JOURNAL OF MARINE SCIENCES & ENVIRONMENTAL TECHNOLOGIES
Vol. 1, Issue No. 1 (June-2015)
ISSN: 2413-5267

Determination the Concentrations of Heavy Metals in Seawater Intake of Desalination Plant

E. M. Abogrean[1,*] and L. O. Abogrian[2]

[1] Biotechnology Research Center (BTRC), Tripoli, Libya.
[2] The Higher Institute of Technical Agriculture-Al-Geeran, Tripoli, Libya.
***Corresponding author:** abogrean60@gmail.com

تحديد تراكيز العناصر الثقيلة بمآخذ مياه البحر لمحطة التحلية

الهادي المبروك أبو قرين[1]، لطفية عون أبو قرين[2]

[1] مركز بحوث التقنيات الحيوية، طرابلس، ليبيا.
[2] المعهد العالي للتقنيات الزراعية، الغيران، طرابلس، ليبيا.

Abstract

The desalination plants are considered to have a major role in developing human life. Recently this technology has become widely distributed along the coastal area. Many countries are adopting these technologies for securing the freshwater supply for consumer consumption all over the world. Therefore, it's necessary to evaluate the Environmental Impact Assessment (EIA) of these technologies on the coastal line.

This study has been monitoring seawater quality used for feeding desalination plants to determine the heavy metals of iron (*Fe*), copper (*Cu*), manganese (*Mn*), and zinc (*Zn*) by using the chemical monitoring system to know their effects on the desalination units and other components. This study was conducted in the year 2010 from March to October, samples were collected from feed water intake of Tripoli's West Desalination Plant (Janzour), the plant was chosen because of its importance in supplying fresh water for potable water and industrial uses.

The results of this study showed monthly differences in most tested parameters. These differences lead to scale and corrosion by precipitation on the components of the desalination units. On the other hand, the concentration of *Fe*, *Cu*, *Mn*, and *Zn* were very high compared to the standard rates of the seawater. The mean concentration in ppm at sites 1 and 2 of *Fe*, *Cu*, *Mn*, and *Zn* were (0.044 & 0.043), (2.30 & 2.85), (0.0585 & 0.0593) and (0.0712 & 0.0713) respectively.

Keywords: *Desalination plants, EIA, heavy metals, precipitation*.

الملخص

محطات التحلية كان لها دورا رئيسا في تطور الحياة. وحديثا هذه التكنولوجيا انتشرت على نطاق واسع على طول المناطق الساحلية. دول كثيرة يتبنون هذه التقنيات للمحافظة على إمدادات المياه العذبة لاستهلاك الزبائن في جميع أنحاء العالم. ولذلك، كان من الضروري تقييم التأثيرات البيئية لهذه التقنيات على شواطئ البحر.

في هذه الدراسة تم مراقبة نوعية مياه البحر المستخدمة لتغذية محطة تحلية المياه لتحديد تركيز المعادن الثقيلة (الحديد، النحاس، المنجنيز والزنك) باستخدام نظام الرصد الكيميائي لمعرفة آثارها على وحدات تحلية المياه والمكونات الأخرى. وقد أجريت هذه الدراسة في عام 2010 من مارس إلى أكتوبر، وتم جمع العينات من مياه التغذية لمحطة تحلية غرب طرابلس (بجنزور)، وقد تم اختيار هذه المحطة نظرا لأهميتها في توفير المياه العذبة الصالحة للشرب والاستخدامات الصناعية.

ISSN: 2413-5267

أظهرت نتائج هذه الدراسة الاختلافات الشهرية في تراكيز العناصر الثقيلة. هذه الاختلافات تؤدي إلى زيادة التآكل والترسيب على مكونات محطة تحلية المياه. ومن ناحية أخرى كان تراكيز الحديد والنحاس والمنجنيز والزنك عالية جدا بالمقارنة مع المعدلات القياسية لمياه البحر. وكان متوسط التراكيز في الموقع الأول والثاني للحديد والنحاس والمنجنيز والزنك (0.044 و0.043)، (2.30 و2.85)، (0.0585 و0.0593) و (0.0712 و0.0713) ملجرام/لتر على التوالي.
الكلمات الدلالية: محطات التحلية، تقييم الأثر البيئي، العناصر الثقيلة، الترسب.

