

Environmental Studies on the Use of Synthesized and Natural Ion Exchange Materials in the Treatment of Drinking and Underground Water.

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ABSTRACT

Samples of drinking water from different sources (wells and dams) were collected for chemical analyses and monitoring the contaminants (if found) in accordance to the requirements of the World Health Organization (WHO). The measurements were carried out using Inductive Coupled Plasma Atomic Emission Spectrometer (ICP-AES) and the data indicated that, the chemical composition for some water samples collected are compatible with the standard constituents for drinking water according to (WHO). On the other hand, some water samples included high level concentrations for As, Be, Fe and Sr ions compared to (WHO). Treatment processes for these samples were conducted using animal bones as natural ion exchanger (N.I.E. I and N.I.E. II) and tin silicate and iron titanate as synthetic inorganic ion exchange materials (S.I.I.E. I and S.I.I.E. II). The data of chemical analysis for the water samples before and after treatment process indicated the higher efficiency of natural and synthesized inorganic ion exchange materials used for the removal of the investigated ions with the following sequence; S.I.I.E. II > S.I.I.E. I > N.I.E. I > N.I.E. II. This sequence means that the synthesized inorganic ion exchange materials have higher efficiency compared to the natural ion exchange materials. On the other hand, the natural ion exchange materials can be used for its availability in the environment and for its lower cost.

Key Words: Environmental / Treatment / Drinking Water / Underground Water / Ion Exchange.

INTRODUCTION

Recently, Water treatment processes play an important role in many countries. These processes used to make water more acceptable for a desired end-use⁽¹⁻⁶⁾. These can include use as drinking water, industrial processes, medical and many other uses. The goal of all water treatment process is to remove existing contaminants in water, or reduce the concentration of such contaminants so the water becomes fit for its desired end-use^(5, 7-8). One such use is returning water that has been used back into the natural environment without adverse ecological impact. The treatment processes involved for drinking purpose may be solids separation using physical processes such as settling, filtration, and chemical processes such as precipitation, coagulation, evaporation and ion exchange techniques⁽⁹⁻¹⁶⁾. All these techniques attempts to reach the polluted water with the standard of WHO guidelines that are generally followed throughout the world for drinking water quality requirements⁽⁴⁾. In addition of the WHO guidelines, each country or territory or water supplier can have their own guidelines in order to access safe drinking water for consumers.

During ion exchange technique, a contaminant ion from solution is reversibly exchanged for a more desirable, similarly charged ion attached to an immobile solid surface. Solid ion exchangers may include; natural or synthesized ion exchangers. Depending on the ion exchange resin selected, the process can be used to remove a group of ions from solution or to preferentially remove only specific ions. Once the ion exchanger becomes saturated, it can be regenerated and placed back into service for further contaminants removal⁽¹⁷⁾. Regeneration involves washing the ion exchanger with a solution to remove sorbed contaminant ions and produces a concentrated contaminant waste stream that may require further treatment before disposal. Selective ion exchanger is generally considered to be more cost than organic resin.

This study is a part of a project (No. 3/1432) funded by Deanship of Scientific Research, Al-Baha University, Kingdom of Saudi Arabia. The project reports the salient features of our findings regarding the treatment of drinking and underground water using synthetic and natural inorganic ion exchange materials.

EXPERIMENTAL

Samples Collection and Preparation:-

In this work different locations in Al-Baha region, Kingdom of Saudi Arabia were chosen. The location for sample collection depends on: the water source, analyses to be performed, purpose of the testing, regulatory requirements. Collected samples were investigated for elemental analysis for monitoring contaminants, if found. Details of collected water samples from dams and wells (as underground water) were presented in Table (1).

All samples collected were packed in bottles and transported to the laboratory and stored in a clean dry place prior to analysis. Samples were marked in numerical manner, and their physical characterization was investigated.

