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Marine *Newslink*

JULY 2021

FEATURE ARTICLE
ACTIVATED CARBON

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Activated Carbon

Activated carbons are produced and used as a black or dark grey solid, in granular, powder, pellet or textile form. It is produced from various types of raw materials such as bituminous coal, coconut shells, lignite, peat, synthetic sources, semi-anthracite and wood.

Activated carbon is a porous, amorphous, high surface area adsorbent material composed of largely elemental carbon, with a low or high skeletal density, depending on the manufacturing process used. The type of raw material also influences the pore size in the final product. In fact, pore diameter in the final product depends on the natural raw material pores. For example, coconut shells and very dense materials produce micropores (< 2 nm), while medium-dense and light materials produce meso- (between 2 and 50 nm) or macro-pores (> 50 nm).

There is no difference between activated carbon and activated charcoal. Both of these terms can and are used interchangeably. Activated carbon is primarily derived from charcoal. When derived from coal, it is referred to as activated coal and when from coke it is referred as Activated coke.

Activated carbon is a highly porous substance that attracts and holds organic chemicals inside it. The media is created by first burning a carbonaceous substance without oxygen which makes a carbon “char”. Next, the “char” is treated chemically or physically to develop an interconnected series of “holes” or pores inside the carbon. The great surface area of this internal pore network results in an extremely large surface area that can attract and hold organic chemicals.

There are two different ways to create higher quality and purer activated carbon:

Physical reactivation: The precursor is developed into activated carbons using gases. This is generally done by using one or a combination of the following processes:

Carbonization: Material with carbon content is pyrolyzed at temperatures in the range 600–900°C, in absence of oxygen (usually in inert atmosphere with gases like argon or nitrogen)

Activation/Oxidation: Raw material or carbonized material is exposed to oxidizing atmospheres (carbon dioxide, oxygen or steam) at temperatures above 250 °C, usually in the temperature range of 600–1200°C.

Chemical activation: Prior to carbonization, 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 raw material is carbonized at lower temperatures (450–900 °C). The carbonization / activation step proceeds simultaneously with the chemical activation. Chemical activation is preferred over physical activation owing to the lower temperatures and shorter time needed for activating of material.

Uses

Activated carbon can be put to a range of uses, including the purification, concentration and separation of gases from liquids, purifying drinking water, wastewater and sewage treatment as well as controlling emissions. They also have further applications in the food, chemical and pharmaceutical industries.

The properties of activated carbon allow it to remove undesirable impurities from a fluid. This works because carbon preferentially adsorbs the impurity onto its large internal surface within the pore structure. The pore sizes are usually characterised as follows:

- micropores <2nm
- mesopore between 2-50 nm
- macropores >50nm (typical 50 to 200nm)

The type of product & different pore size distribution influences the performance properties of the activated carbon. For example, coconut activated carbons have a predominance of pores in the micropore range. Such structure is ideal for adsorption of small molecules. On the other hand, chemical activated wood-based carbon has predominance in the macropore range which is ideal for adsorption of large molecules like colour bodies.

The atoms of carbon comprising the large internal surface area of activated carbon present attractive forces outward from the surface. These very short-range forces, known as Van der Waals forces, attract the molecules of the surrounding gas or liquid. The combination of these attractive forces and those of molecules in the surrounding medium result in adsorption of molecules at the surface of the activated carbon. Some molecules have structures which make them more easily adsorbed than others and it is due to this that separation of molecules is achieved. The force fields within the pore structure of the carbon depend on their size and shape.

Activated carbon attracts and holds organic chemicals from vapor and liquid streams cleaning them of unwanted chemicals. It does not have a great capacity for these chemicals but is very cost effective for treating large volumes of air or water to remove dilute concentrations of contamination. For a better perspective, when individuals ingest chemicals or are experiencing food poisoning, they are instructed to drink a small amount of activated carbon to soak up and remove the poisons.

Organic chemicals are attracted to carbon the best. Very few inorganic chemicals will be removed by carbon. The molecular weight, polarity, solubility in water, temperature of the fluid stream and concentration in the stream are all factors that affect the capacity of the carbon for the material to be removed.

Applications

Activated carbon is used in gas purification, decaffeination, gold purification, metal extraction, water purification, medicine, sewage treatment, air filters in gas masks and respirators, filters in compressed air and many other applications. Activated Carbon is liable to heat slowly and ignite spontaneously in air. This makes activated carbon unfit for use with edible liquids but fit for clarification of non-edible products. Opinion of an analytical chemist should be obtained as to alternative uses.

Major industrial application of activated carbon is in the metal finishing industry. It is very widely employed for purification of electroplating solutions. For example, it is a main purification technique for removing organic impurities from bright nickel-plating solutions

Storage

Activated carbons should be protected from moisture (to maintain the technical properties of the product) and away from solvents (possibility of adsorption of their fumes/vapours by activated carbon) and powerful oxidants.

Incompatible materials to be avoided are liquid oxygen, ozone and powerful oxidants which can lead to rapid combustion.

For storage, large flexible bulk containers, paper bags, aluminium or steel body for road tankers are recommended.

