SEPARATION OF Ca (II) AND Mg (II) METAL ION UNDERGROUND RIVER WATER IN BARON WITH ACTIVATED AND INACTIVATED ZEOLITE BY FIXED BED COLUMN ADSORPTION METHOD

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Abstract

This research aims are determine the optimum condition in separation of Ca(II) and Mg(II) metal ion include flow rate variation and zeolite type treatment and to study the efficiency of zeolite adsorption of Ca(II) and Mg (II) metal ion underground river water in Baron.

The subject of this research is Ca(II) and Mg(II) metal ion. The object in this research is separation of Ca (II) and Mg (II) metal ion underground river water in Baron. The independent variable are flow rate nd zeolite type treatment. The independent variable is efficiency of zeolite adsorption of Ca (II) and Mg (II) metal ion. Method that used is fixed bed column adsorption with a flow system in which sample is applied to the filtration tube containing zeolite with flow rate from bottom to up. Initial and final concentrations of the samples were analyzed using AAS instrument.

The results obtained shows thatCa(II) metal ion optimum condition of flow rate 0.33 L/menit and activated zeolite.SementraaMg(II) metal ion optimum condition of flow rate 0.33 L/menit and inactivated zeolite.The efficiency adsorption of Ca(II) metal ion from underground river water in Baron was obtained in optimum condition is 88.819%. The efficiency adsorption of Mg(II) metal ion from underground river water in Baron was obtained in optimum condition is 84.72%.

Key words: adsorption efficiency, flow rate optimum, Ca (II) and Mg (II) metal ion.

A. INTRODUCTION

Water is the most important thing in life. Living beings on this earth can not be separated from the need for water. The water is relatively clean highly coveted by humans, both for daily living, for industrial purposes, for the city sanitation hygiene, as well as for agriculture and onther purposes. Major sources of water used for human purposes is derived from surface water, rain water and ground water. The third source of the water that humans are more widely used because ground water quality is better than other water sources [1].

Metals contained in the water are found in the form of compounds such as salts of organic and inorganic. Exposuretometalsin the bodycan be dangerous if it is in an amount exceeding the normal threshold. Ionic form of the compound salts into the body where it will be absorbed and then dumped in the bodies of living organisms. Problems arise when them etalenters the body in excessive amounts in quite a long time to leave the toxic properties [2].

Water that contains elements of magnesium and calcium is known as hard water. In general, total hardness of water containing less than 200 mg/L may still be allowed to be consumed by the consumer but the water classified as poor water sources whereas if the source water contains the value oftotal hardness of 500 mg/L, the water un fit for consumption. Hard water contains a lot of divalentions such as iron, manganese, calcium and magnesium. Some of these metals has been known that calcium and magnesium are the most metal species in hard water [3].

Some cases the water hardness can cause some problems and can be considered as well as aesthetic parameters. Hard water is used for washing difficult because magnesium compounds contained in hard water can react with soap to form sludge and prevent the formation of foamin water[4].

Adsorption method has been proven as an economical alternative methods in the separation of metals in water[5]. Adsorption is aphenomen on that occurson the surface, so that the extent of substance adsorbed depends on the surface area of the adsorber substances. Adsorption is done with the addition of the adsorbent, activated carbonorthe like. The adsorption system can be divided into two kinds of batch and continuous systems(column) [6].

This study used zeolite as adsorber substance as zeolite shave been widely

used as an adsorbent because of its ability to separate species-target species through ion exchange principle[7]. Zeolite shave a very regular crystal shape with interconnected voids any direction that causes the zeolite surface area is very large so it is best used as adsorbents[8].

Zeolite activation process can be done in physics and chemistry. Activation is expected to improve the efficiency of adsorption of zeolite because of the physical and chemical activation had a go a leach. Analysis of the metal content of magnesium and calcium was performed using atomic absorption spectrophotometer. Selection of atomic absorption spectrophotometer method because it has high sensitivity, easy, inexpensive, simple, fast, and it takes a little foot age and does not require a preliminary separation.