Perform Natural and Synthetic Ion Exchange Materials:-

In this project animal bone as natural ion exchange material was performed as reported by El Haddad⁽¹⁸⁾ and Chojnacka and Michalak⁽¹⁹⁾. Fats attached with bone were removed and cleaned. The bones were then washed several times with tap water and left in open air for several days to get rid of odors. Later, they were transferred to the oven at 80°C for drying. The dried bones were crushed and then calcinated at 800 and 400°C in muffle furnace for 4 h. The residue was washed with water and was used after drying for 24 h at 80°C. The produced materials were ground, sieved and stored at room temperature. These samples were donated as N.I.E I and N.I.E II, respectively.

Tin silicate and iron titanate as synthetic inorganic ion exchange materials were performed as described earlier⁽²⁰⁻²¹⁾. These samples were donated as S.I.I.E I and S.I.I.E II, respectively.

Treatment Process:-

Treatment process for water samples was performed by a new method for the treatment. This method depends on immersing the prepared materials that packed in a package with a definite weight (2.0 g) into a definite volume (1000 ml) of drinking water as represented in Fig. (1). After definite time (15 min.) the package was removed from the solution and the solution was chemically analyzed to determine the concentration of metals in drinking water after treatment process.

Table (1): Samples collected from dams and Wells.

Code No. for Sample	Sample Specification
Sample No. 1	Zamzam Well
Sample No. 2	Commercial Company for drinking water
Sample No. 3	Commercial Company for drinking water
Sample No. 4	Commercial Company for drinking water
Sample No. 5	Sample collected from dam No. 1
Sample No. 6	Sample collected from dam No. 2
Sample No. 7	Sample collected from well far about 700 meter from dam No. 1
Sample No. 8	Sample collected from well far about 1000 meter from dam No. 1
Sample No. 9	Sample collected from well far about 1500 meter from dam No. 1
Sample No. 10	Samples collected from treatment plant in the region.
Sample No. 11	
Sample No. 12	
Sample No. 13	Samples collected from the distribution system.
Sample No. 14	
Sample No. 15	Commercial Company for drinking water
Sample No. 16	Commercial Company for drinking water
Sample No. 17	Commercial Company for drinking water
Sample No. 18	Sample collected from well in another governorate in the same region.
Sample No. 19	Sample collected from well in another governorate in the same region.
Sample No. 20	Sample collected from well in another governorate in the same region.
Sample No. 21	Sample collected from well in another governorate in the same region.
Sample No. 22	Sample collected from well in another governorate in the same region.

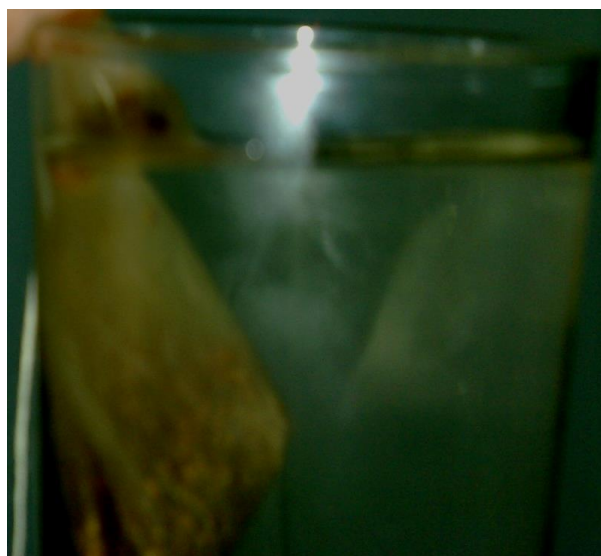


Fig. (1): Treatment manner of drinking water by natural and synthesized ion exchangers.

Instrumentation and Measurements:-

The chemical analysis of the collected water samples were carried out by using a Perkin-Elmer (Optima 2100 DV, Norwalk, CT, USA) Inductive Coupled Plasma – Atomic Emission Spectrometer (ICP-AES) instrument connected with an AS 93 Plus auto-sampler. The 40-MHz free-running generator was operated at a forward power of 1300 W; the outer, intermediate and Ar carrier gas flow rates were 15, 0.2 and 0.8 L/min, respectively. The pump flow rate was 1.5 mL/min. the carrier gas flow rate was optimized to obtain maximum signal - to - background ratios. ICP-AES was calibrated using the standard solution for the investigated metals Pb, Cd, As, Be, Se, Cr, Ag, Zn, Ni, Mn, Cu, Co, V, Fe, Ba, Sb, Al, Ca, Mg, K, Na, Tl, Sr, La, Ti, Hg and Li.

