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Using Adsorption Method by Tea Leaves to Minimize Sulfate Ion Concentration in Polluted Water

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Abstract:

The research aims to study minimizing ordecreasing sulfate ion concentration inpolluted water using adsorption method bytealeaves. The samples were collected from four areas on the Tigris River side in Baghdad city that are, Bab Al-Muddam, Al-Doora, Al-Kademiyah and Al-Adamiyah. At these areas and on the river sides, there are hospitals, Electric power plants, factories, restaurants and residential houses. The result showed that before adsorption method at standard temperature, sulfate ion concentration was high. This referred that these institutes might be pour theirswastewater directly to the river, which leads to pollute the water of the river. Therefore, the wastewaterneeded to be treated before pouring to the river.After adsorption, sulfate ion concentration is decreased gradually depending on twofactors, which are temperature and contact time.The results presented that adsorption process by using tealeaves as an adsorption material hadsignificant impact in decreasing sulfate ion concentration in polluted water. On the other hand, the temperature as a factor was more effective than contact time in minimizing sulfate ion concentration inpolluted water until reach the desired value (200-400mg/l) as standard Iraqi's requirements.

Key words: Adsorption method, Tealeaves, Sulfate ion and Polluted water.

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1-Introduction:

The molecule of waterincludesone oxygen and two hydrogen atoms. The atoms combined by covalent bonding, so they share electrons.Water is the singularmolecule on the Earth that occursin a solid, liquid and gas form; it's boiling point (100 degrees)and freezing point (0 degree) based on the Celsiustemperature scale**[1,4].**

The sulfate or sulphateion is an anion, it'sformula is (SO_4^{-2}). The spelling sulphate is usedin British English while International Union of Pure and Applied Chemistry recommend the spelling sulfate.The anion hasa sulfur atom in the center of it, it bounded by four oxygen atoms

in a tetra preparation as same as of methane molecule.The sulfate ion carriages a negative two charge. Gilbert Lewisis the term by which the first reason of the bonding in sulfate ion. Hedefined the connectionof bonds as electron round each atom so there is no double bonds and a formal charge of (+ 2) on the sulfur atom.
If barium chloride is added to a solution of sulfate ions, white precipitate is presented as barium sulfate, which means that sulfate anions exist **[3,6]**.

High sulfate rangein drinking water can cause diarrhea and dryness. Adults are less sensitive to sulfate ion than children. The sulfate rangeabove(400 mg/l) should not be used in the production of newbornrecipe. Most peopletransformedfamiliar to greatlevel sulfate after a few daysof using it **[3]**.

The joining of atoms, molecules and ions from a gas, liquid to a surface is called adsorption.The adsorptionmethodproduces a film of adsorbents on the surface of the adsorbent material so it is a surface based process.This process is existing in many natural, physical, biological, and chemical arrangements. It is used in industrial applications such as using waste heat to provide cold water for air conditioning and other proceduresupplies (adsorption chillers), increase storage capability of carbide-derived carbons, and water purification.For example, when water is arranged to flow through a pile of sand, ions and toxins in the water may be particularly adsorbed by the surfaces of the particles of sand, provided that a simple, well-known water purify **[9, 10].**

