MODIFICATION OF BAGHDAD POTABLE WATER BY USING RECYCLE WASTE GLASS

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ABSTRACT

Modification or purification of potable water with the use of recycle waste glass reduces the drain on the natural resources of the raw materials, which is widely used in our daily life. However, the disposal of waste glass is not an easy matter, which is because glass is neither incinerated nor decomposed material.

In this study, ten samples of potable water were collected from ten regions in Baghdad capital city in order to investigate their physical and chemical properties. Chemical and physical properties of water were identified. Several parameters of water quality were analyzed including: turbidity, electrical conductivity, and acidity function (pH) and total suspended solids according to Iraqi standards.

The results of all water samples showed that the physical and chemical analysis tests were acceptable for drinking except the station of Madinat Alsadar. Using the waste glass to eliminate this problem, as low cost and inert material, was successful in potable water treatment. As a conclusion, the TSS was decreased after filtration process by waste glass especially for Althaalba and Alameria potable water which were disappeared (being zero).

Keyword: Modification, Purification, Potable water, Total suspended solids, Waste glass.

ملخص:

تعديل او تنقية مياه الشرب مع استخدام نفايات الزجاج المعاد تدويرها يقلل من استنزاف الموارد الطبيعية من المواد الخام، و الذي يستخدم على نطاق واسع في حياتنا اليومية، ويرجع سبب ذلك كون الزجاج من المواد التي لا تحرق ولا تتحلل.

في هذه الدراسة تم جمع عشر عينات من مياه الحنفية لعشرة مناطق في العاصمة بغداد من اجل التحقق من الخواص الفيزيائية والكيميائية للماء. وقد تم تحديد الخواص الفيزيائية و الكيميائية، وتم تحديد العديد من المعاملات المحددة لنوعية المياه بما في ذلك: العكورة، التوصيل الكهربائي، معامل الحموضة (pH) و مجموع المواد الصلبة العالقة وفقا للمعايير العراقية.

واظهرت نتائج جميع عينات المياه من خلال الاختبارات الفيزيائية و الكيميائية بانها مقبولة للشرب ماعدا محطة مدينة الصدر، واستخدمت نفايات الزجاج للقضاء على هذه المشكلة، كونها منخفضة التكلفة و تعتبر من المواد الخاملة، إذ كانت ناجحة في معالجة مياه الشرب. و كاستنتاج، فان (TSS) قد انخفضت بعد عملية الترشيح باستخدام نفايات الزجاج و خاصة بالنسبة لمياه الشرب لمنطقتي الثعالبة و العامرية حيث اختفت و اصبحت (صفر).

Nomenclature:

EC: Electrical Conductivity.

pH: Potential Hydrogen.

TSS: Total Suspended Solids.

INTRODUCTION:

Water remains the most important requirements of daily life and it must be accorded to its importance for the processing of citizens conform to the standard specifications. Filtration is a process by which suspended solid particles are separated from a liquid by passing the liquid through a porous. In this filtration process, waste glass was aimed to use.

With the rapid economy growth and continuously increased consumption, a large amount of waste materials is generated. Among them, waste glass material is an important part**.** Glass is a non-metallic and inorganic material made by sintering selected raw materials, so it can neither be incinerated nor decomposed**.** Glass recycling can save energy and decrease environmental waste. Focus on glass recycling technology will also widen the application domain of waste glass and promote further development of glass techniques**.** The increasing awareness of glass recycling speeds up focus on the use of waste glass with different forms in various fields**.** Large amounts of domestic, industrial and mining waste are generated annually in each country. The use of recycled materials instead of virgin materials will reduce the demanding of virgin materials.

(Simon O. Rutledge and Graham A. Gagnon 2002) evaluated the performance of a pressure filter utilizing crushed glass as the filter media in a dual media anthracite–glass filter compared to a dual media anthracite–sand filter. After 6 months, they found that the crushed glass used in this project had a higher angularity and slightly higher uniformity coefficient then the sand tested.**(YuliaZakharova and Andrew Wheatley 2008)**, for metal removal (copper, iron and zinc) from urban runoff, recycled crushed glass was used as filtration medium. The results indicate that glass can be effectively used for the removal of a metal such as iron in its total form, whereas this medium is likely to be less effective for metals like copper and zinc which are predominantly found in the dissolved form. **(Habayeb Abdul Al-Hussein Majid2008)** worked on Modern Paint Company waste water thrown into the Tigris River to investigate how it is agree with the Iraqi specifications of rivers protection system by measuring: PH , BOD , TDS , TSS , SO4 -2 , PO4 -3 , NO3 -1 , Cl-1.

