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Efficacy of Activated Carbon in Removing Sulphate and Chloride from Sea Water

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Abstract: *Water is a finite resource crucial for all aspects of life on earth. With the growing population and increasing demands in various sectors it is necessary to mitigate water scarcity and thus promote environmental sustainability. To reduce water scarcity recycling, reusing of water methods can be adoptedEarth has a high level of sea water while the oceans constitute approximately 70 percent of the planet's area. Because of this, seawater is one of the planet's most abundant resources. However not all seawater is readily available or useful because of things like distance from coastal regions, desalination technology limits, and environmental issues. Treating seawater or waste water to remove contaminants and impurities, making it suitable for non-potable purposes like irrigation, toilet flushing, car washing etc. Sulphate and chloride, when present in elevated concentrations, not only affect the taste and quality of sea water but also contribute to corrosion issues in infrastructure. Sulphates can react with organic matter present in water and form sulphides which are toxic to aquatic life Based on current technology the adsorption method is an effective approach as it is sustainable and cost effective. Activated carbon can be sustainable solution for the removal of contaminants from sea water. Activated carbon has a large surface area and the porous structure enhance the adsorption capacity. This study investigates the efficacy of activated carbon in removing chloride and sulphate ions from seawater through adsorption processes. The experimental setup involves batch adsorption experiments using varying concentrations of activated carbon also time, pH in artificial seawater samples. The experimental study shows that 20g/l activated carbon can remove 83.33% of chloride (influent chloride concentration is 18000mg/L) and 44.46% of sulphate (influent sulphate concentration is 26181mg/L) from synthetic sea water at pH 5.15. The results indicate that activated carbon effectively removes chloride and sulphate ions from seawater, with higher removal efficiencies observed at higher activated carbon concentrations and longer contact times. Ultimately, this study offers hope for better sea water purification, crucial for communities facing water shortages.*