B.M.W.P.K. Amarasinghea and R.A. Williams (2007)verified tea waste as a low cost adsorbent material to remove of copper andleadions from wastewater. Batch experiments were conducted to resistor the factors that affect the process. At pH (5-6) range, the adsorption rate of lead was higher than of copper. The result showed that Tea waste is a better adsorbent comparingwith other low cost adsorbents **[2]. Wei-Lung Chou et al. (2010)**used tea waste as an adsorbent material to remove gallium ion from water. They used tea waste because it is cheap cost material and to keep the environment from recycled material. This study depends on some factors such as the adsorbent dose, the initial concentration of ion and temperature. The results of the study indicated that tea waste was effective as an adsorbent material for water treatment **[9].BindraShrestha et al. (2012)**used tealeaves as an adsorbent material to removeLead and Zinc ionsfrom their solution. It is invented thatthe maximum adsorption capability of the adsorbent was (120.8 mg/g) for Pb++and (79.76 mg/g) for Zn++. The results offered that the animated tea leaves controlexcessive potential to remove leadand zinc from aqueous solution **[5].Ihsan Habib Dakhil (2013)**observed the abilityof methylene blue(MB) dye adsorptionfrom wastewater by low-cost adsorbent, spent tealeaves (STL). The experimentswere established under someconditions, which are initial concentrationdye (50-500) mg/l, STL dose (0.05-1) g, pH solution (2-11), contact time (10-180) min and constant temperature of 30 C. The results showed that the best conditions for adsorptionwere 0.43 g per 100 ml dye solution, pH=7. The

results recognized that STL has inordinate potential 98% to be used as operative adsorbent for MB dye removal **[7].**

2-Experimental method:

The experimental method to minimize or decrease sulfate residual by using adsorption and tealeaves as an adsorbent material, in the form of barium sulfate by adding barium chloride to the sample that contain sulfates, was used in this study as in equation (1),**[8]:**

$Ba^{+2}+SO4^{-2}\rightarrow$BaSO4 …….. [1]

2-1.The equipment required:

1- Cylinder2- Watch glass3- Volumetric funnel4- Beakers5- Clamp

6- Stand7- Digital balance8- Electrical oven9- PH Scale10- Filter papers

2-2. Chemical materials

1. Solution of Hydrochloric acid HCl(0.1N)
2. Solution of Barium chloride (BaCl2.2H2O)
3. Distilled water

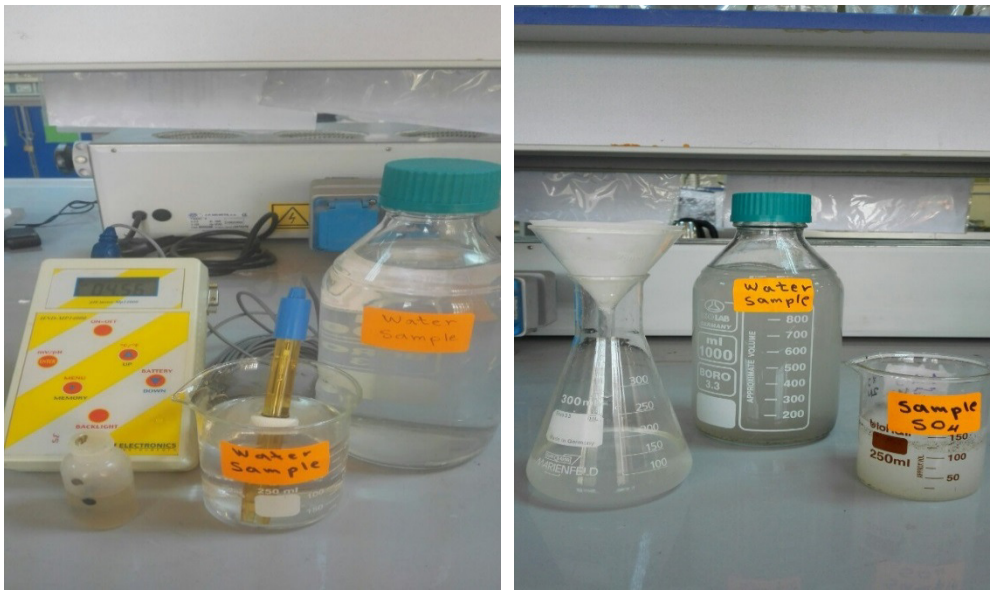
2-3. Steps of test:

1-Take (100 ml) of polluted water sample and put it in Glass beaker.

2- Add a hydrochloric acid (0.1 N) in percent of (1/1 until the PH reach to (4.5 - 5)), then add an extra of the diluted acid (1-2 ml).

