Available online at: www.basra-science-journal.org

ISSN –1817 –2695

The Measurements of Borates Concentration in Waters of Basra city using different Techniques

Thaer M. Salman and Muntadher A. Qasim
Department of Physics, College of Education for pure science, University of Basrah, Iraq
E-mail: thaer_msalman@yahoo.com
Received 3-10-2012, Accepted 23-1-2013

Abstract

concentration of Boron is assess in water samples which are taken from different Regions in Basrah City. A technical method has used in two sets of experimental works in the measurements of Boron concentrations in water. The first measurement by using Curcumin method and the second is the passive method by using the solid state nuclear track detectors,CR39. Tap water in the governorate, has a very low Boron concentration 0.539 ppm at Al-Bedeah river. Shatt Al-Arab Al-Jzeera AlOula did show a Boron level as high as 7.405 ppm at east governorate, waters have Boron level ranging between 7.785mg/l and 0.638 mg/l in curcumin method. A conclusion has been made, that Basrah governorate tap water is safe as far as Boron concentration is concerned, while the rivers waters should be avoided. The high concentration tells us that pollutant in this part of the city is larger than the other parts. Samples of water were collected during February 2012, from all the locations in Basrah City.

Keywords: Neutron Source , Boron, Curcumin , SSNTDs, Drinking water.

1. INTRODUCTION

Boron is a nonmetallic element that belongs to Group IIIA of the periodic table and has an oxidation state of +3. It has an atomic number of 5 and atomic weight of 10.81. Boron is actually a mixture of two stable isotopes, ^{10}B (19.8%) and ^{11}B (80.2%) [1]. Boron is a naturally-occurring element found in rocks, soil, and water. The concentration of boron in the earth's crust has been estimated to be <10 ppm, but concentrations as high as 100 ppm can be found in boron-rich areas[2] . Only the latter has a high thermal neutron capture cross section (3832b).

Solid state nuclear track detectors (SSNTDs) of different materials are important for investigations in basic science and technology [3]. Among such applications, SSNTDs are widely used in radiation protection and environmental radiation monitoring. Their theory was developed more than 40 years ago, the basic fundamentals can be found in Somogyi[4] and in more details in

Durrani et al. [5]. Even more details for detecting alpha particles, which is important from Boron Neutron Capture Therapy (BNCT) point of view, can be found in Nikezic[6]. Therefore, here we touch some aspects of interest, only. Popularly saying, an ionizing particle produces a narrow damaged zone in the plastic, 10-100 nm in diameter, which can be enlarged and visualized by a chemical treatment, so that the particle movement in the detector material, let us say the footprint of the particle or its track can be followed under optical microscope. Depending on the chemical treatment (called etching) and observation method there are basically two requirements: the range and energy deposition of the particle should be adequate.

Figure-1.BasrahCity, dots represent the places where samples taken from, numbering in station number (S) (Basrah map is from Google earth)

This work represent the preliminary findings from Boron concentration measurement data which were collected from different regions in Basrah City. The general aim is to investigate the complex interactions and exchanges with the flow of water, and estimate how much hazards brought with waters. In fact, the study area is located inside Basrah Governorate which is located in the extreme southern part of Iraq,see Figure-1. Al-Basrah Governorate sited at the southern rim of the Gulf, part of the Iraqi Southern Desert in the west and south and relatively short coast on the Gulf. In the northern part of Basrah Governorate, Tigris and Euphrates merge forming Shatt-Al Arab river which flows southward to the Gulf.

2.EXPERIMENTAL PROCEDURE

The Tap water in Basrah City is supplied from two sources; one from Beda's(on Euphrates River) and the other from Shatt-Al-Arab river (formed by the confluence of the Euphrates and the Tigris rivers). Samples from 40 stations and locations were collected during February 2012. The collected, 0.25L, bottles completely filled with water and well sealed to avoidany connection with air. The measurements of Boron concentration water were carried out by two methods:

2.1CURCUMIN TECHNIQUE

Boron in water can be determined by several methods, such as the Curcumin method, consisting of acidification and evaporation in the presence of Curcumin to produce rosocyanine, which is taken up with ethanol and compared photometrically with standards. The Curcumin method is recommended for water with boron concentrations between 0.1 and 1.0 mg/L [7].

