Asian Journal of Chemistry Vol. 22, No. 7 (2010), 5282-5288

Chemical Compositions of Persian Gulf Water Around The Qeshm Island At Various Seasons

M. PAYEHGHADR* and A. ELIASI†
Department of Chemistry, Payame Noor University (PNU), Karaj, Iran
E-mail: mpayehghadr@pnu.ac.ir; mahmood_payehghadr@yahoo.com

In this paper, the results of chemical analysis of Persian Gulf water around Qeshm Island in Strait of Hormuz, is reported. The water samples are taken from various beach places around Qeshm Island and at four different seasons for investigation of effects of place and season changes on water compositions. The total dissolved solids (TDS) at 105, 180 and 550 ºC were found as 43900-57550, 42507-53500 and 34830-47200 mg/L, respectively. The pH was between 8.01-8.34 and the average density was 1.027 g/mL. Concentration of Ca^{2+}, K^{+}, Mg^{2+}, Na^{+}, Sr^{2+}, Ni^{2+}, Cl^{-}, Br^{-}, S^{2+}, SO_4^{2-} and CO_3^{2-} determined as 316-678, 173-555, 1915-1341, 7646-9002, 5-6, 0.312-0.324, 20855-22720, 0.072-0.078, 575-1020, 1725-3060 and 154-160 mg/L, respectively. Some minor components such as Li, Fe, Zn, Mn, SiO_2, Cu, Zr, Mo, V, Pb, Sn and Al were determined.

Key Words: Qeshm Island, Water chemical analysis, Sea water, Persian Gulf, Strait of Hormuz.

INTRODUCTION

The extraction and recovery of bromine from seawater have been reported[1]. In literature[2-5] some scanty data is available on the extent and mechanism of evolution of Br_2. On the other hand, we need to the total composition data of Persian Gulf water for feasibility studies of some important materials manufacturing from sea water design, but the reliable data in literatures is not sufficient in this relation. This project must be done in Qeshm Island for manufacturing of bromine (as original goal), magnesium hydroxide, *etc*. Thus Persian Gulf water around the Qeshm Island must be analyzed for that purpose.

Qeshm Island is the biggest Island in Persian Gulf which covers an area of 1295 km^2. This island is placed on Strait of Hormoz. The potable water of this island is provided by evaporation and reverse osmosis (RO) systems. The feeds of these systems are provided from Persian Gulf water around of the Qeshm Island. So, the knowledge about chemical compositions of the water is very important for providing potable water. On the other hand, there are more than 70 elements in sea

†Department of Chemical Industries Research, Iranian Research Organization for Science and Technology, No. 71, Forsat Street, Enghelab Ave., Tehran, Iran.

water and marines among which 9 important elements are Na^+, Mg^{2+}, Ca^{2+}, K^+, Sr^{2+} and Cl^-, SO_4^{2-}, HCO_3^- and Br^- some of them are valuable for recovery. It is obvious that a feasibility study is necessary before constructing a unit for the recovery. Also, chemical composition of the sea water is one of the most important factors in feasibility study and economic aspects of manufacturing processes for recovery of the mentioned compounds.

In this paper, the chemical analysis of Persian Gulf water around of Qeshm Island is reported and for this goal we have used the AAS, FES, ICP, spectrophotometric, ion selective and classical methods for analysis of water samples[5-9]. In order to demonstrate the role of season changes on sea water composition around the Island, water samples are taken from different places around of the island at four different seasons for 1 year.

EXPERIMENTAL

Samples are taken in poly(ethylene terephthalate) (PET) bottles with fixed cork sent to laboratory for chemical analysis. The samples were taken from 1.5-2.0 Km distance of beach in about 40 cm depth and were sending to Tehran with airplane as soon as possible. In all cases the samples kept at room temperature. Thus the samples have sent to laboratory about 24 h and have been analyzed at 25-30 h after sampling. Because our goal is the design of some salts and bromine units from sea water, we take the samples from different suitable places. For investigation of seasonal effect, the Tourgan[1] that was a best place for manufacturing unit, have selected.

Method of analysis: Atomic and emission spectrometry are the best methods for analysis. Whenever, high concentration of components of sea water and the variety of its components make serious problems in analysis. Since, the samples must be diluted for analysis and then concentration of some components would be below of detection limit of atomic absorption instrument for desired analysis. Therefore, a combination of atomic absorption spectrometry (AAS) and inductively coupled plasma emission spectrometry (ICP-ES) has been used for chemical analysis. Atomic absorption spectrometry is used for major metallic ion detections by working curve method and minor metallic ions analyzed with AAS by standard addition method. Some of minor cations analyzed with ICP-ES method, too.

