The Assessment of Heavy Metals in Drinking Water from Baquba Water Treatment Plant

Mudhar A. Alwahab Rajib
Technical Institute of Baquba – Foundation of Technical Education
Email:mudharalaubedy@yahoo.com

Received on: 8/5/2012 & Accepted on: 7/3/2013

ABSTRACT

This study was achieved for the purpose of determining concentrations of inorganic heavy metals for Baquba drinking water by taking samples from the water treatment plant during the period (February 2011) to (February 2012), and these tests included heavy metals concentrations: iron, copper, lead, nickel, and cadmium. Then, the results were compared with the standard of World Health Organization to determine the expected increase in concentrations of these elements, accompanied with the side effects on human health.

According to this study, it was reached to the fact that the station drinking water concentrations are accepted with iron, copper and lead but with high cadmium concentrations more than recommended international standards with respect to most samples. Also, these tests represented the presence of discrepancy in nickel concentrations along the tested period above and below the permissible limit.

According to the researcher; this is caused by the disposed of sewage waste water in the course of river in some districts of the province without any treatments and also by the excessive using of fertilizers in the agricultural fields near the banks of the river.

It is unfortunate that the station has low efficiency in minerals treatment due to the lack of modern techniques.

Keyword: Water Pollution, Drinking Water, Heavy Metals.

تقييم العناصر الثقيلة في مياه شرب مشروع بعقوبة لمعالجة المياه

الخلاصة

تم إنجاز هذه الدراسة لغرض تحديد تراكيز المعادن اللاعضوية الثقيلة لمياه شرب محطة إسالة بعقوبة عن طريق أخذ نماذج من مياه الشرب الناتجة من المحطة خلال فترة (شباط ٢٠١١) لغاية (شباط ٢٠١٢), وتضمنت هذه التحاليل تحديد تراكيز العناصر الثقيلة التالية: الحديد والنحاس والرصاص والنيكل والكادميوم.

وقد ثم مقارنة نتائج هذه التحاليل مع المواصفات القياسية لمنظمة الصحة العالمية لتحديد أي زيادة متوقعة في تراكيز هذه العناصر مع ما يرافقها من تأثيرات جانبية على صحة الأنسان .

https://doi.org/10.30684/etj.31.12A.4
2412-0758/University of Technology-Iraq, Baghdad, Iraq

تبعا لهذه الدراسة تم التوصل إلى حقيقة أن مياه شرب المحطة ذات تراكيز مقبولة من الحديد والنحاس والرصاص مع وجود تراكيز من الكادميوم أعلى من هو موصى به في المواصفات العالمية لمعظم النماذج, وتبين كذلك من الفحوصات وجود تناوب في تراكيز النيكل فوق وأدنى الحد المسموح به خلال فترة الفحص, وأوعز الباحث السبب في ذلك إلى سكب مياه المجاري في مجرى النهر في بعض مناطق المحافظة دون معالجة تذكر والأستخدام المفرط للأسمدة الكيمياوية في الحقول الزراعية القريبة من ضفاف النهر.
ومما يؤسف له أن للمحطة كفاءة قليلة في معالجة العناصر نظرا لعدم وجود التقنيات الحديثة.

الكلمات المرشدة: تلوث المياه, ماء الشرب, العناصر الثقيلة

INTRODUCTION

Water is a necessary part of our environment and our body systems; it is an essential component of nearly everything we eat and drink. Many metals are of concern because of their toxic properties and some are essential for survival and health of animals and humans. Metals have been classified as essential, beneficial, or harmful.

Trace elements recognized as essential for human health include iron, zinc, copper, chromium, iodine, cobalt and selenium, while lead, cadmium and mercury, which are not known to provide any essential or potentially beneficial for human health at any level of exposure [1]. The common sources of metals in the environment are from their wide natural distribution, residues of industrial processes, sewage, leaching from municipal or agricultural areas, water pipes and from domestic effluents [2], finally, these metals may reach surface waters.