When a sample of water containing boron is acidified and evaporated in the presence of curcumin,a red-colored product called rosocyanine is formed. The rosocyanine is taken up in a suitable solvent and the red color is compared with standards visually or photometrically.

2.2. PASSIVE TECHNIQUE

Solid State Nuclear Track Detectors (SSNTDs) were used for the measurements of Boron concentration in drinking water. The SSNTD, CR39 with dimensions 1×1 cm films, many samples of water from different places have been supplied . One milliliter of each sample of water is dropped on the same area of the $CR-39$ track detector, and was left to dry. After drying ,the samples are exposed to a thermal neutron source (Am-Be) for the same period of time 3 days . A nuclear reaction of type ${}_5B^{10}\ (n,\alpha)\ {}_3Li^7$ has been occurred, Alpha particles are emitted with energy 2.31 MeV which can make suitable track in $CR-39$ plastic-detector. The samples, after being exposed, are washed in distilled water, then etched in a solution of 6.25N (Normality) NaOH at 70^oC temperature, 3 hrs (etching time) , by using a water bath held at a constant temperature. The boron concentrations (5,10,20, 30,40,50,60)were prepared by dissolving 6.1 gm from Boric acid with 1liter from distilled water and then deposited it on the surface of detector and later exposure to neutron source.The track density have been carried out using transmission optical microscope for each concentration and a schematic suitable calibration curve is used to calculate the concentration of Boron.The samples of the detector were irradiated with neutrons that emitted from Am-Be(in contact). The yield of the neutron source was $1.1\times10^7 n/s$ and the mean energy of its emitted neutrons was 4.5 MeV. The source was supplied by Radio-Chemical Ltd. Amersham, England The irradiation times were 3 days to irradiate the films with alpha particles emitted from (Am-Be) source Because the track density in this times was very more .

3.RESULTS AND DISCUSSION

The samples of water coming from rivers have been sampled in glass bottles (0.25 liter) for the chemical parameters determinations and in polietylenebottles for boron determinations. The principle of passive method with Track density for determination of boron is the reaction of passive which isthe product of track density. We obtain the track density for each of boron concentration and then schematic the relation between the track density as a function of boron concentration. For the calibration Curve figure-2, a linear relation was observed, followed by the calculation of the slope factor.

The results are experimented in mg /L.

Regression equation:

$y = 0.568\ x + 0.125$, $R^2 = 0.994$ (figure 2).

