

**THE EFFECTS OF ACTIVE CARBON ON THE INCREASE OF WATER QUALITY**

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**ABSTRACT:** Water is a component of the environment, that its quality is influenced by the health of environment. On the other side, improving environmental health is also directly related to the quality and quantity of water. A healthy water resource must be able to supply safe and sufficient water for the society [3]. For this purpose, the resources have to be under monitoring and control of health responsible regularly; so that by being aware of the presence of any potential contaminants in water, control measures should be applied. Provision of safe water and proper management of wastewaters play the major role in reducing water-related infectious diseases [5]. A set of measures on improving the environment and the health, safe and adequate water supply can reduce 40 to 100% of water related communicable diseases. In this study, the effect of active carbon, as an actual absorbent, on the elimination of turbidity, color, taste and smell has been investigated in order to improve the quality of drinking water [6]. The results of the study indicated that active carbon, as a strong absorbent with high porosities and broad lateral surface is effective to eliminate turbidity, color, and smell.

**INTRODUCTION**

Water is a component of the environment, that its quality is influenced by the health of environment. On the other side, improving environmental health is also directly related to the quality and quantity of water. A healthy water resource must be able to supply safe and sufficient water for the society. For this purpose, the resources have to be under monitoring and control of health responsible regularly; so that by being aware of the presence of any potential contaminants in water, control measures should be applied. Provision of safe water and proper management of wastewaters play the major role in reducing water-related infectious diseases. A set of measures on improving the environment and the health, safe and adequate water supply can reduce 40 to 100% of water related communicable diseases. Seemingly healthy and clear water may contain a variety of pathogenic live microorganisms and therefore we must ensure the health of water before drinking [2]. Supplying healthy and sufficient water in war zones and emergency situations is also very important; in this regard, proper selection of water resources and making necessary plans to protect water resources and distribution network as well as conducting refinery ways and disinfection methods on water as required process of refinement are among the measures of effective prevention of transferring diseases related to the water and providing the conditions for eliminating possible pathogenic factors. In fact, supplying water with less than 1 NTU turbidity and at least 0.05mg free remained chlorine for drinking and sanitary uses are effective factors on the health of people in every situation [4].

**Problem Statement**

Reference to water treatment methods in medical documents of the past times is indicative of the fact that there is a direct relationship between cleanliness of water and human health. Hippocrates who is considered as the father of medical science says: the person who intends to competently investigate and search in medicine must consider the water consumed by residents of an area since water is of high importance in humans' health. Historical resources and images obtained show that since 2000 B.C. water treatment for drinking has been common [7].

For water treatment, the Chinese would boil water. In Sanskrit (ancient language of Indians) and ancient Greek texts that date back to 2000 B.C., water treatment methods have been explained. At the time people knew that heating water leads to its purification; they also used sand and granular filters for water treatment. The images on the walls of the tomb of Ramses II show that in 1500 B.C. Egyptians used the Coagulation method (a chemical method that leads to enlargement of the suspended particles and to settlement, by adding different chemicals to water) for water treatment. By adding Aluminum sulfate to water, they separated a huge amount of the solute through settlement. Also by means of wick siphons that transferred water from one container to another one, Egyptians would separate suspended impurities in water. These practices have also been depicted in the paintings of Egyptians that date back to 1300 B.C. By constructing sand ponds in the course of canals that supplied the city water, Romans would separate suspended particles in water. In Venice which is located on an island with no fresh water source. Water from rainfall was directed into the city water storages through yards and roofs and also passed through sand filters in its path. The first type of these water storages was constructed in approximately 500 A.D. for water supply for private and public use. In Iran, Hippocrates realized about 400 B.C. that water can carry disease agents transmitted by water, and proposed that boiling and fabric filters be used in order to make water safe for drinking. Jabir ibn Hayyan, the Iranian chemist, used distillation for his laboratory use, which is in fact the laboratory sample of one of the public water treatment methods. Geographic conditions of Iran and availability of fresh and healthy water might be one of the reasons why Iranians haven't broadly used water treatment systems since attention to healthy water and not contaminating it, which needs identification of kinds of diseases resulting from water pollutions, is one of the teachings of Zarathustra, the ancient Iranian prophet. The remains of the urban centralized sewage system at the time of the Achaemenids which have been found in excavations of the recent years indicate the ancient Iranians' mastery over water and in some regions even the traditional methods of water treatment might have been used. These ideas regarding water treatment are the basis and foundation of settlement, disinfection and smoothing today which are considered as three main phases of water treatment [11]. Today, water treatment has become more efficient for removal of pathogens and harmful chemicals and specifically disinfection and smoothing draw a lot of attention. Disinfection has changed from the simple chlorination method to the methods of disinfection with chlorine dioxide, ozone or disinfection with ultraviolet light. Smoothing is also changing from the conventional smoothing method of sand and rapid smoothing with high loading to the membrane smoothing. City of Paisley in Scotland is the first city the total water supply of which was treated in the early nineteenth century. Water treatment system was comprised of sedimentation operations following which filtration was conducted as well. Water treatment was gradually spread throughout Europe such that toward the end of the nineteenth century most major resources of city water were filtered (these filtered were of the low sand type).

