International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Comparison of Removal of Chromium by using Natural and Chemical Adsorbents

Dr. Ali Taherabdollah[1], Dr. Mustafa Abdullah[2]

[1]Faculty of Science, University of Zawia, Libya

[2]Faculty of Science, University of Sabha, Libya

Abstract: ***Chromium represents one of the most toxic contaminants. The Chromium is present only in two valences, Chromium (+III) and Chromium (+VI). Both of them are pollutant and have been proved to be harmful to fauna; flora, human beings and waters containing Chromium are extremely hazardous. Natural and chemical adsorbents were used in two separated studies for removal of Chromium from ten collected drinking water samples. The natural absorbents are clay minerals such as Kaolinite, Montmorillonite, Illite, Chlorite, and Vermiculite whereas four different chemical compounds were used such as aluminum Oxide, silicon oxide, mercaptans and carboxylic group. Two special methods were performed: A. S. T. M, which is a UV visible Spectrohotometric procedure and Atomic absorption method. Different approaches for the separation of water in low concentration Chromium have been investigated. Parameters such as, effect of pH, effective contact time and effect of mass were investigated and determined. The results of both studies allow us to compare between the different used approaches. Both natural and chemical compound absorbents display a very good result of removing chromium from the investigated drink water samples, but the natural adsorbents have a higher sorption potential, which ranges from 37 to 68%. The maximum amount of Chromium adsorbed was at 1g weight and pH 2. Chemical compound adsorbents show a less sorption potential for the hexavalent Chromium at pH 2 and the mass was in 1gram of adsorbent. The quantity of adsorbed Chromuim ranges from 0.5 to 55%. Based on our results in both studies, we prefer the natural adsorbents because they are efficient, safe, nonflammable, odorless, non - soluble, non - corrosive materials and as low cost adsorbent materials.***

Keywords: Adsorption, Clay mineral, Chromium, Natural adsorbents, Chemical compounds

1. Introduction

Chromium is main environmental pollutants and has been documented to be harmful to fauna, flora, and human being. Two valence states, trivalent chromium, Cr (III) and hexavalent chromium, Cr (VI). Chromium (III) is considered to be an essential dietary element to the human and mammals, while Chromium (VI) is highly toxic and possesses mutagenic and carcinogenic activity. (Nomanbhay and Palanisamy 2005; Sarin and Pant 2006).

The World Health Organization (WHO) considers Chromium in drinking water more than 0.05 ppm as a major risk to human health and has issued limits that are defined differently in the laws of individual states [1]. Chromium is an odorless and tasteless metallic element. The most common forms of Chromium that occur in natural waters in the environment are trivalent chromium (Chromium - III), and hexavalent Chromium (Chromium - VI [1].

Chromium is an odorless and tasteless metallic element. The most common forms of Chromium that occur in natural waters in the environment are trivalent chromium (Chromium - III), and hexavalent Chromium (Chromium - VI [1]. Chromium is used in industries such as electroplating, leather tanning, paints, and pigments etc., and has the potential to contaminate drinking water sources [2]. Chromium contamination of water originates from a number of natural and industrial sources. In Libya the major sources of Chromium are the oil, petrochemical, chemical and cement industries. Cements additionally were used in enormous quantities in construction a huge pipes (Manmade River Project) that carry the water from south to the major northern cities in for domestic uses [3].

The chemical and petrochemical industries are the main activities of the Libyan economy. These activities make Chromium one of the most hazardous pollutants that threaten the Libyan environment [3].

In the last decades, different methods of Chromium adsorption using the natural adsorbents such as Clay minerals have received more attention because they are more promising and safe comparing to other alternative methods such as Ion exchange, membrane techniques and high performance liquid and gas chromatography. Clay minerals are defined as hydrous aluminum silicates. Petrographically they are the main components of shale sediments. Clay minerals are final products, which are produced mainly from erosion of sedimentary and non - sedimentary rocks [4].

The small size, the flaky shape and their unique crystal structures give clay materials special properties such as swelling behavior, cation exchange capacity, plastic behavior when wet, catalytic abilities, and low permeability. All these specific properties have made clays excellent adsorbent materials [6].

The importance of clays and clay minerals was known for thousands of years ago. The ancient Egyptians had used clays as raw materials for their houses while the Romans used clay materials as a building material. Now a day beside their numerous uses in different industries, their use in ceramic industry is of great importance since ceramics resist high temperatures as well as corrosion [5].

