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Domestic Water Filtration Systems

Fabrication of Purification Filter GAC

The jury composed of:

....	University	President
....	University…	Reporter
....	University … ……….	Examiner

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Par : ZAHEM Aymen

SADALLAH Merouane

Intitulé

Systèmes de filtration d'eau domestique

Fabrication de filtre de purification GAC

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Soutenu devant le jury composé de :

Nom et prénom Enseignant	Université …………..	Président
………………………………	Université … ……….	Rapporteur
………………………………	Université … ……….	Examinateur

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Dedications

I dedicate this Work To my dear parents, my Father Alarabi, and my mother Nora for their patience, their love, their support

To my dear sister Hadjer for her encouragement

To my dear sister Romisa for her support

To my dear brother: salah for his encouragement and support

To my dear brother: Alaa for his encouragement

To my partner, Aymen who shared with me the good and the hard times

To my all friends in particular: Rabie. Oussama. Yakoub

To all my friends from the hydraulic Specialty

Merouane

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We thank God Almighty for giving us the will and courage to do this work. We would like to warmly thank our supervisors Professor **M. Dougha**

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Finally, we thank everyone who contributed to Develop this work

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General Introduction

General Introduction

Water is very important to a person. We can live for a while without food, but we cannot live without water, about 70% of the water in our body. We care about the quality of our drinking water. The concept of drinking is directly linked to human nutrition. Natural water is said to be drinkable if it has the following properties:

- Freshness and clarity
- Lack of odor and color
- Delicate taste
- Delicate and well ventilated
- Responsible mineralization
- Lack of organic matter and pathogens

In recent years, consumers have worried about the quality of tap water due to water pollution issues published in the media and due to perceptual factors, apparent turbidity and prevalence of taste, colors and odors (diffuse chlorine odor). These perceptual factors (color, flavor, turbidity and odor) often warn against contamination undoubtedly posing a risk to health, and these factors can be observed by any citizen.

These problems prompted people to seek solutions. Some people tend to buy bottled mineral water, and it is too expensive for most people. There were also water tankers selling spring water which provided good low cost and affordable service. In the same context, home water purification systems have appeared on the market that use multiple filters to purify water. The membrane filter reduces particles such as dirt, dust and rust. The activated carbon filter reduces volatile organic compounds, chlorine and other pollutants that give water an unpleasant taste or smell. The reverse osmosis system removes many dissolved solids (dissolved solids). These systems can be expensive, but they are a simple solution and have been shown to be effective in purifying tap water and removing pollutants and sensory factors.

Adsorption technology is the most convenient way to remove unwanted odors and tastes from water. The use of activated carbon as an absorbent has been considered one of the most effective solutions for water purification for many years due to its composition. it is characterized by a very high porosity, a large specific surface and a high absorption capacity.

Activated charcoal can be used in many forms, including granular, powdered, or bulk. Granular activated carbon is the most efficient form of carbon for water purification and the least expensive to produce.

It's important to understand the different techniques of water purification and to study water filters in this study. In the first chapter we will give an overview of water quality, and in the second chapter we will try to focus on the study of the household water purification system and the filters it contains and understanding of their operation. In the third chapter, we will study carbon, its method of activation and its properties, and we will understand the phenomenon of adsorption.

In the last chapter which summarizes the experimental work, we will try to simulate a commercial granular activated carbon filter and to create an analogue of it, and to make the comparison between the activated carbon filters (commercial and manufactured) from a performance point of view. in parallel, we will focus on the study of the parameters: the conductivity, the pH and the turbidity of the water before and after passing the filter.

I.

II. Chapter I

save drinking water

Introduction

In this chapter, we will provide an overview of the quality of water and the most important physical and chemical properties of water and identify the standards of the World Health Organization and the standards of the Algerian state in relation to water quality.

1.Save drinking water

The quality of drinking water depends on where we live, the source of raw water, water resources and exposure to pollution as water moves from its source through the distribution system to our tap, and social and economic development and rapid urbanization have negative effects on the quality of water resources, where industrial and urban pollution is observed in dams, groundwater and rivers. Water quality has deteriorated due to the country's rapid development [1].

The causes of bad tap water are due to the deterioration of the water delivery infrastructure, such as the network, main pipelines and storage tanks; The spread of the smell of chlorine as a result of the use of chlorine as a water disinfectant by the concerned authorities, and the long period of storage of water in tanks also causes undesirable odors.

Although Algeria is aware of the pollution of its water resources, there have been no clear measures at the national level, that drinking water should be colorless, odorless, free of pathogenic organisms, non-salty and free of chemical compounds that may affect human health.

Due to the poor quality of tap water, consumers often resort to using home water filters, buying bottled mineral water, or relying on trucks that sell spring water. Therefore, in order to protect public health, we need to know the quality of water in terms of physical and chemical properties. We have the technology and ability to treat water at a high level. However, due to the deterioration of the water delivery infrastructure, such as the network, main pipelines, and storage tanks, the quality of water delivered to the home may be of low quality due to cross-contamination [2].

2.Sources of Water

water supply in Algeria comes from two main resources, surface water and groundwater. Each of these resources has its own advantages and disadvantages as a source of drinking water.

2.1. Surface Water

Surface water is any water which is found flowing or standing on the surface such as river, streams, ponds, lakes and reservoir. Origin of surface water is surface runoff, direct precipitation, interflow and water table discharge

According to the National Water Resources Agency, large parts of the rivers have been contaminated with uncontrolled, untreated municipal and industrial wastewater from either poor connections or non-functioning wastewater treatment plants. Phosphorous, nitrates and pesticides have also been detected in some surface waters as a result of improper agricultural management practices [1].

2.2. Groundwater

Groundwater is the precipitation that seeps down through the soil until it reaches rock material that is saturated with water. In general, groundwater is much cheaper than surface water as it does not require construction of reservoir or long pipelines. Groundwater usually has better quality than surface water; it is usually free from suspended solids, bacteria and other pathogens, Groundwater in Algeria resources are estimated to total 7.6 BCM, according to the National Hydro Graphic Aquarium Plan to monitor water quality in the country's groundwater layers, the quality of groundwater is generally good. However, some changes occurred due to environmental factors and human activities [3], The pollution of groundwater caused by human activities is noted in the north. The large size of local and industrial sewage, which is unloaded daily in valleys, is still a real threat to groundwater sources [4].

3.Water quality

Water quality is determined by physical, chemical and microbiological properties of water. These water quality characteristics throughout the world are characterized with wide variability. Therefore, the quality of natural water sources used for different purposes should be established in terms of the specific water-quality parameters that most affect the possible use of water. That is why the aim of this chapter is to provide an overview of water quality characteristics - Physical, Chemical, Microbiological, and biological characteristics.

3.1. Organoleptic Parameters

Organoleptic factors (colour, flavour, turbidity and odour) are often factoring that warn against pollution without any doubt presenting a risk to health

3.1.1. Colour

Colour is an important aesthetic aspect of water quality. Drinking water should not have a noticeable colour. The colour change in the water is due to the suspended and dissolved particles in the water, The colour in drinking water is usually due to the presence of coloured organic matter (mainly humic acid and fulvic acid). Colour is also strongly influenced by the presence of iron and other minerals, either as natural impurities or as corrosive products. It may also result from contamination of the water source with industrial effluents and may be the first indication of a hazardous condition, Colour levels less than 15 TCU are often acceptable to consumers. (True Colour Units), there is no suggested health guideline value for colour in drinking water. [5] However, the presence of a noticeable colour of water is not acceptable to consumers, so many people resort to using active carbon filters, which have proven to be very effective in removing unwanted colours.

3.1.2. Taste and Odour

Water should be free of tastes and odours that would be objectionable to the majority   Taste and odour can originate from natural inorganic and organic chemical contaminants and biological sources or processes (e.g., aquatic microorganisms), or from contamination by synthetic chemicals, or from corrosion or as a result of water treatment (e.g., chlorination). Taste and odour may also develop during storage and distribution due to microbial activity. Taste and odour in drinking-water may be indicative of some form of pollution orof a malfunction during water treatment or distribution [6], Odours in water are caused mainly by the presence of organic substances. Some odours are indicative of increased biological activity, others may result from industrial pollution. Taste problems (which are sometimes grouped with odour problems) usually account for the largest single category of consumer complaints [7].

3.1.3. Turbidity

Turbidity is an optical determination of water clarity Turbid water will appear cloudy, murky, or otherwise coloured, Turbidity The measurement of turbidity makes it possible to specify the visual information on the water. Turbidity reflects the presence of suspended particles in water (organic debris, clays, microscopic organisms...). The inconveniences caused by turbidity among users are relative because some populations are accustomed to consuming more or less cloudy water and do not appreciate the qualities of a very clear water However, strong turbidity can allow microorganisms to attach to suspended particles. Turbidity is measured in the field using a turbidity meter Maximum turbidity level allowed in drinking water is 5 NTU (Nephelometric Turbidity **Units)** [8].

NTU<5	Clear water
5<NTU<30	Slightly cloudy water
NTU>50	Troubled Water
NTU	Most surface water in Africa reaches this level of Turbidity

Tableau I.1Classes of usual turbidity (NTU, nephelometric turbidity unity)

3.2. Physico-chemical parameters

3.2.1. Temperature

The temperature of water affects some of the important physical properties and characteristics of water: thermal capacity, density, specific weight, viscosity, surface tension, specific conductivity, salinity and solubility of dissolved gases and etc. Chemical and biological reaction rates increase with increasing temperature

3.2.2. Total Dissolved Solids (TDS)

Taste problems in water derive in part from salts, total dissolved solids (TDS), and the presence of specific metals such as iron, copper, manganese, and zinc. The prevalent anions can often have a larger effect on taste. In general, waters with TDS less than 1200 mg/L are minimally acceptable to consumers, [9]

3.2.3. pH (Potential hydrogen)

The term pH is the concentration of hydrogen ions in a solution. In water, this factor is of exceptional importance, especially in treatment processes. In routine laboratories of treatment plants, it is measured and adjusted as necessary to improve coagulation/flocculation as well as to control water disinfection, the pH value ranging from 0 to 14. Below 7 water is considered acidic and above 7 alkaline. Water at pH 7 is neutral. [10] The decree nº 2.914/2011 of the Ministry of Health recommends that the pH of the Water be maintained in the range of 6,0 to 9,5 in the distribute, the pH value recommended by the Official Gazette of the Algerian State is within limits 6.5 to 9.00

pH <5	Strong acidity => presence of mineral or organic acids in natural waters
pH =7	Neutral pH
7<Ph<8	Approximate neutrality => majority of surface water
5.5<pH <8	Majority of groundwater

Tableau I.2classification of water according to their pH

3.2.4. Conductivity

Conductivity measures the ability of water to conduct the current between two electrodes. Most of the dissolved solids in water are in the form of electrically charged ions. The measurement of conductivity therefore makes it possible to assess the quantity of salts dissolved in water [8]

Type of water	conductivity (µS / Cm)	Resistivity (Ω. M)
Pure water	<23	>30000
Little mineralized fresh water	100 to 200	5000 to 10000
highly mineralized water	1000 to 2500	4001000

Tableau I.3Classification of water according to conductivity Classification

3.2.5. Dissolved oxygen

The dissolved oxygen content of water is influenced by the source, raw water temperature, treatment and chemical or biological processes taking place in the distribution system. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide. It can also cause an increase in the concentration of ferrous iron in solution, with subsequent discoloration at the tap when the water is aerated [5]

3.2.6. Potassium

Potassium occurs widely in the environment, including all-natural waters. It can also occur in drinking-water as a consequence of the use of potassium permanganate as an oxidant in water treatment [5], High concentrations of potassium can cause heart problems in humans.[11]

3.2.7. Calcium

Calcium is an alkaline earth element extremely widespread in nature, and in particular in limestone rocks, in the form of carbonates. Calcium is generally the element Dominant in drinking water, it exists mainly in the hydrogen carbonate state and in lesser quantities in the form of sulphates, chlorides, Calcium is the most common cause of hardness in water, and it has no known physiological effects to humans [11]

3.2.8. Sodium

Sodium is an element whose concentration in water varies from region-to-region Sodium salts (e.g., sodium chloride) are found in virtually all food and drinking water. no health-based guideline value is proposed. However, concentrations in excess of 200 mg/l may give rise to unacceptable taste [6]

3.2.9. Sulfate

Sulfates are a mixture of sulfur and oxygen and are part of naturally occurring minerals in some soil and rock formations that contain groundwater. It also comes from industrial waste, no health-based guideline is proposed for sulfate. However, because of the gastrointestinal effects resulting from ingestion of drinking-water containing high sulfate levels, it is recommended that health authorities be notified of sources of drinking water that contain sulfate concentrations in excess of 500 mg/l. The presence of sulfate in drinking-water may also cause noticeable taste [6]

3.2.10. Phosphate

The phosphate ions contained in surface water or in groundwater can be of natural origin: decomposition of organic matter, leaching of minerals, or also due to domestic and industrial (agrifood, etc.) discharges.

3.2.11. Chloride

Chloride in drinking-water originates from natural sources, sewage and industrial effluents, Excessive chloride concentrations increase rates of corrosion of metals in the distribution system, no health-based guideline value is proposed for chloride in drinking-water. However, chloride concentrations in excess of about 250 mg/litre can give rise to detectable taste in water [6]

3.2.12. Ammonia

The term ammonia includes the non-ionized (NH_3) and ionized (NH_4^+) species. Ammonia in the environment originates from metabolic, agricultural and industrial processes and from disinfection with chloramines. Ammonia in drinking-water is not of immediate health relevance, and therefore no health-based guideline value is proposed. However, ammonia can compromise disinfection efficiency, result in nitrite formation in distribution systems, cause the failure of filters for the removal of manganese and cause taste and odour problems [6]

3.2.13. Nitrate

Nitrate is one of the major anions in natural waters, and concentrations can be greatly elevated due to leaching of nitrogen from farm fertilizer, feedlots, and septic tanks. The mean concentration of nitrate nitrogen ($NO_3^–$ as N) in a typical surface water supply is around 0.2 to 2 mg/L, and individual wells can have significantly higher concentrations [9]

3.2.14. Nitrite

Nitrite is part of the natural installation of soil, water and plants. However, its focus is very low there. In the human body, the nitrite is partially produced by the stomach nitrate. In the tap water, nitrite quantity is greater than the maximum legal standard of 0.10 mg / l can be harmful to health. [12]

4.Drinking water quality standard

The water after treatment must meet the quality standards established according to different parameters especially microbiological. analyses are carried out to verify compliance with these standards. These quality standards are based on the medical work of the World Health Organization (WHO) which disseminates recommendations on the maximum admissible doses to be respected, that is to say the quantity that an individual can absorb. in danger daily and throughout life: these recommendations are adapted in each country according to their health status, their economic situation and according to the regulations in force

Characteristics	Algerian standards (2011)	WHO standards
pH	6,5 - 9	6,5 - 9,5
Conductivity (µS ⁄cm)	2800	1000
Temperature**(°C)**	25	25
Dissolved oxygen(mg/l)	5	5
Salinity (psu)	-	-
Turbidity **(**NTU**)**	5	5
Calcium (mg /L)	100	75—200
Potassium (mg /L)	12	20
Sodium (mg /L)	150	200
Nitrates (mg /L)	50	50
Nitrites (mg /L)	0.1	0.1
Ammonium (mg /L)	0.5	0.5
Phosphates (mg /L)	5	5
Sulfates (mg /L)	250	200--400

Tableau I.4 WHO standards and the Algerian Official newspaper

5.Conclusion

Water pollution is a global problem and the global community faces the worst consequences of polluted water. The main sources of water pollution are household and agricultural waste, population growth, excessive use of pesticides and fertilizers, and urbanization. Bacterial, viral and parasitic diseases spread through polluted water and affect human health.

III. Chapter II

Domestic Water Filtration Systems

1.introduction

The concept of drinking is directly related to human food. Natural water is said to be drinkable if it has the following properties:

- Freshness and clarity
- Lack of smell and color
- Nice taste • Sufficiently soft and airy
- Responsible mineralization
- Lack of organic matter and pathogens

One of the ways we can get clean and healthy water is through home water purification filters. There are many types of home water purification filters (or water filters) available on the market, and each uses different water purification technologies to produce cleaner, safer, and better water for you and your family. With more and more pollutants in our water due to industrial and environmental factors, it is crucial for us to understand more about different water purification techniques and to protect ourselves with water filters. In this study, we will try to focus on studying the most common household water purification filters and the household water purification system that relies on several combined filters.

