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# USE OF GRANULAR ACTIVATED CARBON FOR THE TREATMENT OF SEA WATER

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## ABSTRACT

Activated carbon filtration (AC) is effective in reducing certain organic chemicals and chlorine in water. It can also reduce the quantity of lead in water although most lead-reducing systems use another filter medium in addition to carbon. Water is passed through granular or block carbon material to reduce toxic compounds as well as harmless taste and odor-producing chemicals. The study examined the use of granular activated carbon (GAC) pre-treatment for minimization of seawater contents and removal of organic micro pollutants. Batch experiments were carried out for different variables such as time and weight of adsorbent. Reduction in dissolved salts was about 60%.

**Keywords**: Granular activated carbon (GAC), Pollutants, Adsorbent.

## INTRODUCTION

In many cases, removing or modifying hazardous things from seawater is not feasible. To treat seawater to make it potable is a very costly process, which involves the use of new emerged technologies and techniques like Forward Osmosis (FO). These technologies are only limited to developed countries like Australia, U.S.A, Dubai etc. In developing nations like India use of such processes is limited[1,2]. Our experiment deals with the minimization and reduction in the amounts of the dissolved impurities in seawater by treating the seawater. The treatment involved use of Granular Activated Carbon (GAC), which showed a significant reduction in the amount of the dissolved impurities and salts. Among the technologies of desalination of seawater, reverse osmosis has been recognized to be the most cost-efficient technology in comparison to thermal processes[3,4]. However, the desalination industry encounters a major challenge that consists in reverse osmosis membrane fouling, which implies a higher treatment cost due to the important frequency of

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membrane cleaning or/and replacement[5,6]. Forward osmosis (FO) is one of the emerging membrane technologies, which has gained renewed interest recently as a low energy desalination process. The central to FO process is the draw solution (DS) and the membrane because both play a substantial role on its performance[7]. Likewise a study was undertaken to remove Cu, Cd, Ni, Pb and Zn individually (single metal system) and together (mixed metals system) from water by adsorption onto a sodium titanate nanofibrous material[8-10]. Seawater contain different types of contaminants such as heavy metals, micro pollutants, salinity and microorganisms, which need to be removed to make it suitable for potable uses. Reducing the volume of waste streams is an attractive option for minimizing the environmental impact and producing better quality product water[11-14].

## EXPERIMENTAL

Experiments were carried out in batch mode. The seawater was obtained from the Jamphore Beach, Daman and Diu. The characteristics of the seawater are presented in Table 1. The seawater was stored and sampled in glass bottles until the tests were conducted.

**Table 1: Characteristics of sea water**

| Parameter | Value (mg/L) |
|---|---|
| Total dissolved solids | 500 |
| Magnesium | 30 |
| Total hardness | 200 |
| Sodium | 200 |
| Chlorine | 250 |
| Sulphate | 200 |

The adsorbent used in the experiment was (GVC-Grade-1) Granular Activated Carbon that was from the Alkem Laboratories, Daman and Diu. The characteristics of GAC is given in Table 2.

### Batch experiments

Optimization of GAC was done by taking 100 mL of sea water. From 1 g to 5 g adsorbent was taken in 100 mL sea water and kept in horizontal shaker for 2 hrs. The mixture was allowed to settle for specific time and then filtered. The filtrate was analyzed for the different parameters. Batch experiments were carried out by varying parameters such as weight of adsorbent and time.

**Table 2: Characteristics of Granular activated carbon (GAC)**

| S. No. | Properties | Values |
|---|---|---|
| 1 | Grade | GVC-1 |
| 2 | Iodine value | 927 mg/g |
| 3 | Ash count | 4% |
| 4 | Moisture | 5% |
| 5 | Bulk density | 0.45 g/cc |
| 6 | pH | 10 |
| 7 | Mesh size | 8 X 16 |
| 8 | Hardness | 90% |

The pre-analysis treatment of seawater involved the valuation of the reduction in the amount of dissolved salts by treating it with GAC and then reducing the values of reduced slats by carrying out the chemical analysis based on the standard testing procedure.

