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DETERMNATION OF THE BEST RETENTION TIME FOR DESALINATION BY ALGAE PONDS

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ABSTRACT

The study aims to determine the best retention time for desalination using algae under nature conditions. The experiment was applied on a pilot plant exposed to nature conditions. This pilot consists of three consecutive basins; each basin was divided into three equal parts fed by saline water with constant concentration 30000 ppm. Algae was added by 400 ml/path with adding 100 ml/path of the artificial media BG-11. By using varied retention time ranged from 7 days to 9 days for each basin. The results showed that, the TDS removal efficiencies for the different retention time were very close to each other which resulted the 7 days is the best retention time for algae desalination process technically and economically with maximum TDS removal efficiency reached to 92.67% after three serial basins.

Keywords: Water Desalination, biological desalination, desalination by algae Ponds, Factors affects algae desalination ponds.

INTRODUCTION

The aim from going to the biological desalination technology was to overcome the high costs of the other technologies of desalination and reducing the operation and maintenance works required with using the benefits producing algae that could be used in many applications in industry.

Algae are defined as a group of plants have not roots, stems, and leaves include chlorophyll. Also they can classify into varied group of organisms that different in size from microscopically species smaller than some bacteria to seaweeds that might become many feet in length. Algae types grow wherever in water either in salty water or freshwater and under varied climatic conditions during the year, wherever they could be synthesized their components and food by photo- synthesis.

Algae as a group exhibit an extremely wide range of tolerance to salts in their surroundings. Some species can tolerate only millimolar amounts of salt, while others survive in saturated brine. As for the adaptation to salinity, Algae may be roughly divided into halotolerant and halophilic, the later requiring salt for optimum growth and the former having response mechanisms that permit their existence in saline medium **[1]**.

Algae require minor necessary elements Iron (Fe), Silica (Si), Zinc (Zn), Molybdenum (Mo), Copper (Cu), Molybdenum (Mo), Manganese (Mn), Bromium (Br) and Boron (B), and major necessary elements Carbon (C), Phosphorus (P), Nitrogen (N), Potassium (K), Calcium (Ca), Sulphur (S) and Magnesium (Mg) for their maximum growth **[2].**

Algae can uptake several minerals and vitamins from its surrounding environment. In order to confirm that the algae are getting their enough food for growth, some artificial medias could be used to complete their growth.

Desalination depended on the algae usage in decreasing the salt concentration in saline water is a new concept. The algae activity used widely in industrial waste water treatment because of the decreasing in the cost required for the treatment with high efficiency **[3],** which opened the door for its usage in desalination process. So many studies done previously and their results were encouraged this way of desalination **[4][5][6][7][8][9],** where it is continuing to accomplish the removal efficiency up to about 95%. This efficiency could produce water suitable for varied uses.

MATERIAL AND METHODS

The pilot plant was located on the roof of Ain Shams university engineering faculty. It was operated under the nature conditions like temperature, sunlight duration and humidity. The pilot plant consists of three storage tanks, these tanks would feed a basin divided to three parallel equal parts and then two additional basins in series. Figure (1) illustrates the pilot photo and figure (2) shows the pilot components.

The ***Scendesmus*** algae species was the choice for operation process, thanks to its natural feature of growing very well in almost any mineral medium.

Figure (1) Photo of the Pilot

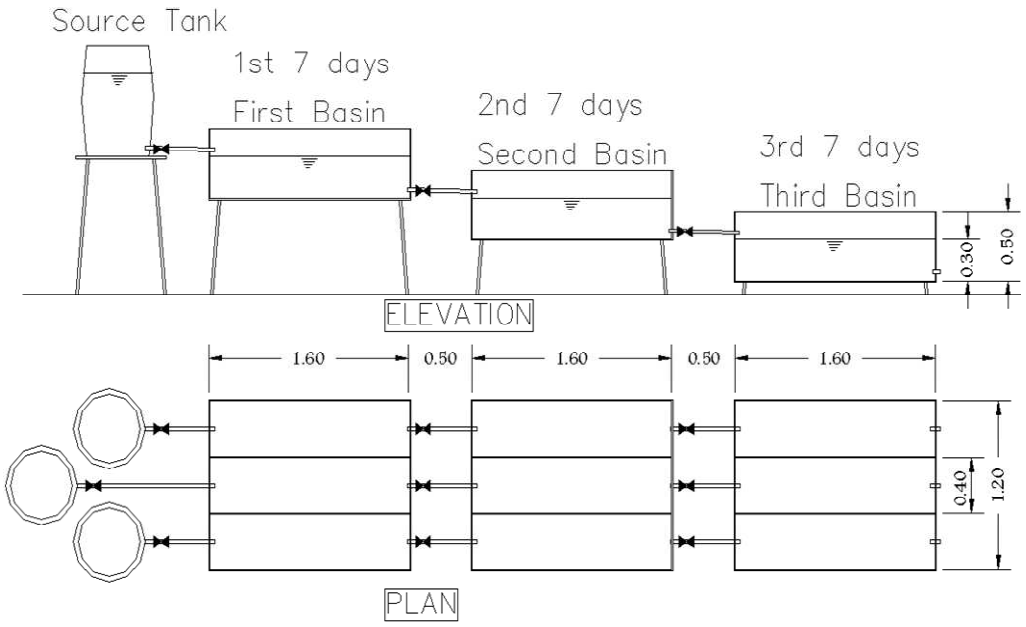

Figure (2) Components of the Pilot

Saline water with constant TDS about 30000 ppm was used in the experiment as raw water resource. ***Scendesmus*** algae were added with a rate of 400 ml/basin and BG-11 solution was added to give algae enough nutrition with a rate of 100 ml/basin. Chemical composition of BG-11 nutrient solutions is as shown in table (1).