2.Domestic Water Filtration Systems

Domestic Water Filtration Systems were usually componed of 3, 4, or 5 stages of filtration.

Each household water filtration system contains a sediment filter, carbon filter and R.O. filter.

Each filtration system contains one or more filters:

•Sediment filter: Reduces particles like dirt, dust, and rust

•The carbon filter: Reduces volatile organic compounds (VOC), chlorine, and other contaminants that give water a bad taste or odor

•Semi-permeable membrane: Removes up to 98% of total dissolved solids (TDS)

•Mineral filter**:** this filter improves water quality supplying it some minerals essential for our health: calcium, magnesium, sodium, potassium

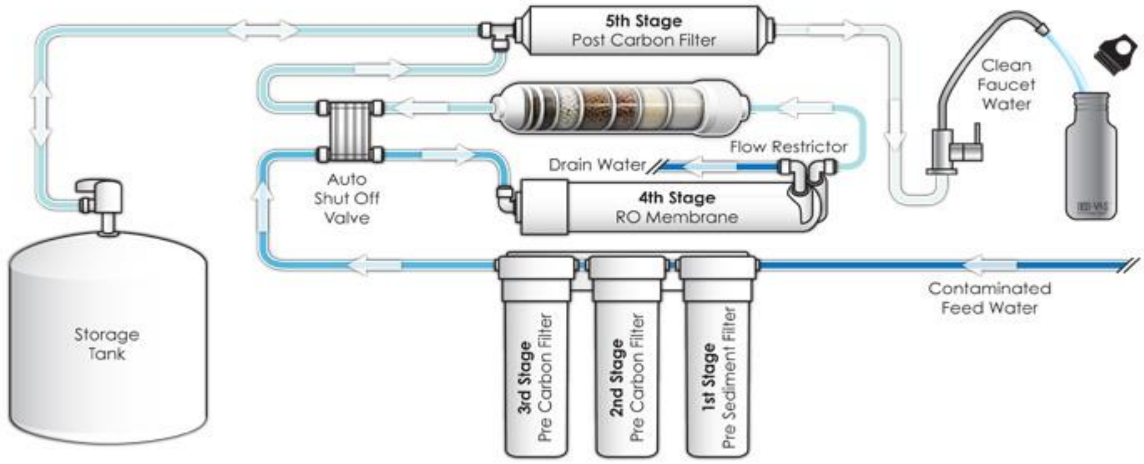


Figure II.1 schema of Domestic Water Filtration System Source

1- When water first enters home water filtration systems, it usually passes through a carbon and sediment filter to remove sediments and chlorine that could clog or damage the reverse osmosis membrane

2- The water then passes through the reverse osmosis membrane where dissolved particles (even too small on a microscopic scale) were removed.

3- After filtration, the water flows to the storage tank, where it's held until needed. Water filtration systems continue to filter water until the storage tank is full then shuts off.

4- Once you turn on your tap for drinking water, water comes out of the storage tank through another post filter to polish drinking water before it gets to your tap.

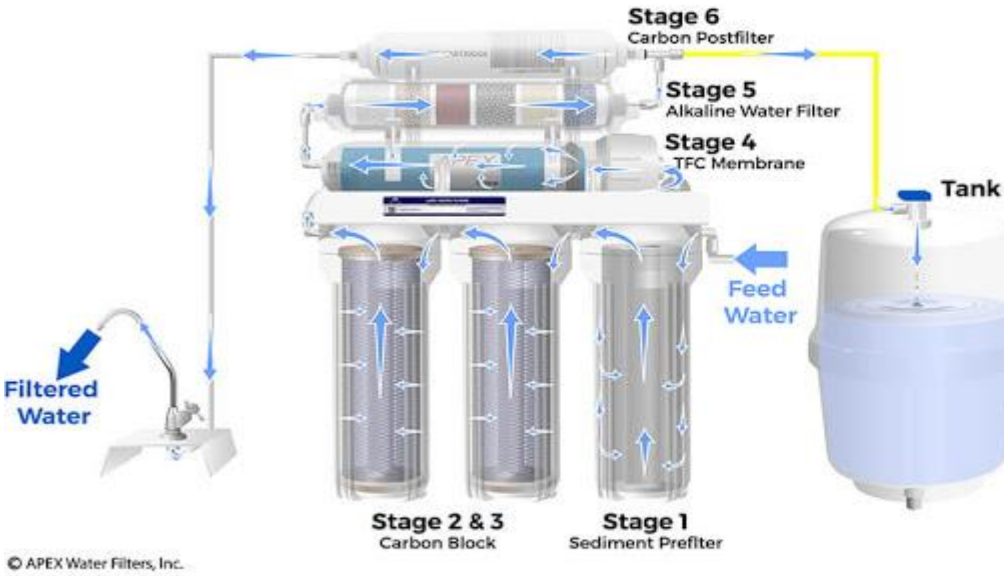


Figure II.2 another schema of Domestic Water Filtration System

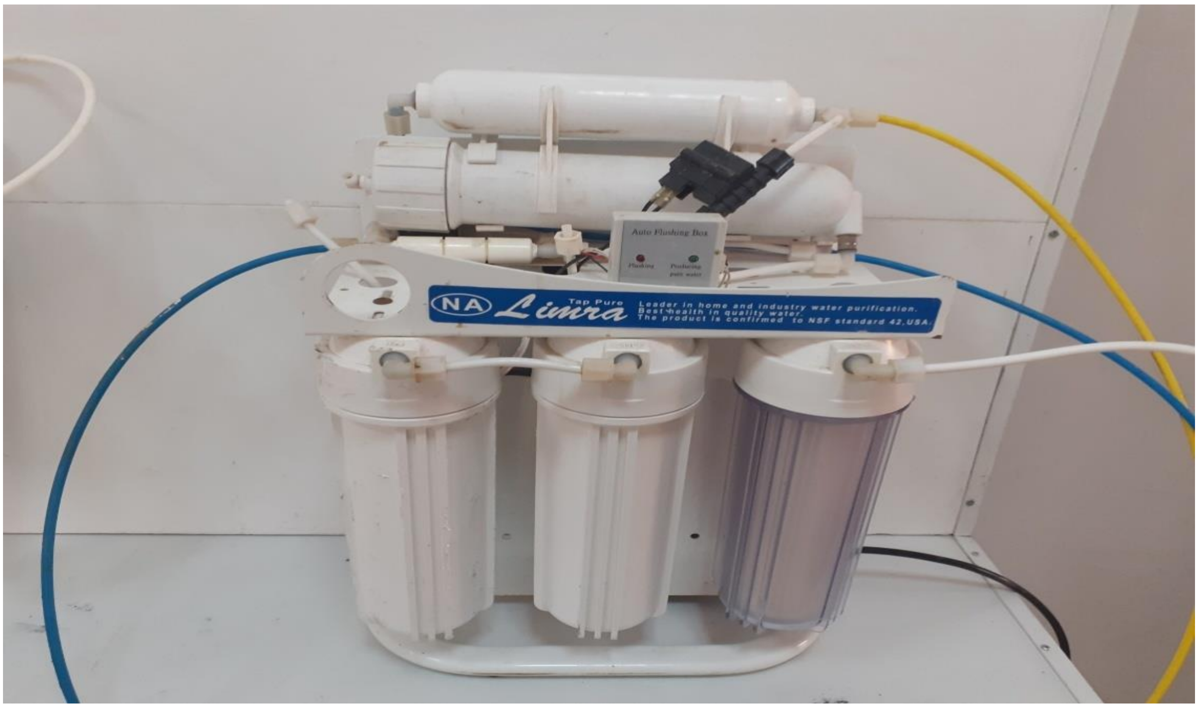


Figure II.3 Real picture of Domestic Water Filtration System

2.1. Sediment Filtration

Sediment filter removes suspended materials such as sand, silt, clay, or organic matter from the water and other large particles in the water. The sediment filter can be made of various materials, such as paper: ceramics, polypropylene, acrylic fibre, glass fibre, polyester and spun cellulose [1]. Usually, a sediment filter is used as a pre-treatment for other processes such as activated carbon filtration (AC) and reverse osmosis (RO) to protect them from clogging by large particles.

Figure II.4 Real picture of Sediment Filtration

2.1.1. Mechanism

Water flows into filter housing, the pressure pushes the water through the casings (fibre stem) to the inner opening that leads to the tap. The fibres will then filter out larger particles such as organic matter, sand, clay, and silt the flow rate is as high with high pressure [2], the contaminants with a size smaller than 5 microns will pass through the sediment filter freely.

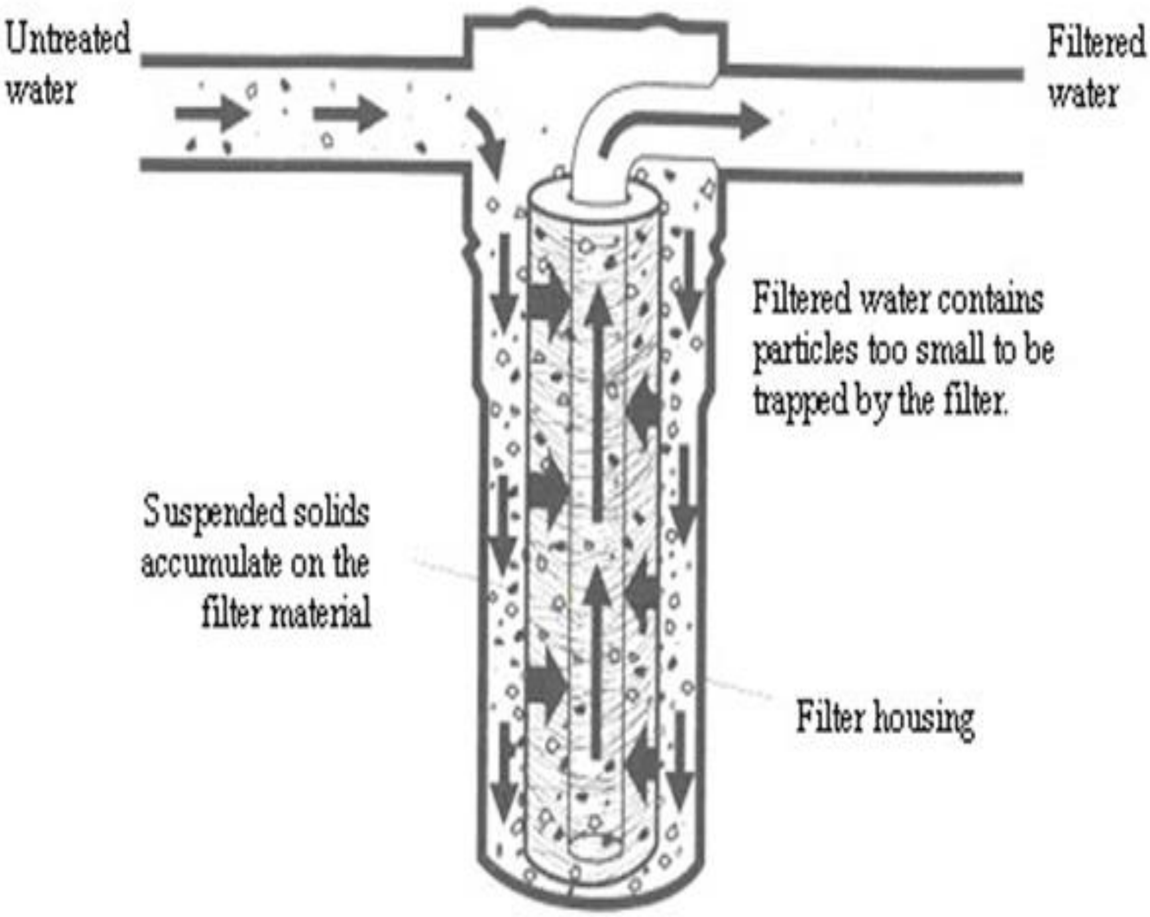


Figure II.5 The sediment filtration process

2.2. Granular Activated Carbon (GAC) Filtration

Figure II.6 Granular Activated Carbon

Activated carbon is used in many applications such as air and water purification, and it's also used in medical fields. It has several forms of use such as (granular, powder, block), The high degree of transition porosity in activated carbon allows for an increase in the diffusion-limited rate of adsorption from solutions and makes it very effective in adsorbing a many organic [3], carbon (GAC) have been widely used to for removing certain chemicals, especially chemicals, from water. GAC filters can also be used to remove chemicals that give unpleasant odors or a bad taste to water [4]

Figure II.7 Real picture of Granular Carbon (GAC) Filtration

2.2.1. Mechanism

Adsorption is the primary mechanism through which GAC works and the main reason for its widespread use to reduce unwanted taste, odor, and colour and to improve drinking water safety. When the water enters the housing, the casing is filled with water under pressure, the water starts to enter the filter from the bottom, then the water meets the granules of activated carbon, carbon particles absorb pollutants in the water that are larger than their pore size when flowing through them. Granules of activated carbon will attract negatively charged chlorine to it. Also, the carbon material itself absorbs the taste and bad smell from the water [5].

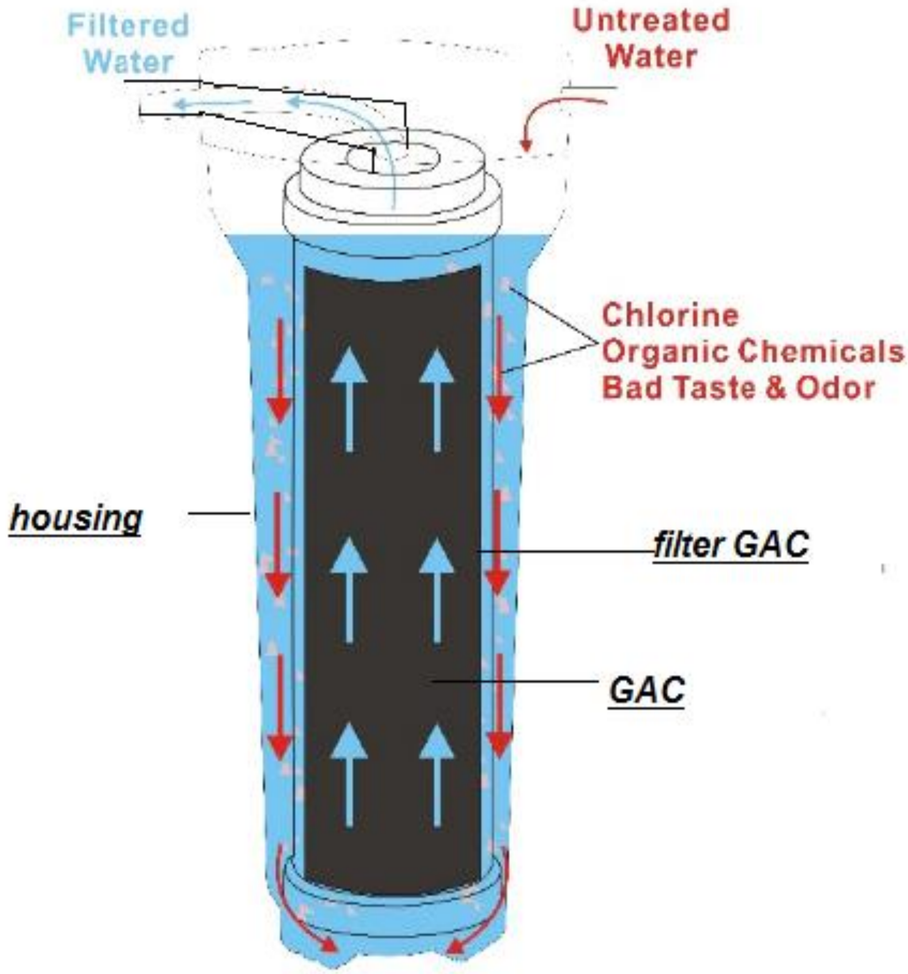


Figure II.8 Mechanism work of Granular Activated Carbon

2.1. Activated Carbon Block (ACB) Filtration

It’s another form of active carbon that is made from fine carbon powder then the powder is combined with a food binder. Finally, the mixture is heated and packed into a solid mold. [6] It’s highly effective in removing the taste and smell of chlorine, chemicals and more pollutants in the water. Also, the block of activated carbon can reduce pollutants such as lead, volatile organic compounds (VOCs) and microscopic cysts in the water. The high porosity of the powder produces a larger surface area, which allows it to absorb more contaminants in the water and prevent the water from penetrating. [5], Carbon block is more efficient in purifying water than carbon granules, as water spends more time in carbon block filters, but it’s expensive to manufacture carbon block filters. On the other hand, granular activated filter manufacture is affordable.

