The Determination of Phosphate Concentration in Sewage Water Collected from Nawroz Quarter – Erbil city

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Abstract

Around (25) sewage samples were collected in different seasons: Summer (June), Autumn (October and November), Winter in (December) 2013 and (January) 2014) from Nawroz quarter – Erbil city. Calorimetric method was used to determine the phosphate concentration, using ammonium molybdate as color indicator reaction procedure. The results were read on spectrophotometer at λ_{max} = 570 nm. The values estimated under the standard curve, the results shows a variation in the recorded values between the different seasons that goes less, within and more than the world recognized standard values.

Keywords: Phosphate, Ammonium molybdate, Sewage water, Nawroz quarter .

قياس تركيز الفوسفات في مياه الصرف الصحي المأخوذة من منطقة نوروز – مدينة اربيل

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الخلاصة

تم جمع 25 عينة من مياه الصرف المنزلي خلال 4 اوقات مختلفة خلال فصول الصيف (حزيران) و الخريف (تشرين الاول و الثاني) و الشتاء(كانون اول) 2013 (كانون ثاني) 2014 من منطقة نوروز الكائنة في الحي العسكري- مدينة أربيل ، تم قياس نسبة الفوسفات في هذه العينات باستخدام جهاز المطياف الضوئي عند طول موجي 570 نانومتر من خلال تفاعل موليبيدات الامونيوم . اشارت النتائج الى وجود اختلاف في نسب الفوسفات بين العينات المجموعة خلال الفصول المختلفة التي سجلت قيم اقل و ضمن و اعلى من القيم القياسية العالمية المعتمدة.

الكلمات المفتاحية: الفوسفات ، موليبيدات الامونيوم ، مياه الصرف المنزلي ، منطقة نوروز.

Introduction

Pure, "elemental" phosphorus (P) is rare. In nature, phosphorus usually exists as part of a phosphate compounds. Phosphorous compounds in the environment is beneficial for many biological processes, but too much of this element compounds can create an imbalance in the ecosystem. Phosphorus compounds are an essential element in DNA, ATP, and RNA, so it is needed by all living things. Plants use phosphorus compounds to form more complex cells, and animals can get phosphorus compounds by feeding on these producers (1). Human activity can increase the concentration of phosphorous compounds in the environment in many ways, particularly with the use of phosphorous-containing fertilizers and laundry detergents. Agricultural runoff and sewage water are a major cause of increased phosphorous compounds in both natural and manmade water way (2) . Phosphorus compounds have a complicated story. In aquatic systems occurs as organic phosphate and inorganic phosphate. Organic phosphate consists of a phosphate molecule associated with a carbon-based molecule, as in plant or animal tissue. Phosphate that is not associated with organic material is inorganic. Inorganic phosphate is the form required by plants. Animals can use either organic or inorganic phosphate. Both organic and inorganic phosphate can either be dissolved in the water or suspended (attached to particles in the water column).Typical synthetic laundry detergents consist of a builder, and other miscellaneous ingredients. The builder in detergents serves to tie up polyvalent cations such as calcium and magnesium ions, which otherwise interfere the surfactant. The builder is particularly necessary in hard water (3). Phosphates are excellent builders, capable of tying up calcium, magnesium, iron and manganese ions, thereby improving overall washing performance (4). Detergents that contain phosphorous compounds can have poisonous effects in all types of aquatic life if they are present in sufficient quantities, and this includes the biodegradable detergents. All detergents destroy the external mucus layers that protect the fish from bacteria and parasites; plus they can cause severe damage to the gills. Most fish will die when detergent concentrations approach 15 parts per million (ppm). Detergent will kill fish eggs when it’s concentrations as low as 5 ppm. A detergent concentration of only 2 ppm can cause fish to absorb double the amount of chemicals they would normally absorb, although that concentration itself is not high enough to affect fish directly. Phosphate concentration determines the level of eutrophication. Eutrophication is the process that occurs when high concentrations of nitrogen and phosphorus compound, which are both fertilizers, pollute the water and boost the growth of plant growth [5]. Obviously, excess phosphates significantly change the body of water for the worse and affect as well hundreds of migratory birds route visit the area annually [6]. Municipal wastewater treatment plants in many areas are required to remove phosphorous in their treatment process. While the biological treatment process removes some phosphorus compound, in most cases precipitation as an insoluble metal phosphate is required to meet discharge regulations. This precipitation step is normally accomplished with a metallic salt such as ferric sulfate, ferric chloride or aluminum sulfate. This precipitation step may be accomplished in the primary or secondary clarifiers. Some new techniques, such as the resin-based system developed by Storm water Management of Portland, Oregon that targets and removes dissolved phosphorus compounds from storm water runoff, are being developed to reduce the pollution that goes into bodies of water[7]. No national criteria have been established for concentrations of phosphorus compounds in water; however, to control eutrophication, the EPA (US Environmental Protection Agency)[8] water quality criteria state that phosphates compounds should not exceed 0.05 mg/L if streams discharge into lakes or reservoirs, 0.025 mg/L within a lake or reservoir, and 0.1 mg/L in streams or flowing waters not discharging into lakes or reservoirs to control algal growth[9]. Surface waters that are maintained at 0.01 to 0.03 mg/L of total phosphate tend to remain uncontaminated by algal blooms.The aim of this research is to find out the concentration of phosphate included in household detergent constituent as a builder through sewage water of Nawroz quarter in Erbil city at different seasons where the temperature vary and determine the level of pollution that this section of Erbil city participate in. The sewage water of Nawroz quarter was ended to wetland of rotten swamp at south-west of Erbil city.

