DESALINATION OF SEA WATER USING ACTIVATED ZEOLITE BY CLORIDE ACID IN TROPICAL AREA BASED ON COLUMN ION EXCHANGE METHOD

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Abstrack: The main objective of this study is to reduce the content of salt in the sea water. Zeolite is material which applied by ion exchange method. Activation of zeolite is significant process which making pores of zeolite can accerelate the adsorption. This research used two size of zeolite which were 40 and 100 mesh. Zeolite can be activated using chloride acid. The highest concentration chloride acid can reduce salinity of sea water greater. This happens because the highest concentration of the reactant has stronger binding power so that the particles in the zeolite can absorb quickly. Based on parameters test of salinity of sea water confirmed the zeolite activated (ZA) with 100 mesh can be used as fresh water because its pH 6.25, tasteless, odorless, colorless, and value of turbidity is lower than 0.29 which is looks like fresh water. These properties have suitable for clean water for widely consumption of people.

Keywords: Desalination, sea water, zeolite, ion exchange.

Abstrak: *Tujuan utama dari penelitian ini adalah untuk mengurangi kandungan garam dalam air laut. Zeolit adalah bahan yang diterapkan dengan metode pertukaran ion. Aktivasi zeolit adalah proses signifikan yang membuat pori-pori zeolit dapat mempercepat adsorpsi. Penelitian ini menggunakan dua ukuran zeolit yaitu 40 dan 100 mesh. Zeolit dapat diaktifkan menggunakan asam klorida. Konsentrasi tertinggi dapat mengurangi salinitas air laut yang lebih besar. Ini terjadi karena konsentrasi tertinggi reaktan memiliki daya ikat yang lebih kuat sehingga partikel-partikel dalam zeolit dapat menyerap dengan cepat. Berdasarkan uji parameter salinitas air laut ditunjukkan bahwa zeolit teraktivasi 100 mesh dapat digunakan sebagai air tawar karena memiliki pH 6,25, tawar, tidak berbau, tidak berwarna, dan nilai kekeruhan lebih rendah 0,29 yang menyerupai sifat air tawar. Hasil ini cocok untuk air bersih untuk konsumsi banyak orang.*

Kata Kunci*: Desalinasi, air laut, zeolit, pertukaran ion.*

INTRODUCTION

People staying around coastal area are lack of fresh water because the water there contains a high salinity. Human demand on water is significant for daily activities as every activity needs much water. However, inhabitants who live in the coastal area have issues on getting fresh water suitable for consumption because the water contains much salt and it decreases the quality of water. Water quality generally indicates the quality or condition of water attributed to a certain activity or necessity. Based on Permenkes No.416/Menkes/Per/IX/1990, what distinguishes between the quality of clean water and drinking water is maximum standard of physical, chemical, biological and radiological parameters which are allowed (Bayat, 2002). Water around the coastal area contains high concentration of salt resulting on inability to be used. Therefore, it is imperative to make an effort to reduce salt content in the water.

Sea water can be used when it contains low salt. The average salt content in sea water is 3.5% which means that in 1 L of sea water there is 35 grams of NaCl. Sea water has a salt content because the earth is filled with mineral salts contained in rocks such as sodium, potassium and calcium. When the river water flows into the oceans, it brings salt. The ocean waves that occur on the coast also produce salt in the rocks. The solutes include inorganic salts while organic compounds are derived from living organisms and dissolved gases (Charcosset, 2009). Sea water consumption is possible it merely consists of low level of salt.

Seawater desalination refers to the removal of salts and minerals to produce fresh water. Most of the water available on earth has the salinity up to 10,000 ppm whereas seawater normally has salinity in the range of 35,000–45,000 ppm in the form of total dissolved salts. According to World Health Organization (WHO), the permissible limit of salinity in water is 500 ppm and for special cases goes up to 1000 ppm (Markić & Briški, 2012). Various desalination technologies have been developed such as multi-stage flash distillation (MSF), multiple effect distillation (MED), vapor compression distillation (VCD), reverse osmosis (RO), and electro dialysis (ED) (Wibowo et al, 2015). These technologies were able to produce fresh water with high level of pureness. However, the operation cost of these technologies is still considered expensive, so it is necessary to find a cheaper alternative methods.

