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RESEARCH PAPER

Small scale sea water treatment plant

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Abstract : The sea water treatment plant consisted of filtering media like sand, gravel, grit, charcoal, broken brick, gypsum, sponge and sawdust. The effective depths for sand, gravel, grit, charcoal, gypsum, broken bricks and sawdust were found to be 45 cm, 30 cm, 15 cm, 15 cm, 7.5 cm, 15 cm and 30 cm, respectively. It was observed that EC and pH of untreated sea water was reduced after filtration. The EC of sea water was 51.9 dS/m which was reduced to 44.9 dS/m with a per cent reduction of 13.48 per cent; while pH was 8.29 which was further reduced to 7.60 with per cent reduction of 8.32. The total cost of newly developed sea water treatment plant was found to be Rs. 623. Thus, it can be predicted that the designed treatment plant can be used for irrigation of salt tolerant crops.

Key Words : Sea water, Plant, EC, pH, Irrigation

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INTRODUCTION

Ocean covers more than 70 per cent of the surface of our planet. 97 per cent of earth's water can be found in our oceans. 2 per cent is frozen up in glaciers and ice caps. Sea water or salt water is water from sea or ocean. On an average, seawater in the World's oceans has a salinity of about 3.5 per cent (35 g/l). Every kilogram of sea water has 35 grams of dissolved salts. Average density at the surface is 1.025 kg/l. It is denser than fresh water. Sea water has a salinity of between 31 g/kg and 38 g/kg *i.e.* 3.1-3.8 per cent. The density of surface sea water ranges from about 1020-1029 kg/m^3, depending on the temperature and salinity (Nagar and Kumar, 2016).

Seawater contains more dissolved ions than all types of fresh water. The density of seawater changes with salinity. The freezing point of seawater decreases as salt concentration increases and freezes at about -2 degree Celsius (2°F) and ocean water has an excellent buffering system with the interaction of carbon dioxide and water. So, pH of sea water is found to be between 7.5 to 8.4. Salinity and pH of seawater are relatively stable measurements whereas temperature, dissolved oxygen, and nutrients may vary (Greenlee *et al.*, 2009).

Water seems to be a super abundant natural resource on the planet. However, only 0.3 per cent of World's total amount of water can be used as clean drinking water. As natural fresh water resources are limited, sea water plays an important part as a source for drinking water as well. In order to use this water, it

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has to be desalinated. We can use it for many applications in agriculture such as irrigation. Seawater desalination for sustaining agricultural production is being reported as an alternative water source in some Mediterranean countries. It represents steady water source which removes climatological and hydrological constraints. High–energy requirement is still an essential feature of seawater desalination, leading to production costs several times higher than other agricultural water sources. (*http://www.researchgate.net*).

The average annual per capita availability of water has continuously decreased to the increase in population. The per capita availability of water is 1816 cubic meters (*http://www.india-wris.nscr.gov.in*). It is found that, a number of research setups and devices are available but are currently not being used due to high initial setup costs and limited technological awareness in the society. Thus, there is a need to find out alternate source of water to fulfill the requirement of growing population.

MATERIAL AND METHODS

Media selection and their characteristics:

The locally and easily available media *viz.*, sand, gravel, grit, broken bricks, charcoal, gypsum and saw dust were selected for the study. These medias have characteristics of filtration as well as adsorbent of pollutant in sea water.

Sand:

Locally available sand is screened properly and used as filtration media. The size of sand is decided on the basis of effective size and uniformity co-efficient (Cu). Grading and screening of sand is done by using standard sieve analysis. The uniformity size of sand is taken as 0.42 mm according to the sieve analysis.

Gravel:

Gravel is a granular broken piece of any type of rock. Gravels are sized between 2 mm to 40 mm. They may be rounded, when from marine or fluvial source or angular when quarried and crushed. It gives support to other media. Gravel of size 15 – 25 mm is used.

Grit:

Grit is another granular material in transition stage between a coarse sand and small pebbles. Generally, grit is 2 mm to 8 mm in size. Grit traditionally had limited uses in construction but now days it can also be used for filtration media. Grit has generally platy structure. Grit of size 6.0 – 8.0 mm is used in filtration media.

Broken bricks:

Burnt bricks are used for filtration media. Broken bricks have high adsorption capacity. It also has high turbidity removal efficiency. Locally available bricks were broken into small pieces of desired size. Screening is done for obtaining uniform size, removal of fine dust and foreign particles. The broken bricks of size 25–30 mm are used in the filtration media.

Charcoal:

Charcoal in the granular form is used for study. It has good adsorption quality. It can trap carbon based impurities (organic compounds) as well as inorganic and odorous compounds. 12-16 mm size of charcoal is used in filtration media.

Gypsum:

Gypsum is used as filtration media. Gypsum has high adsorption efficiency. Locally available gypsum is used in crystal form of desired size.

Saw dust:

Saw dust is a byproduct or waste product of wood working operations such as sawing, milling, drilling, etc. It is composed of fine particles of wood. It has good dust absorption quality. It is generally used for removing nitrates from water.

Sponge:

A sponge is a tool or cleaning aid consisting of soft, porous materials. Usually used for cleaning impervious surface. It removes organic matter flowing through the water.

Methodology for testing of individual material:

To test the individual medias for determining the properties (EC and pH) of sea water, the following steps are followed:

– Collect sea water sample.

– EC and pH of sea water is measured.

– Take the suitable testing containers and fill the individual materials in each container at depth of 15 cm.

– Pass the sea water from each container.