Development of water treatment in the U.S. took place after Europe. The first attempt for filtration was conducted in the city of Richmond in the state of Virginia in 1932 but the project failed and it took several years for another attempt to be made in this regard. After the end of civil wars, other attempts were made for modeling from the European filtration method but few of them succeeded since the nature of suspended solids in rivers of Europe clearly differed from that of the U.S. and the low process of sand filtration couldn't be effective and thus rapid sand filters (under pressure) which were hydraulically cleaned were constructed late in the 19<sup>th</sup> century which led to the higher efficiency of the water treatment process, Discovery of the properties of filtration in the last quarter of the 19<sup>th</sup> century led to the construction and development of different filtration units throughout Europe and the U.S. such that late in the century filtration was counted as the main factor of prevention from diseases of aquatic origin. Acceptance of the microbial theory of disease transmission led to the disinfection operations on the community water supply. Primarily disinfection was temporarily conducted in specific cases by means of the bleaching powder and hypochlorite. The first unit that permanently chlorinated water was launched in Belgium in 1902. Liquid chlorine production primarily commenced in 1909 for water disinfection and in Philadelphia in 1913 for the first time for water disinfection other consumables for infection such as ozone were developed but their consumption didn't become widespread. Disinfection and broad use of chlorine in water supply resources led to a reduction in the great rate of mortality resulting from diseases of aquatic origin. Other processes of water treatment developed with less speed and expansion. Coagulation associated with rapid sand filters (under pressure) developed in the U.S. under the title of complementary settlement process. Softening of hard waters was conducted in the nineteenth century in Europe but it didn't develop until the beginning of the twentieth century for public water supply; also the capacity of coal for separation of dissolved organic matters in experiments related to filtration was considered early in the 19<sup>th</sup> century but wasn't used for public water supply. Amendment of this matter and changing it into activated carbon along with its use in water treatment units were conducted in the recent years. In the twentieth century desalination with high capacity was developed and by construction of semi permeable membranes and emergence of the reverse osmosis method in the U.S. within few years this industry prevailed such that at the present the Persian Gulf States have more than 30% of the capacity to produce world's fresh water.

Based on the standards, until 1974 quality of drinking water in the U.S. was controlled by The U.S. Department of Public Health Service (PHS) and based on the water quality standards of 1962; these standards first developed in 1914 and were revised in the years 1925 and 1962. Only 18 pollutants were regulated and the regulations were applicable only in the considered interstate sections. Other resources of public water supply used these regulations exclusively as guidelines in order to control the quality of the drinking water.