The natural criteria of the increasing metal concentrations in the flowing water is achieved by; water passing over soil in its natural cycle with the effects of erosion and landslides; it carries sediments and metals deposits.

Soil and rocks erode over time; releasing more metals into the water, some of these sediments are harmless metals like calcium, magnesium and potassium, but the other are more worrisome like mercury, aluminum and lead [3].

For all statements; water is considered polluted when the presence of these impurities is sufficient to limit its use for human purposes [4].

The concentrations of these metals change over the months by natural activities, such as the geological, hydrological and climatic conditions in addition to the effects of human activities which are considered expanded and varied.

It is well known that agricultural operations are a major source of pollution in many areas such as the using of fertilizers and agricultural pesticides with the increasing of chemical wastes of factories and domestic water [5], other than plowing, hoeing, harvesting, cutting trees and piling up of waste have all been thrown directly or through the water drainage and flood current towards the river after heavy rain washed away with the remnants of fertilizers and pesticides to and cause the water pollution which can give rise to a number of problems [6].

All metals in this study (chemical contaminants) have been shown to cause adverse health effects in humans through drinking water.

Unfortunately, these contaminant when present in more than limited quantities, can present significant health risk with long-term exposure. Many researches are accomplished by international agencies to estimate the effects of human exposure to heavy metals upon the human health. They found that many heavy metals are an important class of carcinogens. At least three transition metals in one form or another are accepted as human carcinogens. These human carcinogens include cadmium, chromium, and nickel. Several more heavy metals and/or their compounds are suspected to have carcinogenic potential in humans [7].

Many studies were conducted on the pollution of rivers in Iraq to study the effects of sewage and industrial waste water on the quality of river and showed that a significant increases in all determinants. This is mainly due to the low level of water in all rivers in Iraqi cities which lead to increase the concentrations of these contaminants [8].

In underdeveloped countries, there are multiple sources of water pollution, for example, in Egypt, Nile river is affected by the Industrial dangerous residues (un treatment) of the constructed institutes along the river adding to the remains of big cities (domestic) with agricultural sources which may contain organic chemical compounds such as fertilizers and pesticides by(4.5 ton–year /m^3) [9]. With the same trend, an early study was conducted to determine the effects of Baquba residues on the pollution of Diyala river. This study concluded that the river is not suitable to different uses unless it submits to treatment; this is caused by the big industrial and domestic residues [10].

Another study was accomplished for Shat Al- Arab, and they found that the river contains heavy metals with approximately similar concentrations with other unpolluted rivers; this is caused by the dilution processes [11].

An early study demonstrated that Cadmium and Copper concentrations are under the universal standards for the rivers water in Al- Tameem Province. This was caused by the deposition of these metals in the bottom of rivers with the impact of dissolution factor in rainy and snow melting seasons [12].

A study was conducted to determine the quality of drinking tap water for samples taken from some liquefier stations in Baghdad city with respect to heavy metals and some Environmental determinants.

A study was performed for some regions in Baghdad city during September 2009. The results showed that there wasn't any concentration of Lead, Chromium and Copper in the tested samples except one sample of Al- Adamia region where the concentration of Copper was (0.0032 ppm), Cadmium concentration was in the range (0.0004-0.001 ppm), Zinc concentration was in the range (0-0.66 ppm), and Iron concentration was in the range (0.033-0.53 ppm). The researcher confirmed that the high concentration of Iron is caused by the corrosion in the internal water pipes of the old network [13].

The central water treatment plant for Baquba (satellite photo no.1), is the most important and largest project in the city, which provides the city with drinking water and has several units that filter and purify the water drawn from the Kherson river.