## RESULTS AND DISCUSSION

Analysis of the seawater was done by varying time from 30 minutes to 150 minutes. The chemical analysis was done according to standard procedure done and the results are tabulated below for TDS, Magnesium, Sulphate, Sodium and $CaCO_3$.

**Table 3: Different parameters before and after treatment for 30 min**

| Parameter (mg/L) | Before treatment | After treatment | | | | |
|---|---|---|---|---|---|---|
| | | 1 g | 2 g | 3 g | 4 g | 5 g |
| TDS | 63.57262 | 30.514 | 29.243 | 27.971 | 27.336 | 27.123 |
| Magnesium | 776.462 | 395.99 | 388.282 | 357.172 | 349.407 | 357.175 |
| $CaCO_3$ | 3220.882 | 1707.06 | 1642.649 | 1513.819 | 1481.605 | 1546.023 |
| Sodium | 200 | 102 | 100 | 98 | 96 | 98 |
| Sulphate | 347 | 232.49 | 222.08 | 211.67 | 204.73 | 201.26 |

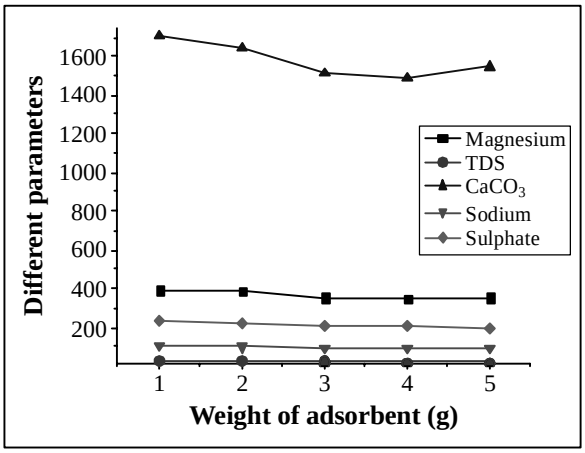


**Fig. 1: Reduction of different parameters for 30 minutes**

**Table 4: Different parameters before and after treatment for 60 minutes**

| Parameter (mg/L) | Before treatment | After treatment | | | | |
|---|---|---|---|---|---|---|
| | | 1 g | 2 g | 3 g | 4 g | 5 g |
| TDS | 63.57262 | 29.243 | 28.6076 | 26.723 | 22.249 | 22.886 |
| Magnesium | 776.462 | 388.231 | 372.701 | 349.0479 | 295.055 | 310.58 |
| $CaCO_3$ | 3220.882 | 1674.85 | 1546.023 | 1513.81 | 1320.561 | 1288.352 |
| Sodium | 200 | 102 | 98 | 92 | 78 | 78 |
| Sulphate | 347 | 225.55 | 218.61 | 209 | 183.91 | 190.85 |