### **Preserving the Quality of Water Resources**

The issue of preserving the quality of water is more important than its quantity. In fact, each part of the distribution network is a small section of a large collection and if the pipes or storages are contaminated for different reasons such as corrosion, they decrease the quality of water and lead to dissatisfaction among consumers. In a water transmission and distribution system the goal is to provide consumers with healthy, constant and high quality water flow. To access this, the qualitative state of water must be regularly sampled and analyzed; also, another important factor is the quantitative measures of water; for this purpose, stability strips are used. On the paper of these stabilities that is divided into the two green and red sections the pen is moving per unit time. The axis of Xs on this paper shows 24 hours in time and the axis of Ys determined the level of water volume in the tank [4].

When the stability pen is moving within the green boundary, it shows that the stored water available in the tank is more than the consumption rate and when the pen is moving in the red boundary, it shows that the consumption rate is more than the amount of water entering the tank; in this state, by turning on the strong pressure pumps, the stored water available in the tank is provided. If the stability pen goes beyond the green boundary, it means that the amount of water pumped into the tank is more than the consumption rate; as a result, due to an increase of water height in the additional storage water overflows the tank. As the consumption amount differs in different hours of the day this amount can also change in different months of the year; thus, the operator responsible for preserving by constant protection of the system provides system such that the consumer's need is provided throughout the day. One of the very important factors in water consumption is seasonal changes and difference in temperature; for instance, in summer many residential units use treated water resources for irrigation of their green spaces and in such cases the consumption level is 100% increased compared with other seasons; also, in warm seasons of the year the consumption rate of cooling systems and the amount of water for showering and washing increase. In these cases, the design of the volume of storages must be such that it can be responsive to this additional amount of consumption. In the cold seasons of the year due to a reduction in consumption, the amount of water turbulence in tanks decreases and when the volume of tanks is designed as very big due to stagnation of water in the tank, freeze is created. This will increase the possibility of cracking of walls of destruction of tanks. In these cases by installing a water circulation system in the tank the possibility of freeze of the water level in that is decreased. Due to the increase in consumption and lack of possibility of water provision by the provider resources in some cases we need to exert limitations for the consumers. The intensity of these limitations is regulated in accordance with the shortage rate of water in the tanks. The incidence of fractures in the pipelines focuses on the importance of preserving the constant quality of water. Usually, at the time of water storage in the tanks its quality is decreased; therefore, the water retention time in the tanks has a special importance and accurate designing of the required water volume helps to the preservation and quality of these resources [6].

### **Components Constituting Ground Waters and their Relations Regarding Drinking**

The standardized methods of most analysis techniques for diagnosis of quality of water have been stated in detail in "standard methods for water and waste water" (American association of public health and their colleagues, 1971). Concentration of an ion with a certain ion is usually stated in mg/L or in ppm. For low concentrations, ppm and mg/L are basically equal but for high concentrations mg/L will be more than ppm. For example, If one liter of salt solution contains 0/9 kg water and 0/2 kg salt, the salt concentration will be 200/000 mg/l and in 181818 ppm. Other properties of water such as color, turbidity, pH and electrical conduction are stated in special units.

#### **Total Dissolvent Solids (TDS)**

The TDS or total concentration of ground waters varies from 100 to more than 100/000 mg/L. Mostly, amount of TDS is stated in water electrical conduction coefficient which is usually in milimos/cm and in 25 degrees centigrade. The relationship between conduction coefficient and TDS follows the specific ions existing in the dissolvent. For irrigation water and most other natural waters, one milimos is usually considered as 40 mg/l. Ground waters are divided as below based on the amount of available TDS:

<1000 mg/l fresh  
 3000-10000 mg/l partly salty  
 10000-100000 ppm very salty  
 >35000 mg/l salt water

When compared, the TDS level of sea water is recommended as 34000 mg/l and from that NaCl solvent the saturation as more than 300000 mg/l, the maximum limit of the TDS level of drinking water as 500 mg/l but when no other water is available, a concentration twice or three times more than the amount above is used.