Chloride and sulfate anions are analyzed by argentometric titration and gravimetric using barium chloride solution, respectively. Bromide and iodide anions are analyzed with ion-selective electrode (ISE) methods.

Total dissolved solids (TDS) is an important factor for water analysis. This parameter has been measured by evaporation of known volume seawater samples at 105 ºC (TDS105), 180 ºC (TDS180) and 550 ºC (TDS550) in a temperature programmable furnace, by a porcelain crucible. In a typical procedure a porcelain crucible is placed at 550 ºC furnace for 1 h and then is weighed after cooling in dessicator (its weight is marked as B). Then a known volume of seawater contains 10-200 mg total dissolved solids is poured in the crucible and is evaporated by

water bath till dryness and then the sample is placed at 105 ºC furnace for 1 h. The crucible is cooled in dessicator and is weighed. This work is repeated for several times until less than 2 % differences is obtained after two consecutive weighing (its weight is marked as A). Finally, the total dissolved solid (TDS) is obtained from the following relation:

$$\text{Total dissolved solids} = \left[\frac{(A - B)}{V_S}\right] \times 1000 \quad (1)$$

where, TDS is total dissolved solids in mg/L and V_S is the sample volume in mL. These procedures are repeated at 180 and 550 ºC temperatures[6].

RESULTS AND DISCUSSION

All of measured quantities and their values are reported in Tables 1-4. The second and the third columns of Table-1 show the values which are related to the samples were taken from beside the beach of Tourgan (Tourgan 1) and about 3 km far from the beach of Tourgan (Tourgan 2), respectively. The reported values show that the chemical compositions of the both samples are nearly the same. Namely, 3 km distance from the beach has not any important effect on chemical composition

TABLE-1
PERSIAN GULF WATER MEASURED QUANTITIES AND THEIR VALUES. THE SAMPLES ARE TAKEN FROM THREE DIFFERENT PLACES AROUND QESHAM ISLAND (TOURGAN 1, TOURGAN 2 AND TOULA) AT SPRING

Measured quantity	Tourgan 1	Tourgan 2	Toula
Ca^{2+}	678	478	528
K^{+}	555	543	552
Mg^{2+}	1340	1268	1311
Na^{+}	8819	7906	7859
Ni^{2+}	0.320	0.324	0.312
Li^{+*}	0.310	0.310	0.320
Fe^{2+*}	0.010	0.010	0.010
Zn^{2+*}	0.130	0.128	0.075
Mn^{2+*}	0.037	0.034	0.040
Si^{4+*}	0	0	0
Cl^{-}	21100	20855	20910
Br^{-}	73	72	78
S^{2-}	765	822	911
SO_4^{2-}	2295	2466	2733
CO_3^{2-}	156	154	160
pH	8.05	8.05	8.09
TDS (105 ºC)	43900	44082	45780
TDS (180 ºC)	42507	42692	42855
TDS (550 ºC)	35312	35497	34830
Density (g/mL)	1.027	1.027	1.027

All of concentrations are in ppm (mg/L) except those are marked by * which are in μg/L.

TABLE-2
PERSIAN GULF WATER SPECIES AT THREE DIFFERENT PLACES AROUND QESHM ISLAND (TOURGAN 1, SALAKH AND TABL) AT SUMMER

Measured quantity	Tourgan 1	Salakh	Tabl
Ca^{2+}	316	342	342
K^{+}	311	397	173
Mg^{2+}	1341	1305	1015
Na^{+}	8940	9002	7646
Sr^{2+}	6	6	5
Li^{+*}	231	252	250
Fe^{2+*}	0	0	0
Zn^{2+*}	120	128	130
Mn^{2+*}	23	28	32
Si^{4+*}	0	0	0
Cl^{-}	21300	22720	21300
S^{2-}	575	1020	895
SO_4^{2-}	1725	3060	2685
F^{-}	0	0	0
pH	8.34	8.01	8.10
TDS (105 ºC)	55204	57544	50948
TDS (180 ºC)	51300	53500	47400
TDS (550 ºC)	45300	47200	41800
Density (g/mL)	1.028	1.028	1.026

All of concentrations are in ppm (mg/L) except those are marked by * which are in µg/L.