Key Word: *Activated carbon, Adsorption, chloride, sulphate.*

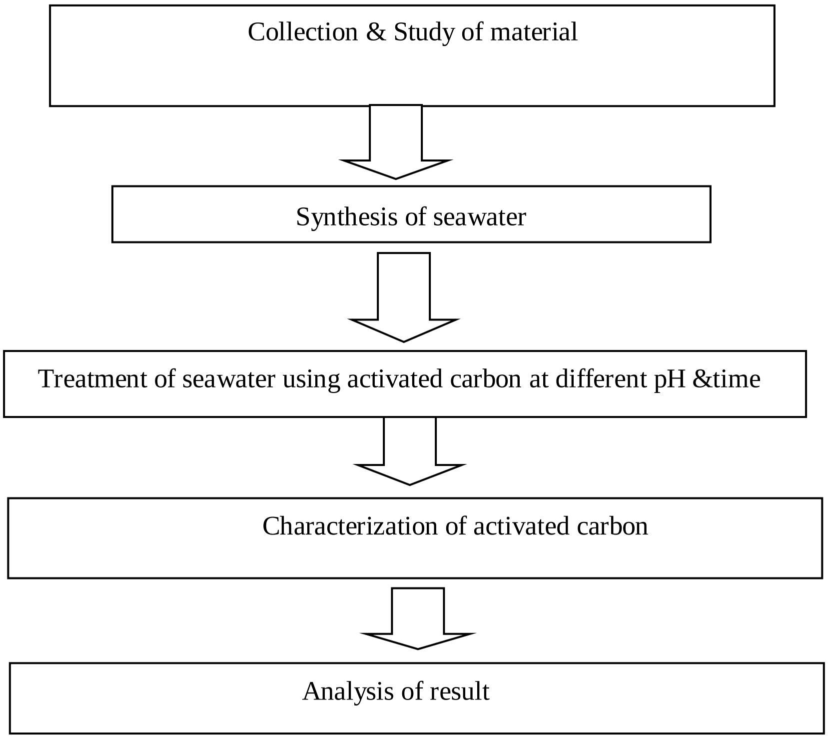
I.INTRODUCTION

The most important and essential component for every organism on earth is water. However, as civilization improves and industry and population growth, the quality of the water supplies is gradually increasing. Water treatment provides an alternate water source, reducing dependence on natural freshwater resources such as lakes, rivers, and groundwater. Investigators have been giving attention to the removal of pollutants from water because of their serious health effects. As climate change impacts water availability, treated water can serve as a strong solution, secure access to water for non-potable purposes even during periods of drought and also reduces water pollution. Chloride has a tendency to cause environmental harm and maintenance problems when it comes to the corrosion of many structures, including ships, pipelines, and coastal infrastructure. Sulphates may result in corrosion in plumbing systems, especially if added to additional substances like high chloride or low pH time, this can lead to damage to appliances, fixtures, and pipes. The study involves investigation on synthetic sea water using activated carbon as an absorbent in the treatment. Sea water contains various contaminants such as heavy metal, micro pollutants and microorganisms. experiment deals with the reduction and minimization of various pollutants and contaminants from sea water. Adsorption is most effective and economical method for removing contaminants from sea waterActivated carbon is an excellent adsorbent for a wide range of substances, including organic compounds, substances, and contaminants like sulphate, chlorine, and other ions. The common method for making activated carbon is called activation, and it involves heating carbon-based substances to high temperatures. Its huge surface area, as big pores, make this possible. These contaminants attach to the surface of activated carbon when water containing them comes into contact with it, removing the contaminants from the water.

II.MATERIAL AND METHODS

2.1 Materials

The chemicals used for study are sodium chloride, magnesium chloride, magnesium sulphate, calcium sulphate, potassium sulphate, calcium carbonate, magnesium bromide. Sulphuric acid and sodium hydroxide used for varying pH, KCl solution for calibration of electric conductivity, Buffer capsule of pH 4 and pH 7 is used for calibration of pH. Activated carbon is used as adsorbent. Potassium chromate is used for preparation of potassium chromate indicator. Silver nitrate is used for preparation silver nitrate. Distilled water is used for entire experiment



2.2 Preparation of Synthetic seawater

Artificial seawater provides a standardized medium, allowing scientists to conduct experiments and analyze the impact of various components present in sea water. The preparation of artificial seawater requires careful consideration of the key components found in natural seawater. These include distilled water, sodium chloride (NaCl), magnesium sulphate ($MgSO_4 \cdot 7H_2O$), calcium chloride ($CaCl_2 \cdot 2H_2O$), and potassium chloride (KCl). Each component contributes to replicating the salinity, mineral content, and pH of natural seawater. Composition of se water is prepared from Reference (iv)

Table 2.2: Composition of synthetic sea water

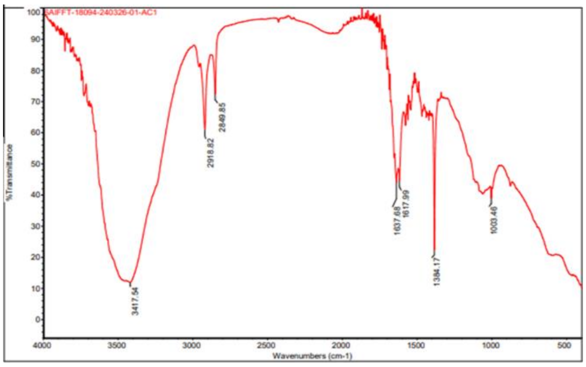
SALT	CHEMICAL FORMULA	AMOUNT	% OF TOTAL SALT	REMARKS
Sodium chloride	NaCl	27.21	77.74	These amount of salts were dissolved in plain water to prepare 1000gm of sea water in concentration.
Magnesium chloride	$MgCl_2$	3.81	10.89	
Magnesium sulphate	$MgSO_4$	1.66	4.74	
Calcium sulphate	$CaSO_4$	1.26	3.60	
Potassium sulphate	K_2SO_4	0.86	2.46	
Calcium carbonate	$CaCO_3$	0.12	0.34	
Magnesium bromide	$MgBr_2$	0.08	0.23	

2.3 Activated carbon

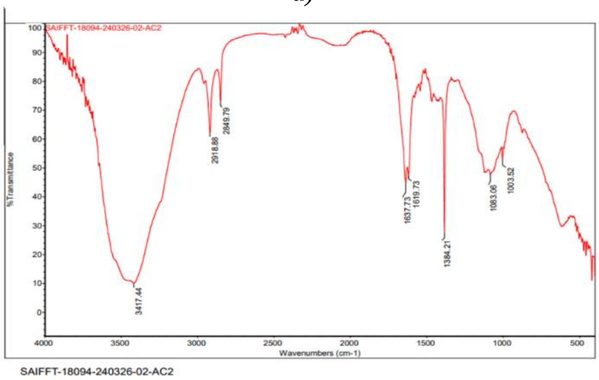
Activated carbon, it is also known as activated charcoal, is a very porous carbon that has a network of small pores and a huge internal surface area. Activated carbon is available in various forms such as granular activated carbon, powdered activated carbon. activated carbon fibbers etc. Among this granular activated carbon has high adsorption capacity as compared to other types of activated carbon. Here, we are using 18 particle size granular activated carbon for the removal of chloride and sulphate from synthetic sea water. Adsorbent was purchased from chemik chemicals, Thrissur.