It was showed by results that the specifications of water coming from the treatment unit have been within the limits except the biological need for Oxygen for some samples because of damage in the aeration pumps. **(Healy, M.G., et. al. 2010)** examined the performance of intermittently loaded filter columns comprising different media – sand, crushed glass and soil. They concluded that 100% of total suspended solids (TSS) were removed and nitrification was complete, and bacterial numbers were reduced by over 80%, with best removals achieved in the soil filters (93%). (**ElifSoyer et. al. 2010),** for rapid filtration, crushed recycled glass was used as a medium. Two physically identical filter columns were operated in parallel in all the experiments. One filter contained a silica sand medium, whereas the other filter contained crushed recycled glass. The observations were (1) Provided that a coagulant was used, the filter containing crushed glass produced effluent turbidities and particle counts similar to those obtained with the sand filter. (2) The crushed glass medium generated both a smaller clean-bed head loss and smaller clogging head losses than those of the sand filter. It is concluded that crushed glass shows significant promise as an alternative to silica sand in rapid filtration (**L. W. Gill,**

et. al. 2011) treated the efficiency of two stratified filters in parallel (one with sand as a media, the other with recycled glass) receiving secondary treated effluent from a single house which also operated as a Bed and Breakfast has been compared over a two year period. It is found that a layer of 100 mm of limestone sand was also included in both filters to target phosphorus removal. The evidence was that the limestone layer started to approach saturation particularly in the glass filter with a reduction in removal efficiency apparent over time. **(RafaHAlsuhaili et. al. 2012)**studied the ability of using crushed glass solid wastes in water filtration by using a pilot plant, constructed in Al-Wathba water treatment plant in Baghdad. Different depths and different grain sizes of crushed glass were used as mono and dual media with sand and porcelaniate in the filtration process. The mathematical model by Tufenkji and Elimelech was used to evaluate the initial collection efficiency η of these filters. The results designated that the collection efficiency varied inversely with the filtration rate. All the dual filters showed that theoretical values ηth was less than practical values ηprac. Whereas the dual filter 35cm porcelanite and 35cm glass showed the highest collection efficiency.

The main objective of this study is to investigate the benefit of using a recycled waste glass as filter in treating portable water, to examine how it could remove total suspended solids or reduce them from portable water, and to find out the effect of using waste glass as a filter on the physical and chemical properties of water.

EXPERIMENTAL METHODS

1. Materials used and Equipments:

a. Ten samples of water
b. Waste glass
c. Filter paper and funnels
d. Beakers
e. pH meter
f. Electrical conductivity meter
g. Turbidity meter
h. Oven
i. Digital Balance

2. Tests

2.1. pH Test:

pH is a measure of the acidity or alkalinity of the water. The pH test is one of the most common analyses done in volunteer estuary monitoring programs.It is measured on a scale from 0 – 14.In this study, the electronic pH meter is used.

The pH of the water is different depending on a number of conditions **(APHA, et. al. 2005):**

1. The source of the water.
2. The type of soil.
3. Bedrock and vegetation through which it travels.
4. The types of contaminants the water encounters in its path.
5. And even the amount of mixing and aeration due to turbulence in its flow.

❖ **The procedure:**

After calibration of the devise (meter), place the electrode into the water sample and record the pH using the pH meter shown in Fig. (1).The glass electrode on these meters must be carefully rinsed with deionized water after each use to ensure accurate results.

Figure (1): pH meter

2.2. Electrical Conductivity Test:

This method is used to measure the electrical conductivity generated by various ions in the water. The electrical conductivity is the capacity of water to carry an electrical current and varies both with number and types of ions in the solutions, which in turn is related to the concentration of ionized substances in the water. Most dissolved inorganic substances in water are in the ionized form and hence contribute to conductance.

Rough estimation of dissolved ionic contents of water sample can be made by multiplying specific conductance (in mS/cm) by an empirical factor which may vary from 0.55 to 0.90 depending on the soluble components of water and on the temperature of measurement.

❖ **The procedure:**

The conductivity meter often indicates conductivity directly as shown in Fig. (2). Commercial probes commonly contain a temperature sensor. With such instruments, rinse probe three times with 0.0100M KCl. Adjust temperature compensation dial to 0.0191 C−1. With probe in standard KCl solution, adjust meter to read 1412 μmho/cm. This procedure automatically adjusts cell constant internal to the meter, [11].