### Calcium

Calcium is one of the main cations in ground waters. The sources providing water calcium include the firey stone minerals such as slicots, piroksens, amphibols and silicotte mineral in metamorphism. As the solvability of these minerals is low the water obtained from the fiery and metamorphic stones will have low levels of calcium and TDS. In sedimentary stone calcium is found in the form of carbonate (calcium and aragonite), magnesium calcium carbonate (dolomite), calsiel (ahak stone) and calcium sophate (chalk stone and anidrit). Some calcium phloorite may also be available. Calcium carbonate is one of the main factors of cohesion of stone sand and varizeh stones. The calcium resources in abrafto materials and other unstrengthened material are mostly the existence of different minerals in stone and components of soil in sediments.

### Magnesium

The magnesium available in ground waters obtained from firy stones are basically attained from ferromagnesian mines such as alivins, amphibules and dark-colored mikas. In metamorphic stones and other destructive stones, magnesium is found in mines such as colerite, monmorionit and serpentin. In sedimentation stones, magnesium is found in the form of magnesia and other carbonates, sometimes mixed with calcium carbonate. Dolomite includes calcium and magnesium equally. Most ground waters include rather low measures of Mg except on occasions when these measures are in contact with dolomite (almost equal Ca and Mg measures) or with rich evaporative stones of Mg that cause Mg to be the dominant Cation in ground waters.

### Sodium

Mostly sodium is obtained from pholdspots available in firey stones and the productions of their disintegration practice (soil minerals) in other materials. Soil schist layers usually yield water which has a great amount of sodium. Other resources of sodium include the washing water and the depth sedimentation water from the top layers of soil (includes atmosphere fallings which have been exposed to effects of concentration) and contamination of ground waters by surrounded salt water or water having sea origin. Salt waters that are usually found in great depths have a great amount of sodium.

### Potassium

In firy stones, potassium exists less than usual amount but in sedimentary stones it is abundant in the form of potassium pholspots. However, these minerals have a low solvability such that the level of potassium concentration in ground waters is very lower than that of the sodium concentration [5].

### Estransim

Chemical properties of estransim are similar to calcium and usually ground waters have stransim less than 10 mg/l but the concentration above 50 mg/l is also observed.

### Iron

Iron is widely found in the ground layer. In minerals such as amphibules, piroksens, biotit, manitit and Alvin it is found. Pitriet is the usual form of iron in sedimentary materials while on the other hand iron oxides and hydroxides are the most important minerals containing iron. The usual form of iron in ground waters is the frori ion of  $Fe^{2+}$  solvent. The concentration changes are usually between 1 to 10 mg/l. When  $Fe^{2+}$  is exposed to the air it is oxidized and produces the  $Fe^{2+}$ frick state which is non-solvent and is settled in the form of frikhidraulized and leads to the brown color of water and clear brown spots in the washed container and cloths. The corrosion of the will pipes and other pipes increases the amount of iron available in the well water. Bacterial activity can increase or decrease the iron in ground waters. The maximum iron concentration for drinking water is recommended as 0/3 mg/L and this amount is basically in relationship with the taste and prevention from generation of spots in water pipes and washed clothes.

### Manganez

Biotit and horon bland are considered as minerals containing manganez and firy stones. The manganeocides and hiraxides are usual sources of manganez in stone and soil. Two-capacity ions are the  $Mn^{2+}$  solvent and exist in most ground waters with a concentration lower than the concentration of  $Fe^{2+}$ . When  $Mn^{2+}$  is exposed in the air it is occidedandchanged into hydrate oxideswhich is low solvent and forms black spots in water pipes and washed clothes. For this reason, the maximum concentration of manganez for drinking water resources is determined as 0/05 mg/l.

### Aluminum

Aluminum is the third abundant element in the external layer of earth; however, ground waters rarely have more than 0/5 mg/l of Aluminum expect the time when pH is lower than 4 in which case Aluminum is solved in these waters.



