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Environmental Impact of Desalination Plant Saline Water on Kuwait Bay

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ABSTRACT

Desalination of the Gulf water has become the only viable source of fresh water for Kuwait and other GCC countries . The discharged saline water of the desalination plant is characterized by increased salinity and elevated temperature . The overall objective of the desalination plants in Kuwait on the costal marine environment . The study deals with the results of analysis of particulate samples , taken at 2 points covering an area from 200 m to 2000 m offshore , inside the Kuwait Bay and also the disposed brine from Doha East Desalination plant Site (DEPS) during the period January – September 2017 .

Generally , it was noticed that the brine disposal increased the water bay temperature by 14 C at disposal point and decreased gradually to the normal temperature at distance varied with the climatic conditions and incoming water from KhorSabyiah from 300 m maximum in winter season to the coverage of the whole bay at summer season. In the other hand , the water Salinity as pollution inside the bay increased from 22ppt at the source point 1 near the DEPS outlet and decreased gradually as pollution motion to distance varied with the climatic conditions and incoming water from KhorSabyiah from 550m maximum in winter season to about 3300m the coverage of half of the bay at summer season .

The continuity of brine disposal to the bay will increase the bay water temperature and Salinity by 8% every 3 years that may cause a very noticeable change during the coming years to the bay environment and its ecology .

KEY WARDS : Water Desalination , Wastewater in Desalination plants environmental impact for brine disposal .

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I. INTRODUCTION

Desalination of the Gulf water has become the only viable source of fresh water for Kuwait and other GCC countries . Kuwait has adopted a dual system in which large-scale desalination plants are coupled to the power generation plants.

These dual systems are located on the coastline and utilize huge amount of water for distillation and cooling . As a result , large volume of wastewater called brine is produced whish disposed back into the Gulf .

The discharged wastewater of the desalination plant is characterized by increased salinity and elevated temperature . It additionally contains substantial amounts of chemical pollutants such as chloride (which is used for bio – fouling control in the plants , anti – sealants (which are used for scale inhibition) and heavy metals (which are present due to corrosion) . Desalination plants impacts on marine environment very widely and typically based on the specifics of each site (AbdelMoneam ,2008) . The degree of the impacts in a large part depends on overall plant design and operation methods used for effluent disposal and specific physical and biological conditions on the vicinity of the plant (Altayran et al , 1992).

The effects on the coastal and marine environment arising from the operation of the power and desalination plant from the routine discharge of effuents . A major environmental problem of wter desalination is the production of a flow of brine containing the salts removed from the intake water and that needs to be disposed . In addition this brine maybe polluted . This brine represents significant fraction of the intake water flow (Al-Ghadban , et 1993).

The overall objective of the research was to study the impact caused by the effluent discharge from one of the desalination plants in Kuwait on the coastal marine environment. The specific objective was to investigate and determine the type and concentration of the impact of brine and the associated pollutants from the desalination plants discharges in the vicinity of the discharge point of the desalination plants .

II. DESALINATION IN KUWAIT

In Kuwait and other GCC countries , water resources are very limited and most of the fresh water is produces by desalting seawater of the Gulf . During the last two decades , the GCC courtiers have become increasingly dependent on desalination to meet their water supply requirements . Experience with desalination in many of the Gulf States , particularly Saudi Arabia and Kuwait Began in 1950s.

Today , over 500 liter per capita per day of fresh water only is consumed by Kuwait's inhabitants . The modern society of Kuwait is adapting itself to the extremely arid environment by installing appropriate technologies to desalinate seawater and to generate electrical power supply (Addel – Jawad et al, 1999)

During the last four decades , Kuwait developed eigh dual – purpose sites for water production and power generation along a 120 Km of shoreline , Large volume of seawater is utilized for these activities and hence , profound changes in the marine and coastal environment are excepted due to this development (El Sayed et al 2004)

Moreover , the availability of fresh water and electrical power has resulted in large changes in the demography and the development of the infrastructure to support the new life style of the inhabitants and to support industries were previously this would mineral scale and biological growth that would otherwise interfere with the processes .