Figure II.9Real picture of Carbon Block (ACB) Filtration

2.3.1. Mechanism

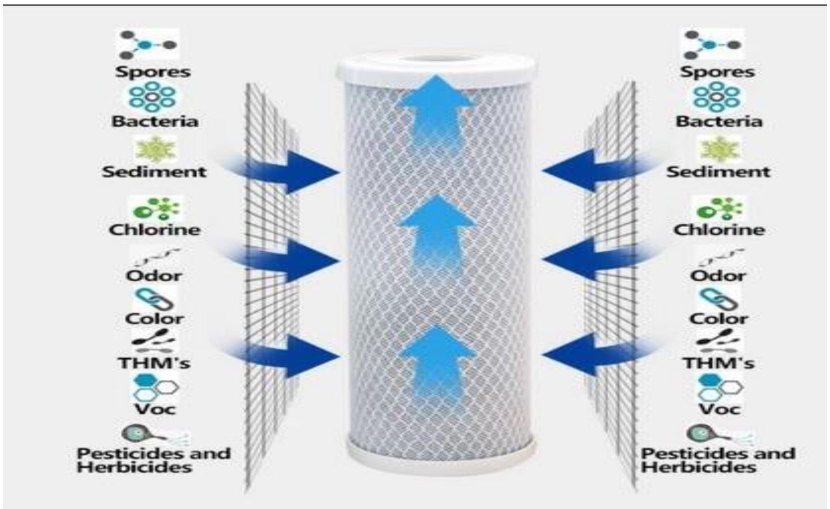


Figure II.10 Activated carbon block filter

Water flows into the filter housing then enters through the pores of the activated carbon block, and all impurities larger than the pore size are mechanically absorbed and accumulate on the surface of the activated carbon. At the same time, positively charged activated carbon attracts all negatively charged chemicals like chlorine and gets rid of bad taste and odor

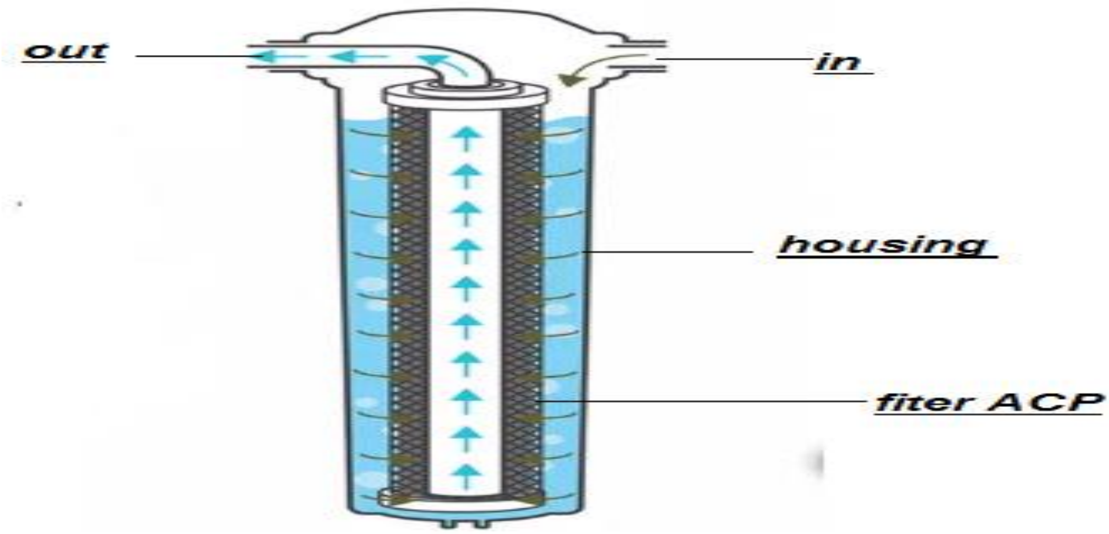


Figure II.11 Mechanism work of Activated Carbon Block

2.4. Reverse Osmosis (RO) Filter

Reverse osmosis (RO) systems always utilize a sediment pre-filter. Reverse osmosis purifies water by passing it through a semi-permeable membrane that eliminates metals, salts, and dissolved solids. It's capable of removing the majority of contaminants (up to 99%, including minerals) from water except for most soluble volatile organic compounds (VOCs), some pesticides, solvents, and chlorine. Of course, behind the highly intensive filtration does come with some costs like a higher price, slow filtration rate, and produce much of brine (usually 3:1 waste water to filtered water ratio) [05]. And because of its slow water filtration rate, most of the reverse osmosis filtration system comes with a pressurized tank to store the filtered water.

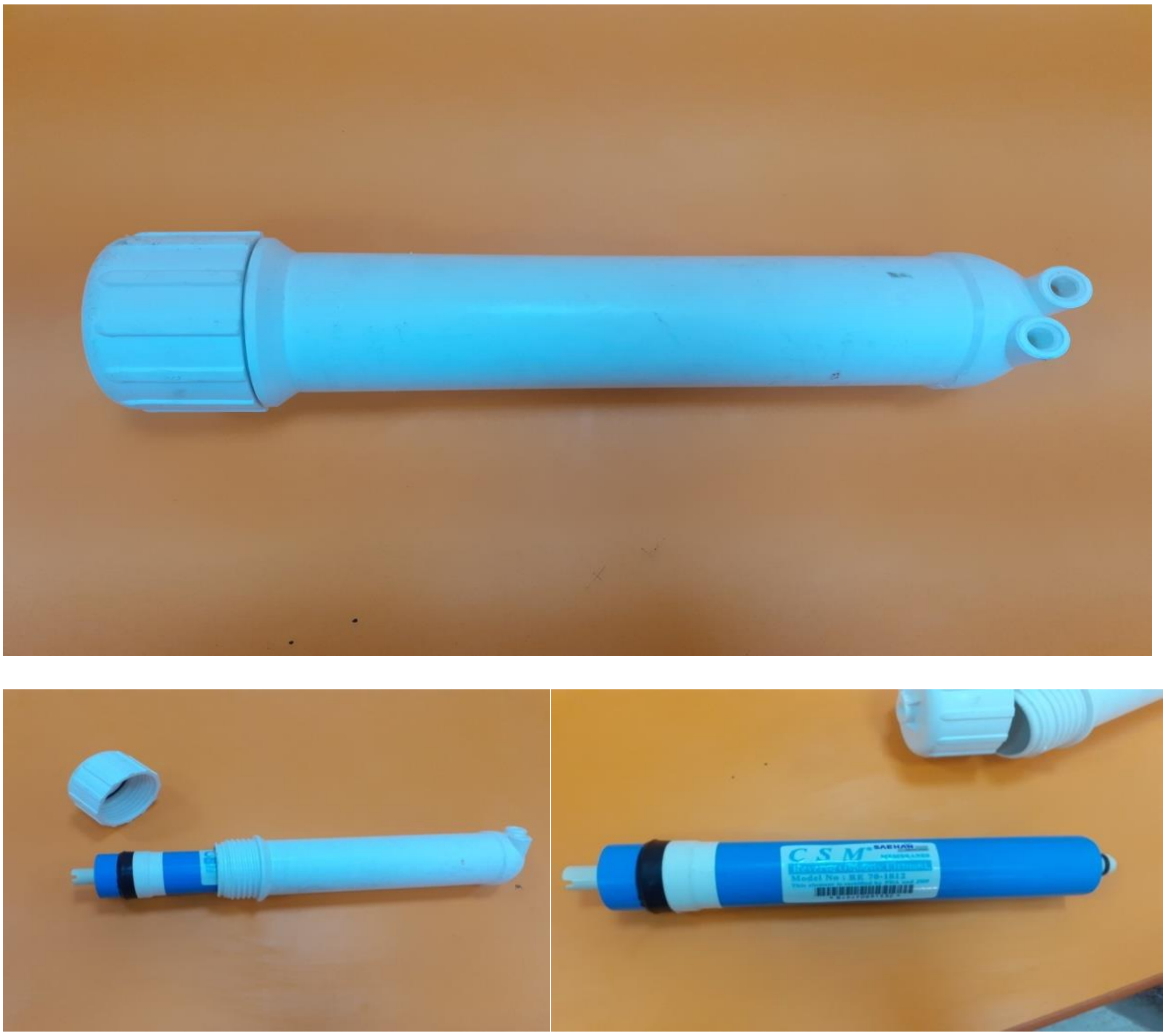


Figure II.12 Real picture of Reverse Osmosis (RO) Filter

2.4.1. Mechanism

It’s the reverse version of the osmosis process, Osmosis is a natural process involving the flow of fluid through a barrier semipermeable membrane. It’s selective in the sense that the solvent passes through the membrane faster than passage of dissolved solids. The difference in passage speed results in a solvent-solid separation. The direction of solvent flow is determined by its potential chemical, which is a function of the pressure, temperature and concentration of dissolved solids. Pure water in contact with both sides of the semipermeable membrane ideal at equal pressure and temperature has no net flow through the membrane because the chemical potential is equal on both sides. If a soluble salt is added to the water on one side of the membrane, the chemical potential of this saline solution is reduced [7]. In the reverse osmosis process, the molecules in the water are forced to pass through a semi-permeable membrane from a more concentrated solute into a less concentrated on. The pore size of the Reverse Osmosis membrane can down to 0.0001 microns, which make it capable of removing up to 99% of contaminants in water including microorganisms like bacteria and cysts. [5].

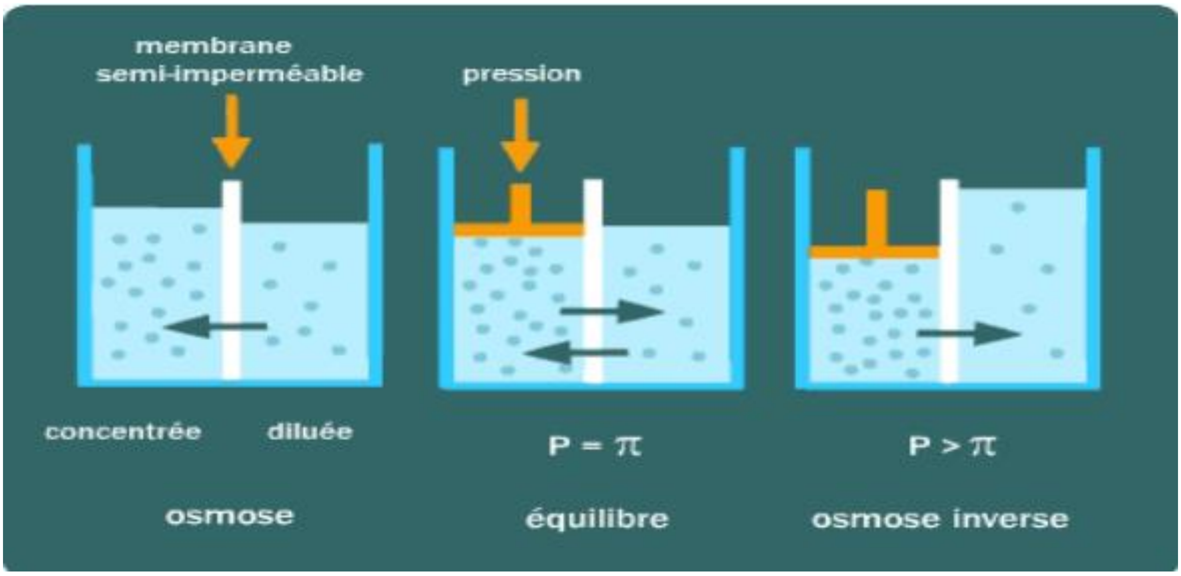


Figure II.13Principle of reverse osmosis [11].

2.4.2.R.O. Membrane

The membrane used in R.O. system is a thin micro-porous surface that rejects all impurities but only allows water molecules to pass through. The three types of commonly used membranes are tubular, spiral wound and hollow fiber. The two most common base materials used to produce membranes are cellulose acetate and polyamide polymers. Polyamide polymer membranes produce both 36 higher rejection and flux; tolerate a wider pH range and higher continuous temperature than cellulose acetate. [2].

2.4.3. Spiral wound membrane

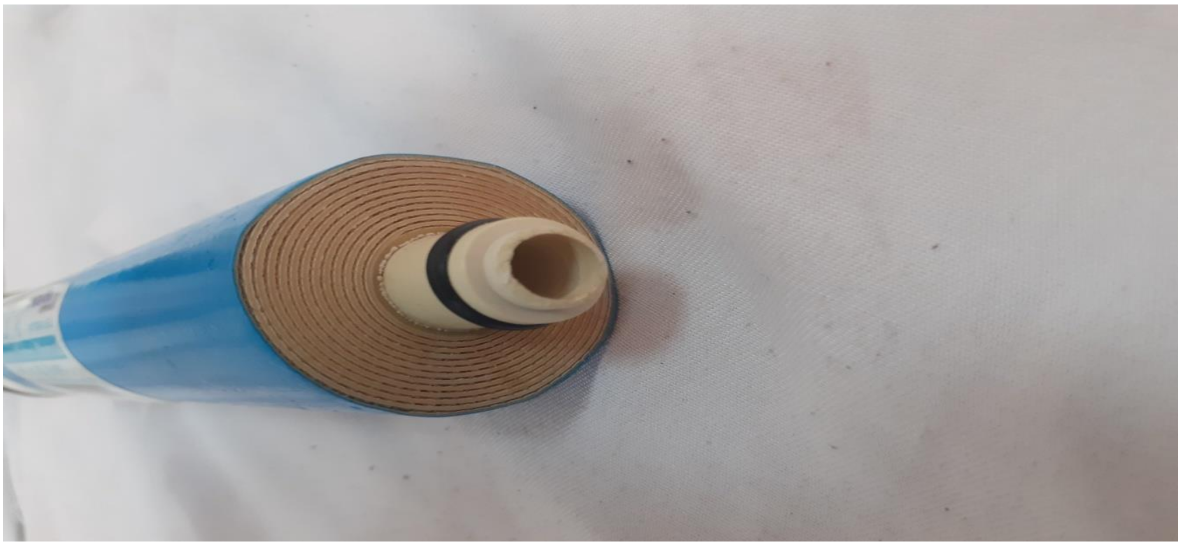


Figure II.14 Real picture of R.O. Membrane (spiral wound membrane)

Spiral wound membrane is the most popular membranes used in household R.O. systems. In the design of spiral wound, two flat sheets of membrane are placed back-to-back to form an envelope that contains a porous sheet of material called a permeate carrier. Then, envelope is glued together on three sides only. The fourth side is attached to a perforated tube [2]

The spiral-wound element typically embodies a flat sheet membrane, cast on to a porous polyester support sheet. The central product water tube, around which the membrane and its supporting layers are wound, collects the fluid that permeates through the membrane. The spiral element operates as a cross-flow membrane filter. Only some membrane to become product water [8], Water that passes through the membrane is flows along the permeate carrier toward the open end of the envelope and leaves through permeate tube. The pores of membrane can range from atomic dimensions (<10 angstroms) to 100+ microns. Membrane can reject bacteria and 85 to 95% of inorganic solids but it allows dissolved solids to pass through.