### **Carbonate and bicarbonate**

The source of carbonate and bicarbonate refers to CO<sub>2</sub> of atmosphere. CO<sub>2</sub> of atmosphere produced by redundant matters of soil or by the decreasing activity of sulfate or other bacteria in deep formations and carbonate stones and different minerals of sodium carbonate are gathered in closed ponds in the form of evaporative stones, and causes the concentration level of carbonate in ground waters which are in contact with that pond to increase. In ground waters, bicarbonate with a concentration more than 200 mg/l is not unusual and when CO<sub>2</sub> is produced inside the water-containing layer, the carbonate concentration in ground waters is usually lower than 10 mg/l.

### **Chloride**

The main source of chloride in ground waters is evaporative stones, salt kept water and sea water. Fiery stone materials provide a lower portion of the chloride, the ground waters that have a considerable chloride also have a great amount of sodium and this implies its contact with water of sea origin. Chloride washing which is gathered in the top layers of soil may be the important source of chloride in dry regions. Maximum chloride concentration in the drinking water is recommended as 250 mg/l which is mostly due to its taste.

### **Silis**

Silis is the second most abundant element (after oxygen) in the ground external layer the highest sodium concentration in ground waters is found when this water is in contact with some volcanic stones. The amount of silicium which is stated in mg/l is stated as SiO<sub>2</sub>, is 20 mg/l for most ground waters.

### **Sulfate**

Sulfate is obtained from peperit oxidation and other sulfates that are in distributed in great amounts in fiery and sedimentary stones. The most important sulfate sediments are found in sediments of evaporative stones (zhips, anidrit, sodium sulfate). In dry regions the sulfate washing from the top layers of sil which are considerable, is considered as the main anion sulfate of ground waters. The sulfate concentration in drinking water must not be more than 250 mg/l since the water taste becomes bitter and created a state of slowness in higher concentrations.

### **Fluor**

In ground waters the source of Fluor is minerals such as calcium fluorite (fluorite), apatit, some criolit amphiboles (in fiery stones) and Fluor spar (in sedimentary stones). Ground waters mostly have more than 1 mg/l of Fluor. Sometimes the concentration of Fluor is more than 10 mg/l and even reaches more than 30 mg/l. These high concentrations are formed along with increasing of pH. Existence of the amount of Fluor in drinking water is useful since it prevents from tooth destruction. However, increase of fluor on the teeth creates spots (flotorzis); therefore, the maximum Fluor in drinking water is recommended between 1/4 to 2/4 mg/l.

### **Phosphorus**

Usually the minerals include apatite phosphorus which has a low solvability. Therefore, the phosphorus concentrations in the form of ground waters are less than 0.1 mg/l [10].

### **Bohr**

One of the minerals including Bohr that is scattered in most places is turmalin. Bohric acid and Fluor and Bohr also may come back to the Bohr ground by means of issued volcanic gases and by the rain; therefore, ground waters obtained from volcanic and geothermal regions have a rather high concentration of Bohr (several mg/l or more). The same state is the case regarding the waters that are in contact with evaporative stones. Other ground waters usually have Bohr lower than 0.5 mg/l. For this reason, the irrigation water must have lower than 0.5 to 1 mg/l in relation to the plant and the soil [9].