2.4 Characterisation of activated carbon

Characterisation of activated carbon is done through FTIR, SEM. The physical, structural, and chemical properties of activated carbon are evaluated using SEM, EDAX and FTIR characterization.



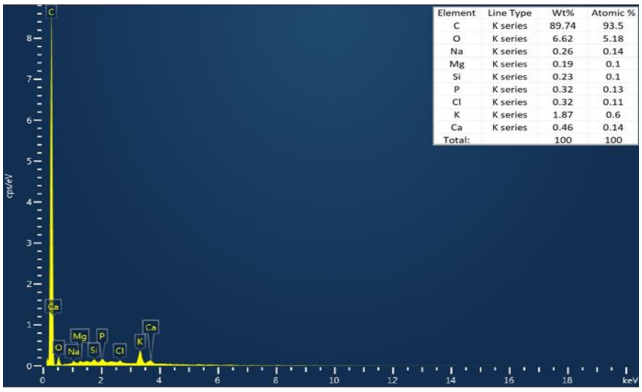
a)



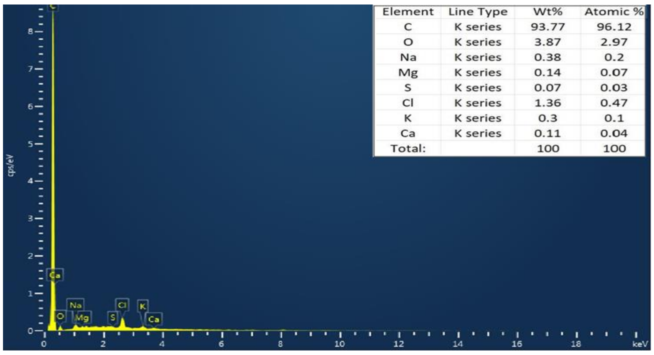
b)

Fig 2.4.1: -a) Ftir result before treatment of activated carbon b) Ftir result after treatment of activated carbon

FTIR analysis helps to identify surface functional groups of the absorbent before and after treatment. FTIR analysis after treatment of activated carbon as shown in figure 3.2.1 b) shows slight variation in peak levels are shifted because of reactions takes place and a new peak is formed due to the presence of C–O group in the sample.



a)



b)

Fig 2.4.2: -a) EDAX result before treatment of activated carbon b) EDAX result after treatment of activated carbon

The elemental makeup of activated carbon can be determined using EDX analysis. It is capable of identifying elements such as carbon (C), oxygen (O), hydrogen (H), nitrogen (N), sulphate (S), and other trace elements that could be present based on the activated carbon's production processes and source. The results show the increased concentration of chloride in as compared to before treatment

III.RESULT AND DISCUSSION

3.1 sulphate and chloride

The analysis of activated carbon in removal of sulphate was done by varying the time from 15 minutes to 105 minutes. The pH also varied from 5.15,6.15,7.15,8.15 and 9.15 correspondingly. Amount of sample taken as 200 ml. The chemical analysis was done according to standard procedure and the results are tabulated below for sulphate and chlorides. The maximum removal efficiency is denoted from a constant pH, concentration of sample and time. Within maximum time and pH absorbent is added correspondingly to the sample The removal of sulphate is done by adding varying amounts of adsorbent in different pH of samples as shown in table 3.1. The maximum removal of sulphate from sea water is obtained as 44.165 % while adding 20g/L of adsorbent as shown in figure 3.1 (b).