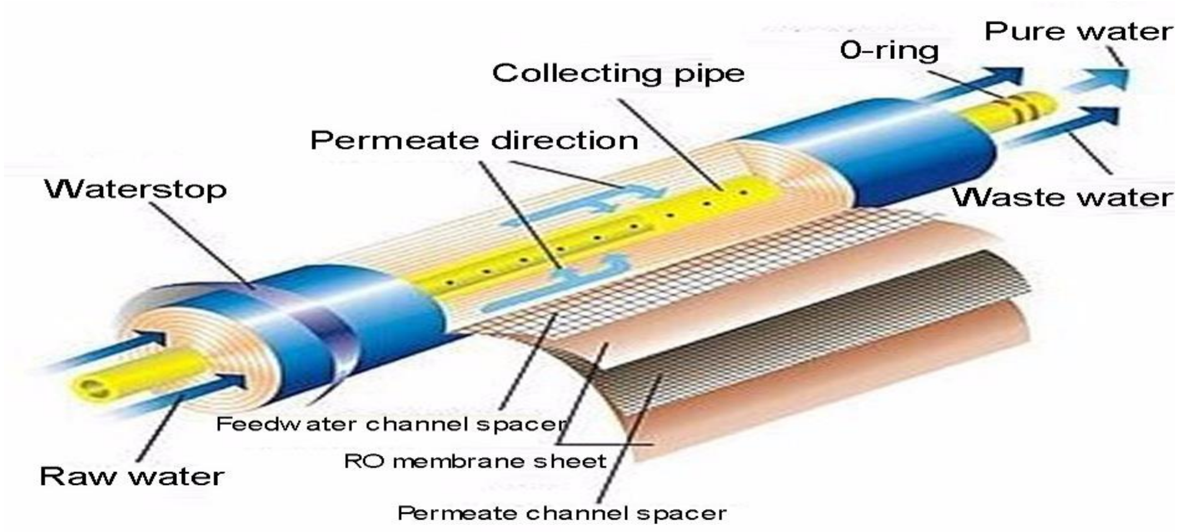


Figure II.15 Mechanism work of Spiral wound membrane

2.5. Mineral filter

The mineral filter is also known as alkaline filter and is installed after RO membrane filter, to impart soothing and sweet taste to pure drinking water. The mineral filter makes the water healthy for drinking by increasing the pH value of drinking water to more than 7 and transferring essential vital minerals to the drinking water. Which the RO membrane filter can remove

Figure II.16 Mineral filter

2.6. Storage Tank

A storage tank is a hydro-pneumatic pressure tank it collects the water being gradually purified by Domestic Water Filtration System membrane. The reverse osmosis filtration process is a slow one. The tank allows water to accumulate, so, when you go to pour yourself a glass of water you can have immediate access to plenty of water.

Reverse osmosis tanks are made of rolled steel and internally lined with an inert material called butyl. The butyl lining ensures that the purified RO water never comes into contact with the steel. [9].

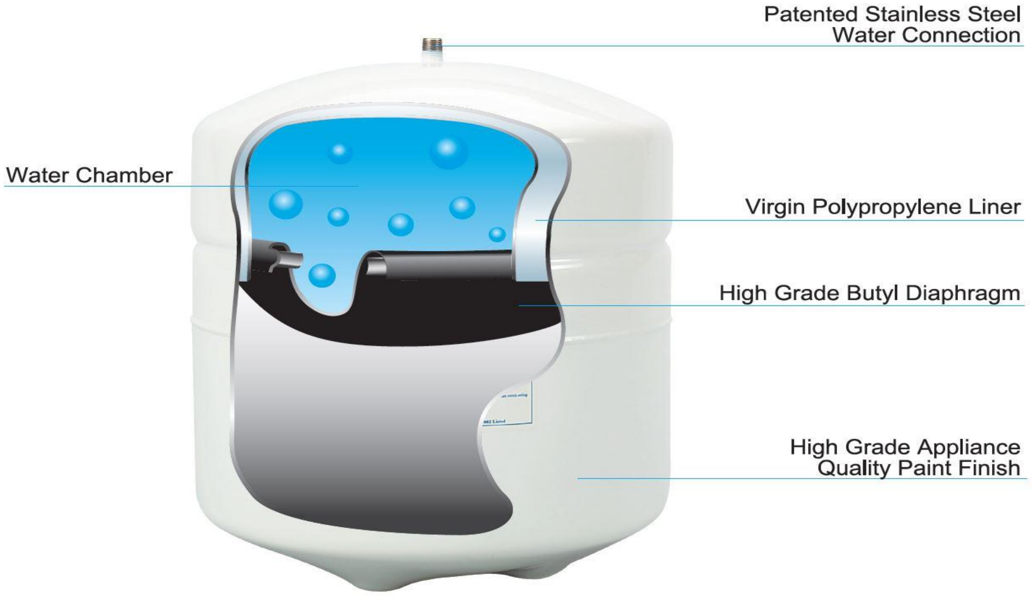


Figure II.17 schema of storage tank

Figure II.18 Real picture of storage tank

2.6.1. Mechanism

A storage tank is hydro pneumatic, meaning the tank is holding not only water but also pressurized air. Hydro pneumatic storage tanks are capable of delivering pressurized water swiftly and on-demand, without necessitating the assistance of a booster pump inside. The storage tank is both an air chamber and a water chamber, divided in the centre by a bladder. Though water doesn't compress, air will. As the Domestic Water Filtration System feeds water into the storage tank, the weight of the water begins to compress the air chamber. As air compresses, it will continue to increase in pressure. When you open your tap, this air pressure propels the water out of the tank and up through your tap. [10].

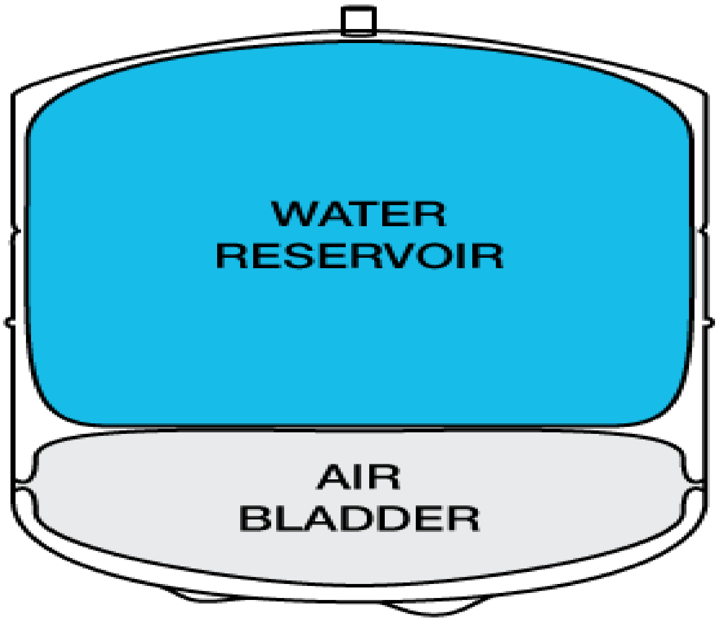


Figure II.19 schema of storage tank

3.CONCLISION

In the end, in the domestic water purification system, the water goes through five stages of filtration

- **The first stage:** (mechanical filter) PP filter removes dirt, dust, sand, soil, rust and impurities suspended in water with dimensions greater than 5 µm.
- **Second stage:** (activated charcoal filter -1) Floor filtration of small activated carbon removes some organic substances, pesticides, detergents, suspended impurities, unpleasant taste, color and heavy metal impurities.
- **The third stage:** (activated carbon filter -2) Activated carbon filter block enhances the removal of organic substances, pesticides, detergents, suspended impurities, unpleasant taste, color also like heavy metal impurities.
- **The fourth stage:** (reverse osmosis filter) The reverse osmosis ultrafiltration floor removes soluble salts, heavy metals, bacteria and other compounds with dimensions greater than 0.0001 µm and eliminates more than 96% of salt in water.
- **Fifth stage:** (mineral filter): this filter improves water quality supplying it some minerals essential for our health: calcium, magnesium, sodium, potassium.

IV. Chapter III
Activated Carbon

1.Introduction

In this chapter we will discuss the process that is the subject of this applied research. Namely, carbon, the history of its use and method of preparation, in addition to its most important characteristics, addressing the phenomenon of adsorption and its method of operation

2.Activated Carbon

Activated carbons are made from a variety of carbonaceous source materials - including coconut shells, peat, hard and soft wood, lignite coal and olive pit to name but just a few. However, any organic material with a high carbon content can effectively be used to create activated carbons through physical modification and thermal decomposition.

3.The Use of Activated Carbon to Purify Water

In drinking water treatment systems, activated carbon helps to ensure that drinking water not only smells and tastes, satisfactory, but is also safe for consumption. Drinking water treatment focuses on: Removal of Contaminants and Taste and odor Control.

Activated carbon is an adsorption medium in which substances are attracted and attached to the surface of carbon particles. The unique porous structure and vast surface area of the activated carbon, combined with the attractive forces, allow the activated carbon to capture and hold different types of materials on its surface [1].

4.History of the use of activated carbon

The use of carbon dates back to 3750 BC, for the reduction of copper (Cu), zinc (Zn), and tin (Sn) ores in the manufacture of bronze by the Egyptians and Sumerian [2]. Hindu documents dating from 450 BC refers to the use of sand and charcoal filters for the purification of drinking water. Recent studies of the wrecks of Phoenician merchant ships have led to the discovery that drinking water is stored in charred wooden barrels to keep the water cool [3]. In 1773, Car Wilhelm, a chemist recognized the absorption power of carbon-derived materials from different sources [2]. In 1862, lips combe prepared a carbon material to purify potable water. This development paved the way for the commercial applications of activated carbon, first for potable water then in the waste water sector.

Activated carbon was first produced on an industrial scale at the beginning of the twentieth century, and major developments then took place in Europe. However, at the beginning of the twentieth century activated carbon was only available in the form of powdered activated carbon (PAC). Swedish chemist Von Ostreijko obtained two patents, in 1900 and 1901, covering the basic concepts of chemical and thermal (or physical) activation of carbon, with metal chlorides and with carbon dioxide and steam, respectively [3].

The commercialization of the first industrially produced activated carbon, Epona (trade name), was first reported in 1911 by Fanto Works, Austria.

5.Preparation of Activated Carbon

Before using the carbon (charcoal) to purify water, we need to activate it, activated carbon doesn't just happen. It must be prepared, two methods to activate carbon.[4]

The so-called physical method consists of a thermal treatment under a reactant gas [5].

The chemical method consists in impregnating the carbonaceous material before or after carbonization, with a solution of a chemical agent; are like mineral bases (potash or soda), mineral acids (phosphoric acid or sulfuric acid), or metal salts (zinc chloride). This impregnation is followed by a heat treatment in an inert atmosphere [5].

(Phosphoric acid 25%, potassium hydroxide 5%, sodium hydroxide 5%, calcium chloride 25%, and zinc chloride 25%) [6].

Some people may ask about the importance of activation, activation increases the pore sizes and creates a continuous pore structure [7]. Pore sizes are at which the adsorption phenomenon occurs.

6.The Granulated Activated Carbon (GAC)

Figure III.1Real picture of granular activated carbon.

Granular carbonates are used for water treatment, deodorization, and flow system separation, and granular active carbon (GAC) contains 0.6 mm to 4.0 mm pellets [8]. It's the most common type of drinking water purifiers. One of its most important characteristics.

- They offer clean handling and tend to last longer than PACs. [9]
- Are hard, abrasion resistant
- Relatively dense to withstand operating conditions
- They cause low hydrodynamic resistance
- Can be conveniently regenerated (regenerated by heat treatment in steam, and used again).

GAC contactors can be classified by the following characteristics:

(1) driving force: gravity versus pressure;

(2) flow direction: down flow versus up flow;

(3) configuration: parallel versus series;

(4) position: filter adsorber versus post-filter contactors [4]

Several types of granular carbon filters used.

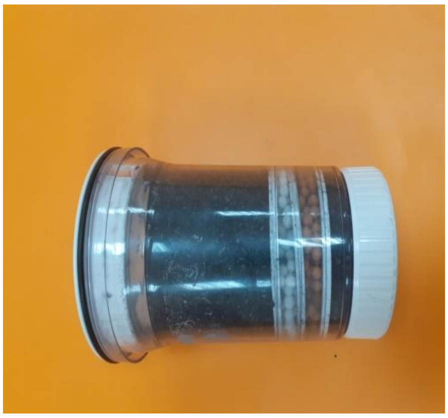


Figure III.2Types of granular activated carbon filters

7.Powdered activated carbons (PAC)

Figure III.3Powdered activated carbons

Powdered activated carbon (PAC) particles are generally around 44 µm in size, which allows for faster absorption, [8]. Offers low processing costs and operating flexibility. But it has its flaws [9] they're difficult to handle when used in fixed adsorption beds they cause a high-pressure drop in fixed beds are difficult to regenerate

8.Bead Activated Carbon (BAC).

Figure III.4Bead Activated Carbon

BAC is a highly spherical activated carbon made from petroleum pitch. Supplied in diameters from approximately 0.35 mm to 0.80 mm. [6]

9.Additional Types

Additional varieties of activated carbon include:

Impregnated Carbon

Polymer Coated Carbon

Activated Carbon Cloths

Activated Carbon Fibers

10.Adsorption

Adsorption is an important phenomenon in most natural physical and biological phenomena. Adsorption is the accumulation or concentration of substances at a surface or at an interface. The adsorbing phase is termed the adsorbent, and the material being adsorbed the adsorbate [3]

10.1. mechanism

Adsorption results from unsaturated and unbalanced molecular forces present on every solid surface. Thus, when a solid surface is brought into contact with a liquid or gas, the presence of the interaction between the force fields of the surface and those of the liquid or gas. The solid surface tends to satisfy these residual forces by attracting and retaining on its surface the molecules, atoms, or ions of the gas or liquid **[8]**

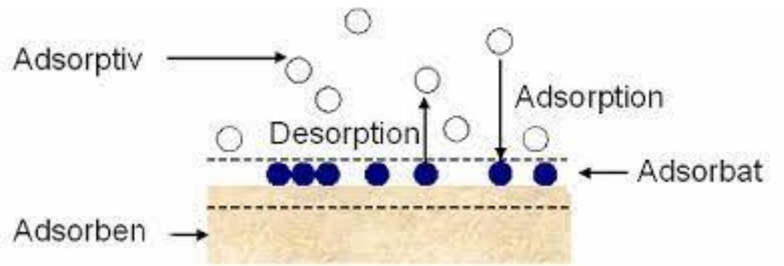


Figure III.5Simplified diagram representing the phenomenon of adsorption

We can classify the phenomenon of adsorption into two categories:

10.1.1. Physical adsorption or physic option

If the interactions between the adsorbate and the adsorbent are very weak of the Van der Waals type, then the adsorption is physisorption. [10], in physical adsorption, the enthalpy of adsorption is of the same order as the heat of liquefaction and generally does not exceed 10 kJ to 20 kJ per mol [8].

Physical adsorption is nonspecific and occurs between any adsorbate-adsorbent systems

10.1.2. chemical adsorption or chemisorption.

If the adsorption force is stronger and partial electron sharing takes place, then it is classified as chemisorption [10]. In chemisorption the change in enthalpy is generally of the order of 40 kJ to 400 kJ per mole [8]. Chemical adsorption involves a chemical reaction between the surface and the adsorbate. New chemical bonds are generated on the surface of the adsorbent.

10.2. Factors influencing adsorption parameters

Adsorption depends on many factors, the main ones being

- The characteristics of the adsorbent: polarity, pore volume, specific surface and surface functions.

- The characteristics of the adsorbate: polarity, solubility and molecular weight, the settings physico-chemical of the environment, temperature and pH [11]

10.2.1. Adsorption Isotherms

The adsorption of gases and solutes is usually described through isotherms, that is, the amount of adsorbate on the adsorbent as a function of its pressure (if gas) or concentration (for liquid phase solutes) at constant temperature. The quantity adsorbed is nearly always normalized by the mass of the adsorbent to allow comparison of different materials. [12]

10.2.2. Modeling of Isotherms

The parameters obtained from the modelling of isotherms provide information important on the adsorption mechanism, surface properties and adsorbent adsorbate affinities. The two most commonly used three-parameter models are the Langmuir and Freundlich and Temkin

10.2.2.1. Langmuir model

$$\frac{1}{\boldsymbol{qe}} = \frac{1}{\boldsymbol{qm}} + \frac{1}{\boldsymbol{K}1 * \boldsymbol{qm}} * \frac{1}{\boldsymbol{Ce}}$$

q: quantity of substance adsorbed at equilibrium per unit of adsorbent weight (adsorption capacity) (mg / g).