– Measure EC and pH of treated sea water from each container.

– Also measure the retention time of the water which is drained out for each container.

– Repeat the procedure and take 3 replications for accuracy.

– Similarly take depths of 30 cm and 45 cm for each media and note the optimum depth of each media to be used for development of sea water treatment plant.

Design and development of filter:

– PVC pipe of 110 mm is used for filling different medias *viz.*, sand, grit, charcoal, gravel, broken bricks, gypsum and saw dust.

– The end caps are fitted at top and bottom of the PVC pipe to enclose it.

– Grommet and take off is used to connect lateral to PVC pipe.

– Lateral is used to pass the water from one candle to another.

– All these materials along with other accessories are used to develop sea water treatment plant.

Methodology for performance evaluation of developed filter:

– Collect sea water sample.

– EC and pH of sea water is measured.

– Pass the sea water from developed sea water treatment plant.

– Measure EC and pH of treated sea water.

– Repeat the procedure and take 3 replications for accuracy.

– Take average of these readings.

Calculations:

$$\text{Percentage reduction in EC} = \frac{\text{Initial EC} - \text{Final EC}}{\text{Initial EC}} \times 100$$

$$\text{Percentage reduction in pH} = \frac{\text{Initial pH} - \text{Final pH}}{\text{Initial pH}} \times 100$$

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Testing the effect of EC on individual medias at various depths:

From Table 1 it is observed that, for sand the EC at 15 cm, 30 cm and 45 cm were 45.06, 44.7 and 44.1 ds/m, respectively. Thus, it is clearly observed that for sand optimum depth was at 45 cm which has least EC of 44.1 ds/m. Similarly, the optimum depths of gravel, grit, broken bricks, charcoal, sawdust were 30 cm, 15 cm, 15 cm, 15 cm and 30 cm, respectively. Gypsum showed EC for 7.5 cm depth as 50.46 ds/m and that for 15 cm depth as 51.83 ds/m. Thus, 7.5 cm depth was selected.

From Table 2 it is observed that, for sand the pH at 15 cm, 30 cm and 45 cm were 7.20, 7.35 and 7.13, respectively. Thus, it is clearly observed that for sand optimum depth was at 45 cm which has least pH of 7.13. Similarly, the optimum depths of gravel, grit, broken bricks, charcoal, sawdust were 30 cm, 15 cm, 15 cm, 15 cm and 30 cm, respectively. Gypsum showed pH for 7.5 cm depth as 4.82 and that for 15 cm depth as 2.96. Thus, 7.5 cm was selected.

Performance evaluation of developed filter for sea water:

The developed filter was tested by passing the sea water from the filter. Table 3 shows the pH of untreated and treated sea water. It was observed that on an average sea water had pH of 8.29 which was reduced to 7.60

Table 1: EC of sea water at various depths

Media \ Depth	EC (ds/m) 15 cm	EC (ds/m) 30 cm	EC (ds/m) 45 cm
Sand	45.06	44.7	44.1
Gravel	51.46	50.74	51.4
Grit	50.33	50.83	50.53
Broken bricks	51.33	51.63	51.76
Charcoal	50.63	51.5	51.46
Sawdust	50.53	50.43	51.26
Gypsum	7.5 cm: 50.46		15 cm: 51.83

Note: The EC of untreated sea water was 51.9 dS/m

Table 2: pH of sea water at various depths

Media \ Depth	pH		
	15 cm	30 cm	45 cm
Sand	7.20	7.35	7.22
Gravel	8.02	7.52	7.92
Grit	7.91	7.98	7.99
Broken bricks	7.72	7.88	7.85
Charcoal	7.41	7.40	7.60
Sawdust	7.45	7.23	7.80
Gypsum	7.5 cm		15 cm
	4.82		2.96

Note: The pH of untreated sea water was 8.29

Table 3: pH of treated and untreated sea water

Sr. No.	Untreated water	Treated water	Percentage reduction
1.	8.34	7.63	8.51
2.	8.35	7.62	8.74
3.	8.20	7.56	7.80
Average	8.29	7.60	8.32

Table 4: EC of treated and untreated sea water

Sr. No.	Untreated water (ds/m)	Treated water (ds/m)	Percentage reduction
1.	52	45.1	13.26
2.	51.8	44.6	13.89
3.	51.9	45	13.29
Average	51.9	44.9	13.48

after treatment. The per cent reduction in pH observed was 8.32 per cent.

Table 4 shows the EC of untreated and treated sea water. It was observed that sea water had EC of 51.9 ds/m which was reduced to 44.9 ds/m after treatment. The per cent reduction in EC observed was 13.48 per cent.

Cost analysis of designed sea water treatment plant:

The cost analysis was carried out as per the present cost of materials used for development of sea water treatment plant. The cost of PVC pipe used for fabrication was Rs. 25 while the lateral cost Rs. 11. The other accessories or material such as grommet, takeoff, end cap, sponge, solution, aluminum wire, etc. were also taken. The total cost of newly developed sea water treatment plant was found to be Rs. 623.

Conclusion:

The sand was effective at 45 cm, gravel at 30 cm, grit at 15 cm, charcoal at 15 cm, broken bricks at 15 cm, gypsum at 7.5 cm and sawdust was effective at 30 cm depth because pH and EC obtained were optimum.

After sea water was passed through the filtration unit, the average percentage reduction in pH of sea water was 8.32 per cent and that for EC was about 13.48 per cent.

Thus, it can be predicted that the designed treatment plant can be used for irrigation of some salt tolerant crops.

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