These chemicals or their reaction products are in tum discharged with the reject brine . Cooling water used in the steam turbine generations are also discharged to the sea with higher temperature than the ambient temperature of the surface seawater normally by 5°C (Letterman , et al , 2003)

In Kuwait , seven coastal sites were developed so far to produce distilled water and electrical energy . Total current installed nominal capacity amounts to 355.6 million imperial gallons per day (MIGD) (1.6 million m^3/d) (MEW,2006) MEW operates the MSF distillation plants at high temperature , mainly during high demand season (summer) whereas : operation at normal temperature is adopted during the rest of the year (Shams El Din et al 2000) Details of the installed distillation plants are listed in Tables 1.

Table (1) Distillation plants in Kuwait

plant	Total capacity	Total Capacity (million m^3/d)
Shuwaikh	**20.5**	**0.092**
Shuaiba	**30**	**0.135**
Daha East	**42**	**0.189**
Doha West	**110.4**	**0.5**
Az-zour South	**115.2**	**0.52**
Sabiya	**37.5**	**0.17**
Total	**355.6**	**1.60**

I. THE MSF DESALINATION PROCESS

A conventional MSF distillation unit starts with a heater and ends with a condenser Between the heater and the condenser are a number of evaporator – heat exchanger subunits in which the heat supplied in the heater from an external heat sources is continuously recycled for distillation m whereas cold seawater is used ad the heat sink in the condenser .

The condenser , known as the heat rejection section usually contains two or three evaporation stages . The cold seawater flows inside the heat exchanger tubes of the heat rejection section , starting with its last stage , which has the lowest absolute pressure and hence the lowest – temperature vapor . The vapor condenses on the outside surface of the heat exchanger tubes and thus gives up its latent heat to the seawater stream , under the effect of several degrees of temperature difference . The seawater temperature rises a few degrees as it flows from one stage to the next .the seawater leaves the first stage of the heat rejection section , with a total temperature rise between 7 to 8 C° and splits into a makeup feed stream and a rejection stream .

The makeup feed water must pass through a column (or columns) known as a deaerator in a stripping process that removes the dissolved gases from the makeup water . Then chemicals such as antifoaming and anticipant agents and sodium sulfite are injected at the required dosing rates into the makeup water before it enter the last evaporation stage (Shublag et al 1988)

On the other side of the MSF distillation unit the external low pressure steam which supplies heat for the process , enters the brine heater and condenses there . Its latent heat is transferred to the preheated recycling brine and raises its temperature to the level known as the top brine temperature (TBT) the TBT values range between 90° to 120° C.

III. MATERIALS & METHODS

This study deals with the results of analysis of water and particulate samples taken at 3 points covering an area from 100 m to 10600m offshore , inside the Kuwait Bay during the period January – September 2017 and also the disposed brine from Doha East Desalination plant Site (DEPS)

All points have depth 8-12 meters . The sea water samples were collected at I m below sea surface using a Niskin water sampler remotely controlled with depth and temperature sensors .All samples from points 2 and 3 were analyzed immediately on-board the research vessel to find

out temperature (T°C) salinity 0% PH dissolved oxygen (D.O mg/1) And the other samples from point 1 and the brine were transported directly to a lab station is located in the plant The work of all chemical analysis to determine the elements chemical readings was made according to (The American standard methods 21 edition 2005)

Table (2) Average Seawater Concentration at point 2

Month	Water Temperature	Salinity S 0% (ppt)	Dissolved Oxygen ($mg.1^{-1)}$
Feb.	**15.25**	**39.59**	**9.44**
Mar.	**19.46**	**39.02**	**8.18**
Apr.	**22.33**	**39.95**	**7.58**
May.	**27.50**	**38.38**	**6.53**
Jun.	**29.57**	**39.21**	**6.53**
Jul.	**29.57**	**39.21**	**6.53**
Aug.	**31.12**	**41.59**	**6.34**
Avr	**25.15**	**39.69**	**7.23**

Table (3) Average Brine Water Concentration

Month	Water Temperature	Salinity S 0% (ppt)	Dissolved Oxygen ($mg.1^{-1)}$
Feb.	**31.50**	**62.20**	**3.46**
Mar.	**35.25**	**62.70**	**4.02**
Apr.	**36.70**	**63.38**	**3.60**
May.	**38.40**	**64.50**	**3.38**
Jun.	**40.24**	**67.40**	**3.18**
Jul.	**42.92**	**66.20**	**3.42**
Aug.	**47.16**	**68.00**	**3.20**
Avr	**38.88**	**64.91**	**3.46**