3-pour barium chloride solution gradually with continues shaking with the sulfate solution until the white residual from barium sulfate salt is formed completely, and then leave it for a while of time.

4- The sulfate solution is filtered by a filter paper at room temperature, and then wash the residual with distilled water to remove the chloride impression from the sulfate residual as shown in Fig. (1) below.



a- pH meter b-Filtration process

Figure (1) pH meter and Filtration process

5- The residual and the filter paper are placed in electric oven at temperature of (103 – 105 C) to drying.
6- Weight the filter paper before and after filtration and dryit to know the weight of sulfate residual.
7-Apply the weight in the following equation to find sulfate concentration. Eq. (2),**[8]:**

$[SO_4{}^{-2}]$: $= Wt. * eq.Wt./V * 1000$ ..... (2)

$[SO_4{}^{-2}] := Wt. * 411.5/100 * 1000$

Where:

$[SO_4{}^{-2}]$: sulfate ion concentration (mg/l)

[Wt.]: Residual weight (g)

[eq. Wt.]: Equivalent weight of sulphate (411.5)

[V]: Sample volume [100] mL

The steps of work were used before and after adsorption method by using tea leaves as an adsorbent material depending on twofactors, which were contact time and temperature as shown in Fig. (2).

Figure (2) Tea Leaves and Adsorption Process

3.Results:

In this study, the magnitude of sulfate concentration inpollutedwater before and after adsorption by using tealeaves was calculated.

Before adsorption, sulfate concentration at zero time and standard temperature was determined for four regions on the side of Tigris River in Baghdad city as shown in figure (3).

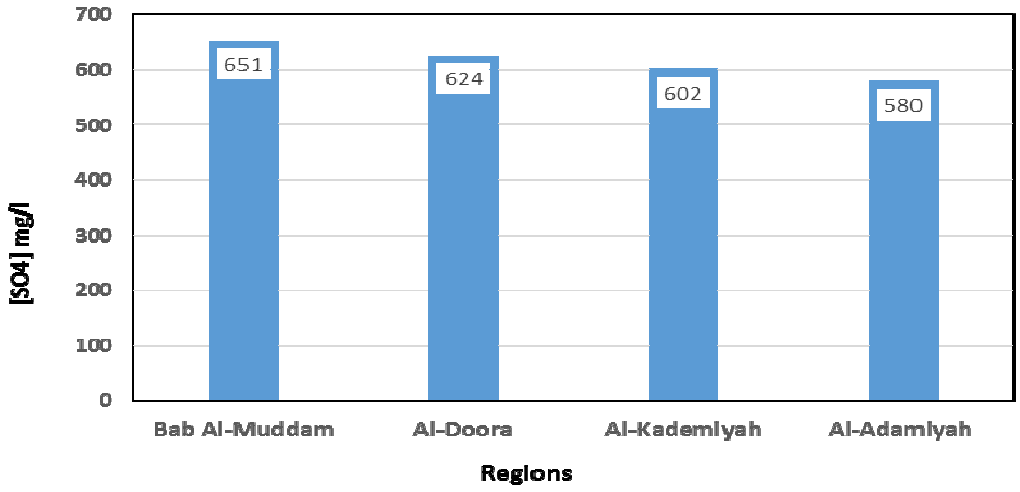


Fig. (3) Sulfate ion concentration in four regions polluted water before adsorption

After adsorption, the results showed that the sulfate ion concentration decreases gradually with increasing the contact time from (0-120 min.) by (20 min.) each step until it reached an acceptable range concentration (200 – 400) mg/L**[4].**