TABLE-3
PERSIAN GULF WATER SPECIES AT THREE DIFFERENT PLACES AROUND QESHAM ISLAND (TOURGAN 1, SUZA AND TABL) AT AUTUMN

Measured quantity	Tourgan 1	Suza	Tabl
Ca^{2+}	480	470	480
K^{+}	520	510	510
Mg^{2+}	1430	1430	1450
Na^{+}	8000	8300	8170
Sr^{2+}	9	6	6
Li^{+*}	350	340	350
Fe^{2+*}	<15	< 15	< 15
Zn^{2+*}	180	150	230
Mn^{2+*}	35	35	35
Si^{4+*}	29	54	150
Cu^{2+}	0.50	–	–
Zr^{4+}	< 2	–	–
Mo^{6+}	< 1	–	–
V^{4+}	< 1	–	–
Pb^{2+}	< 1	–	–
Sn^{2+}	< 1	–	–
Al^{3+}	67	–	–
Cl^{-}	21298	23430	24850
Br^{-}	99	–	–
S^{2-}	730	824	773

SO_4^{2-}	2190	2472	2319
F^-	< 2	–	–
pH	8.03	8.15	8.16
TDS (105 ºC)	45416	51416	45528
TDS (180 ºC)	42500	42200	43100
TDS (550 ºC)	37400	37000	36300
Density (g/mL)	1.027	1.027	1.027

All of concentrations are in ppm (mg/L) except those are marked by * which are in μg/L.

TABLE-4
PERSIAN GULF WATER SPECIES AT TWO DIFFERENT PLACES AROUND QESHAM ISLAND (TOURGAN 1 AND TOULA) AT WINTER

Measured quantity	Tourgan 1	Toula
Ca^{2+}	479	533
K^+	453	500
Mg^{2+}	999	1570
Na^+	9200	10730
Ni^{2+}	0.332	0.328
Li^{+*}	312	325
Fe^{2+*}	9	11
Zn^{2+*}	0.132	0.080
Mn^{2+*}	32	38
Si^{4+*}	0	0
Cl^-	22420	21300
Br^-	62	69
S^{2-}	880	977
SO_4^{2-}	2640	2931
NO_3^{2-}	2.4	2
CO_3^{2-}	150	156
pH	8.04	8.11
TDS (105 ºC)	43720	45805
TDS (180 ºC)	42325	42880
TDS (550 ºC)	35130	34855
Density (g/mL)	1.028	1.028

All of concentrations are in ppm (mg/L) except those are marked by * which are in μg/L.

of the samples. Third column shows the measured values for the sample which was taken from the beach of Toula. All of these quantities are related to the samples which were taken at spring.

Effect of the season changes on concentration of major cations and anions of the studied samples are shown in Figs. 1 and 2. Major cation concentrations of the studied samples at summer are compared in Fig. 3 for three different places. These figures show that the changes of seasons and sampling positions have not any important effects on the water chemical composition.

The effect of sampling positions on major anion concentrations are shown in Fig. 4. According to this figure, the effects of sampling positions on anion concentrations are negligible. Effects of season changes and sampling positions on total dissolved solids (TDS) are shown in Figs. 5 and 6, respectively. These figures show

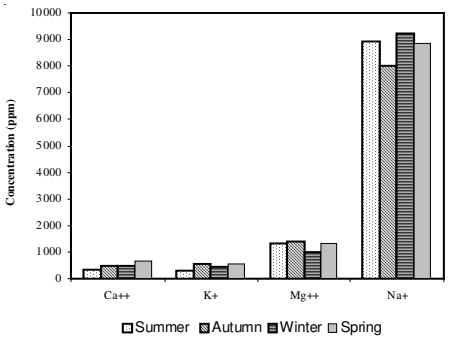

Fig. 1. Effect of season changes on major cation concentrations of Persian Gulf water around Qeshm Island (Tourgan 1)

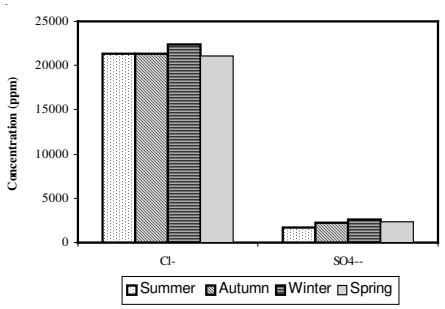

Fig. 2. Effect of season changes on major anion concentrations of Persian Gulf water around Qeshm Island (Tourgan 1)