Figure (2): Conductivity meter

2.3. Turbidity Test:

Water turbidity is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms.

❖ **The procedure:**

- Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the sample which is put in the clean beaker.
- Correlation of turbidity with the weight or particle number concentration of suspended matter is difficult because the size, shape, and refractive index of the particles affect the light-scattering properties of the suspension. When present in significant concentrations, particles consisting of light-absorbing materials such as activated carbon cause a negative interference.
- In low concentrations these particles tend to have a positive influence because they contribute to turbidity. The presence of dissolved, color-causing substances that absorb light may cause a negative interference. Some commercial instruments may have the capability of either correcting for slight color interference or optically blanking out the color effect using the meter shown in Fig. (3).

Figure (3): Turbidity meter

2.4. Total Suspended Solids Test:

Solid analyses are important in control of biological and physical water treatment processes and for calculate the strength of water .the more solids present in particle in water give strong waste water and cause putrefaction problems.

❖ **The Procedure:**

- In this process, the beaker washes and dried in the oven.
- Use filtration papers of (102) moderate which placed in the beaker, then pour amount of (30 ml) of drinking water in the filtration beaker and wait till all amount of water get down to the beaker.
- Residues with filter paper dried at 103 °C to 105°C.

- The difference between the weight of the filter paper (1.0280 g) before and after filtration represents the amount of total suspended solids as in equation (1), **(APHA, et. al. 2005).**

❖ **Calculations**

Water with total suspended solids; it's given by the equation:

$$\textbf{Total suspended solids (TSS mg /L)} = \frac{(A-B)\ \textbf{X}\ 1000}{\textbf{V mL}} \qquad \textbf{(1)}$$

Where: A is the weight of dried residue + filter paper (mg), B is the weight of filter paper (mg), and V is the volume of the sample (mL)

2.5. Filtration Process:

The crushed waste glass was obtained from waste sheet glass (window glass-soda lime glass). Glass objects were cleaned and then crushed manually and mechanically to get the required gradation. Crushed glass was sieved to ensure completely uniform distribution of particle size. The particle size was (150 and 300) µm.

❖ **The Procedure:**

- Wash the crushed waste glass by clean water then dry it by oven.
- Use filtration papers which placed on the filtration flask, and put (10 g) of crushed glass on a cake filtration, in which the particles are removed on the surface of a cake formed by the solids accumulating on a septum
- Put the amount of (30 ml) drinking water on the crushed glass which is at filtration flask, and leave it for ten minutes. The process considered as a batch system.
- Wait until all the amount of filter water get down.
- Use the amount of filtered water to repeat the filtration procedures twice to determine TSS accurately as shown in Fig. (4).

Figure (4): Filtration Process

RESULTS AND DISCUSSION

1- pH Test:

The pH measurements showed that the pH values were almost the same for all stations around (7) before and after filtration and were all in acceptable limit as shown in Table (1) and Fig.(5). The time for each test takes five minutes.

2- Electrical Conductivity Test:

Table (2) and Fig. (6) show the values of the electrical conductivity for ten different samples of water before and after filtration. There is no difference between the values of electrical conductivity for each station before and after filtration, so they have the same values. It is noted that the conductivity values ranged from the maximum (1083)μS/cm at (Madinat Alsader)to the minimum (683)μS/cm at (Almansoor),and other region are between these values . Also, the time for each test takes five minutes.

3- Turbidity Test:

Table (3) and Fig. (7) express the values of the turbidity of ten different water samples before and after filtration and showed that most samples of water are acceptable except (Madinat AlSader) which was very high before filtration, that means this water unacceptable to use for drinking depending on Iraqi standards as shown in Appendix (1), But this value is reduced after filtration from (21.30 NTU to 10.0 NTU). The portable water sample of Madinat AlSader had large amount of suspended solids which were reduced after filtration process by using waste glass and this resulted to reduce the turbidity value for the same station.

4- Total Suspended Solids test before and after filtration process:

Table (4) and Fig. (8) show the total suspended solids (TSS) for ten different water samples before and after filtration. It shows that the TSS values before filtration process were high in some regions that have been testing, it appeared less worthless in (Althaalba) which was (0.3333) mg/L which makes this water acceptable to drink, but the highest values at (Madinat Alsader) was value (5) mg/L, other region between these values.