1. Introduction

Provision of potable water by seawater desalination is generally considered a benefit despite high construction and operating costs of plants. This is especially true when conventional sources of freshwater are absent or cannot be exploited without severe environmental damage. However, is familiar with the situation in arid countries knows that desalination plants are often large industrial facilities, which consume space and emit substantial amounts of combustion gases. It is also known that potable water production means emitting a concentrate into the sea, into the ground or into evaporation ponds (Desalination & Water Reuse, 1997). Though, a generally less noted fact is that this concentrate contains not only the contents of the seawater taken in, but also additives (or their conversion products) necessary for the desalting process and corrosion by-products (Dural et al., 2007). The response of the impacted marine ecosystem depends on its sensitivity and the magnitude of the impact, which in turn depends on factors such as distance, transport direction and dilution. Small enclosed or semi-enclosed seas may be understood as entire ecosystems, although sub-ecosystems may be defined and examined separately (Bradl, 2005). For example, one half of the world's seawater desalination capacity is located in the Arabian Gulf, and overall impacts on this enclosed sea may be considered in addition to local effects on certain biotopes. In contrast, the accumulation of desalination plants (Hassan & Elaber, 2003) on the Canary Islands (GECOL, 2003) will not produce measurable effects on the Atlantic Ocean as a whole, but distinct coastal ecosystems may be affected by the discharge.

Libya is water dependency consists of 90% ground water and 10% on other resources combined. The desalination plants and co- generation power plants in Libya were established between (1979-2008). The Tripoli's West Desalination Plant has started the production of water in 1999. The plant consists of two units using two types of fuel which are HFO+Gas. It's also a cogeneration of steam turbine, and it has been operating with MSF process and possess 2 units with design capacity (20000 m^3/day) and (4×120 *MW*, Unit Design Output 480 *MW/hr*).

On other hand, the EIA is a very important process to know the positive and the negative environmental impact for any new or existing industrial projects to encourage the positive factors and eliminate negative factors in order to lead a sustainable development concept.

The aim of this study to measure some pollutants such as heavy metals (*Fe*, *Cu*, *Mn* and *Zn*) and their effects on desalination components.

2. Methodology

Samples are collected from many pointes and sites of Tripoli's West Desalination Plant. The samples were collected from the two intakes channels and around that area for 8 months (March–October, 2010). The conductivity, pH and Temperature were measured immediately. The samples were filtered through 11 *µm* pore size Whatman No. 1 membrane filter paper. The proper filter is very important for the preservation of samples, when they are kept for a long period of time before the analysis. On the other hand, the samples were added (2 *ml* Nitric Acid Conc.) as according to the Standard Methods, preservation for determination of metal (APHA et al., 1975) and all the samples were kept in polyethylene bottles, then transferred to the laboratory of The Libyan Petroleum Researches Center. The collected samples have been testing for chemical analysis to know the level of maximum concentration and its impact, the following elements was analyzed (*Fe*, *Cu*, *Mn* and *Zn*) by using of the photometric measurements (Ultra-Violet Dr 2010-spectro-photometer), all the analysis are done according to Standard Methods.

3. Results & Discussion

This study was conducted in the year 2010 from March to October, samples were collected from two sites of Tripoli's West Desalination Plant (Janzour). The samples were collected weekly from both sites. According to the data obtained which is showing in this paper, indicates that the difference in concentrations of pollutants (*Fe*, *Cu*, *Mn*, and *Zn*) between the two sites, were very obvious for all testing parameters.

3.1 Iron Concentration

The mean concentrations of Iron from March to October are presented in Table (1). The standard concentration average of Iron in the sea water (0.004 *ppm*). The results show that the mean concentration of Iron in all months were very high comparing with the standard concentration in the clean sea water.