This study aims to determine the optimum conditionsin the separation of metal ions Ca(II) and Mg(II) is the variation of flow rate and type of zeolite treatment, and to determine the efficiency of the zeolite adsorption of metal ions Ca(II) and Mg(II) in river water Baron underground method adsorption column.

B. MATERIALS AND METHODS

The tools used in this study is a glass tools, tube separator, analytical balance, muffle furnace, oven, stopwatch and atomic absorption spectrophotometer. The materials used are natural zeolite, Crystal $MgCl_2.6H_2O$, $CaCl_2.2H_2O$ and distilled water. The working procedure is performed:

1. Preparation of zeolite adsorbent.

Zeolites are not activated or activated first washed with aquadest and then dried in an oven at a temperature of 100^0C. Activated zeolite to be activated chemically and physically. Chemical activation by soaking using 0.1 M HCl solution for 1 hour and activation in physics is calcined in a muffle furnace at a temperature of 400 ^{0}C for 4 hours.

2. Standard Solution Procedure

Standard solutions used are $CaCl_2$ and $MgCl_2$. To make as tandard solution of 0 ppm, 0.2 ppm, 0.4 ppm, 0.6 ppm, 0.8 ppm, and 1.0 ppm initially made standard solutions of $CaCl_2$ and $MgCl_2$ crystal $CaCl_2.2H_2O$ and $MgCl_2.6H_2O$ with a concentration of 100 ppm after dilution. The absorbance was measured at each concentration using atomic absorption spectrophotometer with a wavelength of 422.7 nm to 285.2 nm metals Ca and Mg to

the metal so it will obtain a calibration curve.

3. Determining Optimum Conditions of Separation ions Ca(II) and Mg(II)

The optimum condition interaction optimization is carried out by means of a variable flow rate zeolite as adsorbent interactions with ions of calcium and magnesium in solution simulating Ca^{2+} and Mg^{2+} 100 ppm with zeolite activated and not activated at a flow rate of 0.33 L / min, 1.88 L / min and 3.67 L / min.

4. Absorption of Metal IonsCa(II) and Mg(II) In the Underground River Water Samples Baron

The process of absorption of calcium and magnesium metal ions in water samples underground river Baron performed at the optimum conditions that have been done in the previous step is not activated zeolite at a flow rate of 0.33 L / min. The absorption process is done in a way not activated zeolite encounters with underground river water samples Baron at a flow rate of 0.33 L / min.

C. RESULTS AND DISCUSSION

1. Mg (II) metal ion

The first treatment is activated zeolite with 0.1 M HCl and calcination at temperature of 400 ^{0}C.

The results obtained shows that separation of Mg (II) metal ion iptimum condition of flow rate 0.33 L/menit and inactivated zeolite.

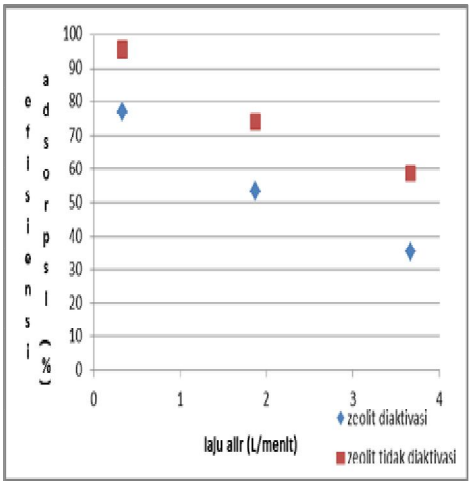

Figure 1. Efficiency of adsorption Mg metal on activated zeolite and inactivated zeolite

The graph shows that adsorption efficiency at inactivated zeolite greater than activated zeolite because on the surface of activated zeolite have a siteH^+ that used to adsorb Mg^{2+} metal ion. Site of H^+ on the surface of activated zeolite has the same charge with Mg^{2+} metal ion, it will happen repel.