Table (4) Average Mixing Water Concentration at point 1

Month	Water Temperature	Salinity S 0% (ppt)	Dissolved Oxygen ($mg.1^{-1)}$
Feb.	**27.20**	**48.21**	**4.80**
Mar.	**30.18**	**49.33**	**5.10**
Apr.	**31.60**	**52.10**	**5.75**
May.	**34.82**	**53.00**	**4.92**
Jun.	**38.30**	**55.25**	**5.27**
Jul.	**40.50**	**56.17**	**5.80**
Aug.	**42.54**	**57.49**	**5.12**
Avr	**35.02**	**53.07**	**5.25**

IV. WATER TEMPERATURE POLLUTION

From previous results it was noticed that water temperature in winter season (February) decreased gradually fro point 1 near the DEPS outlet to the off shore area at point 3 and the middle of the bay at 2. The effect of brine water increased the temperature till the middle of the bay The dispersion of temperature in the bay was moved more to the north side of the bay due to the effect of both the wastewater disposal at El Shuwaikh port and the decreases of water come from KhorSabyiah The effect was noticeable ion distance with range varied between 100 – 350 m from point 1 near the DEPS outlet .

In spring season (March – May) it was noticed that water temperature decreased gradually from point 1 near the DEPS outlet to the offishore area at point 3 and the middle of the bay at point 2 . The effect of brine water increased the temperature until the middle of the bay . The dispersion of temperature was still more to the bay north side due to the effect of both the wastewater disposal at El Shuwaikh port and the decrease of water come from KhorSabyiah . The effect was with distance with range varied between 300 -650 m from point 1 near the DEPS outlet

In summer season (June – August) it was noticed that water temperature in the whole area of the bay is high start from point 1 near the DEPS outlet to the middle of the bay at point 2 . The effect of brine water increased the temperature till the middle of the bay . The dispersion of high temperature is covered a big area of Kuwait bay due to the increase of water come from KhorSabyiah (Al Yamani et al 1995) and the high weather temperature that helps in dispersion of the

high temperature from brine in the bay . The effect was with distance with range varied between 1000-1500 m from point 1 near the DEPS outlet .

Generally it was noticed that the water temperature pollution effect appeared at distance varied with the climatic contents and incoming water from KhorSabyiah from 350 m maximum in winter season to the coverage of the whole bay at summer season .

V. SALINTY POLLUTION

In winter season salinity decreased gradually from point 1 near the DEPS outlet to the offshore area at point 3 and the middle of the bay at point 2 . The effect pf brine water increased the salinity until the middle of the bay . The dispersion of salinity was also to the north side of the bay due to the effect of both the wastewater disposal at El Shuwaikh port and the decrease of water come from KhorSabyiah . The effect was with distance with range varied between 800 01100 m from point 1 near the DEPS outlet/

In summer season the whole area of the bay is high salinity start from point 1 near the DEPS outlet to the middle of the bay at point 2. . The effect of brine water increases the salinity till the middle of the bay . The dispersion of high salinity covers only half of Kuwait bay due to the effect of both the wastewater disposal at Elshuwaikh port and the increase of water come from KhorSabyiah(AlYamani et al 1995) that decrease the high salinity dispersion . The effect was with distance with range varied between 1600-3500m from the DEPS outlet .

Generally it was noticed that the water Salinity as pollution moved inside the bay from the source point 1 near the DEPS outlet to distance varied with the climatice conditions and incoming water from KhorSabyiah from 650 m maximum in winter season to about 3500m the coverage of half of the bay at summer season .

VI. CONCLUSION

Generally the study concluded the following results :

1- The disposal of desalination plants brine to the Juwait bay affected the environment of the bay .
2- The brine increased temperature of bay water by ave3rage 16◌̊c at the disposal point and the effect of this increase dispersed through the bay gradually to distances varied between 350 m in winter and 6000 m in summer with diversion to north part during most period except the flood period of KhorSabyiah .
3- The brine increased the salinity of bay water by average 16 ppt at the disposal point and the effect of this increase dispersed through the bay gradually to distances varied between 550m in winter and 3500 m in summer with diversion to north part during most period and the effect of wastewater disposal from El Shuwailh port and the coming water from KhorSabyiah prevents the pollution motion to east and south of the bay .
4- The continuity of brine disposal to the bay will increase the bay water temperature and Salinity by 8% every 3 years that may caus a very noticeable change during the coming years to the bay environment and its ecology .
5- A need for brine treatment before its disposal may be a very important issue during the coming years to safe the bay environment

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