The aim of this study is to assess and determine the quality of drinking water for Baquba water treatment plant by the examination of water samples to estimate the concentrations of inorganic heavy metals as follows: Iron, Copper, Lead, Nickel and Cadmium and then make a simple comparison with WHO standards (WHO has published guidelines to help countries to set qualities standards with which domestic water supplies

should achieve and should be considered as their long-term targets. These standards [15] can be shown inclusively in Table (1) to determine any excess in their concentrations that have dangerous effects and direct impact on the human health of the consumer with prolonged consumption periods.

MATERIALS AND METHODS

Drinking water samples have been collected from Baquba drinking water treatment plant (stated at the coordinates:
33° 46' 06.05" N, 44° 38' 28.70" E, as shown in the satellite photo no.1, about one sample each month through February 2011 to February 2012.
The plant is a conventional type with a production capacity of 3000 m^3/ day, where the main units in the plant can be summarized as follows:

1 – Water pumping system, contains five water pumps of 700 m^3/day as a capacity for Each pump.
2 – Flocculation system, contains three big basins used for the flocculation by using of (Al2(SO4)3.18H2O).
3 – Three clarifiers.
4 – Filtration system, containing16 sand filters.
5 – Chlorine injection system contains two devices for disinfection treatment.
6 – Seven water pumps for supplying of fresh water to the city.

The examination procedures were accomplished by using the standard methods for the examination of water [14]. These samples are tested for iron, copper, lead, nickel and cadmium concentrations using the atomic absorption device of the type (Phoenix-986/AA- Bioteck Engineering Management Co. ltd (UK)) in the department of Chemistry – College of Science – University of Mustansrya.

RESULTS AND DISCUSSION

Table (1) presents the results of the drinking water samples with the standards of World Health Organization. The concentrations of the heavy metals in drinking water are discussed individually with the estimation of any deviation from the standards.

As it is mentioned above, each of the following metals when present in excessive amounts can decrease the water quality and finally causes the pollution of water.

Under the influence of the major environmental factors (physical, chemical, hydrological and biological), the concentrations of many metals in river water are liable to change from season to other [4]; Hence, the testing of the elements achieved for eight months to ensure the monitoring of changes in the concentrations through all seasons.

From the results obtained, iron concentrations were within the permissible limits except on (24/04/2011) where it reached a peak of 0.41 ppm, this period witnessed heavy rains in Sinjar and Karbala, which resulted to iron overload as a result of decomposition of rocks and dust drifting with river [16].

With respect to copper, all the registered values are not noticeable and did not exceed the acceptable limit during the testing period; this is a good indication of the absence of contamination in water relative to copper. But, it was noticed the variation in copper concentrations during the different months, and this may be caused by the interior corrosion of pipes made from the alloy of lead and copper with the high levels of acidic

waters or due to high- carbonate waters caused by natural sources and human activities [17].

Lead is an important metal in determining the degree of water pollution, and it is

Usually found in drinking water from natural sources and human activities, particularly as a result of dissolution from the interior of pipes and fittings manufactured from the alloy of lead and copper. This is usually influenced by several factors, including temperature, water hardness, acidic medium and the water residence time [18].

High concentrations of lead can cause dangerous diseases to children and pregnant women. Children at the stage of their growth are the most affected of lead pollution, there is a chance to cause anemia and nervous system damage [19].

From Table (1), one reading shows that lead concentration is above the standard limits.

All the readings of nickel have significantly varied during the tested period; it rose to a hazardous concentration of 0.262 ppm, where all the other readings were acceptable.

Generally, this increase may be caused by the industrial sewage and domestic waste effluent, which have a significant impact in the case of this pollution.

Unfortunately, the presence of two readings of nickel with high concentrations confirm the confusing fact of urgent pollution, since, this water is drinking water and consumed by the citizens.

The cadmium was found in unusual increase in most of the recorded readings, which indicates the presence of contamination. Usually, cadmium present in water is from several sources, naturally, it is found in sulfide ores combined with zinc and lead, as well as, fertilizers, local air pollution and the releasing of wastewater have a big reason to spread cadmium in the rivers. Then, cadmium concentrations in drinking water may be presented as a result of wastewater disposal through the course of river without treatment with the absence of modern technologies of water clarifying in Baquba plant.

