The Effect of Discharge Rejected Brine into the Surface Water on the coast of Port Sudan city

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ABSTRACT The general aim of this study is to focus on the effects of discharge reject brine into the surface water in Port Sudan city. It considers baseline study in Port Sudan. Three samples of water were taken from sea land lagoon by using TCD (Temperature, Conductivity and Depth) device, and sample from open sea (Abu Hashish). All samples were collected during summer and winter seasons. The results showed a significant increase in salinity 39.13 – 49.86 , 39.91- 47.45 , 38.62 - 38.87 , 38.48 – 39.27 psu respectively, of the surface water when mixed with the discharge reject brine, this will absolutely affect the marine life. Also the continuous discharge of rejected brine into water near the intake desalination plants will affect the characteristics of the feed water.

Keywords: Rejected brine, Port Sudan City, Desalination plant, Surface Water.

1. INTRODUCTION

Port Sudan city suffers from scarcity and quality in drinking water, where the daily consumption of drinking water was estimated at 120000-150000 m³/day. Water available from various sources (Khor Arbaat and groundwater) ranges from 60000-30000 m³/day with a water deficit of about 66%. In general, the overall situation of the city is characterized by regular shortages. The shortage of water is compensated by desalination plants [1]. It was estimated that the world production of desalination water exceeds 30 million cubic meters per day. There are many options for brine management includes: discharge to surface water or wastewater treatment plants; deep well injection; land disposal; evaporation ponds; and mechanical / thermal evaporation [2]. The rejected brine of high salt concentration was drained into the sea causing environmental impact of aquatic life in the red sea [3].

During the last few decades existing freshwater sources have become increasingly limited in many regions of the world [4,5], particularly in countries along the Arabian Gulf, the Mediterranean coast and the Red Sea, due to the elevated consumption and low precipitation occurring in these zones [6,7]. Desalination was a

maturing technology that has been widely utilized for freshwater supply throughout the world for many years [5,8]. Therefore, seawater desalination has been considered as a feasible alternative available to satisfy the demand of water, and the number of projected and constructed desalination plants has increased throughout this region in recent years [7]. Although there are several desalination technologies, such as those based on thermal processes (e.g. multi-stage flash, multi-effect distillation and vapour compression) or the ones based on membrane processes (e.g. electrodialysis, reverse osmosis, nanofiltration), currently the reverse osmosis (RO) method is the preferred desalination technique in these new facilities, mainly due to its low energy and space consumption and the reduction in the cost of the potable water obtained [5,9–11]. RO consists of applying external pressure to a concentrated solution, like seawater, in order to force the flow of water molecules through a semi-permeable membrane, producing a permeate which consists of fresh water and rejected brine [12]. Therefore, this brine is fundamentally water, relatively concentrated in dissolved salts (44–90 psu (Practical Salinity Unit)) by a factor related to the water recovery

rate (product water/ feed water, .30–70%) utilized during the desalination process [13]. Additionally, some chemicals (such as biocides, anti-scalants, coagulants, antifoaming agents, etc.) used in the desalination processes, and toxic metals (if the discharge water has been in contact with metallic materials) may accompany the brine [9,10,14,15].

There are different options for the concentrate disposal from a desalination plant such as its discharge into the sea, into deep wells or into evaporation ponds, its treatment on wastewater plants or the production of salt and other minerals [16–20]. But cost plays an important role in the selection of the disposal method and today ocean brine disposal was considered the least expensive one [10,15,18,19]. If the concentrate is discharged directly into the sea, it will form a plume of elevated density that will descend to the sea floor and extend horizontally following the slope of the sea bottom bathymetry [21]. This hypersaline mass of water could negatively affect several benthic marine organisms around the discharge point that usually live in stable salinity environments [11,15,22,23]. The most sensitive communities will be the most affected, perhaps resulting in total disappearance of these species inside the area of brine influence. To date, available information regarding the behavior of these hypersaline effluents and their effect on the marine ecosystem is insufficient [21,24,25]. However, the discharge of brine into the sea requires particular attention and scientific assessment of possible impact on the marine environment. The magnitude of these potential impact will depend not only on the characteristics of the desalination plant and its rejected brine, but also on the nature of the physical (i.e., bathymetry, hydrodynamics, etc.) and biological conditions of the receiving marine environment [10,15,18,23]. The main objective of this paper was to estimate the area of influence affected by brine effluent of reverse osmosis (SWRO) desalination plants in Port Sudan city.

Beside that the study illustrated how the behavior of these brine discharges can differ widely according to discharge characteristics. This information may be useful to predict effluent distribution in order to minimize the harmful effects of brine discharges into the sea.

2. MATERIAL AND METHODS

2.1. Location and description of the studied desalination plants and their brine discharge:

We carried out the monitoring of the brine discharge from two SWRO desalination plants with different characteristics, located in the lagoon (sea land) and open sea (Abu Hashish), over a period of several seasons (Figs. 1 and 2). The monitoring programs have been adapted to these characteristics and to the local conditions existing in the brine disposal areas.

Fig.1. Desalination Plant – Sea Land lagoon

Fig.2. Location of samples collection in open sea (Abu Hashish)

2.2 Samples Collection

60 samples of water were taken from sea land lagoon at different stations from in summer (May, June) and winter (April, September) seasons. All samples taken by using conductivity, temperature and depth (CTD) devices with a measuring range of 0–70 psu and a resolution ± 0.01 psu, as shown in Fig.(3). On the other hand, 20 samples from open sea (Abu Hashish) were also taken at different stations

from in summer (May, June) and winter (April, September).

Fig.3. TCD device

3. RESULTS AND DISCUSSION

The results in Figs. 4-7 illustrated that observed increase of salinity between 39.13 – 49.86, 39.91- 47.45, 38.62 - 38.87, 38.48 – 39.27, respectively. The range of salinity of the coastal of port Sudan between 37- 38 ppt in summer and winter respectively [26]. In this paper we have presented the results of the monitoring of the brine effluent originating from several SWRO desalination plants, and we discuss this results with the range of salinity at port Sudan costal, we found the effect of discharge of reject brine desalination plants by increasing the salinity above 38 ppt [26]. This hypersaline mass of water could negatively affect several marine organisms around the discharge point that usually live in stable salinity environments [11,15,22,23]. The most sensitive communities will be the most affected, perhaps resulting in total disappearance of these species inside the area of brine influence [27].

Fig.4. Comparison between increase salinity in summer

Fig.5. Comparison between increase salinity in winter

Fig.6. Comparison between increase salinity in summer

Fig.7. Comparison between increase salinity in winter

4. CONCLUSION

The paper focuses on the effect of discharge reject brine directly in surface sea water. The results showed that there was an increase in coastal water salinity of Port Sudan, which will negatively affect marine organisms. The study recommended that:

- 1- Use rejected brine to produce salt.
- 2- Use nozzles to desperation reject brine of widely area.
- 3- Construction of desalination plants on open sea.

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