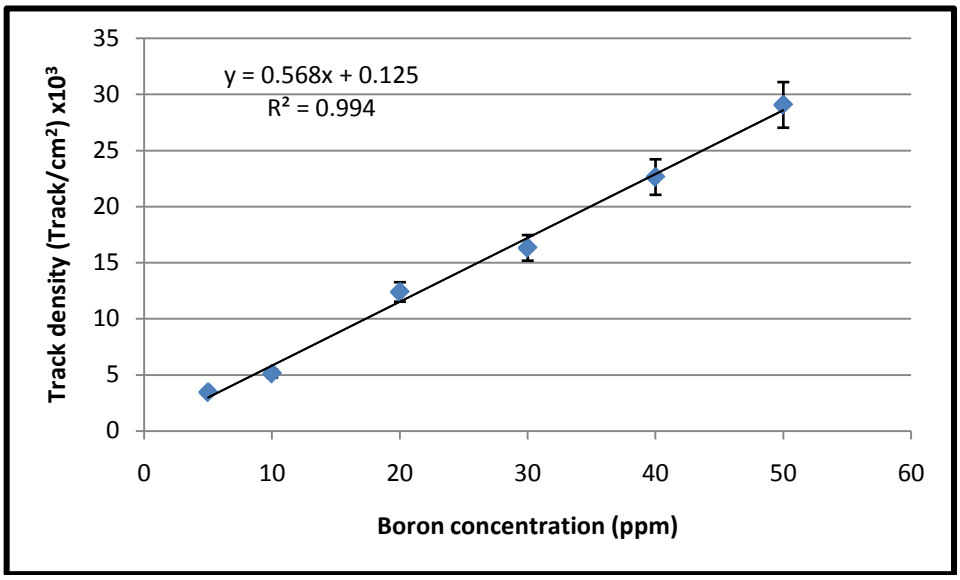

Figure-2. The calibration curve – Boron

with respect to the second method,theprinciple of spectrophotometric with Curcumin method for determination of boron is the reaction of Curcumin which is the product of rosocyanine. In the presence of dissolved forms of borates, at pH=8, formation of red complex is taken place, followed by the spectrophotometric measurements (λ = 540nm). The boron concentrations (0.2,0.5,1, 2,4)were prepared by dissolving 0.286 gm from Boric acid with 1liter from distilled water and then added the oxalic acid and curcumie to sample ,later we are calculate the absorption to to each of the concentration. For the calibration curve figure-3, a linear calibration was observed, followed by the calculation of the slope factor.

The results are experimented in mg/l. Regression equation:

$y = 7.609 x + 0.199$, R^2 =0.981 (figure-3).

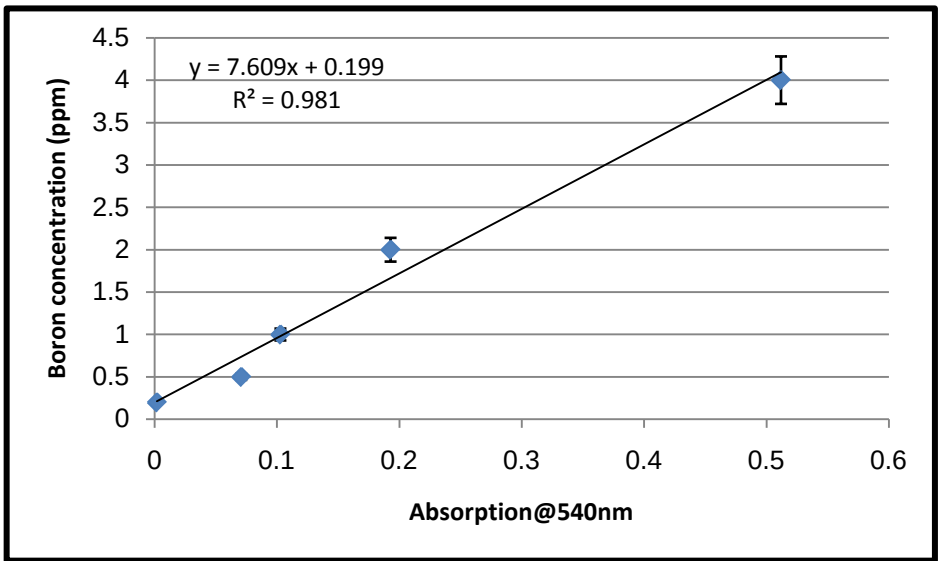

Figure-3. The calibration curve – Boron

A quick term measurements using the Curcumin method for drinking and washing surface water and a measurement using the SSNTDs were done for 40 samples, S1 to S40, in different locations in Basrah. The results are shown in table1 and figure-4.Inasmuch as at the details of the results, for both types of tests, one can recognize that there are some differences or some approximations in the results between Curcumin and SSNTDs. Al-Mudeina (tap)in the governorate, has a very low Boron concentration(0.539)ppm atAl-Bedeah river. Shatt Al-ArabAl-Jzeera AlOula did show a Boron level as high as 7.405 ppm at east governorate, while the waters have Boron high level 7.785 mg/l at Al-Basrah Harbor and a low level concentration 0.638 mg/l in Al-Mudeina(tap).This result obtain in curcumin method. Because the tap water at low level is safe as far as Boron concentration is concerned, while the rivers waters should be avoided. The high concentration tells us that pollutant in this part of the city is larger than the other parts .These differences orapproximated are due to long and short time measurements. For SSNTDs technique the interval of measurements were for 3days, while the Curcumin technique ,the interval of measurements were for 3hr.