All the researches of WHO found that there is a cancerous effect on consumers of water containing high concentrations of cadmium [20].

Cadmium and several cadmium- containing compounds are highly toxic and carcinogens [21].

From Table (1), it can be shown that the concentrations of cadmium in the rain winter months is greater than concentrations in the warm summer months, it is found that the largest concentration was in February 2011, (0.04 ppm), and this may be caused by the high concentrations of cadmium in the raw water with the absence of special treatment units used for heavy metals removing in the plant.

The behavior of the tested metals (iron, nickel and cadmium) concentrations are clearly presented in Figures (1, 2and 3). As can be shown from these Figures, the quarterly changing for each element in the water looks different since each element behaving differently from the other.

The concentrations of these metals are registered for raw water in February 2012, Table (2).

CONCLUSIONS

This study for determines the concentrations of the main heavy metals in drinking water from Baquba water treatment plant as follows:

1 – The concentrations of iron and lead are within the permissible limits of WHO.
2 – The concentrations of cadmium are not compatible with the standards for most of the registered values and the present a confused pollution.
3 – The concentrations of nickel is altering between the accepted and not accepted limits of the standards.

REFERENCES

[1]. WHO/FAO/IAEA. Trace Elements in Human Nutrition and Health. Geneva: World Health Organization, 1996
[2]. Friberg, L. Nordberg, GF. In: L Friberg,GF Nordberg, V Vouk, eds. Handbook of the Toxicology of Metals, 2nd ed. Vol I Holland,Amsterdam: Elsevier/North-pp 1–13, 1986
[3]. Malik, D. S. Sastry, K. V. and Hamilton, D.P., Effects of Zinc Toxicity on Biochemical Composition of Muscle and Liver of Murrel (Channa Punctatus). Environment International, 24 (4): 433 – 438, 1998
[4]. Marine Science Center, The Ecology of the M**ars**hland of Iraq, Training course, Basrah University, 2005
[5]. Al- Kinany, K. I. T.," The Effect of Irrigation and Drainage Developed Projects on Some Chemical Properties of Water For Qurna Saddam District ", Journal Research, of Technical, Technical no. 94, 2001
[6]. Al- Muslah, R. M., Microbiology Science, Ministry of Higher Education and Scientific Research, Baghdad University, House of Wisdom, Baghdad, 1988
[7]. International Agency for Research on Cancer Monographs on the Evaluation of the Carcinogenic Risks to Humans. Vol 58. Beryllium, Cadmium, Mercury, and Exposures in the Glass Manufacturing Industry. Lyon, France: IARC Scientific Publications, 1993
[8]. Al- Aubedy, I. A., The Solutions and Planning Controls to Reduce the Effect of Water Polluting Industries, Master Thesis, Center for Urban and Regional Planning, University of Baghdad,1990, (Arabic)
[9]. Al- Zawka, M. H., Environment and Axes of Their Degradation with Effects on Human Health, House of knowledge, Al- Iskandria, Eqypt, 1996
[10]. Al- Rekaby, N. K., The Effect of Baquba Waste on Diyala river Pollution, University of Baghdad, Higher Institute for Urban and Regional Planning for the Year 1999
[11]. Abaychi, J. K., Dou Abui, A.A.Z.,"Trace Metals in Shatt Al- Arab river, Iraq", Water res. 19 (4): 457-462, 1985
[12]. Othman, M.Y. 1996,"A Study of the Concentration of Al-Tammem rivers by the Heavy Metals "Technical magazine, Technical Researches, no. 73, 2000 (Arabic)
[13]. Muhammed, I. H., Ahmed, H.Y.,"Study in Fact of Drinking Water in Some Regions of Baghdad City", Iraqi Journal of Market Research and Consumer Protection, Vol 2, no.3, 2010
[14]. Abawy, S. A., Environment process engineering for water testing, Dar Al-Hekma for printing and publishing, Mousel, 1990
[15]. World Health Organization Site, 2006, http://www.lenntech.com/periodic-chart-elements/