Firstly, monitoring for the water samples was performed to investigate contaminates (if found) then the concentrations of the metal ions in water samples after treatment by different ion exchange materials were determined. The efficiency of the ion exchange materials used in the treatment process was calculated from the concentration of metals in water samples before and after treatment process.

RESULTS AND DISCUSSION

Tin silicate and iron(III) titanate as synthetic inorganic ion exchange materials used in this work was prepared as reported earlier ⁽²⁰⁻²¹⁾ with granular nature that allowed to be used in the separation process. The empirical formula for tin silicate and iron titanate was written as $\text{SnSi}_2\text{O}_6 \cdot 6.19\text{H}_2\text{O}$ ⁽²⁰⁾ and $\text{Fe}_{1.3}\text{TiO}_4 \cdot 2\text{H}_2\text{O}$ ⁽²¹⁾, respectively. The chemical composition and function groups of animal bone used as natural ion exchange materials was published earlier by Chojnacka and Michalak ⁽¹⁹⁾. This project aims to analyze different sources of drinking water in Al-Baha region and determine its constituents compared with the standard constituents for drinking water according to WHO. God willing identifying sources of drinking and underground water of Al-Baha region. Samples were analyzed qualitatively and quantitatively to identify the chemical composition and contaminants (if found) according to the requirement of WHO. After that, the working group conducting ion exchange treatment using ion exchange technique.

Different collected water samples were analyzed using ICP-AES to investigate their chemical composition (Table 2). The data represented in Table (2) indicated that, the chemical composition of water samples was compatible with the standard constituents for drinking water according to WHO (Table 3). Some samples contain metals such as Be, As, Fe, Sr and Hg with concentration levels which may cause some health problems by accumulative in the body on the long run ⁽²²⁾. These samples were treated using animal bone calcinated at 800 and 400°C as a natural ion exchange (N.I.E. I) and (N.I.E. II), respectively, and tin silicate and iron titanate as synthetic inorganic ion exchange materials, (S.I.I.E. I) and (S.I.I.E. II), respectively. The concentrations of Be, As, Fe, Sr and Hg in samples No. 5 to 13 may be interpreted on the basis of the higher concentrations of these metals in the mountains, rocks and soil in Al-Baha region. During , floods of water from the mountains and rocks, after rains fall in which some of these elements were dissolved, penetrate the soil and thus found in wells and underground water. These data makes us do our best to find substances that have high potential efficiency to remove them from the water.

Treatment process of water samples:-

The data of chemical analysis for the water samples before and after treatment process for the removal of some undesirable metals such as Be, As, Fe, Sr and Hg were tabulated in the Table (4). The data in Table (4) showed that the natural and synthesized ion exchange materials performed by the working group have high efficiency for the removal of the investigated cations. The concentrations of Be, As, Fe, Sr and Hg detected in the treated water samples are very low (Below Detection Limit) of Inductive Coupled Plasma (ICP) accuracy and compatible with the standard constituents for drinking water according to WHO. The efficiency of the ion exchange materials used may be due to the cation functional groups and interstitial water molecules that play an important role in the exchange process⁽¹⁹⁻²¹⁾. The advantages of treatment process by natural and synthesized ion exchange are the very low running costs. Very little energy is required, the regenerate chemicals are cheap and if well maintained resin beds can last for many years before replacement is needed.

The comparison of the metal concentration for Be, As, Fe, Sr and Hg before and after the treatment process as represented in Table (4) for the water samples No. 5 to 13 indicated that, the concentration of the investigated metals (Be, As, Fe, Sr and Hg) in water samples becomes very neglected and near Below Detection (B.D.) level concentration by the treatment of water samples by the natural and synthesized inorganic ion exchange materials. The general sequence for the order of efficiency for these materials was;

$$\mathbf{S.I.I.E. II > S.I.I.E.I > N.I.E. I > N.I.E. II .}$$

This sequence means that the synthesized ion exchange materials have high efficiency compared to the natural ion exchange materials. On the other hand, the natural ion exchange materials can be used for the lower economic cost; especially it has high efficiency removal. The higher efficiency of animal bone calcinated at 800° C (N.I.E. I) compared to animal bone calcinated at 400°C (N.I.E. II) may be due to the condensation and formation of new active sites on the surface of bone at high temperature.

