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A Study of the Product Water Obtained After Desalination of Brackish and Seawater

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ABSTRACT:

The countries in the Middle East are among the most water stressed nations in the world. Rainfall is scarce and underground water resources are fast drying up. These countries depend on desalination of brackish and seawater to meet their growing water needs. The main processes employed are reverse osmosis (RO) and multi stage flash distillation (MSF). The product water obtained after these processes are not potable and need further treatment before use. The product water from a sea water RO plant, MSF plant and a brackish water RO plant were analyzed. The data reveals that the product water does not conform to the standards set by the GCC and that post-treatment is required for the water to be made potable.

KEYWORDS: Reverse osmosis, Multi stage flash distillation, Total dissolved solids, Permeate, Distillate.

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INTRODUCTION:

Desalination occurred on earth millions of years ago- the natural process of water evaporating from the surface of the sea and condensing to form rain. The freezing of seawater near the Polar Regions wherein the ice crystals formed are from pure water, as salt is excluded from the crystal growth is another example. The first references to the use of desalination occur from 300 BC to 200AD.Multistage Flash Distillation processes became popular and many commercial plants were set up using this technique, especially in the Arabian Gulf[1]. Membranes entered the desalination market in the late 1960s and were initially used for brackish water treatment. The next decade saw the use of Reverse Osmosis membranes in seawater desalination[2]. The World Health Organization (WHO) and the Gulf Standardization Organization (GSO) have set guidelines for drinking water quality. The permeate obtained after RO and the distillate from a MSF plants do not meet these standards and need extensive post-treatment[3,4].In this study, product water from a brackish water RO plant, a sea water RO plant and an MSF plant are analyzed.

MATERIALS AND METHODS:

The product water samples were collected from the desalination plants in the U.A.E. Temperature and pH were measured on the site using portable water analysis kit.

Table 1:Physico-chemical analysis of product water after RO of water from an underground well

Parameters	Unit	Results
Total Dissolved solids	mg/L	5
Total Hardness	mg/L	4
Total alkalinity	mg/L	1.2
Temperature	Degree Centigrade	24
pH	pH unit	7.98
Conductivity	µS/cm	9.2
Calcium	mg/L	2
Magnesium	mg/L	1
Sodium	mg/L	40
Silica	mg/L	0.12
Potassium	mg/L	1
Sulphate	mg/L	0.2
Bicarbonate	mg/L	10
Chloride	mg/L	0.3
Nitrate	mg/L	--

The samples were placed in a freezer before being taken for analysis and then allowed to attain lab temperature prior to analysis.Total Dissolved Solids (TDS) was evaluated by evaporating known volume of sample and finding out the weight of solid. Total hardness was determined by complexometric titration using EDTA.Na, K, were analyzed using flame photometry while Ca and Mg were analyzed by titration with EDTA.Phosphate was measured spectrophotometrically, sulphate was measured using a nephelometer and conductivity was measured using the conductivity bridge. Fluoride was estimated using the fluoride reference electrode[5]. Nitrate was estimated using a Nitrate Ion Selective Electrode.The analysis of the product water samples are shown in Tables 1, 2 and 3.

Table 2:Physico-chemical analysis of product water after RO of sea water.

Parameter	**Unit**	**Result**
Temperature	Degree Centigrade	24.5
pH	pH unit	6.8
Turbidity	NTU	<1
Total dissolved solids	mg/L	188
Electrical conductivity	µS/cm	392
Total alkalinity	mg/L	62
Total Hardness	mg/L	46
Calcium	mg/L	15.6
Magnesium	mg/L	1.7
Sodium	mg/L	48
Free residual chlorine	mg/L	0.31
Bicarbonate	mg/L	75.6
Chloride	mg/L	74
Fluoride	mg/L	0.04
Sulphate	mg/L	3.6
Nitrate as N	mg/L	0.09
Iron	mg/L	0.10
Copper	mg/L	<0.05
Aluminium	mg/L	0.10
Boron	mg/L	0.88
Silica	mg/L	0.24

Table 3: Physico-chemical analysis of product water after desalination by MSF process.