Materials and Equipment

a- All reagents and solvents used were available commercially and were used without further purification unless indicated otherwise.

b- All the glassware were washed with 0.1 M HCl (Washing solution) and properly rinsed with distilled water and dried before use.

c- Samples of sewage water from Nawroz quarter were collected in clean 1L Erlenmeyer flask and either tested directly or sterilized and incubated for later test.

d- Spectrophotometer model 721-2000 – wavelength 320 – 1000 nm were used for absorbance reading at λ_{max} = 570 nm.

Procedure

A-Preparation of Calibration Curve

Standard stock solution of potassium dihydrogen phosphate KH_2PO_4 (Molecular wt. = 136.1 g/mol.) was prepared by dissolving 1g of KH_2PO_4 (this accurately weighed) in 1L distilled water to prepare the 7.5 x10^{-3} M stock solution.

Accurately 5, 10, 15, 25, 40 mL of stock solution were transferred to 100 mL volumetric flasks and marked up to the mark with distilled water and all diluted solutions were organized for colour development.

B- Analysis of sewage water sample

Sewage water samples were filtered to remove dirt and fragments, then either tested directly without any dilution or sterilized and incubated for later test for determination of dissolved reactive phosphorus

C- Colour development

Ammonium molybdate10 mL was added to 50 mL sewage water samples and then followed by 3mL nitric acid. Yellow colour was developed. Prior to measurement, the wavelength of photometer was set to 570 nm, then to zero with distilled water in a 1-cm plastic cuvette. The absorbance of standard series of phosphate solutions was measured in order of increasing concentration followed by that of the sample solutions.

The results was recorded in the table (1), and a calibration curve was generated by plotting phosphate concentration of the standard series versus absorbance as shown in figure (1)

Results

The results recorded in table (1) shows the relationship between phosphate concentration in standard solution and λ_{max} at 570 nm.

Table "1" shows the relationship of stander phosphate concentration g/L versus λ_{max} = 570 nm.

Sample No.	Phosphate concentration g/L x10^{-5}	Absorbance λ_{max} = 570 nm.
1	5	0.18
2	10	0.19
3	15	0.27
4	25	0.36
5	40	0.58