After filtration process, the TSS values showed a significant reduction in most regions especially in (Althaalba and Alameria) which disappeared and become (zero).That means, the process of filtration using waste glass was successful and it can be used to help in purification of potable water. The TSS values for Aldora and Bab Al moatham did not change before and after filtration process because of the small size of suspended particles which penetrate through the waste glass filter.

CONCLUSION

The objective of this study is to investigate the effect of using crushed waste glass as coarse sand and filter in the treatment process to drinking water, where the results can be concluded as the following:

- The process of using the recycling waste glass is successful to be as a water treatment component.
- After testing the physical and chemical properties of the ten samples of drinking water, most of the stations of water are acceptable for drinking except the station of Madinat Alsader which was not acceptable depending on the Iraqi standards.
- After filtration treatment by waste glass, the drinking water were more acceptable to drink, the (TSS) were less in some samples and the others were being zero (disappears) such as in Althaalba and Alameria.
- So the process of using the recycling waste glass is an important method with many advantages such as:
  - Saving energy reduces acid rain, global warming and air pollution.
  - Saving the environment from waste glass.
  - Saving the cost of the raw material.
  - It can be reused in many cases.
  - Creates employment in the glass industry.
  - Reduces operating waste disposal costs by reducing weight and volume of waste storage, transportation and disposal…etc.

APPENDIX (1)

The Iraqi standards of drinking water

Parameters	Concentration or Value (maximum unless otherwise stated)	Units of Measurement
Color	15-20	mg/l Pt/Co
Odor	Should be acceptable	-
Taste	Should be acceptable	-
Turbidity	4-5	NTU
Temperature	9-15	˚C
Conductivity	301-2000	µS/cm
PH value	6.5-8.5	-
TSS	It should be zero	mg/l

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Table (1): pH values

Sample No.	The region	pH. Value
1	Almansoor	6.67
2	Alameria	7.08
3	MadinatAlsader	6.99
4	Albaladiat	6.90
5	Althaalba	6.82
6	Alzaafarania	7.03
7	Haifa street	7.01
8	Aldora	7.17
9	Alkathmia	7.02
10	Bab Al moatham	7.04

Table (2): Conductivity values

Sample No.	The region	Conductivity value μS/cm
1	Almansoor	16˚C (683)
2	Alameria	15.4˚C(784)
3	MadinatAlsader	16.2˚C(1083)
4	Albaladiat	16.2˚C(982)
5	Althaalba	16.1˚C(914)
6	Alzaafarania	16˚C(890)
7	Haifa street	16.2˚C(1035)
8	Aldora	16.1˚C(960)
9	Alkathmia	16.1˚C(1010)
10	Bab Al moatham	16.1˚C(1034)

Table (3): Turbidity values

Sample No.	The region	Turbidity value(NTU) Before filtration	Turbidity value(NTU) After filtration
1	Almansoor	0.82	0.82
2	Alameria	0.58	0.58
3	MadinatAlsader	21.30	10.0
4	Albaladiat	0.91	0.91
5	Althaalba	2.24	2.24
6	Alzaafarania	3.91	3.91
7	Haifa street	1.27	1.27
8	Aldora	5.04	5.0
9	Alkathmia	2.45	2.45
10	Bab Al moatham	0.97	0.97

Table (4): TSS Values before and after filtration process

Samples No.	**Region name**	**TSS values before filtration(mg/L)**	**TSS values after filtration (mg/L)**
1	Almansoor	1.3333	0.333
2	Alameria	1	0
3	Haifa street	3	1.3333
4	Aldora	1	1
5	Alkathmia	2.333	1.6666
6	MadinAlalsader	5	3.6666
7	Albaladiat	4	1.66666
8	Althaalba	0.333	0
9	Alzaafarania	3.3333	1
10	Bab Almoatham	0.666667	0.66666