Sorption method is supposed as prospective technique for use in seawater desalination. Sorption method is interesting due to its simplicity and high efficiency (Günay, 2007). Furthermore, the availability of a wide range of sorbent materials make sorption method is potential developed as cost-effective model (Komosinska et al, 2015). A number of sorbent material such as carbon active (Günay, 2007), fly ash (Eltawil et al,2009), clay (Al-Anber & Al-Anber, 2008) and natural zeolites (Azis, 2008) have been used in sorption systems for wide range application. Natural zeolites are considered as low-cost sorbent material with abundant availability (Bleiman & Mishael, 2010). In addition, it gained a significant interest due to their valuable properties such as ion-exchange (Kumar et al, 2010), high sorpsibility for inorganic and organic ions, ease of activation and regeneration as well as non-toxic material (Permenkes, 1990)

Natural zeolite is one of materials which can be used to decrease the presence of salt in the water. It is a hydrated alumina silicate compound with the main element consisted by cation alkali and soil alkaline (Setyawan, 2002). Utilizing of zeolite can be maximized by the activated zeolite. Activation of zeolite is a process to increase adsorbing capacity to obtain suitable properties. Zeolite can be activated

by acid such as chloride acid (HCl). The purpose of zeolite activation is to produce a wider surface area through the formation of porous structures, the elimination of impurity compounds which are contained in the zeolite and the rearrangement of the location of the interchangeable atoms (Inglezakis et al, 2016). Natural zeolite that has been activated with chloride acid has higher adsorption power because the mineral acid reacts with components such as Ca and Mg salts to cover the pores of adsorbent. Al-Anber et al. have reported utilization of natural zeolite as ion-exchange and sorbent material in the removal of iron.

The current work is aims to decrease the presence of salt in the sea water. Zeolite which is activated by chloride acid mixes with sea water for determining the salinity value using conductometric instrument.

EXPERIMENTAL

Activation of zeolite with Chloride Acid

Approximately 50 grams of natural zeolite were mixed with 500 mL of HCl solution with concentrations of 0.2, N 0.6 N and 1 N. The mixture was heated while stirring for 1 hour to boil. The mixture is then cooled, filtered using filter paper and washed with aquades to pH 6-7. The residue is dried in a kiln at a temperature of 300^{o}C for 1 hour. The ion exchange and the zeolite adsorbent are used to decrease the salinity of seawater by ion exchange. The same treatment is carried out 100 mesh sieve.

Sea Water with Acidated Zeolite Acid by Column Method

In the treatment of water contact time zeolite which has been activated with HCl must be known value of salinity of sea water using conductometric. Then, active zeolite 15 grams inserted into the column and then add 500 mL of sea water, filtering by using filter paper produced in the form of fresh water then measure the salinity decrease by using the conductometrel. Then measure the pH of fresh water. After that measure of turbidity. The same treatment of the zeolite with 100 mesh.

RESULT AND DISCUSSION

Composition of Zeolite

Determination of zeolite mineral constituent types using X-ray diffraction (XRD) was carried out at the Tonasa Instrument Laboratory in Pangkep Regency, South Sulawesi. Zeolite changed its color from clear to grey after being mixed and heated with HCl. After 1 hour it turn of greenish yellow color. Activated zeolite have pH 6-7. The results is obtained in Table 1. The content of zeolite composition before activation of Si/Al (Si = 66.42) (Al = 13.11) is 5,066% then after activation ratio Si/Al (Si = 71.91) (Al = 12.14) is 5,923%. Ratio of Si/Al after activation increased. Its occurs because dealumination process which is the release of element of Al on the zeolite structure as a result the reform of the structure the place of Al will be filled by Si which is content of Si will be increased.