Sample No.	pH	TDS, ppm (mg/L)	Conductivity, μ s	Concentration, mg/L												
				Pb	Be	Cd	Se	As	Cr	Ag	Mn	Zn	Cu	Ni	Co	V
1	7.7	571	955	B.D.	0.01	B.D.	0.01	0.01	0.003	B.D.	0.002	0.007	B.D.	B.D.	0.001	0.02
2	7.87	128	213	B.D.	B.D.	B.D.	B.D.	0.01	0.003	B.D.	0.002	0.009	B.D.	B.D.	0.002	0.002
3	8.04	153	255	B.D.	B.D.	B.D.	B.D.	0.01	0.003	B.D.	0.002	0.008	B.D.	B.D.	0.002	0.017
4	7.81	133	221	B.D.	B.D.	B.D.	B.D.	0.01	0.003	B.D.	0.002	0.009	B.D.	B.D.	0.002	0.017
5	8.34	276	460	B.D.	0.01	B.D.	0.01	0.01	0.003	B.D.	0.011	0.007	B.D.	B.D.	0.002	B.D.
6	7.79	237	396	B.D.	B.D.	B.D.	0.01	0.01	0.003	B.D.	0.02	0.031	B.D.	B.D.	0.002	B.D.
7	7.57	502	837	B.D.	0.01	B.D.	0.01	0.01	0.003	B.D.	0.003	0.011	B.D.	B.D.	0.001	B.D.
8	7.96	364	609	B.D.	B.D.	B.D.	0.01	0.01	0.004	B.D.	0.003	0.008	B.D.	B.D.	0.001	B.D.
9	8.16	348	581	B.D.	0.01	B.D.	0.01	0.01	0.004	B.D.	0.004	0.008	B.D.	B.D.	0.001	0.005
10	7.88	244	407	B.D.	0.01	B.D.	B.D.	0.01	0.003	B.D.	0.016	0.008	B.D.	B.D.	0.002	0.002
11	7.75	248	413	B.D.	0.01	B.D.	B.D.	0.01	0.004	B.D.	0.008	0.01	B.D.	B.D.	0.002	B.D.
12	8.01	245	409	B.D.	0.01	B.D.	B.D.	0.01	0.003	B.D.	0.008	0.01	B.D.	B.D.	0.001	0.004
13	8.22	226	377	B.D.	0.01	B.D.	B.D.	0.01	0.004	B.D.	0.003	0.008	B.D.	B.D.	0.001	0.001
14	7.74	110	183	B.D.	0.01	B.D.	B.D.	0.01	0.004	B.D.	0.002	0.008	B.D.	B.D.	0.001	0.007
15	7.85	152	254	B.D.	0.01	B.D.	B.D.	0.01	0.003	B.D.	0.002	0.008	B.D.	B.D.	0.001	0.009
16	7.71	113	186	B.D.	0.01	B.D.	B.D.	0.01	0.003	B.D.	0.002	0.008	B.D.	B.D.	0.001	0.006
17	8.03	168	281	B.D.	B.D.	B.D.	B.D.	0.01	0.004	B.D.	0.002	0.007	B.D.	B.D.	0.001	0.019
18	7.76	465	520	B.D.	0.001	B.D.	B.D.	0.001	0.002	B.D.	0.001	0.004	B.D.	B.D.	0.001	B.D.
19	7.91	500	500	B.D.	B.D.	B.D.	B.D.	0.001	0.001	B.D.	0.002	0.005	B.D.	B.D.	0.001	B.D.
20	8.02	397	491	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	0.002	0.008	B.D.	B.D.	0.002	B.D.
21	7.95	365	563	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	0.021	B.D.	B.D.	0.001	0.001
22	7.88	401	575	B.D.	0.002	B.D.	B.D.	B.D.	B.D.	B.D.	0.003	0.006	B.D.	B.D.	0.001	0.001

B.D. : Below Detection.