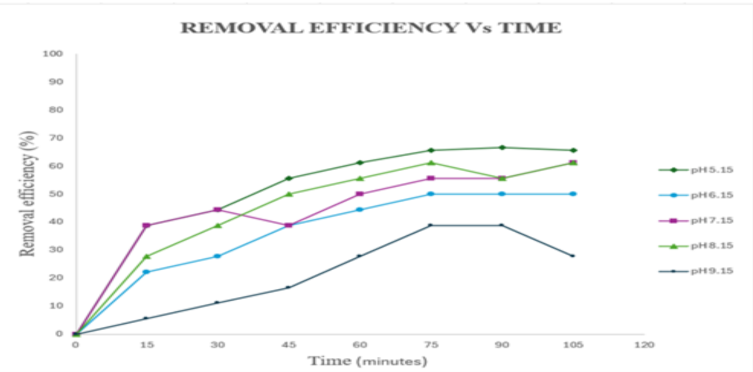
Table 3.1: Removal efficiency of sulphate in varying adsorbent

parameter	After treatment	
	Amount of Adsorbent (g/l)	Removal efficiency (%)
sulphate	2.5	37.17
	5	40.56
	10	41.036
	15	43.797
	20	44.46
	25	40.944

The analysis of activated carbon in removal of chloride was done by varying the time from 15 minutes to 105 minutes. The pH also varied from 5.15,6.15,7.15,8.15 and 9.15 correspondingly. Amount of sample taken as 200 ml. The chemical analysis was done according to standard procedure and the results are tabulated below for sulphate and chlorides. The maximum removal efficiency is denoted from a constant pH, concentration of sample and time. Within maximum time and pH absorbent is added correspondingly to the sample The removal of chloride is done by adding varying amounts of adsorbent in different pH of samples as shown in table 3.1.1 The maximum removal efficiency of chloride is 55.55% while adding 10g/L of adsorbent as shown in the figure3.1.1

Table 3.1.1: -Removal efficiency of chloride in varying adsorbent

parameter	After treatment	
	Amount of Adsorbent(g)	Removal efficiency (%)
chloride	2.5	11.11
	5	35.210
	10	41.036
	15	55.555
	20	83.333
	25	72.222



a)

b)

Fig 3.1.1: -a) Removal efficiency vs time graph of chloride b) Removal efficiency vs time graph of sulphate

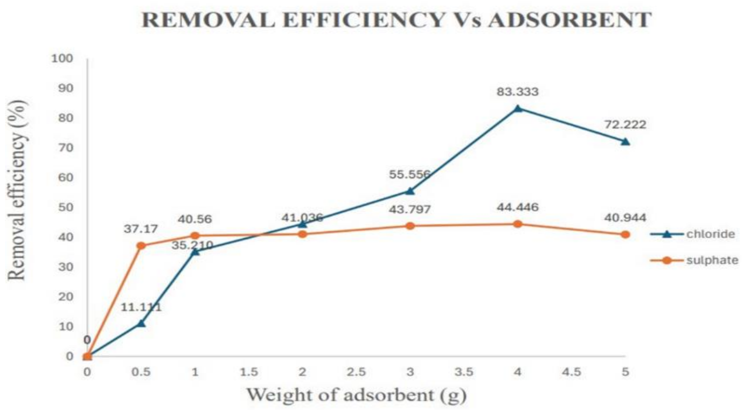


Fig 3.1.2: - a) Removal efficiency of chloride and sulphate in varying adsorbent

The reason for the removal due to positive and negative ions attraction also due to the porous structure and size of the adsorbent added and dosage etc. The adsorption capability of activated carbon can be restored through heating. For removing sulphate and chloride ions from water, this makes it a reasonable and reusable treatment.

IV.CONCLUSION

The study investigates the removal of chloride and sulphate from synthetic sea water. Activated carbon plays a crucial role in the removal of chloride and sulphate. In an acidic medium, activated carbon effectively removes impurities due to the strong attraction between its surface and positively charged hydrogen ions (H+). Conversely, in a basic medium, the presence of negatively charged hydroxide ions (OH-) weakens the attraction to activated carbon, leading to lower removal efficiency. The study investigates that removal efficiency of chloride and sulphate from synthetic sea water here the adsorbent is used to removal is Granular activated carbon of 18 particle size. This adsorbent is used to check the physiochemical parameter such as chloride and sulphate present in synthetic sea water before analysis is done for varying pH and time. And here the maximum removal is obtained at Ph of 5.15 corresponding removal of chloride and sulphate are 83.33 and 44.466respectively and 20g/L of adsorbent were added for the entire removal. This method can be adopted for the treatment of sea water and treated sea water used for toilet flushing, car washing, gardening etc. also it helps in reducing the consumption of fresh water, thus the impact of water scarcity in many regions can be reduced. from the analysis adsorption amount of chloride is increased in after treatment of the activated carbon. Thus, we can conclude that activated carbon is good adsorbent for the removal of chloride and sulphate from sea water.

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