Table-1. Measurement results for water samples (rivers, tap) in Basrah Governorate by SSNTDs Method .

Site Number	Site Name	Boron concentration In ppm using (SSNTDs)
S1	Al- Mudeina -Anter river	1.815
S2	Al- Mudeina -Salah river	2.025
S3	Al-Mudeina (tap)	0.539
S4	AL-Huwair AL-Aujan	1.673
S5	Qurna river	0.911
S6	Tigris river AL-Qurna-Muzereh	1.654
S7	Qurna – AlNahirat (tap)	0.549
S8	Al-Sharish- AlAgmaij river	1.214
S9	Al-Shafi river	3.957
S10	Tigris river AL-Deir AL-Zwein	5.634
S11	Tigris river AL-Deir AL-Nashwa	3.842
S12	Paper factory (tap)	0.598
S13	Al-Hartha- Hour Rajab	1.153
S14	Thermal enrgy station AL-Hartha	2.874
S15	Qarmat Ali- AlMacehab river	1.063
S16	Qarmat Ali-AlGhait	0.831
S17	Al- Khora	1.052
S18	Shatt Al-Qarma	1.261
S19	Shatt Al-Arab Al-Jzeera Al-Oula	7.405
S20	Shatt Al-Arab Al-Jzeera Al-Thania	6.656
S21	Shatt Al-Arab Al-Jzeera Al-Thaltha	2.787
S22	Shatt Al-Arab Al-Jzeera Al-Rabaa	3.018
S23	AL-Tennuma–Hassan river	3.641
S24	AL-Tennuma - Gurdlan river	3.482
S25	AL-Tennuma -Jaseem river	2.341
S26	Al-Basrah (tap)	0.547
S27	Ashaar river	1.005
S28	Al-Handia river	2.248
S29	Abu Floos	1.529
S30	Abu AL-Khaseeb river	1.768
S31	Abu AL-KhaseebGhuz river	2.081
S32	Abu AL-KhaseebHamdan river	1.574
S33	Abu AL-Khaseeb Abu Mgira river	1.347
S34	AL-Zubeir river	2.481
S35	AumQaser Harbor	6.957
S36	Ras Al-Bisha	4.924
S37	Al-Fao	4.541
S38	Al-carun river	7.381
S39	Tina river	4.007
S40	Al-Basrah Harbor	7.337