- qm: Adsorption capacity at saturation (mg / g).

- Ce: Concentration of the substrate in adsorbate at equilibrium (mg / l).

- K1: Langmuir's constant

10.2.2.2. Freundlich model

Freundlich's empirical model is based on adsorption on heterogeneous surfaces.

$$\ln \boldsymbol{qe} = \boldsymbol{lnKf} * \frac{1}{\boldsymbol{n}} \boldsymbol{lnCe}$$

- qe: the quantity adsorbed per gram of solid.

- Ce: adsorbed concentration at adsorption equilibrium.

- Kf and 1/n: Freundlich constant characteristic of the efficiency of an adsorbent relative to a solute.

10.2.2.3. Temkin model

$$\boldsymbol{qe} = \frac{\boldsymbol{Rt}}{\boldsymbol{bt}} * \boldsymbol{ln}(\boldsymbol{kt} * \boldsymbol{Ce})$$

- qe: quantity of adsorbed metal ions (mg / g).

- Ce: concentration of the solute at equilibrium (mg / l).

- R: universal constant of ideal gases (J / mol. K).

- t: absolute temperature (K).

- bT: variation of adsorption energy (J. mol / g.mg)

- KT: equilibrium constant (L / mg)

11.Activated carbon as an adsorbent:

The adsorption power of activated carbons is attributed to porosity, specific surface area, and functional surface groups

11.1. The properties of adsorbents:

11.1.1. Porous structure

The carbon is prepared in order to exhibit a highly ramified porous structure,[13] A porous solid can be defined from the volume of adsorbed substance required to saturate all the open pores with one gram of this solid. An open pore is a pore that has access to the surface of the grain, so it is accessible to the fluid. This pore volume, in cm3.g-1, is therefore only characteristic of the open porosity (Figure 06).[5]

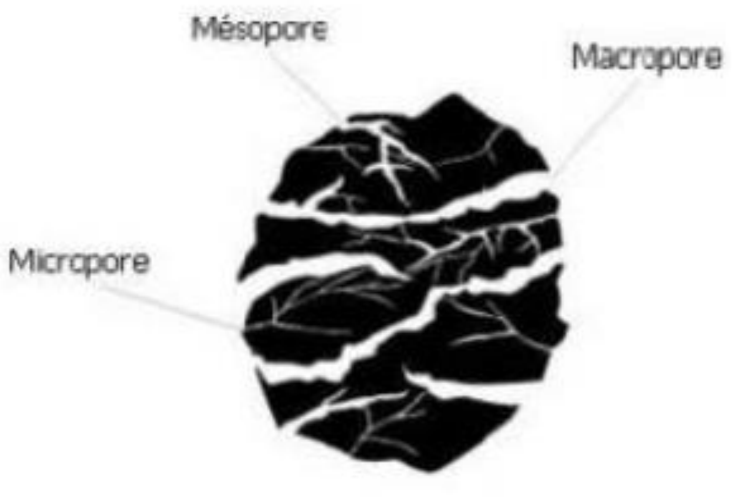


Figure III.6Schematic representation of the different types of pores.

The pore classification proposed by Dubinin (1979) and currently adopted by the Union International Pure and Applied Chemistry (U.I.C.P.A.) is based on their sizes. Three

Micro Pore with a diameter of less than 2 nm;

Meso Pore with a diameter of between 2 and 50 nm;

Macro Pore with a diameter greater than 50 nm;

The Macro Pores are used as entrance of contaminated Molecules onto Activated Carbon, Meso Pores are used for transportation and Micro Pores are used to adsorb molecules. The diffused molecules are removed onto the Activated Carbon pores and it sticks to the internal surfaces. all molecules are not adsorbed onto the Activated Carbon surface equally. Smaller molecules will diffuse deeper onto Activated Carbon and can adsorbed more surface area than large molecules because of the size of the Pores.[14]

11.1.2. The specific surface

The specific surface or mass area (in m2 g-1) is the total surface area per unit mass of adsorbent accessible to molecules.

The entire surface area of the adsorbent particles is considered, including open porosity, for the calculation of the specific surface area which therefore combines the interior surface of all the pores constituting the adsorbent grain. The specific surface includes the external surface and the internal surface of an adsorbent (Figure 07)

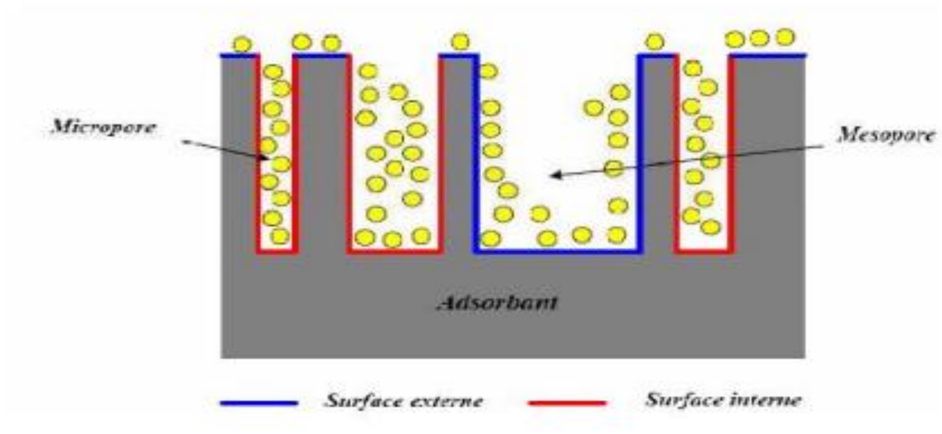


Figure III.7Schematic representation of the internal and external surface of an adsorbent.

the outer surface is the non-microporous surface that includes the walls of the mesopores and macro-pores, as well as the non-porous surface of the sample.

From a physical point of view, the difference between the inner surface and the outer surface is that the value of the absorption energy can be up to twice as great on the walls of the micropores than on the outer surface. This phenomenon is explained by the presence of two close opposite walls creating a double interaction for a molecule adsorbed in a micropore. [15]

12. Properties of active carbon

The most important characteristics to consider when choosing a carbon for applications

12.1. Hardness number

The hardness, or abrasion resistance, of chars is dependent on the nature of the feedstock. The Hardness number measures the external integrity against wearing along exterior and breakage of small points of activated carbon. It is expressed as a percentage of loss on a particular sieve after shaking granules under certain conditions. [16]

12.2. Abrasion number

Another important characteristic that distinguishes different types of carbons used in liquid phase treatments is abrasion resistance. This is significant because of the harsh handling to which granular carbon is subjected. Dry and dewatered material must be loaded and conveyed; slurries are pumped. Resistance to attrition is important if carbon loss is to be minimized. The abrasion resistance of activated carbons is particularly important if the carbon is to be used in an application where frequent backwash cycles will be required. Testing procedures which assess ability to resist abrasion are usually expressed in terms of abrasion number. Depending on the test used, the higher the abrasion number, the more resistant the carbon is to abrasion [17]

The abrasion number measures the structural strength of granular activated carbon. It is a measure of the ability of the particle to stand up to shear forces caused by particles rubbing together or particles rubbing against another surface such as a column wall or supporting screen. It is measured by shaking granules with steel balls in a container under certain conditions and expressed as a percentage reduction in Mean Particle Diameter. [16]

12.3. iodine number

The iodine number (or "iodine value") is an indication of the available surface area in m2/gram of virgin carbon. Although the Iodine number has become synonymous with the "activity" of activated carbon and it is widely used as a quality control parameter in production and reactivation of activated carbon, it does not necessarily provide a measure of the carbon's ability to adsorb other species [2]

The amount of iodine absorbed (in milligrams) by 1 g of carbon is called the iodine number. Iodine number can be used as an approximation for surface area and microporosity of active carbons with good precision. Iodine number tests were conducted based on the American Society for Testing and Materials method using the sodium thiosulfate ($Na_2S_2O_3$) volumetric method. The iodine number was estimated by mixing the activated carbon with 0.02 N iodine solution shaken occasionally and then by titration of the solution against $Na_2S_2O_3$ the resulting values gave the amount of iodine adsorbed per weight of carbon; expressed in mg/g. [18]

12.4. Pore structure

The pore structure of activated carbon is varied and is largely a result of the source of the material and the method of production. It is the structure of the pores, in combination with the attractive forces, that allows adsorption to occur.

12.5. Adsorption properties

Adsorption properties include surface area and porosity that affect adsorption capacity and the rate of adsorption

12.6. Moisture

Ideally, the amount of physical moisture contained within the activated carbon should fall within less than 5%.

12.7. Particle Size

Particle size has a direct effect on adsorption kinetics, flow characteristics, and filter ability of the activated carbon [9].

V. CHAPTER IV

Expérimental part

1.The products used

1.1. Charcoal vegetal

is a lightweight black carbon residue produced by strongly heating wood (or other animal and plant materials) in minimal oxygen to remove all water and volatile constituents. In the traditional version of this pyrolysis process, called charcoal burning, the heat is supplied by burning part of the starting material itself, with a limited supply of oxygen. The material can also be heated in a closed retort. [1]

Figure IV.1 Carbon vegetal

1.2. Potassium hydroxide

Potassium hydroxide is an inorganic compound with the formula KOH, and is commonly called caustic potash. KOH is a prototypical strong base. It has many industrial and niche applications, most of which exploit its caustic nature and its reactivity toward acids. KOH is noteworthy as the precursor to most soft and liquid soaps, as well as numerous potassium-containing chemicals. It is a white solid that is dangerously corrosive [2].

Figure IV.2 Potassium hydroxide KOH

1.3. Methylene blue

Methylene blue is a formal derivative of phenothiazine. It is a dark green powder that yields a blue solution in water. The hydrated form has 3 molecules of water per unit of methylene blue. Methylene blue has a pH of 6 in water(10g/l) at 25 °C (77 °F). This compound is prepared by oxidation of dimethyl-4-phenylenediamine in the presence of sodium thiosulfate. [3]

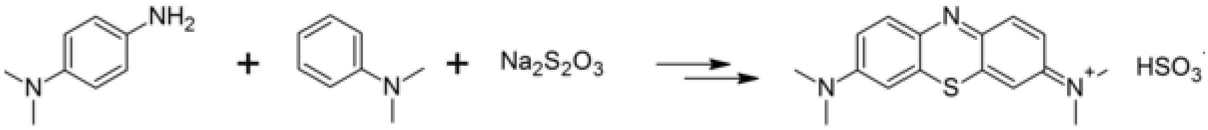


Figure IV.3 Methylene blue

2.Materials

2.1. Crusher

A crusher is a machine designed to reduce large rocks into smaller rocks, gravel, sand or rock dust.

Crushers may be used to reduce the size, or change the form, of waste materials so they can be more easily disposed of or recycled, or to reduce the size of a solid mix of raw materials (as in rock ore), so that pieces of different composition can be differentiated. Crushing is the process of transferring a force amplified by mechanical advantage through a material made of molecules that bond together more strongly, and resist deformation more, than those in the material being crushed do. Crushing devices hold material between two parallel or tangent solid surfaces, and apply sufficient force to bring the surfaces together to generate enough energy within the material being crushed so that its molecules separate from (fracturing), or change alignment in relation to (deformation), each other. The earliest crushers were hand-held stones, where the weight of the stone provided a boost to muscle power, used against a stone anvil.

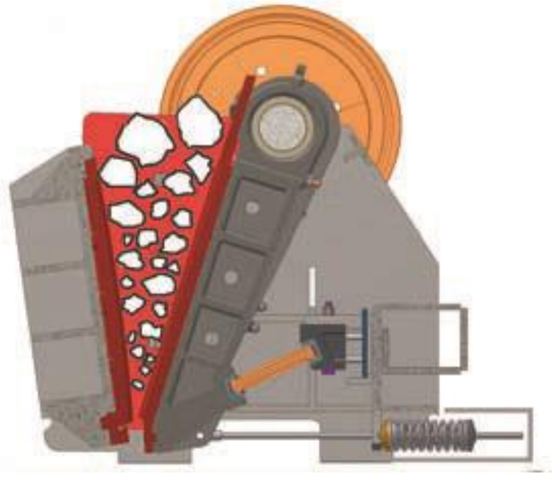


Figure IV.4 Crusher

Figure IV.5 Crusher in our laboratory

2.2. Sieve analysis

A sieve analysis (or gradation test) is a practice or procedure used in civil engineering[1] and chemical engineering[2] to assess the particle size distribution (also called gradation) of a granular material by allowing the material to pass through a series of sieves of progressively smaller mesh size and weighing the amount of material that is stopped by each sieve as a fraction of the whole mass.

The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common[3].

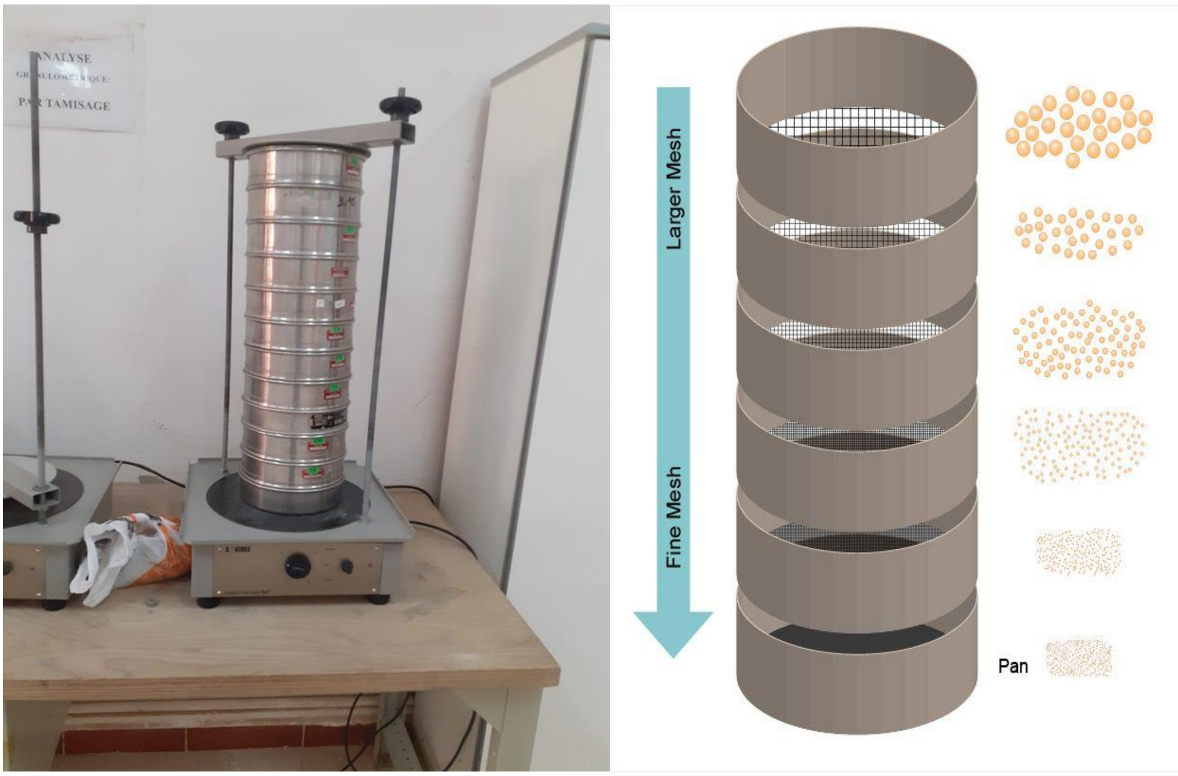


Figure IV.6 sieve analysis

2.3. Oven

An oven is a tool which is used to expose materials to a hot environment. Ovens contain a hollow chamber and provide a means of heating the chamber in a controlled way. In use since antiquity, they have been used to accomplish a wide variety of tasks requiring controlled heating.[2] Because they are used for a variety of purposes, there are many different types of ovens. These types differ depending on their intended purpose and based upon how they generate heat.