The mean maximum concentrations of iron in sites 1 and 2 were recorded in August (0.087 *ppm*, and 0.091 *ppm*), while the mean minimum concentrations were in October (0.016 *ppm*, and 0.011 *ppm*) respectively. On the other hand, the average concentration of all months in site 1 and 2 were 0.044 and 0.043 *ppm* respectively, which is 10 times higher than the standard concentration of the sea water. May be the iron is dissolved in the seawater and precipitate into the bottom and forming the red ferrous hydroxide, it means may came with chemical waste water which is rejected to the sea side without treatment.

ISSN: 2413-5267

Table 1. The mean iron concentrations in sites 1and 2

Month	Number of Samples	Mean Conc. of site 1 (*ppm*)	Mean Conc. of site 2 (*ppm*)
March	4	0.035 ± 0.01	0.041 ± 0.00
April	4	0.027 ± 0.00	0.038 ± 0.00
May	4	0.055 ± 0.01	0.059 ± 0.01
June	4	0.019 ± 0.01	0.017 ± 0.01
July	4	0.045 ± 0.02	0.026 ± 0.01
August	4	0.087 ±0.02	0.091 ± 0.00
September	4	0.035 ± 0.01	0.065 ± 0.01
October	4	0.016 ± 0.00	0.011 ± 0.00
Average		**0.044**	**0.043**

3.2 Copper Concentration

According to the data obtained which is showing in Table (2), the mean maximum concentration of cupper in sites 1 and 2 were recorded in October (4.02 *ppm*, and 5.03 *ppm*), and the mean minimum concentration in June (1.04 *ppm*, and 1.06 *ppm*) respectively. However, the average copper concentration of 8 months in site 1 and 2 were (2.30 *ppm*, and 2.85 *ppm*) respectively. The standard copper concentration in the clean sea water is about (0.023 *ppm*). The average results which obtained in the study were very high comparing with standard concentration of copper in the clean sea water, which means that this pollution maybe due to the pretreatment of the plant and the industrial sources located near the plant location.

3.3 Manganese Concentration

As presented in Table (3), the minimum mean concentration of manganese in sites 1 and 2 were recorded in may (0.039 *ppm*, and 0.041 *ppm*), whereas the maximum concentration in September (0.084 *ppm*, and 0.086 *ppm*) respectively. All the results of the manganese concentrations are higher than the standard concentration of the sea water, perhaps due to the high salinity of brine solution after desalted and reject of all the wastewater disposal from power plant station. Moreover, some of industrial pollutant which near-by the study area may found its way to sea water.

Table 2. The mean copper concentrations in sites 1 and 2

Month	Number of Samples	Mean Conc. of site 1 (*ppm*)	Mean Conc. of site 2 (*ppm*)
March	4	1.24 ± 0.01	2.04 ± 0.02
April	4	1.63 ± 0.01	4.02 ± 0.01
May	4	2.02 ± 0.01	2.06 ± 0.01
June	4	1.04 ± 0.01	1.06 ± 0.01
July	4	3.05 ± 0.02	3.81 ± 0.01
August	4	2.09 ± 0.02	3.19 ± 0.03
September	4	3.28 ± 0.01	1.64 ± 0.02
October	4	4.02 ± 0.00	5.03 ± 0.00
Average		**2.30**	**2.85**

Table 3. The mean manganese concentrations in sites 1 and 2

Month	Number of Samples	Mean Conc. of site 1 (*ppm*)	Mean Conc. of site 2 (*ppm*)
March	4	0.042 ± 0.01	0.045 ± 0.01
April	4	0.051 ± 0.01	0.049 ± 0.01
May	4	0.039 ± 0.01	0.041 ± 0.02
June	4	0.046 ± 0.01	0.045 ± 0.02
July	4	0.055 ± 0.01	0.056 ± 0.01
August	4	0.073 ± 0.01	0.075 ± 0.01
September	4	0.084 ± 0.01	0.086 ± 0.01
October	4	0.078 ± 0.00	0.077 ± 0.01
Average		**0.0585**	**0.0593**

3.3 Zinc concentration

The results presented in Table (4), show that the zinc concentration at both sites ranged from 0.031 *ppm* to 0.12 *ppm* with an average of 0.071 *ppm*. On the other hand, the maximum mean value of zinc concentration in sites 1 and 2 were in October, while the minimum concentration was recorded in March. The corrosion of the pipes due to high salinity of the brine may cause high concentration of the zinc.