This resulted in the disruption repel ion exchange and adsorption of the metal ions Mg^{2+}. Thus, only a few metal Mg^{2+} that can be absorbed by activated zeolite which affects the efficiency of adsorption by activated zeolite was also lower [9].

Adsorption occurs because ion exchange mechanism, ion on the surface exchanged with other ions from solution. Ion exchange process takes place as a result of differences in binding affinity between cation on the adsorbent surface with cation from solution. H^+ ions on the surface of the zeolite can be replaced by the position of the Mg^{2+} ion from solution because binding affinity for Mg^+ ions is greater than H^+. Cation binding affinity of the adsorbent depends on the cationic charge and ionic radius of hydrated cations. The greater the ion charge or hydrated ionic radius of the cation binding affinity are also getting bigger[10].

Flow rate also affects the adsorption of metal ions $Mg\ 2^+$. Based from the graph in Figure 1 it can be seen that the optimum adsorption produced at flow rate of 0.33 L / min either on activated zeolite or inactivated zeolite. This flow rate is related to the contact time of zeolite with a standard solution

At a flow rate of 0.33 L / min, standard solution to be missed experience a longer interaction with the zeoliteso that more metal ions Mg^{2+} that can be adsorbed by the zeolite. The efficiency adsorption of Mg(II) metal ion from underground river water in Baron was obtained in optimum condition is 84.72%.

2. Ca (II) metal ion

The interaction between the zeolite with a solution of simulated Ca (II) shows the optimum results in the zeolite activated. Here are the results of the adsorption efficiency of zeolite.

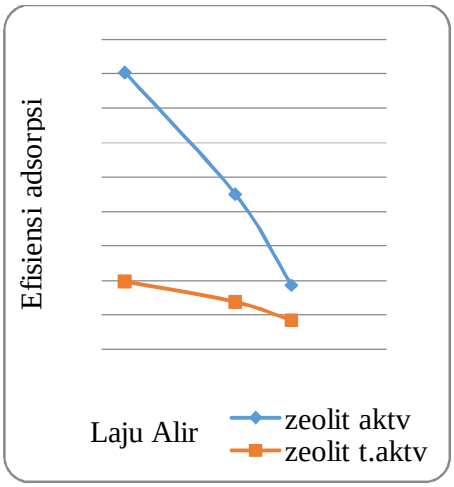

Figure 2. Efficiency of adsorption Ca metal on activated zeolite and inactivated zeolite

Graph between flow rate and efficiency of adsorption showed that the activated zeolite have the results adsorption efficiency better, because the activation of natural zeolite with acid treatment led to increased value of Si / Al ratio, the value of acidity, as well as surface area. Zeolite adsorption of the metals Ca greater because of higher value chemical and physical character and reduced metal impurities from the

activated zeolite. The acid contains many minerals that will lead to Al in the zeolite structure will be separated form the hydrogen zeolite and open channels of zeolite structure. Hydrochloric acid solution can be cast out of aluminum in the zeolite framework as hydrochloric acid can react with aluminum [11]. The release of Al forming hydrogen zeolite is dealumination. Dealumination process is the release of Al from the site of Si-O-Al cause realignment of Si-O-Si from outside the frame, thus causing the amount of Si in the framework increases. So the value of Si / Al ratio will increase zeolite adsorption power of the Ca^{2+} [12].

Flow rate is related to the interaction time simulation solution standard. The smaller flow rate, the metal ions adsorption capacity of greater [13]. At a flow rate of 0.33 L / minute, the flow is flowing relatively smaller because the faucet is open only slightly. Optimization results obtained by the use of activated zeolite at a low flow rate. Application of the results of the simulation solution of the optimization of underground river water Baron Beach shows the adsorption efficiency of 88.819%.