Figure IV.7 the oven

2.4. pH meter

A pH meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH.[2] The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to the acidity or pH of the solution.[3] The pH meter is used in many applications ranging from laboratory experimentation to quality control

2.4.1. Principle of operation

Potentiometric pH meters measure the voltage between two electrodes and display the result converted into the corresponding pH value. They comprise a simple electronic amplifier and a pair of electrodes, or alternatively a combination electrode, and some form of display calibrated in pH units. It usually has a glass electrode and a reference electrode, or a combination electrode. The electrodes, or probes, are inserted into the solution to be tested[8].

After each measurement, the pH probe is rinsed briefly with purified water (demineralized, deionized, distilled water, etc.).

Once the campaign has been carried out, the probe must be rinsed, then quickly immersed in the preservation liquid indicated by the manufacturer (examples, depending on the probe model, potassium chloride solution, buffer solution of pH = 4, special electrolyte).

Contrary to some beliefs, the probe should never be wiped clean. The mechanical action destroys the gel present on the bulb of the probe necessary for the correct functioning of the device.

2.5. Electrical conductivity meter

A conductivity meter measures the amount of electrical current or conductance in a solution. Conductivity is useful in determining the overall health of a natural water body. It is also a way to measure changes in wastewater procedures at water treatment plants. Conductivity meters are common in any water treatment or monitoring situation, as well as in environmental laboratories. According the Environmental Protection Agency.

2.5.1. Principle of operation

The meter is equipped with a probe, usually handheld, for field or on-site measurements. After the probe is placed in the liquid to be measured, the meter applies voltage between two electrodes inside the probe. Electrical resistance from the solution causes a drop in voltage, which is read by the meter. The meter converts this reading to milli- or micromhos or milli- or microSiemens per centimeter. This value indicates the total dissolved solids. Total dissolved solids are the number of solids that can pass through a glass-fiber filter.

2.5.2. Conductivity Basics

Conductivity is the electrical current in a solution, but that value depends on the liquid's ionic strength. It also relies on which ions are present, in what concentration and in what form, such as what state of oxidation or mobility the ions are in. Ions carry a negative or positive electrical charge: anions are negative and cations are positive. In natural water bodies, the ions that contribute to high conductivity result from dissolved minerals and salts.

2.5.3. Temperature Dependence

The reading of a conductivity meter is usually without a temperature correlation. Since ionic strength, and therefore conductance, is temperature-dependent, the reading may be inaccurate. Thus, many conductivity meters have a specific conductance measurement as well. When in the specific conductance mode, the meter reads the conductivity of the solution at 25 degrees Celsius, not at the actual temperature. This results in a more standardized reading.

2.6. Turbidimetry

Turbidimetry (the name being derived from turbidity) is the process of measuring the loss of intensity of transmitted light due to the scattering effect of particles suspended in it. Light is passed through a filter creating a light of known wavelength which is then passed through a cuvette containing a solution. A photoelectric cell collects the light which passes through the cuvette. A measurement is then given for the amount of absorbed light [4].

Figure IV.8 Turbidimetry

3.Fabrication of purification Filter GAC

3.1. Filter commercial

Granular activated carbon filter is a filter that contains a certain amount of activated carbon particles. In order to make our own filter and find out information on it, we purchased a commercial filter and tested it as shown below.

Figure IV.9 Commercial granulated activated carbon filter used in home purification system

We open the filter commercial and empty it

Figure IV.10 Recovery of granulated activated carbon from the commercial filter

3.2. Granulometry

Granulometry is the measure of the size distribution in a collection of grains.

In order to perform the test, a sufficient sample of the aggregate must be obtained at the source. To prepare the sample, the aggregate must be thoroughly mixed and reduced to a size suitable for the test. The total mass of the sample is also required.

Particle size curve (commercial carbon filter)

Figure IV.11 The granulometry used to know the particle size of the commercial carbon filter

Sieve Number	Diameter (mm)	Mass of Sieve (g)	Mass of Sieve with Carbon (g)	Carbon Retained (g)	Carbon Retained (%)	Carbon Passing (%)

1	3.15	600	600	0.0	0.0	100.0
2	2.50	596	760	164.0	33.0	67.0
3	2.00	601	764	163.0	32.8	34.2
4	1.60	541	602	61.0	12.3	22.0
5	1.00	491	581	90.0	18.1	3.9
6	0.800	512	519	7.0	1.4	2.5
Pan		370	371	1.0	0.2	0.0
			TOTAL :	**486**	**97.7**	

Tableau IV:1The particle size analyzer used to know the dimensions of the grains

3.3. Proprieties of commercial GAC

- **Grain Size Distribution Curve Results:**

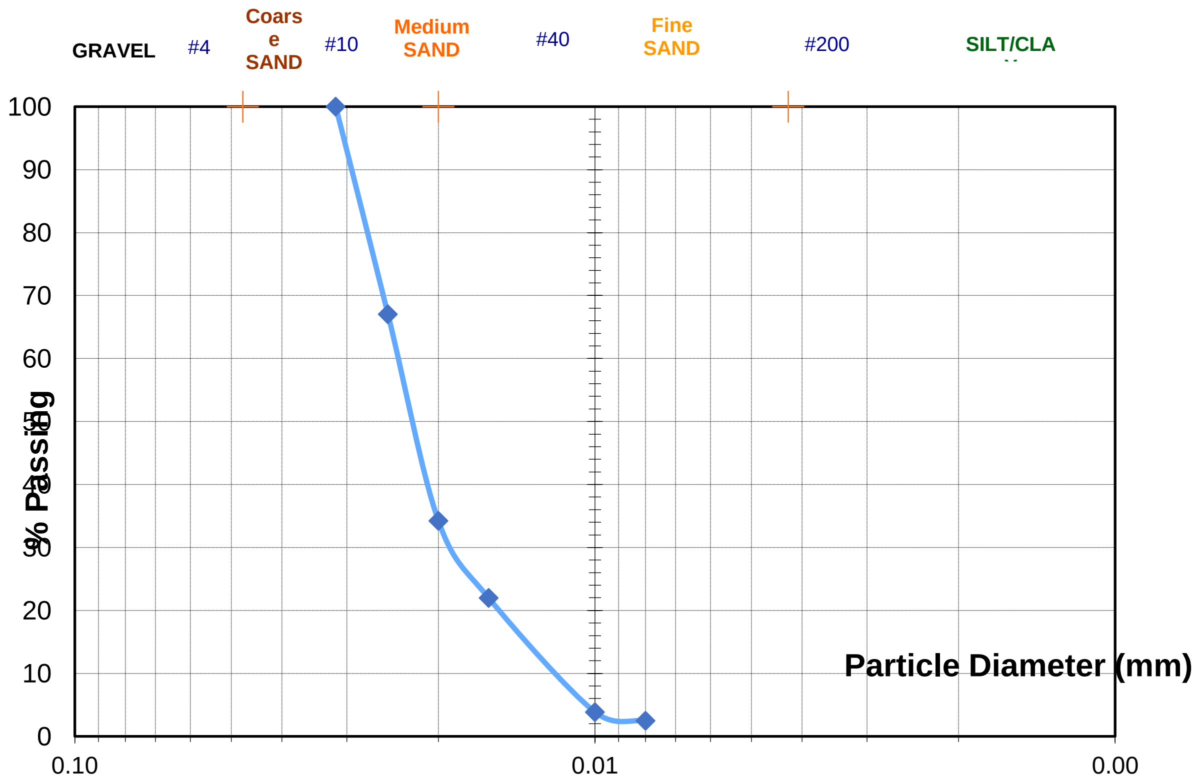


Figure IV.12 Particle size curve on a logarithmic scale

3.4. Stages of GAC Manufacturing

In the interest of obtaining acceptable and rapid results, we have adopted the method of making a filter similar to the one available on the market, and we have followed the steps below.

- **Stage One:**

We select good vegetal charcoal and crush them with a crusher machine, with marked 2.5mm as medium diameter of crushing the process.

Figure IV.13 Raw vegetable charcoal crushed by the machine

- **Stage Two:**

We perform the granular analysis of the crushed carbon using sieve analysis, and we have chosen the following sieve mesh dimensions (2,5mm, 2mm, 1,6mm, 1mm, 0,8 mm).

Figure IV.14Selection of sieves to have the same grain dimensions as those of the commercial filter

Then, we choose the series of sieves closest to the series of commercial carbon is selected in order to have an identical particle size curve. After this operation of separating the grains by diameter, we were able to group together the volumes necessary to form our representative filter.

The following table shows the selection of the screened sieves:

Sieve Number	Diameter (mm)	Carbon Retained (g)	PASSING %
1	2.50	164.0	33,74
2	2.00	163.0	33,54
3	1.60	61.0	12,55
4	1.00	90.0	18,52
5	0.800	7.0	1,65
	Total	**486**	**100%**

Tableau IV.2 sieving result of our carbon sample

- **Stage three:**

3.5. Activated Charcoal Preparation

1. Prepare the 5% solution of potassium hydroxide with water (50 g of potassium hydroxide mixed with 1 liter of distilled water). Be careful when mixing these substances, it will cause the solution to heat up. You will need enough preparation to completely cover the granulated charcoal.

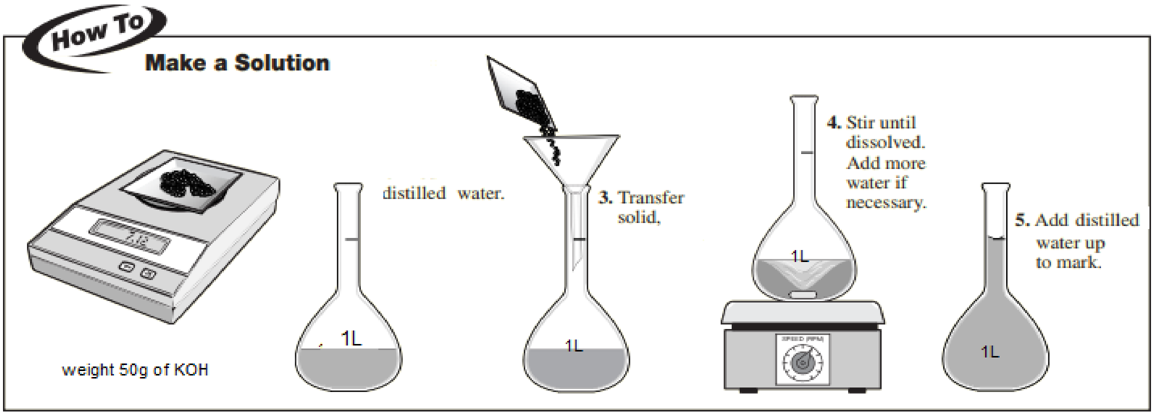


Figure IV.15 Descriptive diagram showing the stages of preparation of the 5% KOH solution

2. Prepare the potassium hydroxide solution set and the granulated charcoal. Place the dry granulated charcoal in a stainless steel or glass bowl then add the potassium hydroxide solution to the charcoal in small increments; stop adding the solution when submerging the charcoal. Stirring with a spoon.

Figure IV.16 Photo shows the charcoal in the activation solution

3. Cover the bowl and let stand granulated charcoal for 24 hours. After that, drain as much as possible. At this point, the charcoal remains moist, but not saturated.

4. Wash the granulated charcoal well several times with distilled water, then put the charcoal in the oven for 1 hour at a temperature of 110 °C to complete the activation.

Figure IV.17 Laboratory drying oven

5. Finally, we put our GAC in the empty cage of a used filter and closed it tightly, then we place it in the water filtration system.

Figure IV.18 Preparation of our GAC filter using an existing packaging

.

- **Stage four:**

3.6. Efficiency GAC by Blue Methylene Test

There are many methods of filtration; all aim to achieve the separation of substances. Separation is achieved by some form of interaction between the substance or objects to be removed and the filter. The substance which must pass through the filter must be a fluid. Filtration methods vary depending on the location of the target material, whether it's dissolved in the fluid phase or suspended as a solid.

There are several filtration techniques depending on the desired result, namely hot, cold and vacuum filtration. Some of the main goals for achieving the desired result are the removal of impurities from a mixture.

3.6.1. Experimental part:

In this experiment, we use granulated activated carbon (GAC) to remove colors and odors in the water, and that was created by adding methylene blue.

The experience reflects the wide application of GAC in organic chemistry and industry, including its use to remove unpleasant tastes and odors from drinking water. Numerous techniques for decontaminating effluents laden with dyes have been developed in recent years.

In our study, we're interested in a very important process which is the phenomenon of adsorption.

We're also experimenting with commercial GACs to compare them with our GAC which was made in the laboratory.

3.6.2. Equipment used

•Beaker, 100 cm^3

•Filter funnel

•Filter paper

•Test tubes, x2

•Test tube rack

•Spatula

3.6.3. Chemicals :

1. Activated charcoal, two spatulas full.

2. Fifteen percent methylene blue solution. Dosage: 15 drops of methylene blue in 1L of distilled water.

Figure IV.19 Preparation of methylene blue solution at such concentration

3.6.4. Procedure

1. Fold a piece of filter paper, place it in a funnel, and put the stem of the funnel above a beaker.

2. Add about two spatulas of activated charcoal to the funnel.

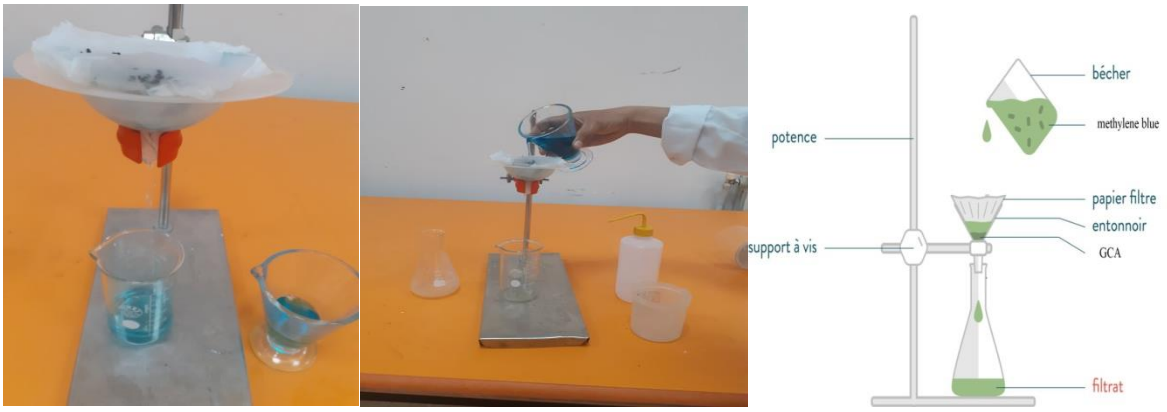


Figure IV.20 Filtration of the methylene blue solution on granulated activated carbon

3. Carefully pour some of the distilled water on to the charcoal in the filter paper. Note whether the drops of liquid in the beaker have lost the original color.

4. Repeat the activity, this time pour $100cm^3$ of methylene blue through the charcoal. Note whether the filtered liquid has lost some of its original strong color.