### **Quality of Water**

Sometimes the matters that are dissolved in water give it medical properties while in some cases dissolution of various objects renders water as inconsumable and it can even cause the water to become corrosive such that it causes corrosion on glass and metal pipes. The type and amount of the solutions of the water resources vary and in changes regarding their quality the water consumption must be focused since in various cases the water solution and their allowed amount differ and depend on the water consumption; for instance, the water that is consumed for preparation of carbonated beverages must lack iron and manganese since otherwise it will induce a change in the quality of their taste. These waters must have a turbidity of less than one, lack color and smell and organic materials. Also, the chemicals of the treated water must be in such a balance that sedimentation or turbidity is not produced and its alkalinity level doesn't exceed 100 mg/l per Calcium Carbonate and the water hardness is less than 200 mg/l per Calcium Carbonate. The water that is produced in beer production industries must have a constant pH about 7 and its Sodium Chloride must be lower than 250 mg/l per Chloride. Also, its Sodium Bicarbonate and Carbonate hardness must be low and if its Calcium Sulfate is more compared with other waters, it is effective. The level of turbidity, hardness, color, iron and manganese of the water which is used in textile industry must be about zero; otherwise, colors change and mostly some spots are produced; in addition, the alkalinity of water must be low. The water that is consumed in washing clothes must be light and without iron and manganese. Presence of iron and manganese produces spots on the washed cloths. The water that is used for provision of food must be completely pure in terms of hygiene and the level of solutions must be low in that. In many industries, water is consumed as a cooling factor [14].

The temperature of this water should be low; also it should be completely devoid of sludge, combined materials and algae. The water that is used in steam boilers must be clear, light, and devoid of oxygen, carbonic anhydride, free acids and organic components. Total hardness for conventional boilers must not exceed an amount of 35 mg/l per Calcium Carbonate but for steam boilers that operate under pressure, total hardness must be at least close to zero. The water that is used in tannery must be completely devoid of iron and also its Calcareous salts must be low so as not to produce dyes and insoluble materials. The water that is consumed in dyeing must be clear, colorless, without iron and also its soluble must be low, and the water that is deployed in paint factories must have a constant level of PH.

### **Activated Carbon and Treatment through that**

Many liquid and gas materials have unwanted and impure measures. Some materials of these impurities include microbes, bacteria and toxins and pollutants, taste and smell, etc[8]. Activated carbon is a type of strong absorbent with an extraordinary surface adsorption, and it can't be resolved in any know solvent and its most prominent feature is the selective removal of contaminants and it is used in some cases and for recycling of materials as well.

### **Adsorption**

Adsorption refers to the obtaining or gathering of materials (absorbed material) on the surface of the absorbing material (absorbents). The most common absorbent material is activated carbon and the taste and smell generating matters that t omits are absorbed materials. Activated carob removes a large number of generating matters of taste and smell. Treatment with activated carbon and coagulation are two instances of the common methods of absorption in water treatment.

### **Adsorption by means of the activated carbon**

This method is the main method of treatment for removal of taste and smell, fugitive organic components and artificial organic chemical components (pesticides). For a long time improvement of the water taste was recognized through smoothing by the wood coal. Coal filters were used since 1883 for improvement of the water taste. In most regions where filters are used the activated carbon is used as well. In water treatment two forms of the activated carbon i.e. activated carbon powder and activated carbon granule are used [5]. Selection of the proper form for use in water treatment depends on the quality of the source water and the design method of the treatment center. Activated carbon is one of the wood products that is created by burning the plant materials for formation of coal. Its production is conducted by means of the two carbonation and oxidation processes (activation). In the carbonation process, wood materials are burnt for formation of coal in a temperature of 550-700 degrees centigrade and in the absence of air. In the activation process and burning of the coal at the temperature of 800-900 degrees centigrade and in the presence of vapor and carbon dioxide it is continued so that pores and cracks are formed inside and on the surface of the particles. Pores and cracks greatly increase the adsorption and thereby activate the absorption process. The activated coal is powdered for production of powder of activated carbon (PAC) and for production of granule of activated carbon (GAC) it is crushed into the form of granule. It is estimated that one pound (450 g) of the granule of activated carbon has a level between 810000-225000 square meters (9-2/5 million of square foot).