Recently they are used to treat chemical wastes because of their cation - exchange capabilities and as adsorbents with long term structure stability. In order to achieve the main target, the clay minerals were used are Kaolinite, Montmorillonite, Illite, Chlorite, and Vermiculite. These natural adsorbents were collected from the south of Libya [5]. In this study selective removal of toxic Chromium from the liquid phase using natural adsorbents based on silica are investigated.

2. Material and methods

2.1 Collection of samples

All natural adsorbents (clay materials) were collected from different areas in Libya (Sabha, Tamenhint and Yefren cities). They were kept in plastic - stopper bottles. All the natural adsorbents were dried out and were grinded in mortar and passed through 20 – 50 mµ standard sieves. The weighed mass of the grinded adsorbents were dried step by step in the dryer at first for two hours at 60° C then for two hours at 100° C and then left to dry overnight at a temperature of 100°C. The natural adsorbents were divided into 0.20, 0.40, 0.50, 0.60, 0.80, 1.0 and 1.2 g weight samples. Chemical compounds were prepared in the chemistry labor.

2.2 The standard solution of Chromium was prepared as the following:

The stock solution of chromium (100mg/l) was prepared, several different concentration were taken from the stock solution. In order to determine the total chromium in each investigated water samples. Two special methods were performed: A. S. T. M, which is Atomic absorption method used to determine the total chromium and UV visible spectrophotometer for the determination of hexavalent chromium. Different water samples were collected from different places which are near to the chemical and petrochemical complexes

3. Results and Discussion

The Chromium removal was investigated by using natural and chemical adsorbents under different conditions and parameters for examples effect of absorber size and mass in addition to the effect of the pH value and effective time in order to reach the maximum sorption potential.

3.1 Effect of the pH

The pH of the aqueous solutions is a significant parameter that affects the adsorption of Chromium on a chemical compounds surface. The effect of pH on the adsorption efficiency of Chromium was studied in different pH values Figs (1 and 2).

The results indicated that adsorption of Chromium was influenced by the pH of the solutions. The amount of percentage of Chromium removal by using natural adsorbents were increase with decrease of the pH values Fig.1, while the amount of percentage of Chromium removal by using chemical compound adsorbents were increase also with decrease of the pH values as it has been shown in Fig 2.

Based on our investigations it's not surprising that, the results indicated that adsorption of Chromium was influenced by the pH of the solutions.

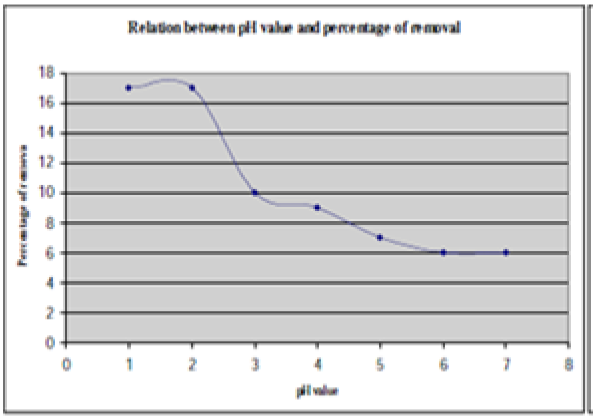

Figure 1: Effect of pH on the amount of Chromium adsorption process

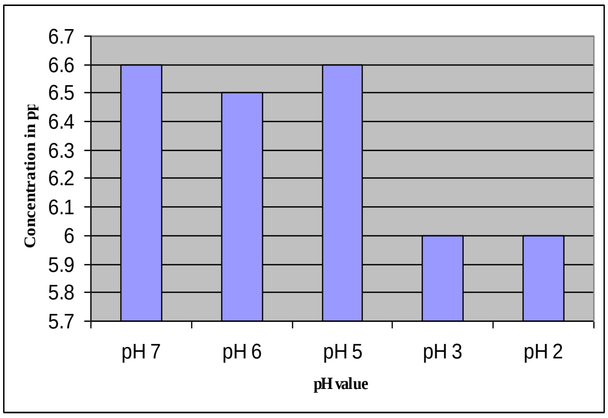

Figure 2: Effect of pH on the amount of Chromium adsorption process

3.2 Effect of mass

The mass has a clear effect of the adsorbent load on the removal of Chromium has been shown in Figs. (3 and 4), which shows that, the percentage of removal of Chromium in case of use of chemical compouns as adsorbent increase gradually with the increasing in adsorbent load, the maximum removal was reached at 1.0 gram of the chemical compounds.