Table 1. Constituent Compound of Zeolite

Compound	Before Activation (%)	After Activation (%)
Calcium oxide (CaO)	17.92	17.43
Silicon (II) Oxide (SiO_2)	66.42	71.91
Aluminium (III) Oxide (Al_2O_3)	13.11	12.14
Iron (III) Oxide	2.24	2.04

(Fe_2O_3)		
Magnesium Oxide (MgO)	1.07	0.84
Potassium Oxide (K_2O)	1.8	1.68
Sulphate (SO_3)	0.03	0.03
Sodium oxide (Na_2O)	0.51	0.27
Linguistics Systemic Functional	8.83	8.03
Silica Modulus (SM)	4.33	5.07
Alumina Modulus (AM)	5.85	5.96
SUM	118.32	120.93

Figure 1 shows the effect of zeolite activated with 0.2, 0.6, and 1 N HCl to reduce salinity of seawater with size of zeolite 40 and 100 mesh. Salinity of sea water using a conductometer obtained 15%. The result showed that The highest concentration can reduce salinity of sea water greater. This happens because the highest concentration of the reactant has stronger binding power so that the particles in the zeolite can absorb quickly. The zeolite has small pores and large surface area can accelerate the adsorption.

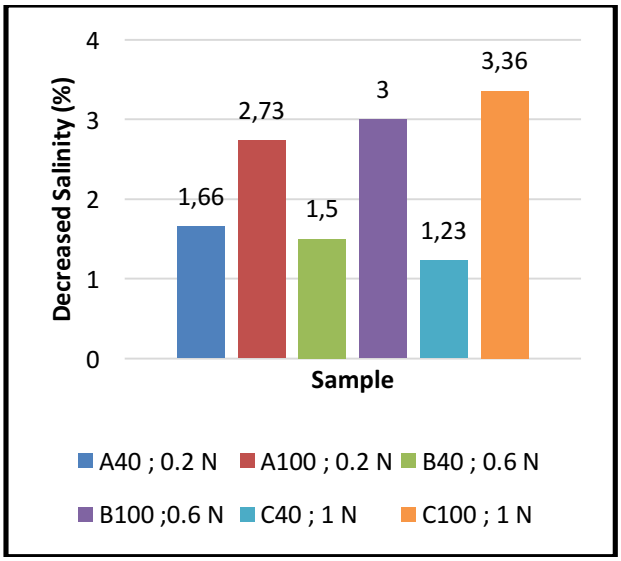

Figure 1. Desalination of seawater using activated zeolite by HCl at 29.3°C with initial salinity of 15%.

Based on the table 2, it can be seen that activated zeolite of 100 mesh had pH of 6.25. 40 mesh zeolite had pH of 3.54; pH of 40 mesh zeolite and 100 mesh zeolite without activation were 3.26 and 4.56, respectively. The activated zeolite of 100 mesh indicates tasteless water because according to the theory, threshold values of freshwater were pH of 6 to 8.5. Based on regulation of Health Minister Number: 416/MEN.KES/PER/IX/1990, the result is appropriate. pH obtained below the maximum allowable value, 6.5-9. Then the turbidity test of zeolite 100 mesh had a very low turbidity of 0.29 ntu, while the turbidity value of 40 mesh zeolite was 1.66 ntu; without activation of 40 mesh is 2.13 and without activation of 100 mesh is 2.03. Therefore, it can be concluded that the 100 mesh of zeolite has a very low turbidity compared to other sizes. In taste, smell and color tests for zeolite of 40 mesh and 100 mesh have tasteless, odorless and colorless. It showed that the sea water after contacted with zeolite can be consumed.

Table 2. Parameters Test of Salinity of Sea Water

Test	None of Activation 40 Mesh	ZA 40 Mesh	None of Activation 100 Mesh	ZA 100 Mesh
pH	3.26	3.54	4.56	6.25
Odor	none	none	none	none
Smell	none	none	none	none
Color	none	none	none	none
Turbidity	2.13	1.66	2.03	0.29

CONCLUSION

A zeolite has been successfully used to reduce content of salt in the sea water using column ion exchange method. Chloride acid can be used to activation of zeolite as a result zeolite can accelerate the adsorption. Value of zeolite before activation has Si/Al ratio of 5.0663% and after activation Si/Al ratio of 5.9233%. In the activation zeolite size 40 mesh obtained average salinity decrease of 1.44 while and size of 100 mesh obtained 3.03.

In zeolite without activation with size of zeolite 40 mesh obtained salinity 0.74 decrease while at the size of 100 mesh obtained 1.14. Finally, desalination used zeolite can be reduced content of salt in the sea water.

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