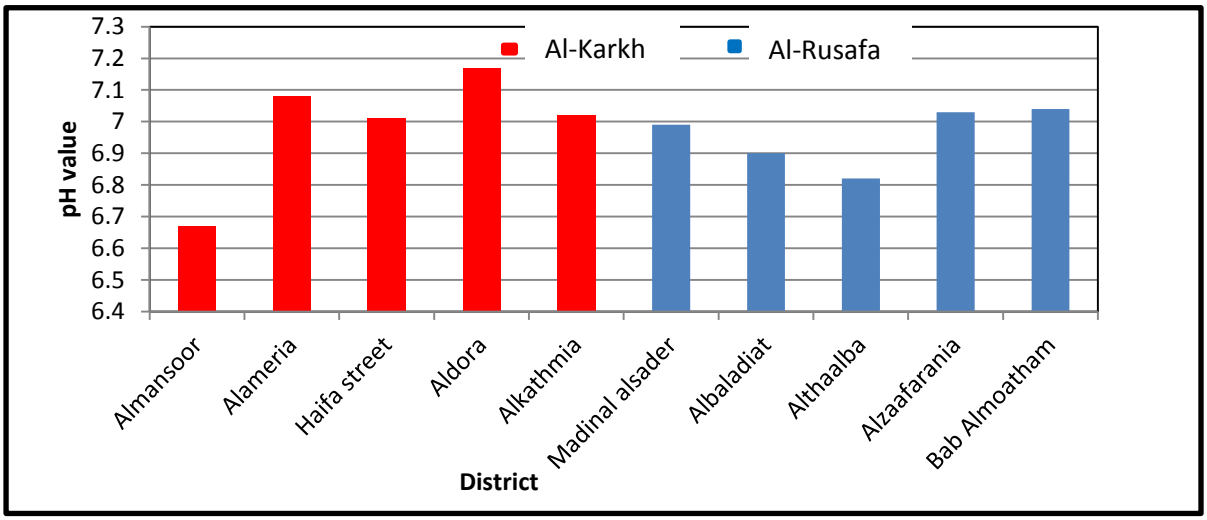

Figure (5): pH values for different Baghdad districts

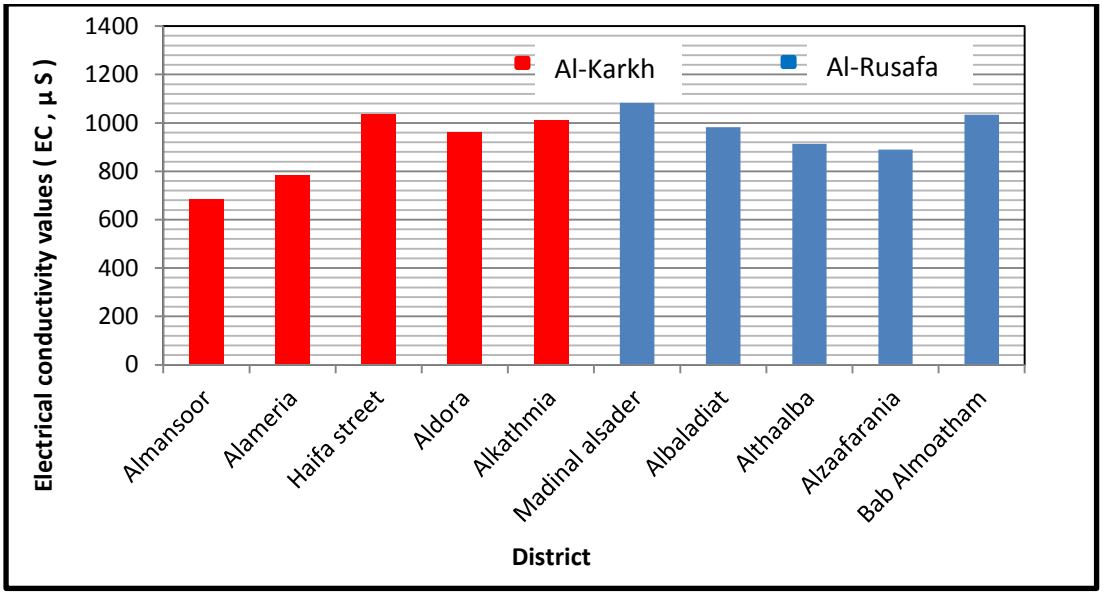

Figure (6): Electrical Conductivity values (µ S) for different Baghdad districts