[16]. Iraqi Meteorological Organization and Seismology Site, http://www.meteoseism.gov.iq/arabic/
[17]. IPCS, Copper, World Health Organization, International Program on Chemical Safety (Environmental Health Criteria 200), Geneva, 1998
[18]. WHO, Lead in Drinking-Water, Background Document for Preparation of WHO Guidelines for Drinking-Water Quality. Geneva, World Health Organization (WHO/SDE/WSH/03.04/9), 2003
[19]. Al- Saed, J. A., Chemical pollutants of the environment, Faculty of Science Benha–Egypt, Al- Assel Center for Publishing and Distributing, 2003
[20]. WHO, Cadmium in Drinking- Water, Background Document for Preparation of WHO Guidelines for Drinking-Water Quality. Geneva, World Health Organization (WHO/SDE/WSH/03.04/80), 2003
[21]. National Toxicology Program, 11th Report on Carcinogens, Retrieved on 2008-04-2 http://ntp.niehs.nih.gov/ index.cfm? objectid=32BA9724- F1F6-975E- 7FCE50709CB4C932

Table (1) The experimental analysis for Baquba water treatment plant with WHO standards.

Parameter ppm	WHO standards 2006 (ppm)	Date							
		2/2011	3/2011	4/2011	6/2011	7/2011	9/2011	1/2012	2/2012
Iron	0.3	0.027	0.019	0.41	0.042	0.042	0.004	0.067	0.003
Copper	2	0.065	0.027	0.169	0.010	0.011	0.00	0.531	0.220
Lead	0.01	0.114	0.00	0.00	0.00	0.00	0.00	0.006	0.006
Nickel	0.07	0.066	0.231	0.013	0.05	0.262	0.055	0.00	0.037
Cadmium	0.003	0.04	0.015	0.028	0.002	0.006	0.00	0.012	0.014

Table (2) the estimation of metals concentrations for raw and clean water (February 2012).

Parameter ppm	Raw water	Clean water
Iron	**0.046**	**0.003**
Copper	**1.012**	**0.220**
Lead	**0.010**	**0.006**
Nickel	**0.042**	**0.037**
Cadmium	**0.015**	**0.014**

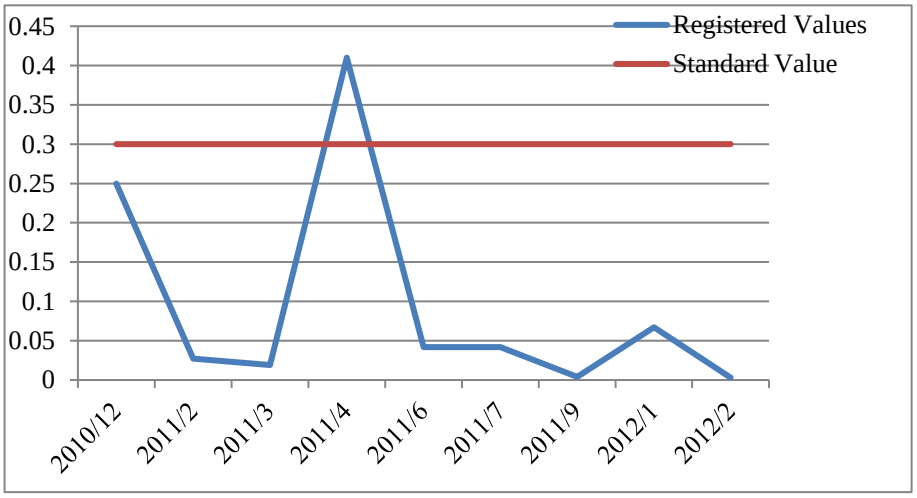

Figure (1) The experimental and standard values for iron .