Based on Fig.3 we can say that only the Aluminum oxide from the chemical compounds gives higher results in comparison to others chemical compounds such as silicon oxide adsorbents.

Fig.4 shows at low loading of natural adsorbents the amount of removal of Chromium was very low and it increases proportionally with the increase of amount of loading. The maximum percentage of removal was reached at 1.0 g of adsorbent weight.

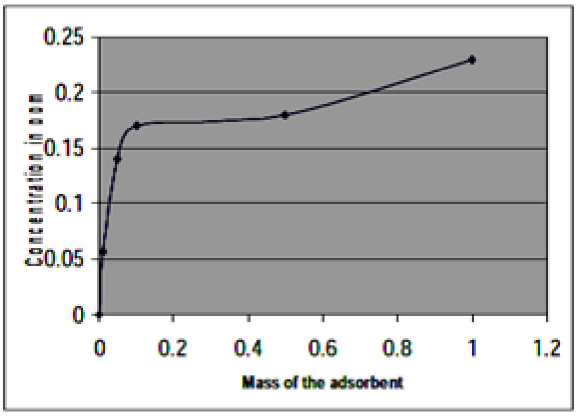

Figure 3: shows the relationship between the mass of the used adsorbent clay from Sabha area and the initial Chromium.

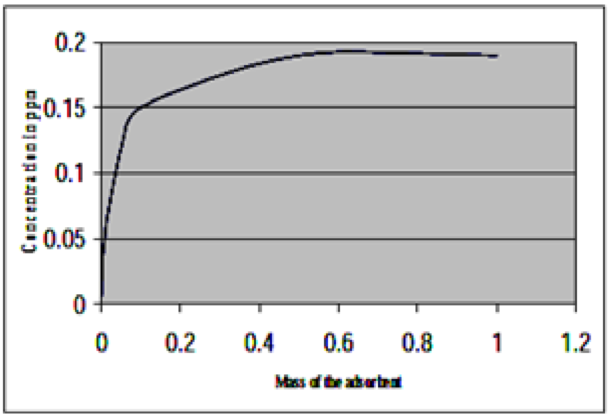

Figure 4: Effect of adsorber dose on the amount of adsorbed Chromium by using natural adsorbents collected from Yefren.

3.3 Effect of contact of time

The contact time is one the effective factors in the adsorption process, and it is essential to evaluate the effect of contact time required to reach equilibrium. It is clear from Fig.5 that, the adsorption capacity of Chromium by two different natural adsorbents increases as the contact time increases and reached the equilibrium state within 24 hours from the start. This means that, in both adsorption tests, it was possible to determine the equilibrium situation in each case respectively (Fig.5). Partial steps of adsorption speed determination illustrate that, at the start of the experiments the speed of adsorption process and the load of the natural adsorbent increases proportionally with the time. The two resulted adsorbent curves run parallel to each other and build a linear relationship (Fig.5). The linear relationship indicates that, the equilibrium is already has been taken place. Based on the drown trend lines in Fig.8, it can be concluded that, the rate of adsorbed Chromium by using the adsorbent number 2 is more higher in comparison to same rate of the adsorbed Chromium by using the Adsorbent number 1. Our interpretation for the clear difference between the two used adsorbents is the ion exchange process capacity of the adsorbent 2 is more greater than the adsorbent 1 the adsorbent 2 is able to adsorbed more Chromium from the any solution in a relative short period in comparison to the adsorbent 2.

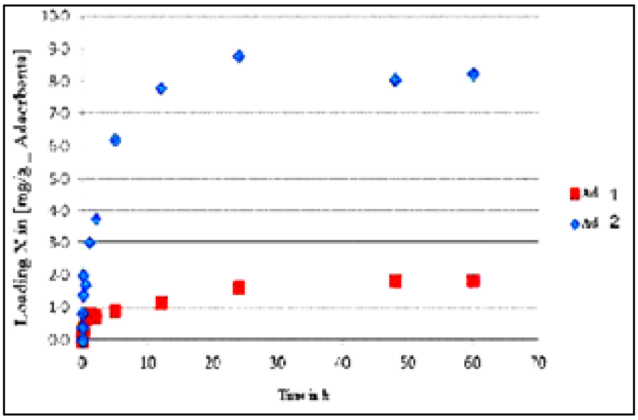

Figure 5: Exhibits the development of the adsorbents loading, depending on the time of contact