Table (2):- Chemical Analysis For The Different Collected Water Samples.

Sample No.	Concentration, mg/L													
	Sb	Fe	Al	Ba	Ca	Mg	Na	K	Tl	Sr	Hg	La	Li	Ti
1	B.D.	B.D.	0.01	0.02	48.2	16.2	122	51.72	B.D.	0.59	0.05	B.D.	0.02	B.D.
2	B.D.	B.D.	B.D.	B.D.	10.5	3.41	29.8	B.D.	B.D.	0.01	0.05	B.D.	0.02	B.D.
3	B.D.	B.D.	B.D.	B.D.	0.94	4.31	64	0.154	B.D.	0.01	0.05	B.D.	0.02	B.D.
4	B.D.	B.D.	B.D.	B.D.	0.05	17.4	19.2	0.97	B.D.	0.01	0.05	B.D.	0.02	B.D.
5	B.D.	0.004	B.D.	0.03	35.9	17.7	27.8	8.498	B.D.	0.29	0.05	B.D.	0.02	B.D.
6	B.D.	0.025	0.01	0.03	34.8	17.1	17.3	9.083	B.D.	0.29	0.05	B.D.	0.02	B.D.
7	B.D.	B.D.	B.D.	0.05	88.9	27	41.4	5.546	B.D.	0.53	0.05	B.D.	0.02	B.D.
8	B.D.	B.D.	B.D.	0.03	60.9	18.8	32.0	4.388	B.D.	0.37	0.05	B.D.	0.02	B.D.
9	B.D.	0.001	B.D.	0.03	58.5	17.7	29.8	3.546	B.D.	0.34	0.05	B.D.	0.02	B.D.
10	B.D.	0.011	0.45	0.02	34.8	17.1	17.2	9.067	B.D.	0.28	0.05	B.D.	0.02	B.D.
11	B.D.	0.004	B.D.	0.02	35.4	17.6	17.2	9.055	B.D.	0.3	0.05	B.D.	0.02	B.D.
12	B.D.	B.D.	0.11	0.02	35.1	17.5	17.2	9.078	B.D.	0.3	0.05	B.D.	0.02	B.D.
13	B.D.	B.D.	0.07	0.02	33.3	13.8	18.6	6.447	B.D.	0.23	0.05	B.D.	0.02	B.D.
14	B.D.	B.D.	0.01	B.D.	9.60	3.89	19.8	0.807	B.D.	0.13	0.05	B.D.	0.02	B.D.
15	B.D.	B.D.	B.D.	B.D.	4.54	1.98	51.0	0.873	B.D.	0.07	0.05	B.D.	0.02	B.D.
16	B.D.	B.D.	B.D.	B.D.	7.70	3.65	26.7	B.D.	B.D.	0.01	0.05	B.D.	0.02	B.D.
17	B.D.	B.D.	B.D.	B.D.	9.4	4.96	46.5	1.288	B.D.	0.12	0.05	B.D.	0.02	B.D.
18	B.D.	B.D.	B.D.	0.006	45.6	15.7	21.3	3.45	B.D.	0.001	B.D.	B.D.	0.007	B.D.
19	B.D.	B.D.	B.D.	0.005	39.4	17.4	20.4	2.31	B.D.	B.D.	B.D.	B.D.	0.005	B.D.
20	B.D.	B.D.	B.D.	0.004	30.4	18.4	25.5	4.52	B.D.	B.D.	B.D.	B.D.	0.02	B.D.
21	B.D.	B.D.	0.01	0.007	30.7	15.3	22.5	3.12	B.D.	B.D.	B.D.	B.D.	0.006	B.D.
22	B.D.	B.D.	B.D.	0.005	49.6	12.4	19.4	4.21	B.D.	B.D.	B.D.	B.D.	0.019	B.D.

B.D. : Below Detection.

Cont. Table (2):- Chemical Analysis For The Different Collected Water Samples.