3.6.5. RESULTS

1.Commercial GAC filter (I)

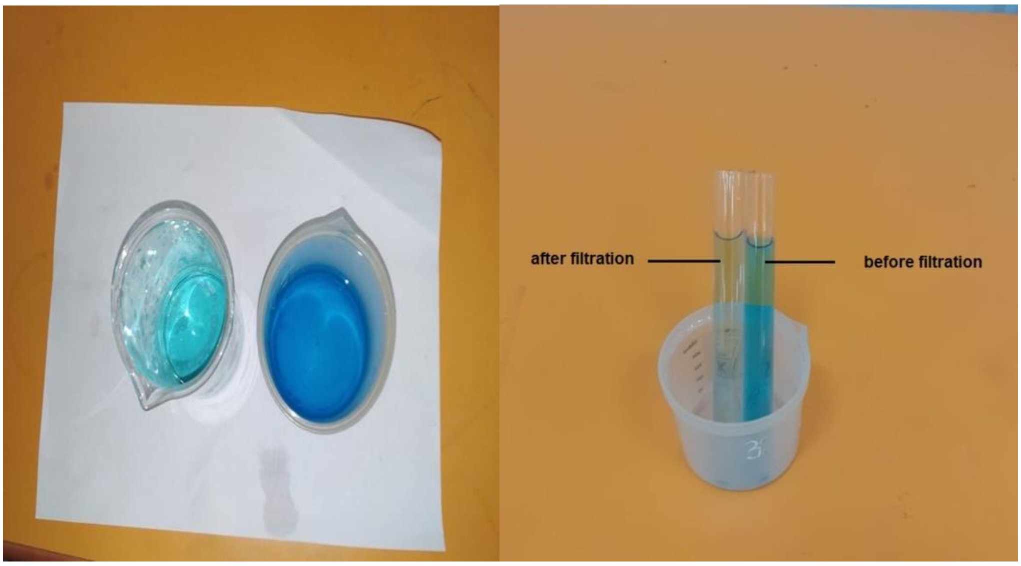


Figure IV.21 Photos showing the color change of the methylene blue solution before and after filtration (commercial Activated carbon of Filter I)

Visual comparison of the solution before and after filtration (passage through the GAC samples) was treated.

It's observed with the eye that the intensity of the color has decreased, which indicates that the activated granulated carbon has adsorption present in front of the pollutants of drinking water.

2.Another commercial GAC filter (II)

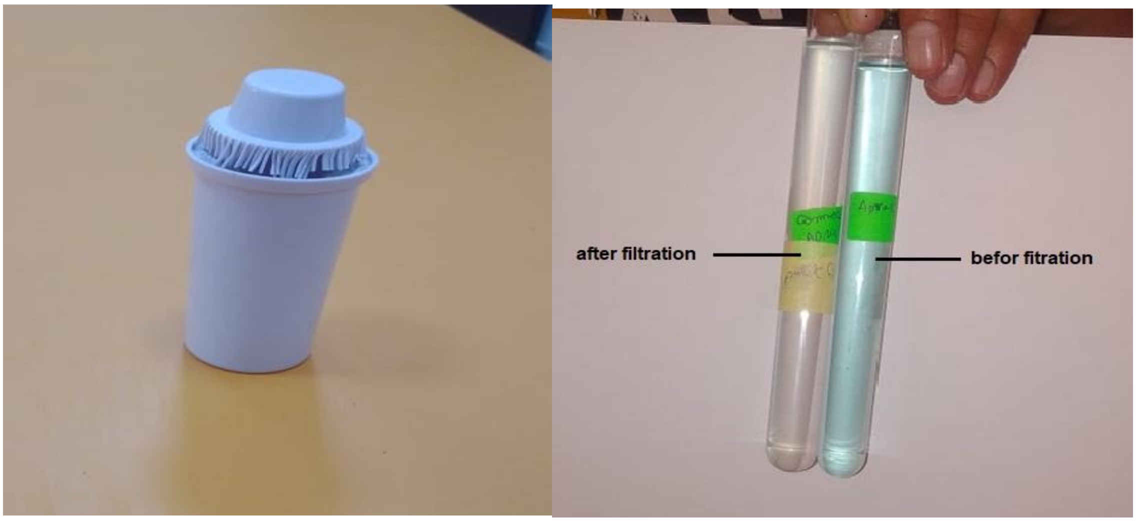


Figure IV.22 Photos showing the color change of the methylene blue solution before and after filtration (commercial Activated carbon of Filter II)

3. Our Granular Activated Carbon (GAC)

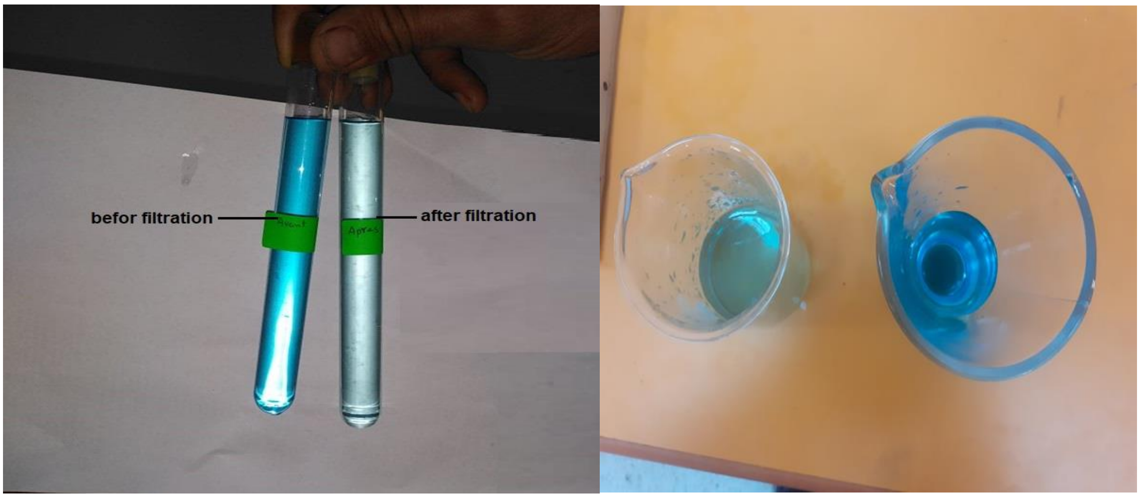


Figure IV.23 Photos showing the color change of the methylene blue solution before and after filtration (local Activated carbon)

It's also noted that the intensity of the color has decreased, which shows the presence of the positive effect of the adsorption of GAC.

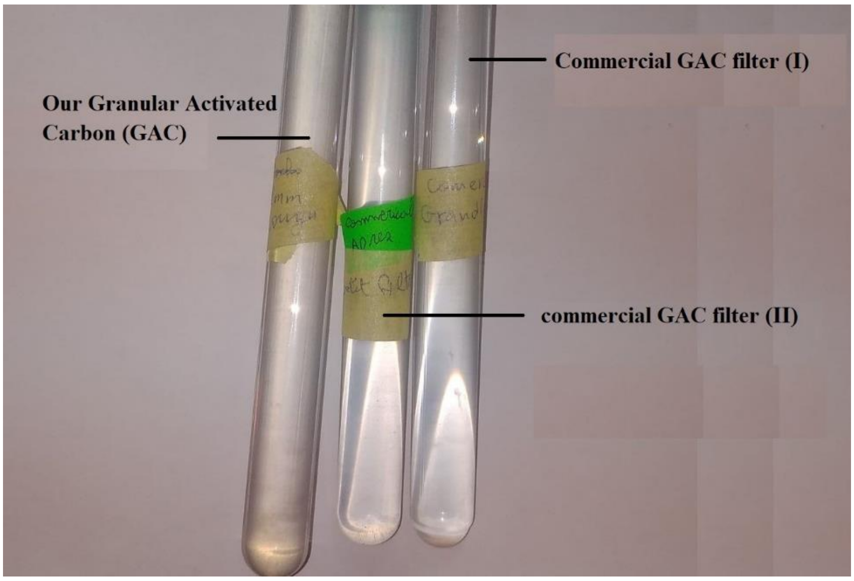


Figure IV.24 Photos showing the visual comparison between the different samples of solution after filtration

After filtering the solutions, it's found that the color results are almost the same.

Our granular activated carbon filter gave us the best result as its brand new and has been carefully made in the lab, as well as the new activation method using KOH.

4.Spectrophotometre analysis

We conducted a Spectrophotometer analysis of methylene blue solution before and after passing through

- Our Granular Activated Carbon Filter
- big Commercial Granular Activated Carbon Filter
- And little Commercial Granular Activated Carbon Filter

The analysis by this instrument is based on the fact that any colored solution crossed by a beam of light allows a fraction of incident light to pass, the amount of light absorbed is proportional to the concentration of the desired colored compound

The absorbance of the previously prepared methylene blue solutions is measured at 664 nm

	Before filtering	After filtering		
	methylene blue solution	our filter	big commercial filter	little commercial filter
transmittance %	50,8	90,2	83,6	71,6
absorbance	0,295	0,039	0,079	0,145

The relationship between the permeability ratio and the absorption rate is inversely proportional, the higher the permeability ratio, the lower the absorption rate

We note that the percentage of transmittance in the methylene blue solution before filtering was in the range of 50, meaning that a large proportion of the light was absorbed, and after filtering in 3 filters, we noticed that the percentage of transmittance increased and this is evidence that the solution was purified well, In the granular activated carbon manufactured by us, the light transmittance ratio was in the range of 90.2, and this indicates that our carbon is better because it is well prepared, while in the large filter the ratio was 83.6 and in the small filter it was 71.6.

Figure IV.25 Spectrophotometer

3.7. Testing GAC filter

Description of purification system: We connect our filter and the commercial filter on the branch with the same inlet, taking into account the flow, where it must be equal, and we connect each outlet with the flow regulator in order to change the flow and know its effect on the system

Inlet parameters:

Water flow(0,4L/min-0,2L/min),

PH of inlet water (8,2)

Turbidity of inlet water (0.40-0.50NTU)

Conductivity of inlet water (1808-1790 µS)

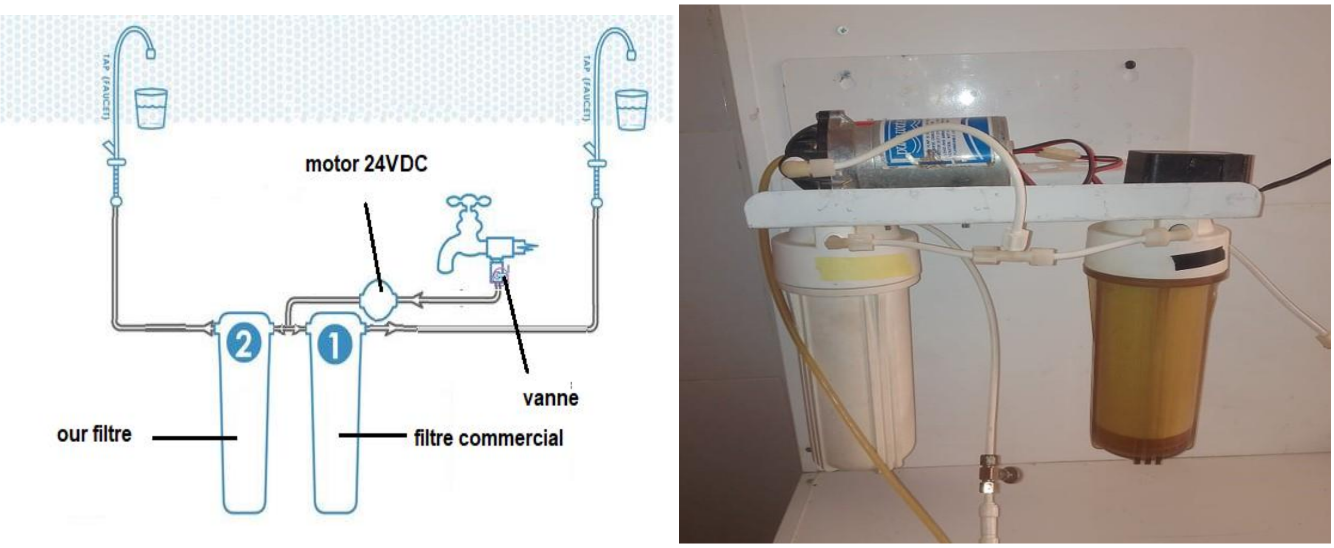


Figure IV.26 Schema of testing system

3.7.1. Results

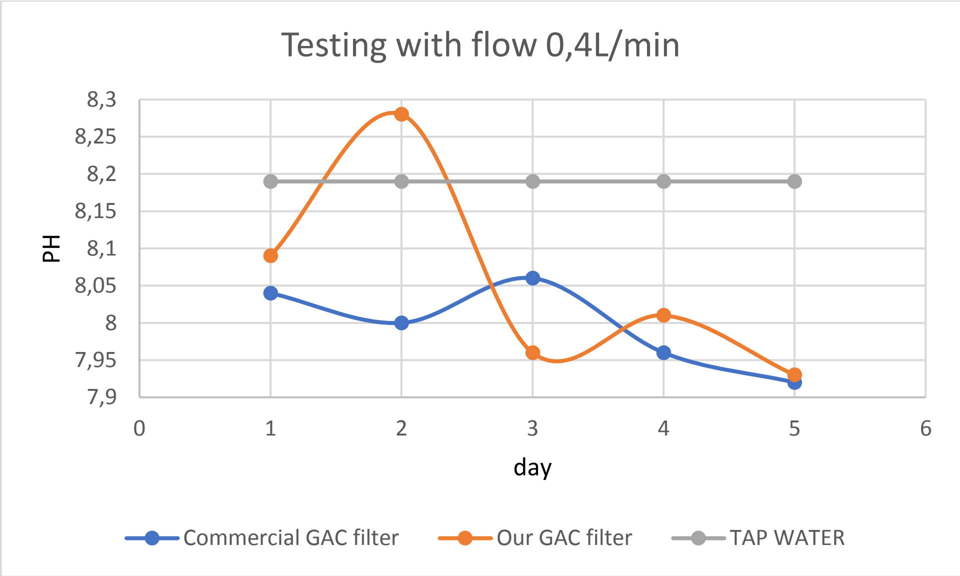
Outlet parameters:

pH measure:

Figure IV.27 Photo taken during the measure of pH

Testing with flow 0,4L/min			
Number	pH		
DAY	Commercial GAC filter	Our GAC filter	TAP WATER
1	8,04	8,09	8,19
2	8	8,28	8,19
3	8,06	7,96	8,19
4	7,96	8,01	8,19
5	7,92	7,93	8,19

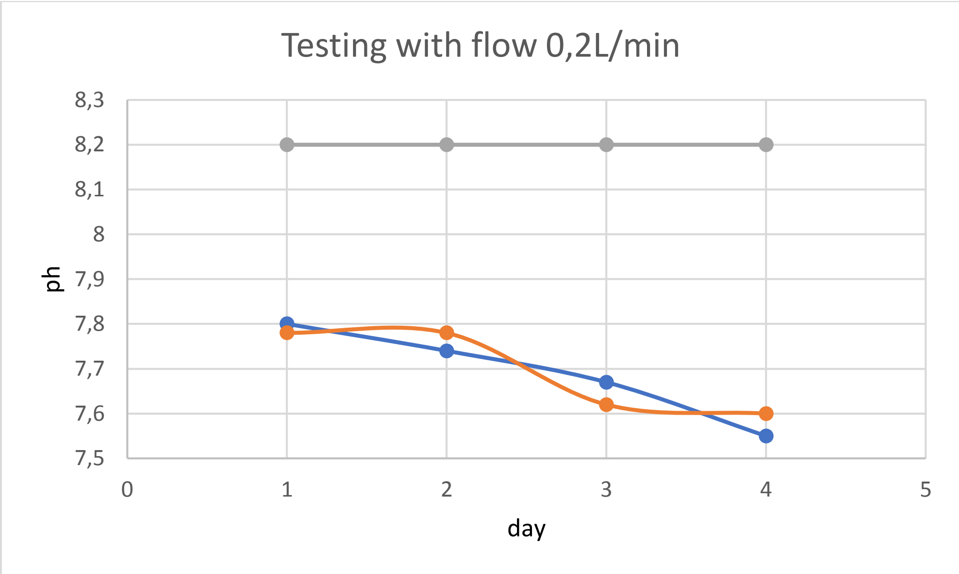
Tableau IV.3Testing PH with flow 0,4L/min



Ph in the first week The first week: We turned on our system and let it run 3 hours every day with a flow of 0.4 liters per minute at a rate of 72 liters per day. We notice from the curve (pH curve) that In our filter, the pH curve on the first day and the second day has slightly increased from the average pH in the tap water and this is due to our preparation of activated carbon using potassium hydroxide acid solution (granules of activated carbon moistened with acid solution) and starting from the third day the pH curve decreased and this is for the purity of the activated carbon granules from the acidic solution, and did its role to purify the water and reduce the pH level in the commercial filter We note that the pH curve decreased, and this is due to the purification of the water by the activated carbon granules .

