against standardized carbon. Due to the dimensions of color bodies, the syrup variety represents the potential pore volume on the market for larger take up species. As all of the pore volume might not be on the market for sorption in an exceedingly explicit waste water application, and as some of the adsorbate may enter smaller pores, it is not an honest live of the value of a specific carbon for a particular application. Frequently, this parameter is helpful in evaluating a series of active carbons for his or her rates of sorption. Given a pair of active carbons with similar pore volumes for activity, the one having the upper sirup range can sometimes have larger feeder pores leading to a lot of economical transfer of adsorbate into the adsorption space.

Tannin

Tannins square measure a mix of enormous and medium size molecules. Carbons with a mix of macropores and mesopores sorb tannins. The ability of a carbon to sorb tannins is reported in elements per million concentration (range two hundred ppm–362 ppm).

Methylene blue

Some carbons have a mesopore (20 Å to fifty Å, or 2 to 5 nm) structure which adsorbs medium size molecules, such as the dye methylene blue. Methylene blue sorption is reported in g/100g (range 11–28 g/100g).

Dechlorination

Some carbons square measure evaluated supported the dechlorination half-life length, that measures the chlorine-removal potency of carbon. The dechlorination half-value length is that the depth of carbon needed to scale back the chemical element level of a flowing stream from five ppm to three.5 ppm. A lower half-value length indicates superior performance.

Apparent density

The solid or skeletal density of activated carbons can generally vary between 2000 and 2100 kg/m3 (125–130 lbs./cubic foot). However, an outsized a part of associate carbon sample can encompass air house between particles,

thus the|and also the} actual or apparent density can therefore be lower, generally four hundred to 500 kg/m3 (25–31 lbs./cubic foot).

Higher density provides larger volume activity and unremarkably indicates better-quality carbon. ASTM D 2854 - 09 (2014) is employed to see the apparent density of carbon.

Hardness/abrasion number

It is a live of the activated carbon's resistance to attrition. It is a very important indicator of carbon to take care of its physical integrity and stand up to resistance forces. There square measure massive variations within the hardness of activated carbons, betting on the staple and activity levels.

Ash content

Ash reduces the general activity of carbon and reduces the potency of reactivation. The metal oxides (Fe2O3) will leach out of carbon leading to discoloration. Acid/water-soluble ash content is a lot of vital than total ash content. Soluble ash content are often vital for aquarists, as oxide will promote protoctist growths. A carbon with a coffee soluble ash content ought to be used for marine, seafood and reef tanks to avoid significant metal poisoning and excess plant/algal growth. Standard methodology D 2866-2011 is employed to see the ash content of carbon.

Carbon tetrachloride activity

Measurement of the body of associate carbon by the sorption of saturated dissolver vapour.

Particle size distribution

The finer the particle size of associate carbon, the higher the access to the extent and also the quicker the speed of sorption mechanics. In vapour part systems this has to be thought of against pressure drop, which can have an effect on energy price. Careful thought of particle size distribution will offer vital operative advantages. However, within the case of victimisation carbon for sorption of minerals like gold, the particle size ought to be within the vary of three.35–1.4 millimetres (0.132–0.055 in). Activated carbon with particle size but one metric linear unit wouldn't be appropriate for extraction (the denudation of mineral from associate activated carbon).

5. Production

Activated carbon is carbon created from carbonous source like bamboo, coconut husk, willow vegetable matter, wood, coir, lignite, coal, and crude pitch. There are mainly two methods for the production of activated charcoal which are given as follows;

1. Physical activation.
2. Chemical activation.

1)Physical activation.

This method is generally used on coconut shells and coal. The supply material is developed into activated carbons victimization hot gases. Then air is introduced to burn out the gasses, creating a graded, screened and de-dusted form of activated carbon. This is typically done by victimization one or a mixture of the subsequent processes:

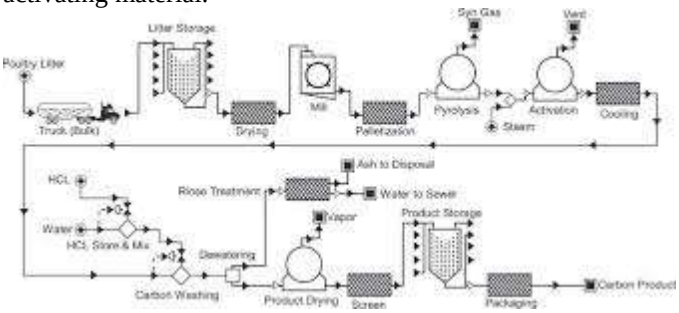
Carbonization: Material with carbon content is pyrolyzed at temperatures within the vary 600–900 °C, usually in inert atmosphere with gases like argon or nitrogen.

Activation/Oxidation: Here steam becomes an oxidizing agent to the raw material. Raw material or change state material is exposed to oxidizing atmospheres (oxygen or steam) at temperatures higher than 250 °C, usually in the temperature range of 600–1200 °C.

2)Chemical activation.