Element / substance	Symbol / formula	Health based guideline by the WHO 1993
Aluminum	Al	0,2 mg/l
Antimony	Sb	0.005 mg/l
Arsenic	As	0,01 mg/l
Asbestos		7 million fibers per liter
Barium	Ba	0,3 mg/l
Beryllium	Be	0.004 mg/L
Boron	B	0,3 mg/l
Cadmium	Cd	0,003 mg/l
Chloride	Cl	250 mg/l
Chromium	Cr ⁺³ , Cr ⁺⁶	0,05 mg/l
Color		5 platinum-cobalt scale
Copper	Cu	2 mg/l
Cyanide	CN ⁻	0,07 mg/l
Fluoride	F	1,5 mg/l
Hardness	mg/l CaCO ₃	soft 0 - 17.1 ppm; slightly hard 17.1 – 60 ppm; moderately hard 60 - 120 ppm; hard 120 -180 ppm; and very hard 180 or more ppm.
Iron	Fe	< 0.3 mg/L
Lead	Pb	0,01 mg/l
Manganese	Mn	0.1 – 0.5 mg/l
Mercury	Hg	0,001 mg/L
Molybdenum	Mb	0.05 – 0.07 mg/l
Nickel	Ni	0,02 mg/l
Nitrate and nitrite	NO ₃ , NO ₂	50 mg/l total nitrogen
Turbidity		5 Nephelometric Turbidity Unit
pH		6.5 – 8.5
Selenium	Se	0,01 mg/l
Silver	Ag	0.1 mg/L
Sodium	Na	180- 200 mg/l
Strontium	Sr	5.7 × 10 ⁻⁵ mg/L according to U.S. Environmental Protection Agency (EPA), as presented in Federal Guidance Reports 11 and 13 (EPA 1988 and EPA 1999).
Sulfate	SO ₄	250 - 500 mg/l
TDS		500 mg/L
Uranium	U	1,4 mg/l
Zinc	Zn	3- 5 mg/l

Table (3): WHO's Guidelines for Drinking-water Quality, set up in Geneva, 1993, are the international reference point for standard setting and drinking-water safety.

Sample No.	Parameter / Elements	Concentration of Cations (mg/L)				
		Original Sample (Before Treatment)	Sample After Treatment With			
			Natural Ion Exchanger		Synthetic Ion Exchanger	
			N.I.E. I	N.I.E. II	S.I.I.E. I	S.I.I.E. II
5	Be	0.001	B.D.	B.D.	B.D.	B.D.
	As	0.011	B.D.	B.D.	B.D.	B.D.
	Fe	0.004	0.003	0.003	0.003	0.003
	Sr	0.292	0.131	0.208	0.04	0.015
	Hg	0.047	0.008	0.001	0.003	0.003
6	Be	B.D.	B.D.	B.D.	B.D.	B.D.
	As	0.011	B.D.	B.D.	B.D.	B.D.
	Fe	0.025	0.012	0.019	0.01	0.011
	Sr	0.291	0.137	0.196	0.019	0.008
	Hg	0.047	B.D.	B.D.	0.002	0.002
7	Be	0.001	B.D.	B.D.	B.D.	B.D.
	As	0.012	B.D.	B.D.	B.D.	B.D.
	Fe	B.D.	B.D.	B.D.	B.D.	B.D.
	Sr	0.528	0.284	0.402	0.107	0.047
	Hg	0.046	B.D.	B.D.	B.D.	B.D.
8	Be	B.D.	B.D.	B.D.	B.D.	B.D.
	As	0.01	B.D.	B.D.	B.D.	B.D.
	Fe	B.D.	B.D.	B.D.	B.D.	B.D.
	Sr	0.365	0.213	0.246	0.051	0.029
	Hg	0.046	B.D.	B.D.	B.D.	B.D.
9	Be	0.001	B.D.	B.D.	B.D.	B.D.
	As	0.009	B.D.	B.D.	B.D.	B.D.
	Fe	0.001	B.D.	B.D.	B.D.	B.D.
	Sr	0.341	0.195	0.240	0.033	0.027
	Hg	0.046	B.D.	B.D.	B.D.	B.D.

B.D. : Below Detection

Table (4): Chemical analysis for samples No. 5, 6, 7, 8, 9, 10, 11, 12 and 13 before and after treatment using natural and synthetic ion exchange materials.