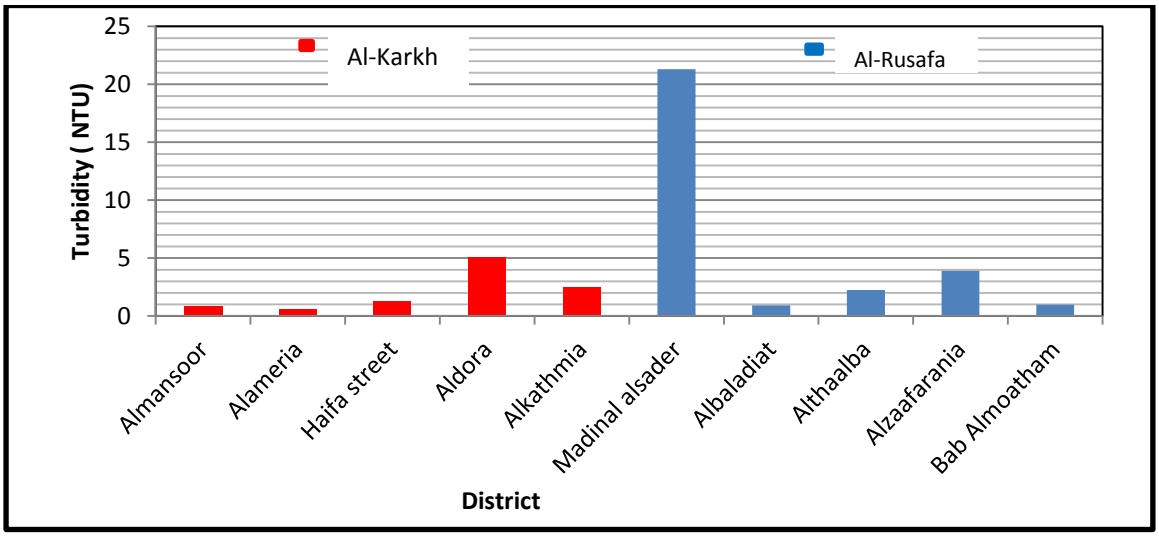

Figure (7): Turbidity values (NTU) for different Baghdad districts

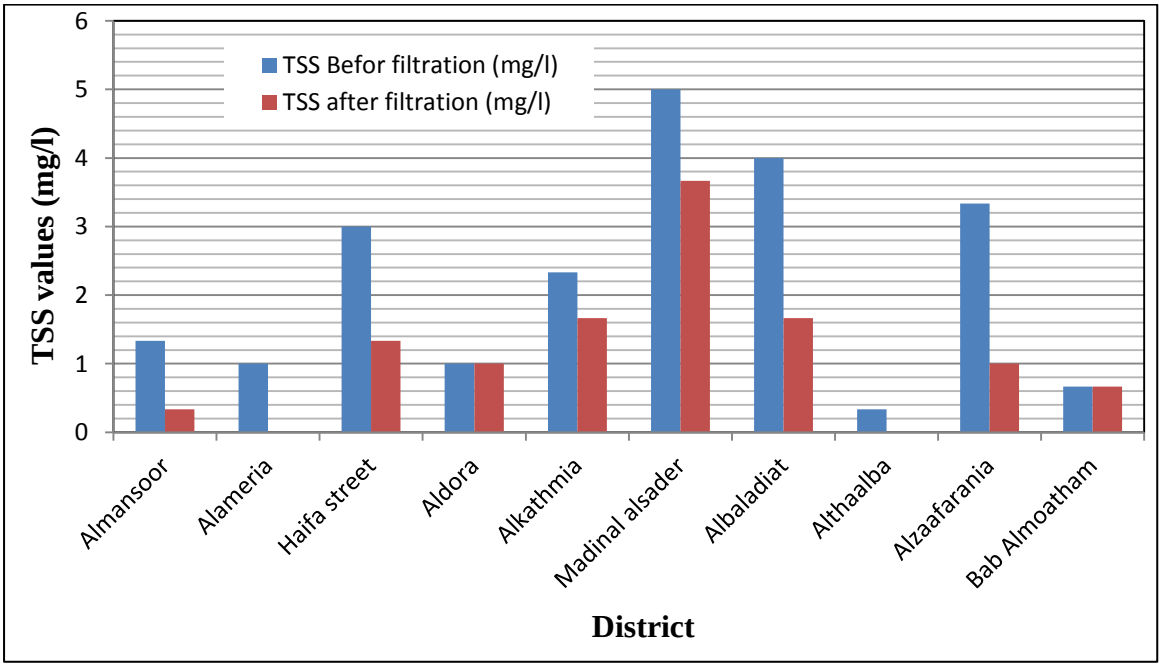

Figure (8): TSS values before and after filtration (mg/l) for different Baghdad districts