4. Conclusion

The present study of adsorption of hexavalent chromium characterized prosopisspicegera as an efficient chemical compounds adsorbent for the removal of toxic hexavalent chromium from the drinking water the adsorption of hexavalent chromium was found to be dependent on the pH value and the amount of adsorbent, am find the maximum of removal of hexavalent chromium was observed at pH 2 and the mass was in 1gram of adsorbent. The chemical compound as silicon oxide giving about 15% of removal fig 6. Also another chemical compound were used as aluminum oxide giving about 55% of removal fig, mercaptan and carboxylic group for the removal of hexavalent chromium the aluminum oxide is the best one for removal and gives more than of the adsorbents loading, depending on the time of contact.

Our experimental data shows the visibility of the partial use of the natural adsorbents as a low cost adsorbents for the completely removal of Chromium from the drinking water. We can use the aluminum oxide as the best chemical compound to be uses as good chemical adsorbent. That means the chemical compounds we can used to remove big amount of hexavalent chromium from the drinking water to keep it safer from the heavy metals only the disadvantages is very expensive to used.

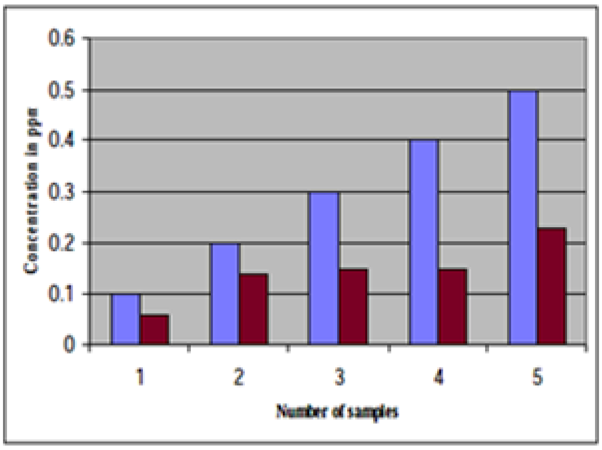

Figure 6: Percentage of removal Chromium by using the Clay from Yefren city/Libya

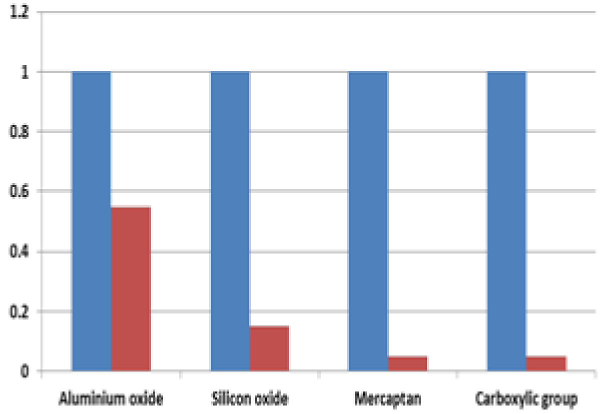

Figure 7: Percentage of removal Cr (VI) by using chemical compounds

References

[1] Mahmoud Elsallay, 1986. Ground water between the oretical and abblication" Arabicedition, AlDarof Jamahiriya, Libya, 13.
[2] Sharma, Y. C. (2001). Adsorption of Cr (VI) on to Wollastonite: Effect of pH", Indian Journal of Chemical Technology, 8, 186.
[3] John M. Maher, Richard P. Beatty, N., John Cooper 1982. Preparation of Dlanlonlc Carbonyl Complexes of Molybdenum and Tungsten. Organometallic, 1, 1, 215 - 217.
[4] Vereinigten Nationen, Bundesministerium fürwirtschaftliche Zusammenarbeitund Entwicklung, "2011 [Online]. Available: http: //www.bmz. de/de/publikationen/reihen/sonderpub likationen/ Millenniums_Entwicklungsziele_Bericht_2011. pdf. [Zugriffam16Juni2012].
[5] Bailcy, S. E., Olin, T. J., Bricka, R. M. and Adrian, D. D. (1999). A review of potentially low – cost sorbents for heavy metals, WaterRes.33, 2469 - 2479.
[6] Bhattacharyya, K., S. S., Gupta, "Adsorption of Chromium (VI) fromWaterbyClays.2006. Iing. Chemistry Research, **45**, 21, 7232 - 7240. doi: 10.1021/ie060586j