Parameter	Unit	Result
Temperature	Degree Centigrade	28.5
pH	pH unit	5.9
Turbidity	NTU	<1
Total dissolved solids	mg/L	19.2
Electrical conductivity	µS/cm	34
Total alkalinity	mg/L	1
Calcium	mg/L	0.4
Magnesium	mg/L	-
Sodium	mg/L	7.1
Bicarbonate	mg/L	-
Chloride	mg/L	11
Fluoride	mg/L	-
Sulphate	mg/L	-
Nitrate as N	mg/L	-
Iron	mg/L	0.10
Copper	mg/L	<0.05
Aluminium	mg/L	0.10
Boron	mg/L	0.58
Silica	mg/L	0.2

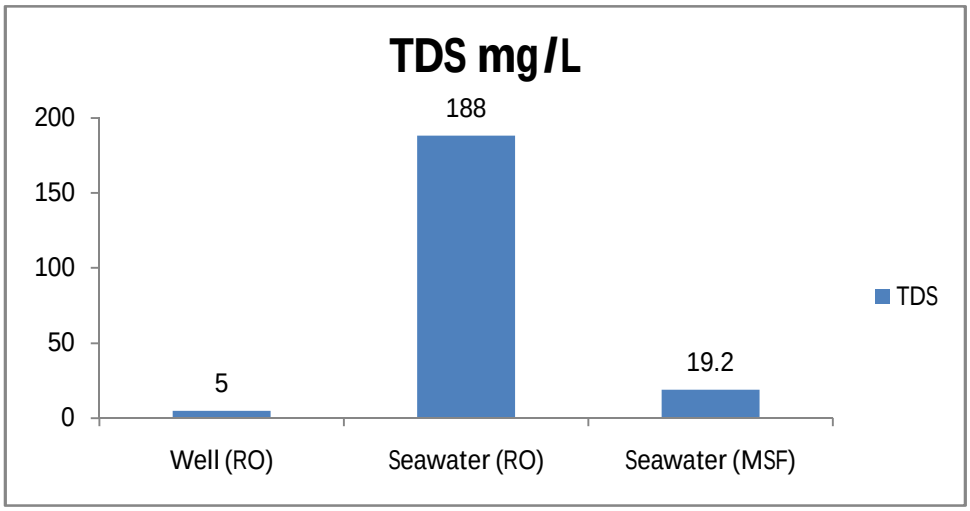

Figure 1: TDS (ppm) of the product water samples after desalination.

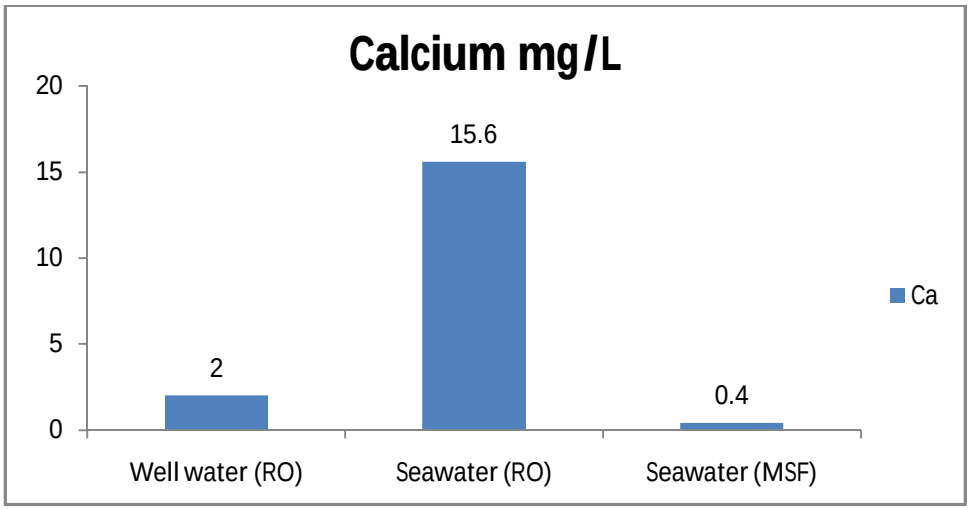

Figure 2:Calcium concentration (ppm) of the product water samples after desalination.