C. CONCLUSION

Based on the research and discussion that has been done, it can be concluded that:

1. Optimum conditions in the separation of metal ions Ca (II) was at flow rate of 0.33 L / minute and activated zeolite. The efficiency of adsorption on the underground river water samples Baron at the optimum conditions was 88.819%.
2. Optimum conditions in the separation of metal ions Mg (II) was at flow rate of 0.33 L / minute and was inactivated zeolite. The efficiency of adsorption on the underground river water samples Baron at the optimum conditions was 84.72%.

REFERENCES

1. Thomas Triadi Putranto. (2011). Pencemaran Logam Berat Merkuri Pada Air Tanah. *Jurnal Teknik*. 32(1): 62-71.
2. Darmono. (1994). *Logam Dalam Sistem Biologi Makhluk Hidup*. Jakarta: UI Press, Hal 65.
3. M. Yan, D. Wang, & J. Ni. (2008). Effect of polyaluminum chloride on enhanced softening for the typical organic-polluted high hardness North-China surface waters. *Journal of Purification and Technology*. 62(1): 401-406.
4. Mohammad Noori Sepehr, Mansur Zarabi, & Hossein Kazemian. (2013). Removal of Hardness Agents,

calcium and magnesium, by Natural andAlkaline Modified Pumice Stones in single and binary systems. *Journal of Applied Surface Science*. 274(1): 295-305.

5. Zahra Saadi, Reyhane Saadi, & Reza Fazaeli. (2013). Fixed-bed adsorption dynamics of Pb (II)adsorption from aqueous solution using nano structured γ-alumina. *Journal of Nano structure in Chemistry*. 48(3). 1-8.
6. Anita Nurfitriyani, Eka Wardani, & Mila Dirgawati. (2013). Penentuan Efisiensi Penyisihan Kromium Heksavalen (Cr^{6+}) Dengan Adsorpsi Menggunakan Tempurung Kelapa Secara Kontinyu. *Jurnal Teknik Lingkungan Itenas*. 2(1): 1-1
7. Zurida Agustiningtyas. (2012). Optimasi Optimasi Adsorpsi ion Pb(II) Menggunakan Zeolit Alam Termodifikasi Ditizon. *Skripsi*. Institut Pertanian Bogor: Jurusan Kimia IPB.
8. I Nyoman Suardana. (2008). Optimasi Daya Adsorpsi Zeolit Terhadap Ion Kromium (III). *Jurnal Penelitiandan Pengembangan Sains & Humaniora*. 2(1): 17-33
9. Bekti Yulianingsih .(2009). Daya Adsorpsi Zeolit Teraktivasi HCl Terhadap Kadar Nitrogen dalam Urin Manusia.*Skripsi*. Universitas Negeri Yogyakarta: Jurdik Kimia FMIPA.
10. Adel Fisli., Saeful Yusuf, & Deswita. (2006). Pengaruh Homokation Permukaan Bentonit Terhadap Penyerapan Kation Cs dan Sr. *Jurnal Sains Materi Indonesia* : 206-210.
11. Eddy Heraldy, Hisyam S.W, Sulistiyono.(2003). Karakterisasi dan Aktivasi Zeolit Alam Ponorogo. *Indonesian Journal of Chemistry. 3(2): 91-97.*
12. Mia Ratnasari dan Nurul Widiastuti.(2011). Adsorpsi Ion Logam Cu(II) Pada Zeolit A yang Disintesis Dari Abu Dasar Batubara PT. Ipmomi Paiton dengan Metode Kolom. *Prosiding Seminar Nasional Kimia Unesa*. Surabaya: ITS. Hal B120-B125.
13. Didi Supriyadi. (2002). Aktivasi Zeolit Alam sebagai Absorben Zat Warna pada Proses Pemurnian Minyak Kelapa.*Skripsi*. Yogyakarta: FMIPA UNY.