Sample No.	Parameter / Elements	Concentration of Cations (mg/L)				
		Original Sample (Before Treatment)	Sample After Treatment With			
			Natural Ion Exchanger		Synthetic Ion Exchanger	
			N.I.E. I	N.I.E. II	S.I.I.E. I	S.I.I.E. II
10	Be	0.001	B.D.	B.D.	B.D.	B.D.
	As	0.008	B.D.	0.003	B.D.	B.D.
	Fe	0.011	0.006	0.009	0.007	0.008
	Sr	0.284	0.162	0.205	0.026	0.039
	Hg	0.047	B.D.	B.D.	B.D.	B.D.
11	Be	0.001	B.D.	B.D.	B.D.	B.D.
	As	0.010	0.001	0.002	0.004	0.002
	Fe	0.004	B.D.	B.D.	B.D.	B.D.
	Sr	0.295	0.158	0.209	0.028	0.014
	Hg	0.047	B.D.	B.D.	B.D.	B.D.
12	Be	0.001	B.D.	B.D.	B.D.	B.D.
	As	0.010	0.004	0.003	0.004	0.005
	Fe	B.D.	B.D.	B.D.	B.D.	B.D.
	Sr	0.296	0.169	0.231	0.03	0.06
	Hg	0.047	B.D.	B.D.	B.D.	B.D.
13	Be	0.001	B.D.	B.D.	B.D.	B.D.
	As	0.010	0.004	0.007	0.004	0.007
	Fe	B.D.	B.D.	B.D.	B.D.	B.D.
	Sr	0.229	0.140	0.178	0.014	0.027
	Hg	0.049	B.D.	B.D.	B.D.	B.D.

B.D. : Below Detection

Cont. Table (4): Chemical analysis for samples No. 5, 6, 7, 8, 9, 10, 11, 12 and 13 before and after treatment using natural and synthetic ion exchange materials.

In future work completed to this project, the materials used in the treatment process will be prepared and designed in a spherical disc to be placed in the line pipe of supplied water to remove undesirable ions from water. The disk will be pressed in different sizes to be suitable for the line water supplies as shown in figure 2.

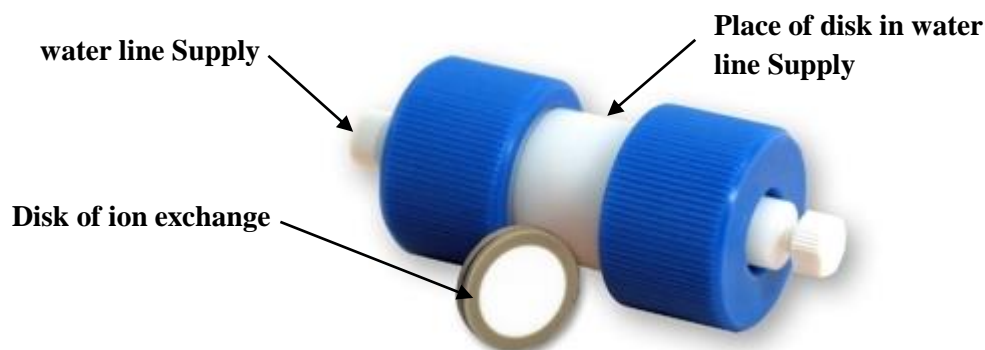


Fig. (2): Diagram of natural and synthesized ion exchange disk design.

CONCLUSION

Different samples of drinking and ground water were collected for the qualitative and quantitative chemical analyses and monitoring the contaminants in accordance with the requirement of WHO. The data indicated that, the chemical composition of water samples for some metals is compatible with the standard constituents for drinking water WHO. Some samples contain metals such as Be, As, Fe, Sr and Hg with concentration levels which may cause some health problems by accumulative in the body on the long run. Animal bone as natural ion exchange (N.I.E. I), (N.I.E. II) and tin silicate and iron titanate as synthetic inorganic ion exchange materials (S.I.I.E.I) and (S.I.I.E. II) were performed for the treatment process with the efficiency sequence order; S.I.I.E. II > S.I.I.E.I > N.I.E. I > N.I.E. II .

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