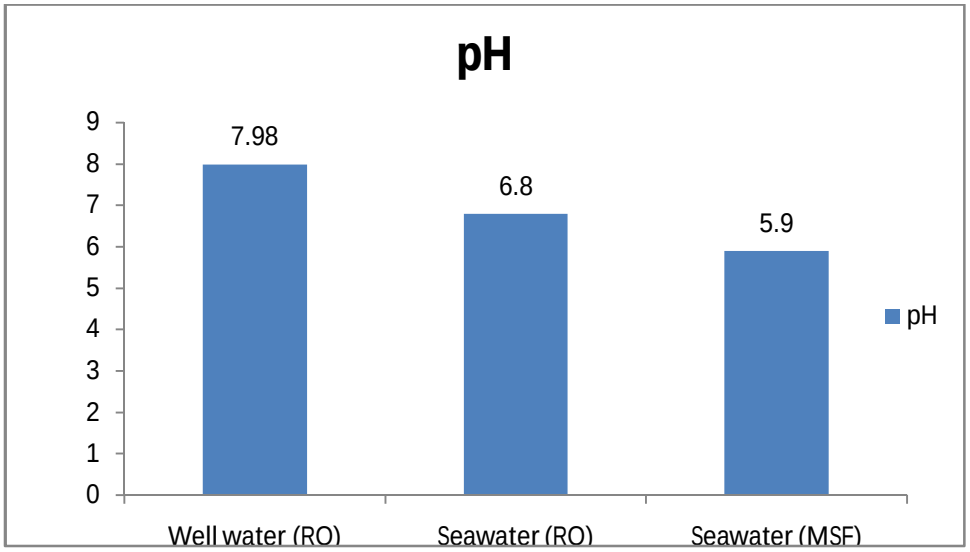

Figure 3: pH of the product water samples after desalination.

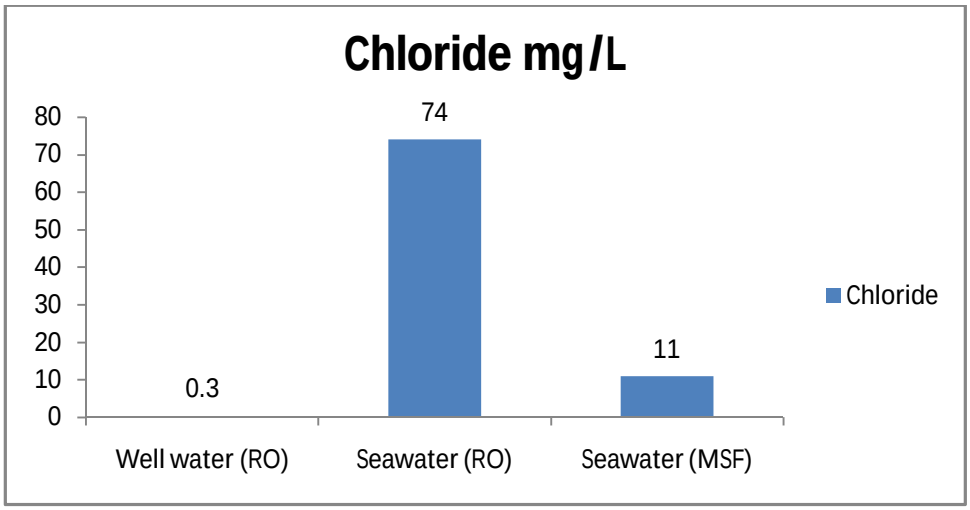

Figure 4: Chloride concentration (ppm) of the product water samples after desalination.

RESULTS AND CONCLUSIONs:

The permeate obtained from the underground wellwater has low TDS, hardness and the concentrations of Ca, Mg, Na and alkalinity is below the standards set by GCC. The permeate has to be demineralized using limestone and the alkalinity adjusted before it can be made potable.The permeate obtained after RO of seawater does not conform to the GCC standards and can be corrosive and unpalatable. It has to be re-hardened to prevent corrosion of the distribution systems and pH value needs to be adjusted[6]. Re carbonation/ re-mineralization is necessary. The product water has to be further disinfected to prevent pollution introduced during distribution.The product water obtained after MSF is very low in hardness and alkalinity and has high corrosion potential. Also, water devoid of dissolved substances tastes flat and insipid. Post treatment is required to increase the pH and hardness. The distillate has to be re-aerated with compressed air[7].

As per the analysis, permeate from RO and the distillate from MSF have to be subject to post treatment to obtain the required water parameters set by the GCC.

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