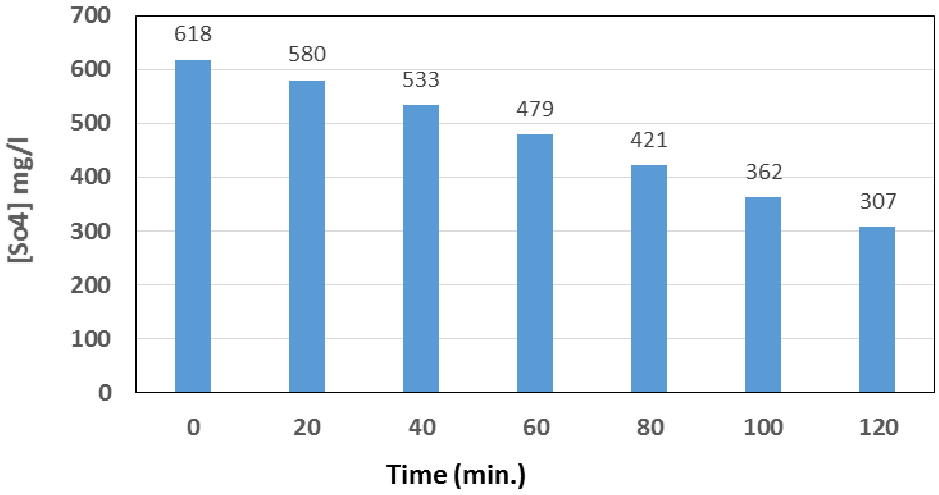


Fig. (4) [SO_4^{-2}] VS. Time in Bab Al-Muddampolluted water after adsorption

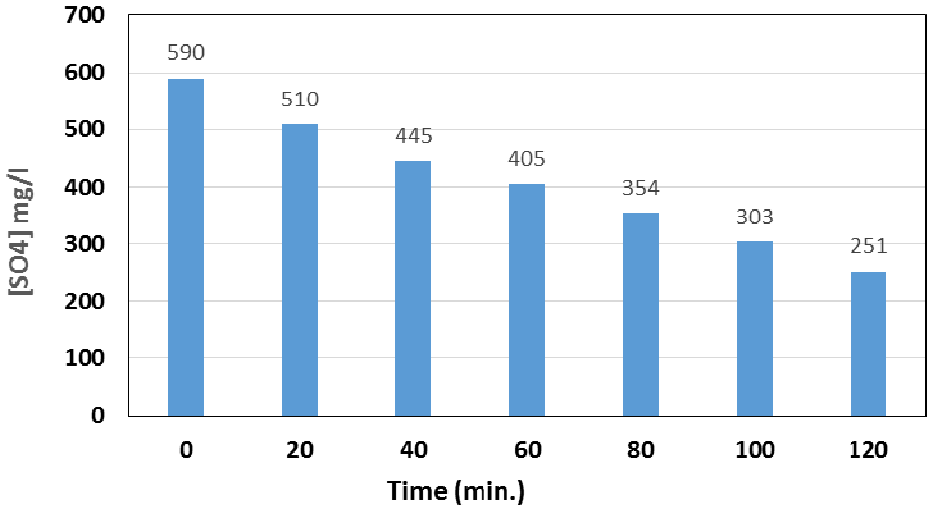


Fig. (5) [SO_4^{-2}] VS. Time in Al-Doorapolluted water after adsorption

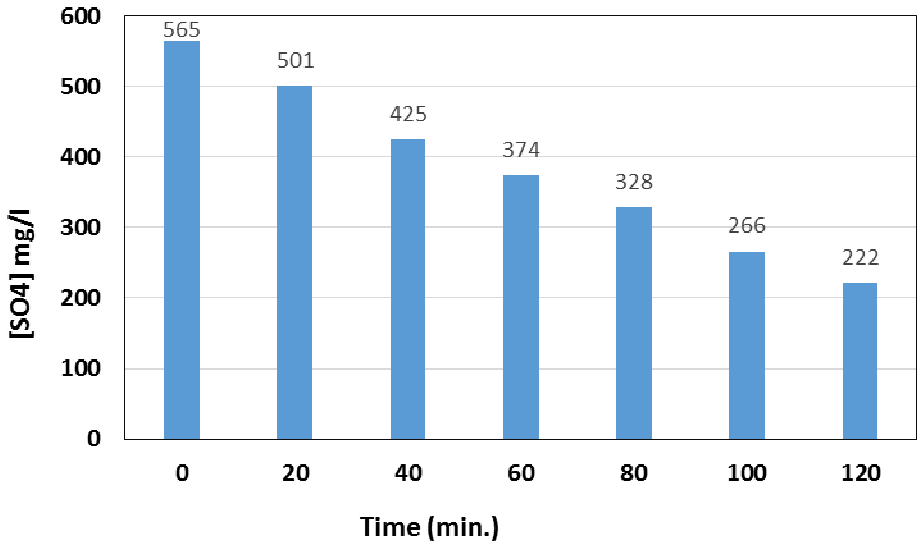


Fig. (6) [SO_4^{-2}] VS. Time in Al-Kademiyahpolluted water after adsorption

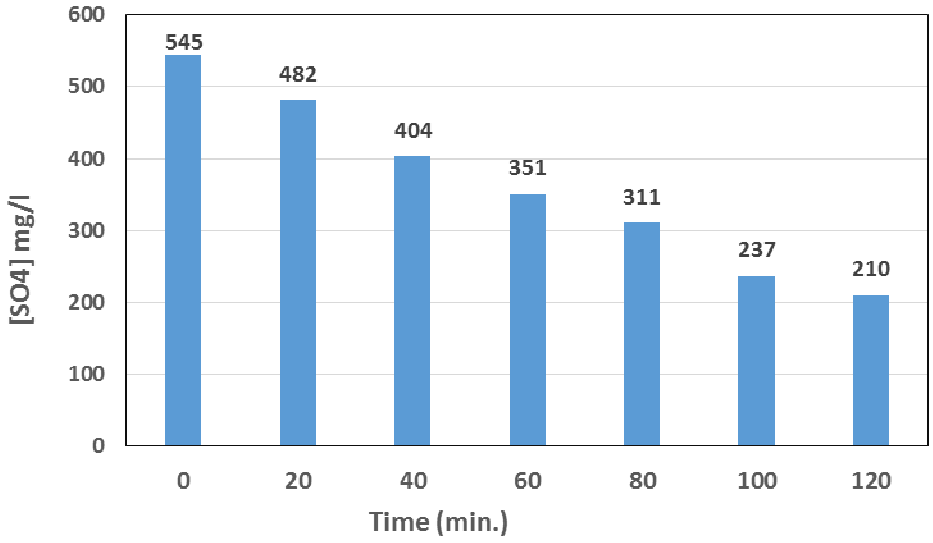