Testing with flow 0,2L/min			
Number	pH		
DAY	Commercial GAC filter	Our GAC filter	TAP WATER
1	7,8	7,78	8,2
2	7,74	7,78	8,2
3	7,67	7,62	8,2
4	7,55	7,6	8,2

Tableau IV.4 Testing PH with flow 0,2L/min



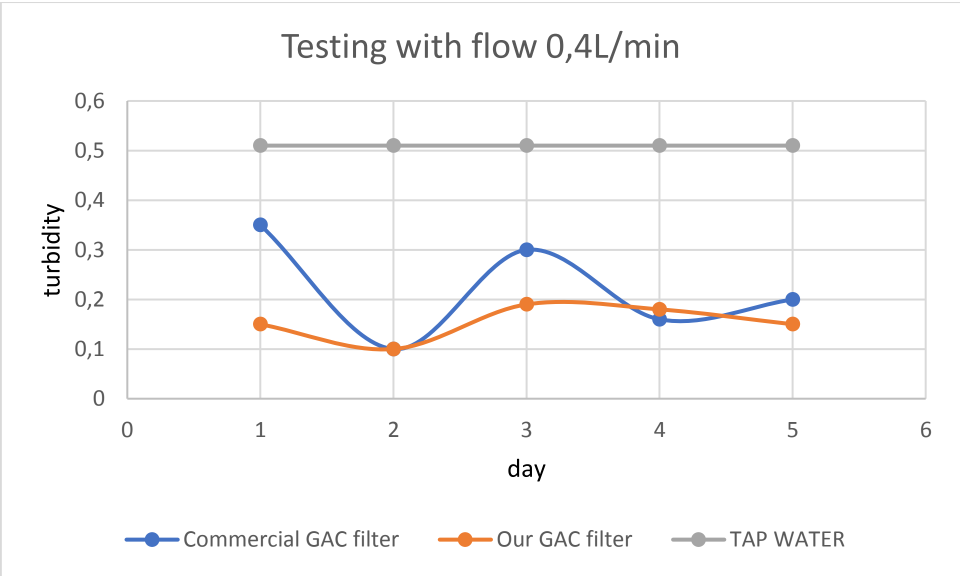
Ph in the second week the second Week: We turned on our system and let it run 3 hours each day with a flow of 0.2 liters per minute at a rate of 36 liters per day We noticed in our filter. The pH curve is decreasing compared to the pH rate in tap water from day one to day four, and this is evidence that our filter is working at a high efficiency in the commercial filter, we show that the pH curve has decreased in a gradual manner, compared to the pH value in tap water.

Turbidity measure:

Figure 28 photo taken during the measure of Turbidity

Testing with flow 0,4L/min			
Number	Turbidity (NTU)		
DAY	Commercial GAC filter	Our GAC filter	TAP WATER
1	0,35	0,15	0,51
2	0,1	0,1	0,51
3	0,3	0,19	0,51
4	0,16	0,18	0,51
5	0,2	0,15	0,51

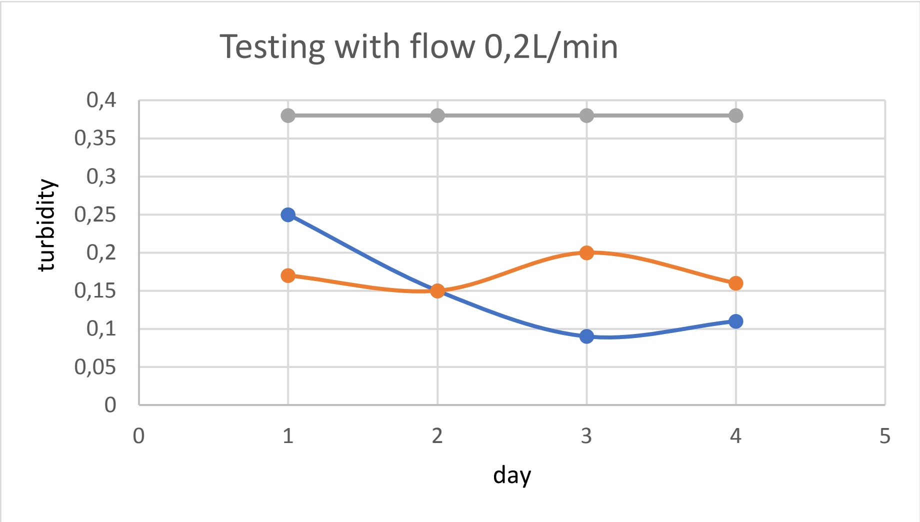
Tableau IV.5 Testing turbidity with flow 0,4L/min



Turbidity in the first week The first Week: We turned on our system and let it run 3 hours each day with a flow of 0.4 liters per minute at a rate of 72 liter per day. We notice in our filter and on the first day until the third day the turbidity decreased value compared to tap water, but the performance of the commercial filter was better and this is due to the fact that our activated carbon still emits a little gray (not washed it well), and from the fourth day the performance was better . In the commercial filter, the turbidity value gradually decreased, and this is due to the filter's role in purifying the water.

Testing with flow 0,2L/min			
Number	Turbidity (NTU)		
DAY	Commercial GAC filter	Our GAC filter	TAP WATER
1	0,25	0,17	0,38
2	0,15	0,15	0,38
3	0,09	0,2	0,38
4	0,11	0,16	0,38

Tableau IV.6 Testing turbidity with flow 0,2L/min

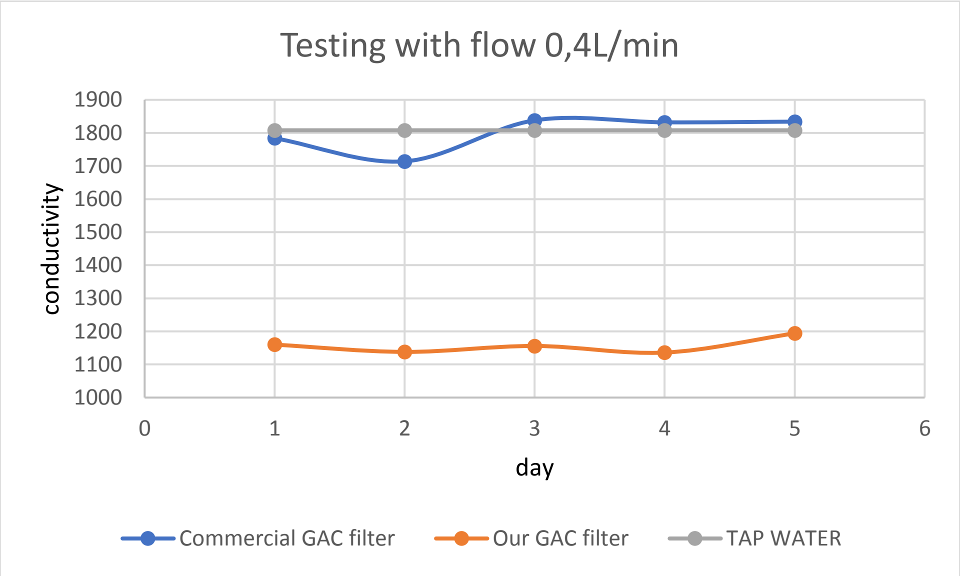


Turbidity in the second week Week 2: We turned on our system and let it run 3 hours each day with a flow of 0.2 liters per minute at a rate of 36 liters per day in our filter, we notice that the turbidity value is decreasing, and this is due to the action of the activated carbon granules to purify the water and get rid of unwanted colors in the commercial filter, the turbidity curve is decreasing.

Conductivity measure:

Testing with flow 0,4L/min			
Number	Conductivity (µS)		
DAY	Commercial GAC filter	Our GAC filter	TAP WATER
1	1784	1160	1808
2	1714	1138	1808
3	1838	1156	1808
4	1832	1136	1808
5	1834	1194	1808

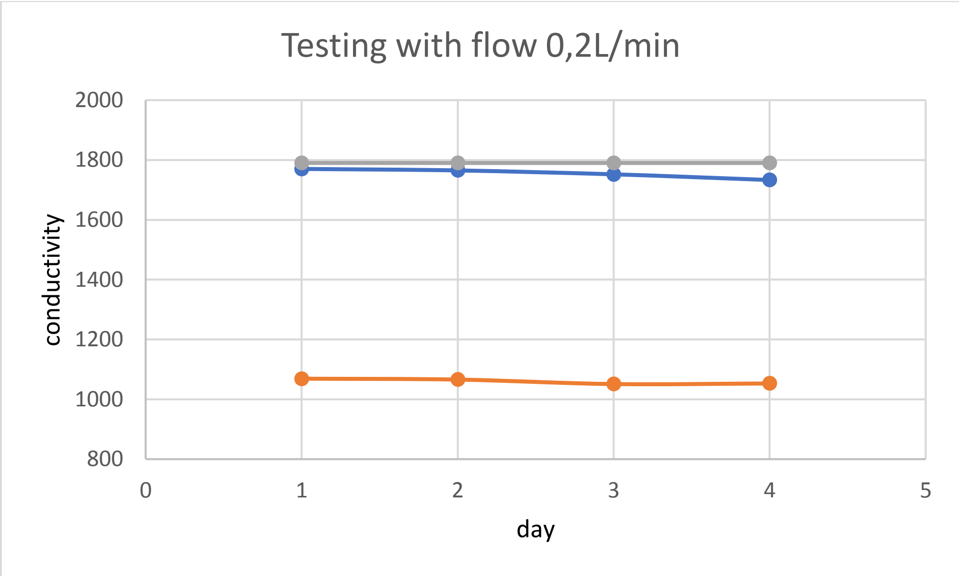
Tableau IV:7Testing conductivity with flow 0,4L/min



Conductivity in the first week 1: We turned on our system and let it run 3 hours each day with a flow of 0.4 liters per minute at a rate of 72 liters per day. In our filter, we notice that the conductivity value decreased from 1808 in tap water to 1160 after filtering on the first day, and this is evidence of the high performance of our filter, and the curve continued to decrease, evidence of the effectiveness of activated carbon granules in removing dissolved substances in water. In the commercial filter, we notice that the curve of the conductivity value is slightly decreasing, and this is evidence that the performance of the filter was poor, and this may be due to the old filter (a used filter that has been reactivated).

Testing with flow 0,2L/min			
Number	Conductivity (µS)		
DAY	Commercial GAC filter	Our GAC filter	TAP WATER
1	1770	1069	1790
2	1765	1066	1790
3	1752	1051	1790
4	1733	1053	1790

Tableau IV.8 Testing conductivity with flow 0,2L/min



Conductivity in the second week The second Week : We turned on our system and let it run 3 hours each day with a flow of 0.2 liters per minute at a rate of 36 liters per day We note in our filter the performance of the filter in reducing the total dissolved substances has improved more and this is after reducing the flow value In the commercial filter, the curve was decreasing very slightly, and this was due to the reason mentioned above Conclusion We conclude from the above the effectiveness of granular activated carbon in providing pure water and getting rid of many pollutants, undesirable colors and odors We also conclude that the filter performance is better the lower the flow (the longer the water stays in contact with the granular carbon, provides better water purification).

4.Conclusion

Carbon has a long history of being used as a water softener, and it is one of the most important and easiest ways to provide pure water, and it has many forms of use. One of the uses of carbon is the granular form, where our experimental study proved the effectiveness of the granular activated carbon filter in obtaining pure water.

In our study, we were able to manufacture a granular activated carbon filter by simple and low-cost methods by imitating a commercial filter, and we were able to obtain great results in water purification with our filter.

VI. conclusion

Many consumers are not satisfied with the quality of tap water due to problems such as smell, color, excess chlorine content and undesirable taste. Because of these problems, trucks selling spring water have proliferated in M’sila, providing citizens with an alternative solution to tap water.

We focused in the first axis of our study on water quality, and the most important physical and chemical properties, we found that the quality of drinking water contains many pollutants that affect the taste and smell of water and even color, and these pollutants can become a threat to human health.

The causes of these problems are mainly due to the deterioration of the water delivery infrastructure, such as the network, main pipelines and storage tanks; The spread of chlorine smell as a result of the use of chlorine as a water disinfectant by the competent authorities, and the length of the water storage period in cabinets also cause undesirable odors.

Water pollution problems prompted people to search for solutions to get healthy and pure water Free from unwanted odors and tastes.

In the second axis of our study, we focused on one of these solutions, which are the water purification system, which contains several filters, each filter removing certain impurities from the water. Each filter can be used separately, but for greater effectiveness we need to use a combined system.

We found that the system is highly effective in purifying water, providing healthy water and getting rid of impurities (suspended materials such as sand and clay through a membrane filter, chemicals that cause odors through a carbon filter, minerals and salts and dissolved solids through a reverse osmosis filter).

Adsorption is a particularly important phenomenon in the removal of pollutants from water. Carbon is one of the most important adsorbents present and its adsorption strength is attributed to the porosity, specific surface area and surface functional groups.

In the third axis of our study, we focused on carbon, its source and method of preparation. We found that carbon has a long history of being used as a water softener and is one of the most important and easiest ways to provide pure water. It also has several forms of use, being used as granules, powder and even block.

In the fourth axis of our study, we focused on a granular activated carbon filter commercial and made a similar filter and tested its performance. We installed our filter and another commercial filter in a system that allows water to pass through the filters at the same time. Laboratory experiments were conducted on water samples in order to correct a water quality problem. We focused on measuring turbidity, conductivity and pH before and after the filtration process.

Through our in vitro study, we found that the granular activated carbon is effective in removing color (methylene blue adsorption experiment) and is considered one of the best adsorbents in the field of water pollution control, where the results were very satisfactory, the activated carbon granules were effective in reducing the conductivity and this is evidence of concern. of total dissolved substances; He also adjusted the pH value and lowered the turbidity in a good way, showing us that the effectiveness of our filter was better than the commercial one.

The production cost of the granular activated carbon filter was low, and its manufacturing method was easy and uncomplicated.

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abstract

Many consumers are not satisfied with the quality of tap water due to problems such as odor, color, excessive chlorine content and unacceptable taste.

Our study was completed on the domestic water purification system and the filters in the system. In our study, we focused on active carbon and its most important properties, method of preparation, and its most important types. We also talked about the adsorption phenomenon, its properties and method of operation.

In the last axis we focused on the granular activated carbon filter and made our own filter similar to the commercial filter.

We tested the filter by adsorption of methylene blue, we compared our filter and the commercial filter by measuring the pH, conductivity and turbidity in the water before filtration and after filtration

Résumé

De nombreux consommateurs ne sont pas satisfaits de la qualité de l'eau du robinet en raison de problèmes tels que l'odeur, la couleur, une teneur excessive en chlore et un goût inacceptable.

Notre étude a été réalisée sur le système de purification d'eau domestique et les filtres du système. Nous nous sommes également concentrés dans notre étude sur le charbon actif et ses propriétés les plus importantes, sa méthode de préparation et ses types les plus importants. Nous avons également évoqué le phénomène d'adsorption, ses caractéristiques et son mode de fonctionnement.

Dans le dernier axe, nous nous sommes concentrés sur le filtre à charbon actif granulaire et avons fabriqué notre propre filtre similaire au filtre commercial.

Nous avons testé le filtre par l'adsorption de bleu de méthylène, nous avons comparé notre filtre et le filtre du commerce en mesurant le pH, la conductivité et la turbidité dans l'eau avant filtration et après filtration

ملخص

العديد من المستهلكين غير راضين عن جودة مياه الصنبور بسبب مشاكل مثل الرائحة واللون ومحتوى الكلور الزائد والطعم غير مقبول

تمثلت دراستنا حول نضام تنقية المياه المنزلية وعلى المرشحات التي في النظام

ركزنا في دراستنا على الكربون النشط وعلى أهم خصائصه وطريقة تحضيره واهم أنواعه، كما تحدثنا على ظاهرة الامتزاز وخصائصها وطريقة عملها

في المحور الأخير ركزنا على فلتر الكربون النشط الحبيبي وصنعنا فلتر خاص بنا مشابه للفلتر التجاري

قمنا بالتجربة المرشح بواسطة امتصاص المثيلين الأزرق، قمنا بالمقارنة المرشح الخاص بنا والمرشح التجاري عن طريق قياس الأس الهيدروجيني والناقلية والعكارة في الماء قبل الترشيح وبعد