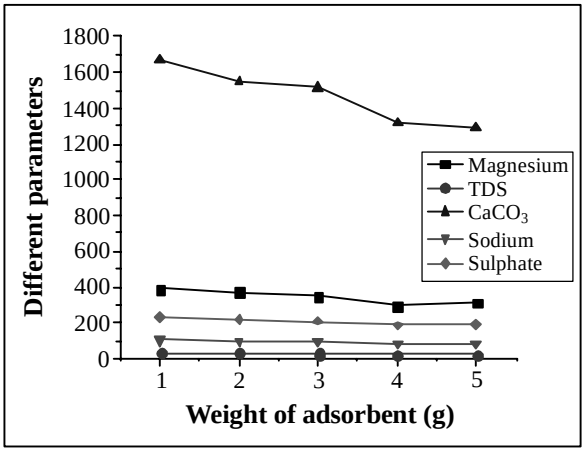


**Fig. 2: Reduction of different parameters for 60 minutes**

**Table 5: Different parameters before and after treatment for 90 minutes**

| Parameter (mg/L) | Before treatment | After treatment | | | | |
|---|---|---|---|---|---|---|
| | | 1 g | 2 g | 3 g | 4 g | 5 g |
| TDS | 63.57262 | 27.336 | 26.700 | 26.064 | 24.1575 | 25.429 |
| Magnesium | 776.462 | 372.701 | 372.462 | 333.87 | 318.34 | 326.114 |
| $CaCO_3$ | 3220.882 | 1513.814 | 1449.396 | 1417.188 | 1352.770 | 1384.97 |
| Sodium | 200 | 92 | 92 | 90 | 80 | 82 |
| Sulphate | 347 | 211.67 | 211.32 | 204.73 | 194.32 | 197.79 |

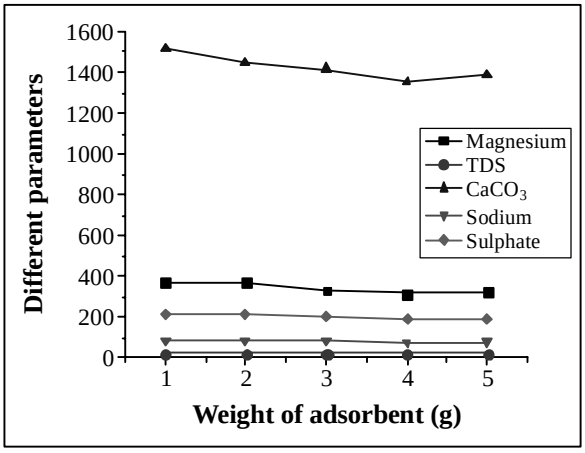


**Fig. 3: Reduction of different parameters for 90 minutes**

**Table 6: Different parameters before and after treatment for 120 minutes**

| Parameter | Before treatment | After treatment | | | | |
|---|---|---|---|---|---|---|
| | | 1 g | 2 g | 3 g | 4 g | 5 g |
| TDS | 63.57262 | 27.336 | 26.064 | 24.793 | 23.521 | 24.793 |
| Magnesium | 776.462 | 364.937 | 357.17252 | 326.114 | 302.82 | 318.349 |
| $CaCO_3$ | 3220.882 | 1481.605 | 1384.979 | 1385 | 1320.56 | 1352.770 |
| Sodium | 200 | 90 | 88 | 88 | 80 | 78 |
| Sulphate | 347 | 208.2 | 204.79 | 197.79 | 190.85 | 194.32 |

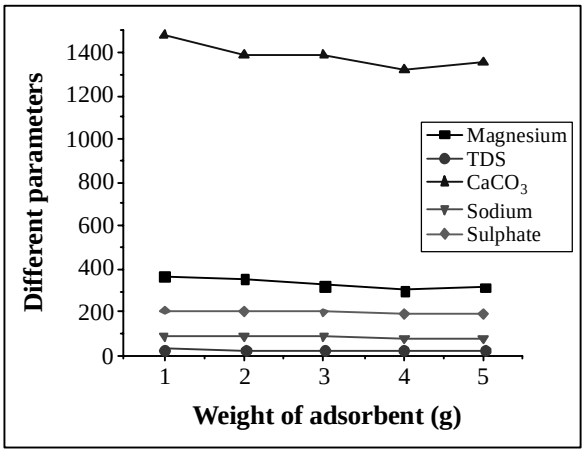


**Fig. 4: Reduction of different parameters for 120 minutes**

4 g of GAC gave the best removal efficiency in two hours. Further work will be carried out for different parameters, which can make the sea water for drinking purpose. Table 7 shows the best readings for removal of sea water content.

**Table 7: Maximum removal from 4 g in two hours**

| Component | Initial value | Final value |
|---|---|---|
| TDS | 63.572 | 22.886 |
| Magnesium | 776.462 | 295.055 |
| $CaCO_3$ | 3220.882 | 1256.143 |
| Sodium | 200 | 78 |
| Sulphate | 347 | 187.38 |

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