### **Powder of Activated Carbon (PAC)**

The size of the PAC particles is between 10-74 micrometers; when the particles are smaller the absorption rate will increase. The PAC density is also between 0/36-0/74 g/cm<sup>3</sup> and is provided in the form of a mass amount and in powdered form. The powder is mixed with water inside the tank which is mostly mixed in the 1 lb/gal degree so that doghab is created. For injection it must be preserved in the form of doghab. The obtained doghab is used by emans of a volume evaluator and injection system. In order to conduct effective treatment doghab is added to water in several zones which starts from abgir and can be added up to the entering flow zone into the filter. Selection of these points for adding doghab depends on the quality of water and design method of treatment center. This process is such that after use, the redundant materials are produced and re-used; therefore, after a proper contact the redundant materials must be settled in the settlement pond; besides being a good absorbent, activated carbon is also a reviving factor since it is also combined with disinfectors such as chloride, amin chlorides, chloride dioxide and ozone. Activated carbon neutralizes these compounds and therefore causes the required rate of disinfection to increase; thus, activated carbon and disinfectors must never be used at once. In order to provide the proper contact time and prevention from their interference in disinfectors, mostly activated carbon is added into the flow entering the preliminary settlement ponds and flow entering the final settlement pond. Other user points of it include rapid combination pond, coagulation, and the flow entering the primary settlement pond. It is also used in the floe entering the smoothing processes of rizdaneh and great smoothing of rizdaneh. In addition to the effect of activated carbon being decreased by disinfectors, its effectiveness in the existence of surplus amounts of calcium carbonate in water (like hardened destabilized water) is also reduced. In this state, calcium carbonate covers the carbon particles and blocks the absorption places. In order to prevent from the emergence of a problem due to calcium carbonate the carbon is used after the re-carbonation process of the lighted water.

### Removal of pesticides

Treatment with the activated carbon is the only treatment method effective for removal of pesticides such as atrazin and other artificial organic chemical compounds of water and based on the view of EPA, GAC is the best technology available for removal of fugitive and artificial organic materials from water. Using the 12-18 mg/l dose, the amount of atrazin can be reduced from 8-9 ppb (g/lm) to the amount of 3 ppb (MCL or maximum level of atrazin concentration). Other qualitative properties of water must be good and also water must have a good taste as well. Drinking a glass of water must be also pleasurable besides being a need [7].

**Table-1: The different methods of water treatment have been compared with one another**

Soluble and non-soluble materials in water	RO method	Distillation	UV method	Ionic exchange method	Active carbon method
Chlorine	100% removal	Partial removal	Doesn't remove	Doesn't remove	100% removal
Virus	100% removal	100% removal	100% removal	Doesn't remove	Doesn't remove
Bacteria	100% removal	100% removal	100% removal	Doesn't remove	Partial removal
Taste and smell	100% removal	Doesn't remove	Doesn't remove	Doesn't remove	100% removal
Pesticides pests	100% removal	100% removal	Doesn't remove	Doesn't remove	100% removal
Chemicals	100% removal	Partial removal	Doesn't remove	Doesn't remove	100% removal
Nitrate	100% removal	96 to 99% removal	Doesn't remove	Partial removal	Doesn't remove
Arsenic	96 to 99% removal	96 to 99% removal	Doesn't remove	96 to 99% removal	Doesn't remove
Radioactive materials	96 to 99% removal	100% removal	Doesn't remove	100% removal	Doesn't remove
Lead	96 to 99% removal	100% removal	Doesn't remove	96 to 99% removal	Doesn't remove
Sodium	96 to 99% removal	100% removal	Doesn't remove	96 to 99% removal	Doesn't remove
Aluminum	96 to 99% removal	100% removal	Doesn't remove	96 to 99% removal	Doesn't remove
Sulfate	96 to 99% removal	100% removal	Doesn't remove	96 to 99% removal	Doesn't remove
Phosphor	96 to 99% removal	100% removal	Doesn't remove	96 to 99% removal	Doesn't remove
Chloroform	100% removal	Partial removal	Doesn't remove	Doesn't remove	100% removal
Potassium	96 to 99% removal	100% removal	Doesn't remove	100% removal	Doesn't remove
Magnesium	96 to 99% removal	100% removal	Doesn't remove	96 to 99% removal	100% removal
Cadmium	96 to 99% removal	96 to 99% removal	Doesn't remove	96 to 99% removal	Doesn't remove