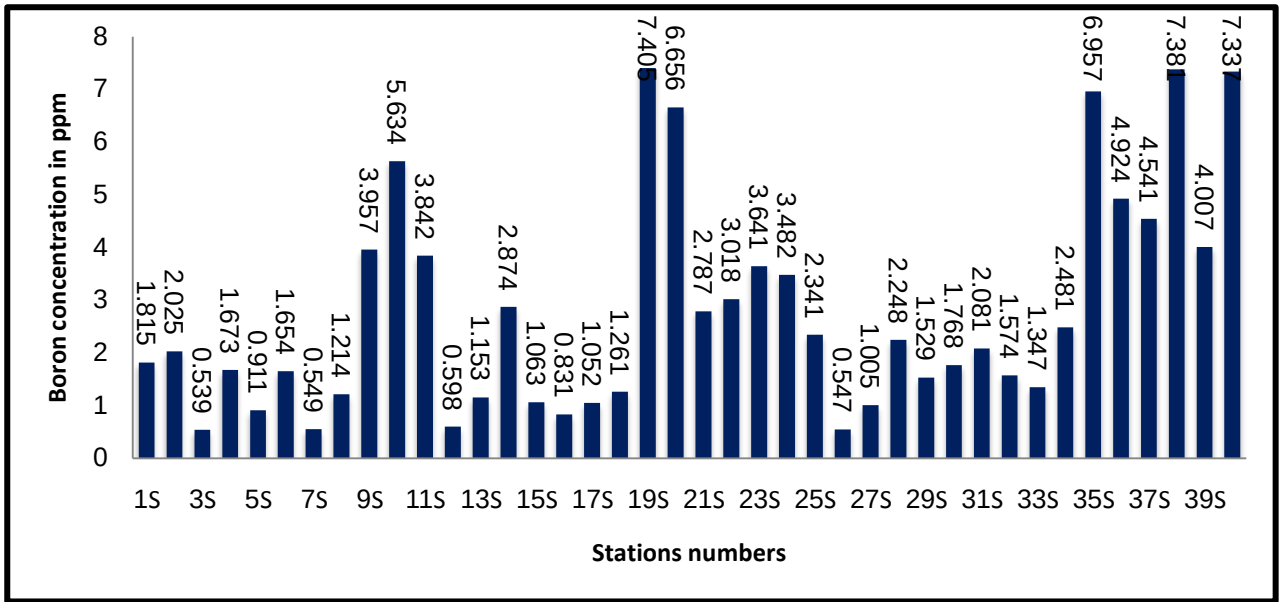

Figure-4 Boron concentrations in rivers and drinking water at Basrah City by using SSNTDs method.

For the measurement of boron concentration level in water by Curcumin method, Table-2 and Fgure-5, reflect the fact that, there was some high level of boron concentration in this water higher than the most of public tap and washing surface water in the governorate. The results for these 40 samples categorized from s1 to s40, are shown in Figure-5. The data is ranging from 0.638 mg/l in S3, S7,S12 to 7.621 , 7.785at S19 , S40 samples.

Table-2. Measurement results for water samples (rivers, tap) in Basrah Governorate by Curcumin Method.

Site Number	Site Name	Absorpion In 540 nm	Boron concentration In mg/L using (Curcumin Method)
S1	Al- Mudeina -Anter river	0.241	2.031
S2	Al- Mudeina -Salah river	0.269	2.245
S3	Al-Mudeina (tap)	0.058	0.638
S4	AL-Huwair AL-Aujan	0.133	1.210
S5	Qurna river	0.136	1.235
S6	Tigris river AL-Qurna-Muzereh	0.208	1.782
S7	Qurna – AlNahirat (tap)	0.059	0.648
S8	Al-Sharish- AlAgmaij river	0.165	1.452
S9	Al-Shafi river	0.533	4.254
S10	Tigris river AL-Deir AL-Zwein	0.768	6.045
S11	Tigris river AL-Deir AL-Nashwa	0.378	3.073
S12	Paper factory (tap)	0.060	0.659
S13	Al-Hartha- Hour Rajab	0.119	1.102
S14	Thermal enrgy station AL-Hartha	0.366	2.984
S15	Qarmat Ali- AlMacehab river	0.131	1.194
S16	Qarmat Ali-AlGhait	0.119	1.107
S17	Al- Khora	0.145	1.301
S18	Shatt Al-Qarma	0.160	1.420
S19	Shatt Al-Arab Al-Jzeera Al-Oula	0.969	7.573
S20	Shatt Al-Arab Al-Jzeera Al-Thania	0.884	6.924
S21	Shatt Al-Arab Al-Jzeera Al-Thaltha	0.355	2.899
S22	Shatt Al-Arab Al-Jzeera Al-Rabaa	0.421	3.402
S23	AL-Tennuma –Hassan river	0.486	3.897
S24	AL-Tennuma - Gurdlan river	0.453	3.648
S25	AL-Tennuma -Jaseem river	0.343	2.811
S26	Al-Basrah (tap)	0.067	0.706
S27	Ashaar river	0.122	1.129
S28	Al-Handia river	0.319	2.625
S29	Abu Floos	0.209	1.789
S30	Abu AL-Khaseeb river	0.250	2.105
S31	Abu AL-KhaseebGhuz river	0.300	2.482
S32	Abu AL-KhaseebHamdan river	0.210	1.795
S33	Abu AL-Khaseeb Abu Mgira river	0.200	1.720
S34	AL-Zubeir river	0.322	2.651
S35	AumQaser Harbor	0.840	6.587
S36	Ras Al-Bisha	0.614	4.872
S37	Al-Fao	0.559	4.452
S38	Al-carun river	0.965	7.541
S39	Tina river	0.571	4.543
S40	Al-Basrah Harbor	0.997	7.785