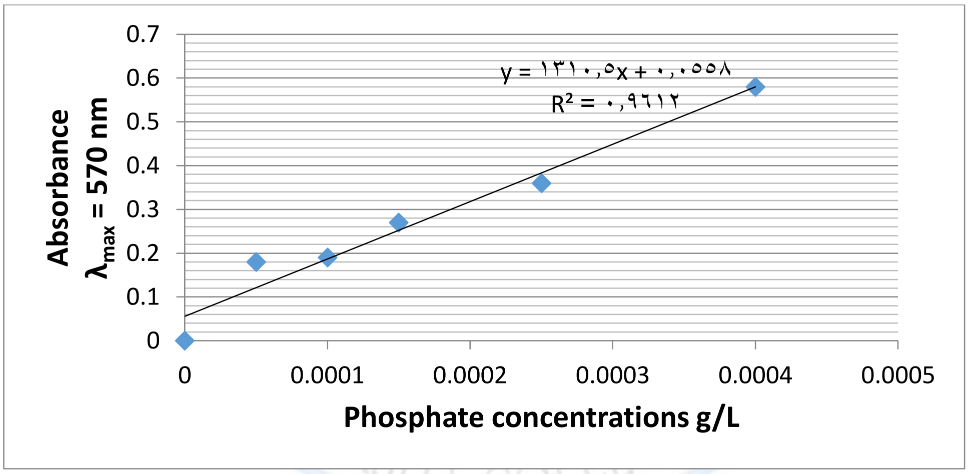
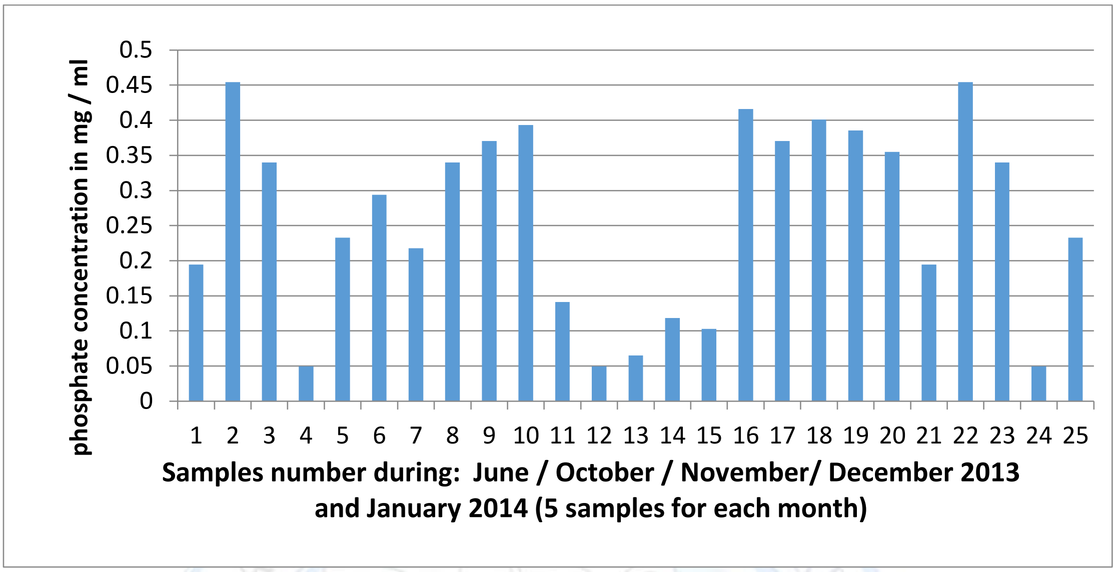


Figure "1" represent the curve that shows the relationship between phosphate concentration versus λ_{max} = 570 nm

The phosphate level which was estimated during the four periods appeared as it shown in table 2:

Table "2" shows different concentrations of phosphate in sewage sample during June, November, December 2013 and January 2014 in sewage water collected from Nawroz quarter / Haey Al-askary – Erbil city:

Sample number	Date	Season	Month	Absorbency at λ_{max} = 570 nm	Phosphate concentration (g/L) x10^{-5}
1	3/**6**/2013	Summer	June	0.31	19.5
2	6/**6**/2013	Summer		0.65	45.4
3	9/**6**/2013	Summer		0.5	34.0
4	12/**6**/2013	Summer		0.12	5.0
5	15/**6**/2013	Summer		0.36	23.3
6	3/**10**/2013	Autumn	October	0.44	29.4
7	6/**10**/2013	Autumn		0.34	21.8
8	9/**10**/2013	Autumn		0.5	34.0
9	12/**10**/2013	Autumn		0.54	37.0
10	15/**10**/2013	Autumn		0.57	39.3
11	3/**11**/2013	Winter	November	0.24	14.1
12	6/**11**/2013	Winter		0.12	5.0
13	9/**11**/2013	Winter		0.14	6.5
14	12/**11**/2013	Winter		0.21	11.8
15	15/**11**/2013	Winter		0.19	10.3
16	3/**12**/2013	Winter	December	0.6	41.6
17	6/**12**/2013	Winter		0.54	37.0
18	9/**12**/2013	Winter		0.58	40.1
19	12/**12**/2013	Winter		0.56	38.5
20	15/**12**/2013	Winter		0.52	35.5
21	3/**1**/2014	Winter	January	0.31	19.5
22	6/**1**/2014	Winter		0.65	45.4
23	9/**1**/2014	Winter		0.5	34.0
24	12/**1**/2014	Winter		0.12	5.0
25	15/**1**/2014	Winter		0.36	23.3