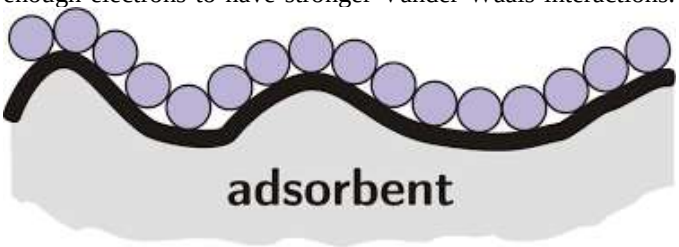
This method is basically a coating process. Before destructive distillation, the raw material is impregnated with certain chemicals. The chemical is typically an acid, strong base, or a salt (phosphoric acid, potassium hydroxide, sodium hydroxide, calcium chloride, and zinc chloride 25%). Then, the staple is change state at lower temperatures (450–900 °C). It is believed that the destructive distillation / activation step take at the same time with the chemical activation.

Note: Chemical activation is preferred over physical activation due to the lower temperatures and shorter time required for activating material.



6. Adsorption

It is basically a surface phenomenon. Adsorption is the process of binding of molecules of one compound to that of the surface of other compound. This is a surface phenomenon. These molecules bind to the surface due to the Vander Waal forces i.e., the weak attractive force between uncharged molecules. Basically depending on where the electrons are, one side of the molecule might be more electrically charged than other even if the molecule doesn't have an overall charge. So when a molecule passes through the tiny pores in the activated charcoal, those very weak charges make it cling to the carbon atom. They are usually large enough and have enough electrons to have stronger Vander Waals interactions.



7. Applications of activated charcoal

- Industrial applications: In industries activated charcoal is used for metal finishing and purification of electroplating solutions. it is a main purification technique for removing organic impurities from

bright nickel plating solutions. A variety of organic chemicals unit of measurement added to plating solutions for up their deposit qualities and for enhancing properties like brightness, smoothness, ductility, etc. Due to passage of DC and electrolytic reactions of anodic oxidisation and electrode reduction, organic additives generate unwanted breakdown products in solution. Their excessive build up will adversely have an effect on plating quality and physical properties of deposited metal. Activated carbon treatment removes such impurities and restores plating performance to the specified level.

- • Medical applications: Coconut shell activated charcoal is the best antidote for radioactive poisoning. It is also used in case of accidental poisoning and drug overdose for reducing the risk of death due to poisoning in the body. It is also used in dialysis machines, to check infections in liver and kidney and to purify them. Also in wound dressing where the activated charcoal stops the growth of infection causing bacteria in the wound and letting the wound to heal faster. Ostomy bags are also used in hospitals and also for cancer surgery.
- • Outer space applications: In the outer space, the astronauts require water to drink and oxygen to breathe. This water and air needs to be purified before intaking or inhailing respectively, so there are filters and purifiers used which contains activated charcoal in it. This makes the water drinkable and the air breathable for the astronauts.
- • Storage applications: Research is being done testing various activated carbons' ability to store natural gas. and hydrogen gas. The porous material acts sort of a sponge for various varieties of gases. The gas is interested in the carbon material via Van der Waals forces. Some carbons are able to win bonding energies of 5–10 kJ per mole. The gas could then be desorbed once subjected to higher temperatures and either combusted to try to work or within the case of chemical element gas extracted to be used in an exceedingly hydrogen fuel cell. Gas storage Associate in Nursing exceedingly|in a very}activated carbons is an appealing gas storage methodology as a result of the gas will be hold on in a depression, low mass, low volume environment that would be much more possible than large on-board pressure tanks in vehicles. The Department of Energy has such bound goals to be achieved within the space of analysis and development of nano-porous carbon materials. All of the goals area unit however to be glad however various establishments, together with the ALL-CRAFT program, area unit continued to conduct add this promising field.
- Purification applications:
  - Air purification: Filters with activated carbon are usually used in compressed air and gas purification to remove oil vapours, odour, and other hydrocarbons from the air. The most common styles use a 1-stage or a pair of stage filtration principle within which C is embedded within the filter media. Activated carbon filters are used to retain radioactive gases at intervals the air vacuumed from a nuclear boiling water reactor rotary engine condenser. The large charcoal beds sorb these gases and retain them whereas they quickly decay to non-radioactive solid species. The solids are cornered within the charcoal particles, whereas the filtered air passes through.
  - Water purification: A portable personal water filtration and purification device which includes an elongate tubular filter housing with layers of mechanical filtration and contains a layer of granular activated charcoal fertile with silver situated between the layers of mechanical filter medium. A mouthpiece limits the speed of flow of water through the filter unit, whereas creating it convenient to draw water through the filter. In one embodiment, a filter unit is hooked up to a versatile drinking tube and therefore the filter unit is found among a transportable water instrumentation handily carried by an individual.

3. CONCLUSION

So hence we can conclude that activated carbon has tremendous amount of uses and applications in a vast variety of fields i.e., it has a huge variety of applications ranging from small scale industries to large scale industries and from a small product of daily use to environmental issue related techniques on a large scale.

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