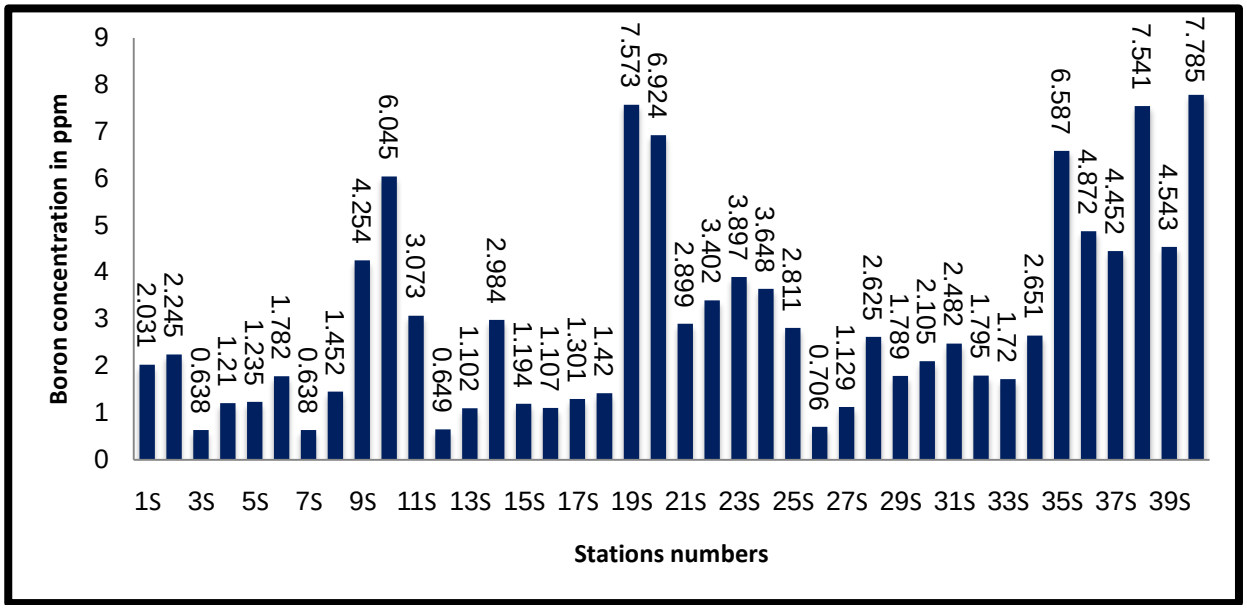

Figure-5 Boron concentrations in rivers and drinking water at Basrah Governorate by using Curcumin method.

The World Health Organization (WHO) in 1993 established a health-based Guideline of 0.3 mg/L for boron. This value was raised to 0.5 mg/L in 1998 primarily. Furthermore, in 2000 it was decided to leave the guideline at 0.5 mg/L until data from ongoing research becomes available that may change the current view of boron toxicity or boron treatment technology [8].The European Union established a value of 1.0 mg/L for boron in 1998 for the quality of water intended for human consumption [9].New Zealand has established a drinking water standard for boron of 1.4 mg/L[10]. The interim maximum acceptable concentration (IMAC) for boron in Canada is 5 mg/L. The Canadians have established this value on the basis of practical treatment technology. They believe that available technologies are inadequate to reduce boron concentrations to less than 5 mg/L. They will review this IMAC periodically as new data becomes available [11].