Packaging

The IMDG Code defines what packaging can be used for Charcoal / Carbon classified as dangerous goods. This is currently set out in Part 4 of the IMDG Code, Chapters 4.1, for UN number 1361, UN number 1362 and UN number 3088. Packaging should be water resistant & able to withstand normal transit perils without exposing cargo.

Activated carbon can be packed in paper bags, HDPE bags, Poly bags, Jumbo bags, Plastic drums & carboys. It can also be packed in metal drums. There should be minimum of 14 days of pre-cooling of

activated carbon, prior to packaging.

Transport

Activated carbon is categorised as dangerous goods. Dangerous substances are classified according to their main characteristics and properties into 9 classes of the IMDG Code (International Maritime Dangerous Goods Code). Some substances have properties fitting them for inclusion in more than one Class: these have been placed in the class appropriate to the most dangerous property when carried on ships.

IMDG Class	UN Number	Description
Class 4.2	UN 1361	CARBON animal or vegetable origin
Class 4.2	UN 1362	CARBON, ACTIVATED
Class 4.2	UN 3088	SELF-HEATING SOLID, N.O.S (technical name: Charcoal)

Some activated carbons, even if they are not classified as Dangerous Substances, exist in a powder form. Therefore, breathing this dust should be avoided, as well as contact with skin and eyes, formation and spread of dust in the air. To crush the product is strongly inadvisable. Furthermore, activated carbons absorbs oxygen from air, reducing oxygen available for breathing, so confined spaces should not be entered unless they are adequately ventilated.

Activated carbon is mostly shipped in ordinary shipping containers. The spontaneous combustion of Carbon may cause a fire in a container. Just like coal, Carbon is considered to be a self-heating substance & the self-heating reaction may result in extensive heat development and fire.

The most combustible matter in the Charcoal is Carbon and when stored in an environment containing oxygen, slowly oxidizes to form carbon dioxide and carbon monoxide. This reaction produces heat and since Charcoal is a relatively good thermal insulator, it traps the heat, increasing both the temperature and rate

of oxidation, which in turn gives rise to self-ignition. Such a process is further accelerated by wetting.

To verify whether Carbon offered is subject to the provisions of the IMDG Code, it is of the utmost importance that the product presented to be loaded has been correctly sampled by trained staff from a laboratory accredited by the competent authority and has passed the self-heating test. The test certificate is to be provided by the shipper and is required to accompany the shipment. Non-declaration of Carbon can lead to unsafe stowage and hence increases the risk of fire, leading to potential loss of life, assets and damage to the environment.

It is strongly recommended under these guidelines that Charcoal / Carbon not subject to the provisions of the IMDG Code (under IMDG Code Special Provision 925) should meet the requirements for container selection, packaging, stuffing, inspection, stowage and segregation set out in guidelines below for Charcoal / Carbon that is classified as dangerous goods.

Container Selection

The type of container and size selection should be based on the principle of maximum filling to reduce the free space in the container and thus reduce the air (oxygen) in the container. Containers should also be in a good condition and clean.

Container Stuffing

It is recommended to fill the container to the maximum amount permitted in order to reduce the free space in the container and thus reduce the volume of air (oxygen). Air circulation should be reduced as much as possible. The cargo should be properly stowed and secured. However, packing should take account of the weight of the bags so as not to cause those at the bottom to be crushed or to split. The temperature of cargo prior to stuffing should not be more than 5°C above the ambient temperature.

Note: No (packaged) dangerous goods shall be taken on board any ship to which these Rules apply for carriage in that ship unless the shipper of the goods has furnished the shipowner or master of the ship with a dangerous goods declaration. Such declaration shall indicate with the correct technical name, the identity of the goods and the United Nations number (whenever such a number exists) and shall indicate to which of the classes the goods belong.

Risk Factors

Steam activated carbon is not classified as a dangerous cargo, whereas chemically activated carbon is listed as UN Number: 1362; Class 4.2, S2, PGIII. In the IMDG and IATA regulations, both types of activated carbons are listed as UN Number: 1362; Class 4.2, S2, PGIII. In simple words, where carbon is not made by the steam activation process, it is subject to the provisions of the IMDG Code and should carry spontaneously combustible label.

PHOTOS OF THE MONTH

BACK-TO-BASICS

QUESTION OF THE MONTH

Assured is importing a machinery from Germany to Mumbai. The coverage under the policy is INSTITUTE CARGO CLAUSES (A) + War + SRCC. During the course of the voyage, there was leakage and spillage of hazardous chemicals in some containers, onboard the vessel, due to which the voyage is frustrated at a nearest port of call. The Assured has to bear extra charges which are reasonable enough for safe unloading and warehousing at the port of call. The cargo was in sound condition and then forwarded to its original destination within 30 days.

Q. Will these extra charges for unloading, warehousing at the port of call and forwarding to the original destination be payable under the scope of policy since the cargo has not suffered any damages?

Please send your replies/answers ONLY to: marine.newslink@tataaig.com

IF YOU HAVE ANY COMMENTS / FEEDBACK PLEASE SEND IT TO

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