### Granules of Activated Carbon (GAC)

This method is used in constant treatment that is, when it is necessary that volatile and artificial organic components be constantly removed and the taste and smell that are sometimes emerged be controlled. GAC is used as multi-platform carbon filters or single-platform contactors. GAC carries out both the smoothing and also the adsorption operations. The reaction zone is located in 2/5-15 cm (5-6 in) top depth of the carbon layer; thus, the minimum depth required for the platform is 30 cm (12 in). For maximum effectiveness the depth of 60 cm (2 ft) is recommended. The retention time for doing the proper absorption is at least 3 to 4 minutes. The effective proper size of the particles is between 0/35-0/45 mm (although particles with the effective size between 0/55-0/75 mm and even between 0/85-1/05 mm exist as well).

If the GAC neutralizes every disinfectant available on the surface in this case the bacteria can grow and develop in the internal part of particles and the filter platform. In order to prevent from bacterial growth a single dose of 2 mg/l of the free chlorine remaining is added to the water used for reverse washing. After GAC is consumed (i.e. the absorption zones are completely used), the adsorbed materials are freed again and this freeing process is called *vajazb*. In this state, GAC needs revival. Revival of GAC is similar to its production. To revive GAC the platform is excluded from inside the filter and is dried at the temperature of 100 degrees centigrade and is pyrolyzed (heating analysis) at the temperature between 650-670 degrees centigrade and then it is re-activated in the temperature between 870-880 degrees centigrade and in the presence of vapor. Treatment with GAC is much more costly than treatment with PAC since GAC requires revival and also requires a primary cost for construction of contactors; additionally. The application points of GAC such as PAC don't have flexibility and they can't be used in every point. Based on the reasons mentioned, most treatment centers mostly use PAC for treatment.

### **Water Treatment and the Role of Carbon Filters**

Carbon filters are widely used in water treatment systems. The activated carbon used in these filters has a high capability in removing unpleasant smell and taste and also removing the residual chlorine in drinking water. Removal of many chemicals dissolved in water and also the gases dissolved in water is conducted via carbon filters but carbon filters have no part in removing total dissolved solids (TDS) in water which is the same as the weight of water and also in removing the detrimental hardness of water or heavy metals. Activated carbon which is used in the water treatment process is constituted by thermal operations conducted on matters whose main element is carbon and on whose surface there are millions of small microscopic vents, cracks and holes. If we take a look at the surface of activated carbon by microscope, we will observe a surface like that of the pumice. These pores and holes on the surface of the activated carbon cause the contact surface of the carbon filter with water to increase such that half a kilo of activated carbon will provide a surface equivalent to 63 to 253 hectares. These microscopic pores will act as a trap for large organic molecules and small organic molecules will also be attracted to the surface of carbon [3].

The ability of activated carbon to remove some microorganisms and organic chemicals specifically pesticides, trihalomethanes (THMs) that are byproducts of chlorination, trichloroethylene (TCE) and PCB depends on different factors such as type and amount of carbon, filter design, amount of water flow, duration of filter use and type of impurities existing in the water.

### **CONCLUSION**

Water is a component of the environment, that its quality is influenced by the health of environment. On the other side, improving environmental health is also directly related to the quality and quantity of water. A healthy water resource must be able to supply safe and sufficient water for the society. For this purpose, the resources have to be under monitoring and control of health responsible regularly; so that by being aware of the presence of any potential contaminants in water, control measures should be applied. Provision of safe water and proper management of wastewaters play the major role in reducing water-related infectious diseases. A set of measures on improving the environment and the health, safe and adequate water supply can reduce 40 to 100% of water related communicable diseases. In this study, the effect of active carbon, as an actual adsorbent, on the elimination of turbidity, color, taste and smell has been investigated in order to improve the quality of drinking water. The results of the study indicated that active carbon, as a strong adsorbent with high porosities and broad lateral surface is effective to eliminate turbidity, color, and smell.

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