4.CONCLUSION

- Well waters are used for drinking purpose in many rural localities in rural areas and which were existent in the north of basrah.
- The analytical results of chemicalwater analysis revealed the presenceof boron in the limit of Law 0.5/1998, with a variation between 0.538-7.85 mg/l.
- Another important aspect is the high concentrations of Boron that exceed 4.52 mg/l in most of the sample of the surface waters.
- In general, well waters within the investigated areas, are highly mineralized.

The correlation analysis revealed the strong positive association between boron and some chemical compounds in drinking water. Access to safe drinking water is essential to human wellbeing and is a key public health issue. The maintenance of good quality of drinking water is achieved both by protecting the raw water supply and water treatment. It is possible to protect the raw waters supply by means of pollution control measures that prevent undesirable constituents from entering the water and by good watershed management practices.

REFERENCES

[1] WHO. 1998. World Health Organization. Environmental Health Criteria 204: Boron. Geneva, Switzerland: World Health Organization (as cited in U.S. EPA, 2004).

[2] Woods, W.G. 1994. An introduction to boron: history, sources, uses, and chemistry. Environ. Health Perspect. 102(Suppl 7):5-11.

[3] Dietrich Hermsdorf.2009. Evaluation of the sensitivity function V for registration of a-particles in PADC CR-39 solid state nuclear track detector material, Radiation Measurements 44 ,283–288.

[4]Somogyi G. and Szalay, S.A., (1973). Track-diameter kinetics in dielectric track detectors.Nucl. Inst. Meth. 109, 211-232.

[5]Durrani, S.A., Bull, R.K., (1987). Solid State Nuclear Track Detection: Principles, Methodsand Applications. Pergamon Press, Oxford. p. 284.

[6]Nikezic D. and Yu K.N., (2003). Calculations of track parameters and plots of track openings and wall profiles in CR-39 detector. Rad. Meas. 37, 595-601.

[7] Greenberg, A.F., Trussell, R.R. and Clesceri, L.S. (eds.). Standard methods for the examination of water and wastewater. 16th edition. American Public Health Association, Washington, DC (1985).

[8] World Health Organization (2003). Guidelines for drinking water quality. Boron, WorldHealth Organization.

[9] Council of the European Union (1998). Council Directive 98/83/EC, November3, 1998 on the quality of water intended for human consumption.

[10] New Zealand Ministry of Health (2000). Drinking-Water Standards for New Zealand2000. Wellington, Ministry of Health.

[11] Health Canada (2002). Summary of Guidelines for Canadian Drinking Water Quality.2003.

دراسة تركيز البوريتس في مياه مدينة البصرة باستخدام تقنيات مختلفة

ثائر منشد سلمان و منتظر عدنان قاسم

قسم الفيزياء , كلية التربية, جامعة البصرة, البصرة, العراق

الخلاصة

تركيز البورونِ قُيّمَ في عيناتِ المياه التي كَانتْ أُخِذتْ مِنْ المناطقِ المختلفةِ في مدينةِ البصرة. في البحث الحالي استخدمت تقنيتين في قياس تركيز البورون المأخوذ من مياه مدينة البصره. وجد ان اعلى تركيز للبورون هو 7.405 ppm في شط العرب الجزيرة الاولى وأقل تركيز كان 0.539 ppm في مدينة المدينة (الاسالة) باستخدام تقنية كواشف الاثر النووي بينما وجد اعلى تركيز للبورون كان 7.785ppm واقل تركيز هو 0.639 ppm باستخدام تقنية الكركومين .استنتج بان ماء الحنفية في محافظة البصرة امن بعيدا عن القلق من تركيز البورون بينما مياه الانهر يجب تجنبها. التركيز العالي يدل على ان هنالك تلوث في هذا الجزء من المدينة اعلى من بقية الاجزاء الاخرى.جمعت العينات في الشهر الثاني من عام 2012 من كل المواقع في مدينة البصرة.