Table (1) Chemical composition of BG 11 nutrient solutions [10]

Chemical	$NaNO_3$	$K_2HPO_4.3H_2O$	Na_2CO_3	$MgSO_4.7H_2O$	$CaCl_2.2H_2O$	EDTA -Na_2	$Fe(NH_3)_2$ Citrate	Citric acid
BG 11(g/l)	**1.5**	**0.04**	**0.02**	**0.075**	**0.036**	**0.001**	**0.006**	**0.006**

Using three retention time (7 days for the left part, 8 days for the middle part and 9 days for the right part) ***Scendesmus*** algae were complete their mission to treat the saline water in first basin. Water after separating algae in the first basin was then transferred to the second basin. ***Scendesmus*** algae in second basin did the second stage of treatment for retention time. Then the work repeated in the third basin. Desalinated water was collected in the effluent after the third basin.

Samples were taken randomly each day from each part of each basin. The sample volume was 300 ml. Water samples were routinely collected at 7:00 am each morning and analyzed to investigate water quality during the examination period. The measured parameters were Total dissolved solids (TDS), Temperature, Duration of Sunlight and Humidity.

RESULT AND DISCUSSION

The run was applied for 21 days through the left part as 7 days per basin, 24 days through the middle part for eight days per basin and 27 days through the right part as nine days per basin. The run was for three parallel lines with sampling interval each 24 hours for the three parts of the basin.

The measurements of different parameters through the experiment period are illustrated in table (2)

Table (2) TDS Concentrations and Climatic Conditions during the Run

Date	Climatic Conditions				TDS (mg/l)		
	Temperature c°		Humidity %	Sun Light Duration (hr)	Left Part	Middle Part	Right Part
	Day	Night					
12/1/2016	19	10	62	10:14	30000	30000	30000
13/1/2016	17	10	77	10:14	27600	27600	27600
14/1/2016	19	10	91	10:14	25900	25900	25900
15/1/2016	19	10	89	10:14	23400	23400	23400
16/1/2016	19	12	69	10:13	19100	19100	19100
17/1/2016	19	11	44	10:13	15600	15600	15600
18/1/2016	19	10	64	10:13	14400	14400	14400
19/1/2016	20	9	67	10:12	13600	13600	13600
20/1/2016	19	9	67	10:12	13000	13000	13000
21/1/2016	21	10	75	10:12	12300	12300	12300
22/1/2016	21	10	40	10:12	10700	10700	10700
23/1/2016	19	11	84	10:13	10000	10000	10000
24/1/2016	21	9	63	10:12	8400	8400	8400
25/1/2016	20	9	56	10:13	6700	6700	6700
26/1/2016	21	10	75	10:13	5900	5900	5900
27/1/2016	22	11	71	10:13	5100	5100	5100
28/1/2016	21	10	55	10:14	4400	4400	4400
29/1/2016	21	10	68	10:14	3800	3800	3800
30/1/2016	19	10	70	10:15	3200	3200	3200
31/1/2016	17	9	77	10:15	2700	2700	2700
1/2/2016	14	6	52	10:16	2200	2200	2200
2/2/2016	14	7	55	10:16		2000	2000
3/2/2016	18	9	64	10:16		1800	1800
4/2/2016	20	10	47	10:17		1700	1700
5/2/2016	20	11	46	10:17			1600
6/2/2016	23	13	33	10:17			1550
7/2/2016	23	12	42	10:17			1500

The data in Table (2) show that the maximum TDS removal efficiency using 7 days period / basin was 52% after first basin then reached 77.67% after second basin and achieved 92.67 % after the third basin. The TDS removal ratios for the line that using 8 days period / basin were 54.67%, 83.00% & 94.33% after the third basin. For line use 9 days period / basin it were 56.67%, 87.33% & 95.00% respectively.

This shows that the difference increase in removal efficiency for 9 days period basin is very small compared with 7 days period (less than 3%) that from the financial point of view means it not worth to increase the basin period for the result will not be comparable with the cost saving. This is for it saves about 22 % of basin cost and area if it applied the 7 days period with lowering the TDS removal efficiency by 2.60%.

The TDS removal efficiency for the retention time of 7 days is very close to that of 9 days which make 7 days is better than increasing the retention time without very little benefit which means that 7 days is the best retention time for algae desalination process.

CONCLUSION

Generally, The results of this study had shown the following specific conclusions:-

1. The suitability of the new concept of biological desalination to be applied in continuous flow in the field however, the experiment was applied under low temperature.
2. ***Scendesmus species*** feed on salts and use them in its life cycle to complete its growth.
3. The maximum TDS removal efficiency reached 92.67 % after 21 days, 94.33 % after 24 days and 95.00 % after 27 days.
4. The TDS removal efficiency for the three retention time was very close to each other so the best retention time was 7 days.
5. This system gives a solution of the obstacles of the disposal of the brine as it doesn't have any rejected water left. This also means that all the influent is treated.
6. The number of stages depends on the degree of water salinity and the degree required of desalination.

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