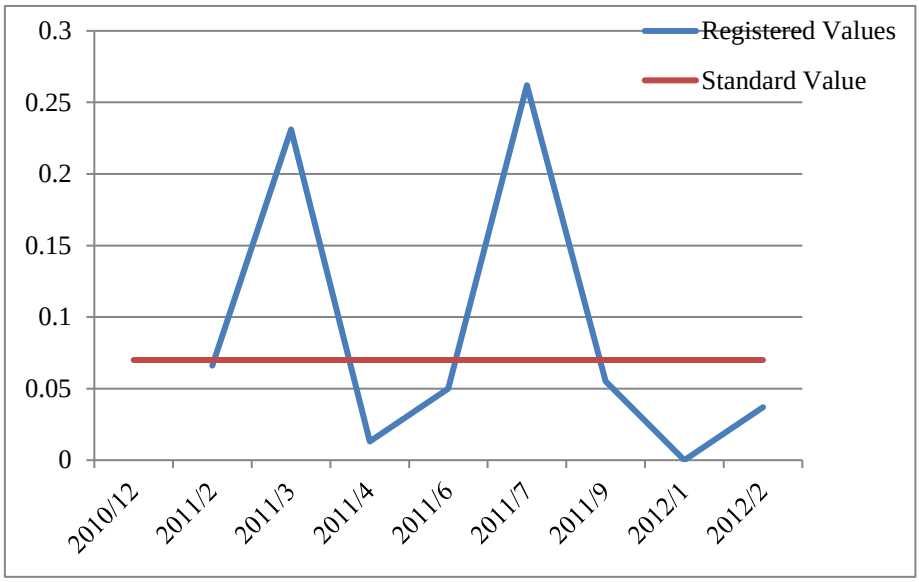

Figure (2) The experimental and standard values for nickle.

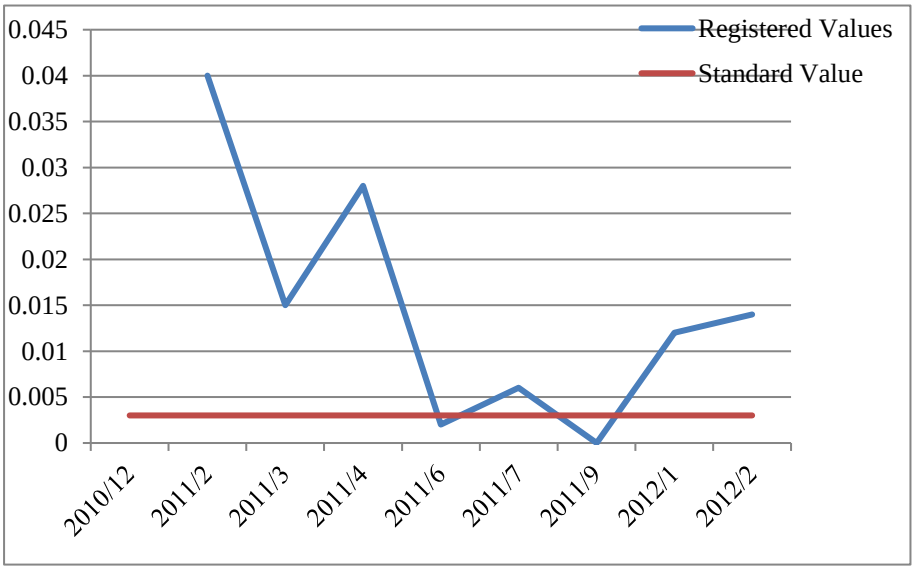

Figure (3) The experimental and standard values for cadmium.

Satellite photo no.1: The location of Baquba water treatment plant (33° 46' 06.05" N, 44° 38' 28.70" E).