Figure"2" shows phosphate concentrations in mg/mL in all samples of phosphate which was collected in different seasons (Summer, Autumn, Winter 2013 and Winter 2014)

Discussion

Inorganic phosphate reacts with ammonium molybdate in an acidic medium to form a yellow phosphomolybdate complex which absorbs light at **570** nm.

$$K_2HPO_{4\,(aq)} + 12[NH_4]_2MoO_{4(aq)} + 23HNO_{3(aq)} \rightarrow\rightarrow\rightarrow\rightarrow$$

Dipotassium hydrogen phosphate **Ammonium molybdate** **Nitric acid**

$$[NH_4]_3PMo_{12}O_{40} + 2KNO_{3(aq)} + 21NH_4NO_{3(aq)} + 12H_2O_{(L)}$$

yellow colouration Ammonium phospho molybdate **Potassium nitrate** **Ammonium nitrate** **Water**

OR $$PO_4^{3-} + 12MoO_4^{2-} + 2H^+ \rightarrow [PMo_{12}O_{40}]^{3-} + 12H_2O_{(L)}$$

The absorbance at this wavelength is directly proportional to the amount of inorganic phosphorus present in the sample.

There is often a direct relationship between the intensity of the colour of a solution and the concentration of the colored component (the analyte species) which it contains. . One might readily determine the concentration of a sample based on its colour intensity, simply by comparing its colour with those of a series of solutions of known concentration of the analyte species [10]. In our case the colour of the solution obeys Beer-Lambert Law and the graph of different standard concentration versus absorption is straight line as shown in figure (1).

The recorded results showed that phosphate concentration reached its highest value at the beginning of summer and winter. Samples number (2) and (22) with a value reached 0.454 mg/L considered very high while the less values were 0.05 mg/L(samples number (12) and (24)) which determined less than the recognized standard values according to Bonfim-Silva, et al 2014[11] values as table "3" shows:

Table "3" shows standards values for phosphate concentration according to (Bonfim-Silva, et al 2014) values.

Category	Standard value mg/L
Low	< 0.06
Medium	0.06 – 0.15
High	> 0.15 – 0.45
Very High	> 0.45

Different climate changes during different seasons may affect the concentration of the phosphate , for example higher temperature increase the phosphate concentration because of high consumption of household detergents and high evaporation in the liquid volume while it will be less concentrated in the winter season for less consumption of household detergents and less evaporation level, beside that the health awareness and climate sudden changing as rains may play another role in diluting the concentrations with much amount of rain water.

In this work, the authors find out that there was no good relationship between the phosphate concentrations in sewage water with different temperature in different seasons.

The reason for this poor relationship refers to irregular consumption of the detergent by consumers. That is as a result of everyday life activities of consumers. Moreover the concentrations of phosphate were affected by different atmospheric elements more than only temperature for example, wind speed, percent of rainfall according to different seasons and habits of residence where they use plain water, has big role in phosphate concentrations in sewage water

Conclusion

1-High level of phosphate has been recorded in the sewage water of Nawroz quarter in Erbil city.

2- No methods present in Erbil city for extraction of phosphate compounds from sewage water.

3-Phosphate level in swage water not linked to climate changes in different seasons because of irregular consumption of detergent by consumers and atmospheric elements.

4- There was poor relationship between the phosphate concentrations in sewage water at different temperature in different seasons with the phosphate concentrations in sewage water.

Recommendation:

1- Urgent needs to construct a sewage treatment plant in Erbil city

2- Daily measuring of the phosphate rate in sewage water to have a good review upon the maximum values in order to avoid eutrophication .

3- Achieve a rapid method for extracting phosphate from swage water in order to use it next as a fertilizer under control.

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