Fig. (7) [SO_4^{-2}] VS. Time in Al-Adamiyahpolluted water after adsorption

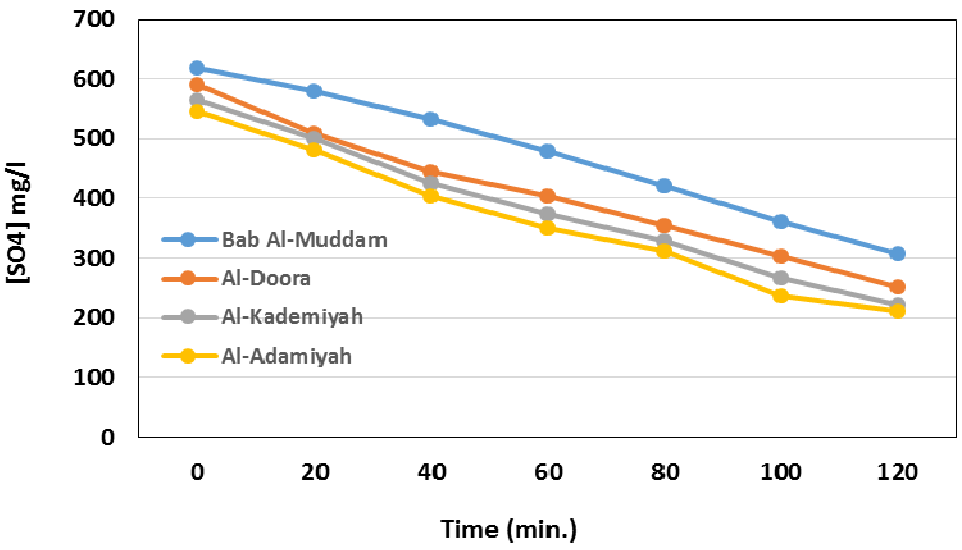


Fig. (8) [SO_4^{-2}] VS. Time in Four regions polluted water after adsorption

The results indicated that the sulfate ion concentration decreases graduallyafter adsorption with increasing the temperaturefrom (20-80 C°) by (10 C°)until it reached an acceptable range concentration (200 – 400) mg/L.