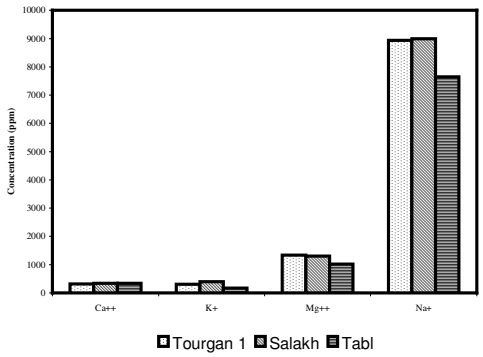

Fig. 3. Major cation concentrations in three different area around Qheshm Island (Tourgan 1, Salakh and Tabl) at summer

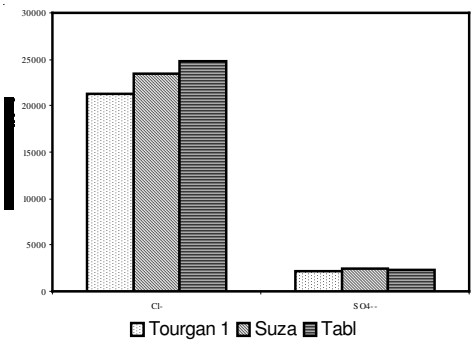

Fig. 4. Major anion concentrations in three different area around Qheshm Island (Tourgan 1, Suza and Tabl) at summer

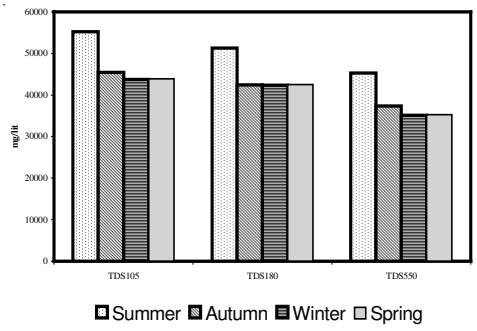

Fig. 5. Season effects on TDS values of Persian Gulf water around Qeshm island (Tourgan 1)

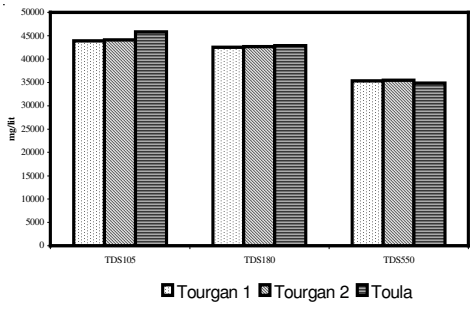

Fig. 6. TDS values of Persian Gulf water around Qeshm Island (Tourgan 1, Tourgan 2 and Toula) at spring

that the effects of the mentioned parameters on TDS measured values are negligible. There are a little difference between TDS values of samples which were providing at different seasons and positions which can be related to uncontrollable site and laboratory errors.

ACKNOWLEDGEMENTS

The authors thank Iranian Research Organization for Science and Technology (IROST) for financial support of this work.

REFERENCES

1. A.M. El-Hamouz and R. Mann, *Ind. Eng. Chem. Res*., **46**, 3008 (2007).
2. J.W. Oldfield and B. Todd, *Desalination*, **38**, 233 (1981).
3. W.S.W. Lee, J.W. Oldfield and B. Todd, *Desalination*, **44**, 209 (1983).
4. A. Bousher, P. Brimblecombe and D. Midgley, *Water. Res.*, **20**, 865 (1986).
5. F.H. Butt, A.G. Maadhah, F. Rahman and H.M. Al-Zahrani, *Desalination*, **45**, 345 (1983).
6. Standard Methods for the Examination of Water and Wastewater, American Public Health Association (1995).
7. Z. Marczenko, Separation and Spectrophotometric Determination of Elements, John Wiley and Sons (1986).
8. M.M. Rutgers, Van Der Loeff and W.S. Moore, Methods of Seawater Analysis, Chap. 13 (1999).
9. C.R. Cho and R.P. Ashdown, Seawater Analysis using the Varian 820-MS, ICP-MS Application note No. 32, Varian Corporation.

(*Received*: 17 August 2009; *Accepted*: 20 March 2010) AJC-8551