Table 4. The mean zinc concentrations in sites 1 and 2

Month	Number of Samples	Mean Conc. of site 1 (*ppm*)	Mean Conc. of site 2 (*ppm*)
March	4	0.031 ± 0.01	0.031 ± 0.02
April	4	0.042 ± 0.02	0.044 ± 0.01
May	4	0.054 ± 0.01	0.054 ± 0.02
June	4	0.063 ± 0.01	0.058 ± 0.01
July	4	0.076 ± 0.02	0.075 ± 0.03
Augustus	4	0.087 ± 0.02	0.083 ± 0.03
September	4	0.095 ± 0.01	0.097 ± 0.02
October	4	0.12 ± 0.0001	0.12 ± 0.02
Average		**0.0712**	**0.0713**

Finally the main reason of these pollutants (*Fe, Cu, Mn,* and *Zn*) is the geographic environmental location and predominant condition, such as the motion of water current which helps to transport the pollutants into the sea side (study area) from all the different pollutant sources such as a high salinity of brine solution after desalted which are rejected to the seaside without treatment and nearby the location of the industrial activities also wastewater disposal into the sea without any control. Also these metals are normally associated with corrosion.

4. Conclusion

Desalination plants are known to produce waste brine with heavy metals in relatively low concentrations (Lattemann and Hoepner, 2008). Increase in heavy metals are associated with distillation techniques whereas high temperature aids corrosion of metals constructed with iron, copper, manganese, zinc, nickel, chromium, and molybdenum alloys (Ahmed *et al*., 2001; and Hoepner & Lattemann, 2002). Therefore, the results of this study showed the concentration of heavy metals (*Fe, Cu, Mn*, and *Zn*) were very high compared to the standard of the sea water. Moreover, the results illustrated monthly differences in most tested parameters. These differences lead to the scale and corrosion by precipitation on the components of the desalination unites. On the other hand the reason of these pollution could be because of the geographic environmental location and predominant condition, such as

ISSN: 2413-5267

motion of water current which help to transport the pollutants into the seaside (study area) from all the different pollutant sources such as a high salinity of brine solution after desalted which are rejected to the sea side without treatment and nearby the location of the industrial activities also wastewater disposal into the sea without any control. Therefore, the following important points have to consider when planning to establish a new desalination plants:

- Environmental Impacts Assessment process to prevent operating problems and protection marine and coastline ecology.
- Optimum use of chemical additional with according to specification to guaranty and to save the efficiency of the plant.
- Establishing a monitoring system for feed water quality.

References

Ahmed M., Shayya W.H., Hoey D., & Al-Handaly J. (2001). Brine disposal from reverse osmosis desalination plants in Oman and United Arab Emirates. *Desalination*, 133: 135-147.

Bradl H. (2005). Heavy Metals in the Environment: Origin, Interaction and Remediation Elsevier/Academic Press, London.

Desalination & Water Reuse, Vol. 614, February– March 1997 IDA, Florida, USA.

Dural M., Goksu M.Z.L., & Ozak A.A. (2007). Investigation of heavy metal levels in economically important fish species captured from the Tuzal Laagoon. *Food Chem*., 102: 415-421.

Hassan M., & Elaber S. Tripoli, Operation & maintenance of MSF Desalination plant, Training course, GECOL & PRC, Libya, 2003.

Hoepner T., & Lattemann S., (2002). Chemical impacts from seawater desalination plants—a case study of the northern Red Sea. *Desalination*, 152: 133–140.

Lattemann S., & Hoepner T. (2008). Environmental impact and impact assessment of seawater desalination. *Desalination,* 220: 1–15.

APHA, AWWA, & WPCF (1975). Standard Methods for the Examination of Water and Wastewater. 14^{th} ed., Washington DC.

GECOL (2003). The Annual Report of General Electricity Company of Libya for 2003. Desalination Department Eastern side, GECOL.