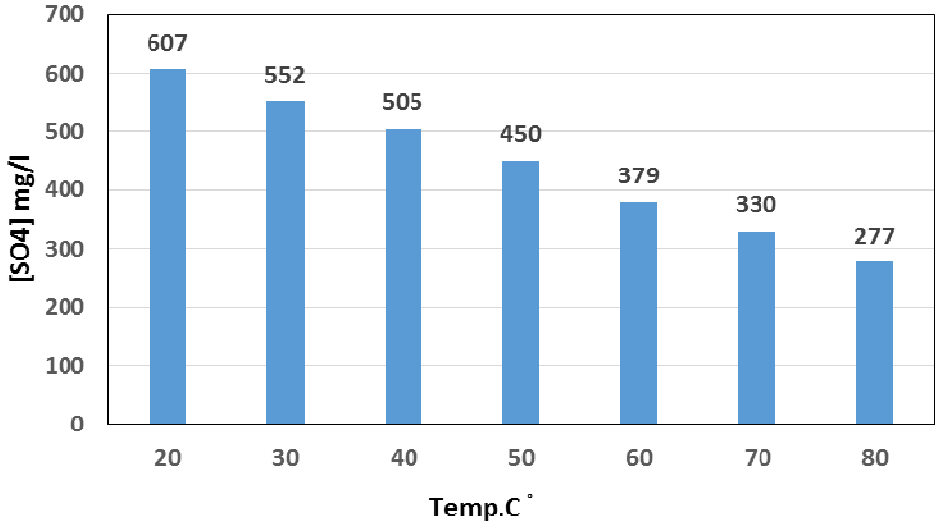


Fig. (9) [SO_4^{-2}] VS. Temp. InBab Al-Muddampolluted water after adsorption

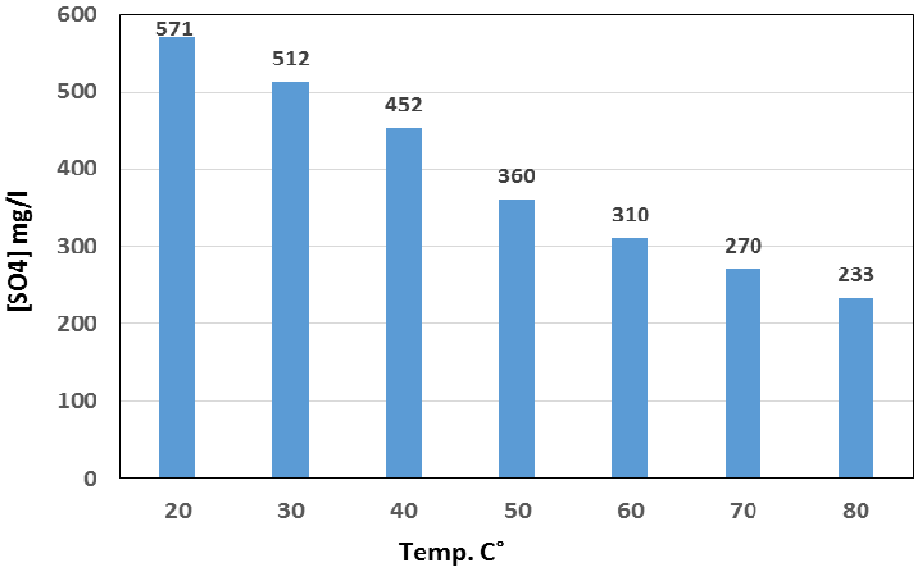


Fig. (10) [SO_4^{-2}] VS. Temp. In Al-Doorapolluted water after adsorption

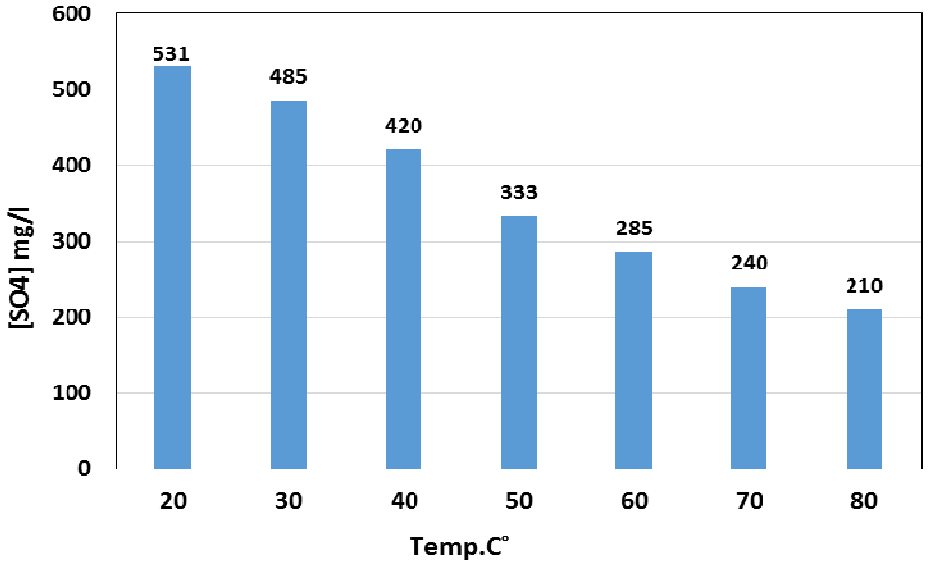


Fig. (11) [SO_4^{-2}] VS. Temp. In Al-Kademiyahpolluted water after adsorption

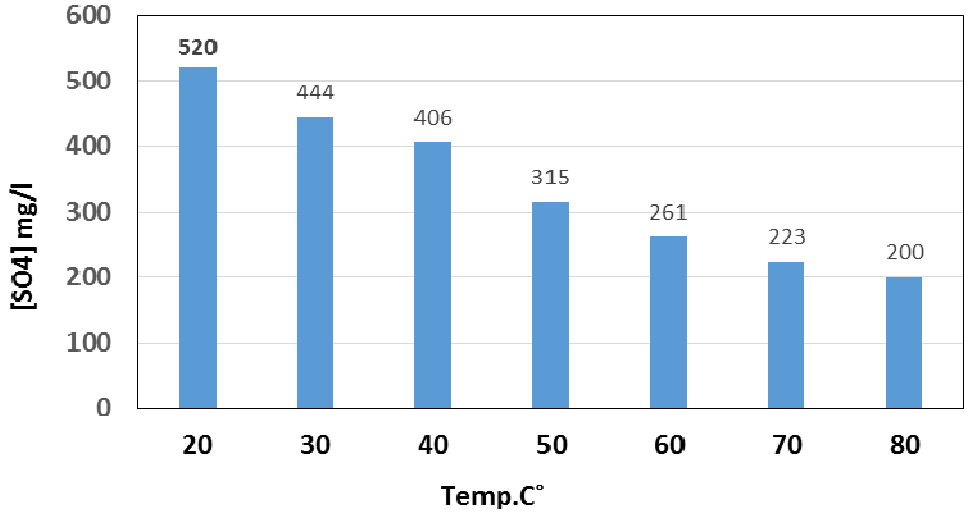


Fig. (12) [SO_4^{-2}] VS. Temp. In Al-Adamiyaholluted water after adsorption

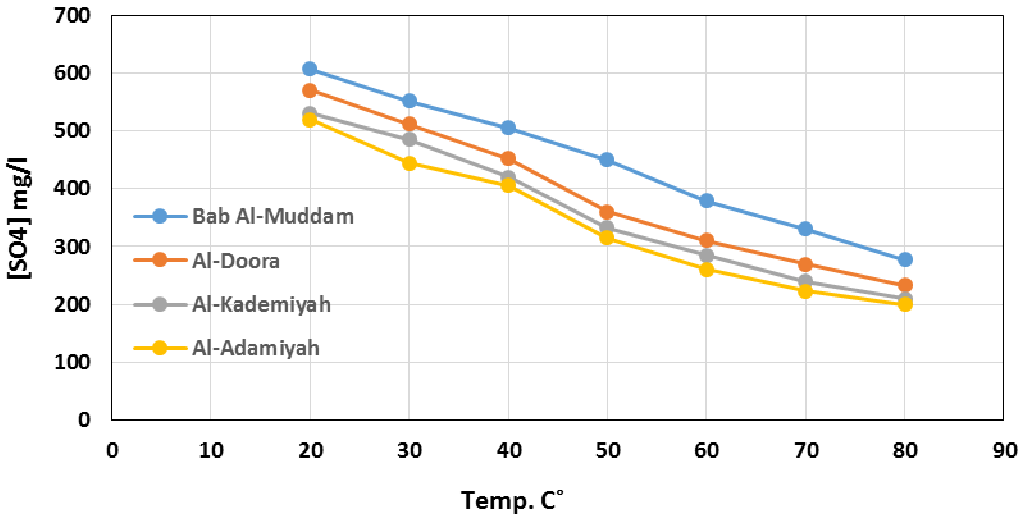


Fig. (13) [SO_4^{-2}] VS. Temp. In Four regionspolluted water afteradsorption

4.Conclusion:

This study aims to examine the effect of using tealeaves as an adsorbent material by adsorption method to minimize sulfate ion concentration in polluted water.The results can be determined the following:

- After take a sample of water that has sulfate ion, the sample was treated with Dehydrated Barium chloride to get Barium Sulfate salt and then calculate the concentration of sulfate ion by equation (2), which was unacceptable concentration. It should be as standard value between (200 - 400 mg/L).
- To decrease the concentration of sulfate ion, an adsorption method by using tealeaves as an adsorbent material was used.
- The concentration of sulfate ion was decreased gradually after each treatment by adsorption method until reached acceptable range. The contact time used as a factor that influence the adsorption process, which begins from (0 min.) Until (120 min.). The calculation was repeated after each (20) minutes.
- In addition, temperature was used as another factor that influence reducing sulfate ion in polluted water by using adsorption method with tealeaves as an adsorbent material, which was (20-80 C°) by increasing (10 C°) each time. The results after adsorption showed that the temperature has significant effect on decreasing sulfate ion concentration inpolluted water until reach acceptable range.
- The results indicated that the impact of temperature on decreasing sulfate ion concentration in polluted water was more effective than contact time, which referred to theefficiency of temperature in breakdown the ion bonds, which leads to adsorption faster and more effectively than contact time.
- In addition, using tealeaves as an adsorbent material was affected because it is available, low cost and recycled in treatment process material.
- The study showed that the sulphate ion concentration in polluted water for four regions was minimized gradually from the high ion concentration in Bab Al-Muddam, Al-Doora, Al-Kademiyah and Al-Adamiyah respectively to the acceptable range that mentioned before after adsorption process by using tealeaves as an adsorbent material.

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