Improving zeolite power of pahae natural adsorption as the hydrogen filter with the addition of blood clams (Anadara Granosa) as the filler

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Abstract. The hydrogen filter based on natural zeolite Pahae with blood clams filler has been able to increase the adsorption of purification hydrogen filter through electrolysis. The purpose of adding blood clams in hydrogen based on zeolite Pahae to improve mechanical feature and maintain adsorption filter power. Before hydrogen filter is performed zeolite activation using 6% H2SO4 solution, and the blood clams were washed to have neutral pH. The variation of compositions which was 200 mesh formed in solids, at a burning temperature of 850°C was 100%: 0%, 90%: 10%, 80%: 20%, 70%: 30%, and 60%: 40. The optimum adsorption rate is at 80%: 20% by 980 ppm, and the porosity was 38%, with mechanical hardness as 98.65 N/mm², while the mixture with 60%: 40% composition has a low 726 ppm adsorption and a small porosity of 19%.

1. Introduction

Utilization of new and renewable energy sources for oil fuel substitutes is very important to develop because of the increasingly limited petroleum reserves [4]. Some alternative energy sources that can be developed are hydrogen [1]. Hydrogen is not available freely in nature must be purified from sources such as freshwater, seawater, methane and so forth [8]. Hydrogen can be an alternative energy because it has a high energy density [3]. To obtain pure hydrogen is generally done through an electrolysis process [9]. However, the process of electrolysis is generally not able to produce hydrogen optimally. Efforts are made to maximize the yield of the electrolysis by made a filter to purify the hydrogen from the modification of the Pahae natural zeolite with blood clams shell (Anadara Granosa).

The ability of the zeolite as an adsorbent because of it is highly ordered crystal structure, has interconnected cavities in all directions with a very large surface and pore area to absorb small
molecules[3]. Zeolite consists of tetrahedral [SiO4]4- and [AlO4]5- mined in nature have a lot of impurities, diverse compositions and poor crystallinity should get the activation treatment to be optimal in its application [2]. Pahae natural zeolite activation technique that has been mashed up to 200 mesh by mixed 6% H2SO4 which aims to open the pores and remove impurities on the zeolite [7]. As the nature of zeolite is dehydration of zeolite will effect the nature of adsorption. Zeolite can release water molecules from within the surface cavity causing the electric field to extend into the main cavity and will effectively interact with the molecule to be adsorbed.

Pahae natural zeolite modification with the addition of a blood clams (Anadara Granosa) to hydrogen purification filters because the blood clams shell is contained high calcium carbonate (CaCO3) capable of absorbing inorganic and organic compounds [6]. The calcined CaCO3 content can produce CaCO with large pore size.

2. Materials and Methods
The pahae natural zeolite to be used as an adsorbent is mined from Ambar village, North Tapanuli with filler of blood clams (Anadara Granosa) waste in Tanjung Pinang area of Riau Islands Province. Step of natural zeolite mixing with a blood clams (Anadara Granosa) begins with crushing treatment for the stages of chunk zeolite destroyed and then crushed with mortar. The surface of the blood clams is used first to be cleaned with running water until the dirt on the shell is removed, then dried for about a week in the sun after that in the oven at 40°C for 12 hours to remove the water content in the shell of the blood clams (anadara granosa). Treatment in refining the shells of blood clams by used a ballmil.

The next step of sieving zeolites and blood clams shell using a 200 mesh sieve. Blood clams shell powder of 200 mesh was washed with aquades before being used as an adsorbent until the pH was neutral. In addition to the zeolite also performed the activationned by immersion using H2SO4 6% for 2 hours using a magnetic stirrer. Activation with 6% H2SO4 immersion can increase the surface area and eliminate impurities contained in the adsorbent. The result of immersion of zeolite with 6% H2SO4 solution was separated by using a filter which was then washed with aquades until the pH was neutral. After the pH is neutral, the zeolite is dried by means of an oven at 100°C for 5 hours.

While the blood clams are dried at a temperature of 12 hours with a tempature of 100 °C. Zeolite and dried blood clams shell powder are ready to be molded with a square solid shape. Mixing the two adsorbents with the composition of sample I is the percentage of zeolite 100% and 0% of the shell of the total mass of 10 g.; composition of sample II that is 90% percentage or equal to 9 g of zeolite and 10% or 1 gr of shell; composition of sample III that is 80% percentage or equal to 8 gr zeolite and 20% or 2 gr of shell; composition of sample IV that is percentage 70% or equal to 7 gr zeolite and 30% or 3 gr of shell; composition of sample V that is 60% percentage or equal to 6 gr zeolite and 40% or 4 gr of shell.

The mixing process of the zeolite composition and the blood clams shell was done and mixed until homogeneous and then inserted into a rectangular molding tool with a thickness of 1 cm plate, 3 cm long and 3 cm wide with a mass of 10 gram composition and pressed using Hydraulic Press with a pressure of 3 tons for 10 minutes. Samples that have been printed using hydraulic press in the form of solids are left in open space for 1 week, this aims to avoid the cracked sample at the time of burning. Samples that have been left for a week, then burned at a temperature of 850°C for 3 hours on the oven. The activated sample was left for 1 day in oven off condition. From the activation of the resulting filter that is already in the form of solids that are ready to be test.
In Figure 2 Scheme of hydrogen purification filter adsorption application. The number in the figure 2 shows that 1) PLX program (sensor reading view), 2) Hydrogen Sensor (TGS 821), 3) PSA (Power Supply Adaptor), 4) Filter hydrogen purification, and 5) Electrolyzer.

3. Results and Discussion

3.1 Hardness Test

Hardness test with Vickers method, aims to determine the hardness of a material in the material resistance to the diamond indentor is quite small and has a pyramid-shaped geometry shape. The hard value of Vickers microstructure is the divide between the maximum static press load and the penetrator area.

Test of filter hardness that is activated at 850°C with 100% or 10 gram zeolite composition has mechanical hardness of Hardness Of Vickers test of 52.31 N/m². Addition of shellfish filler shells affect the rise of mechanical hardness properties. In the composition of 80% or 8 gram zeolite with 20% or 2 gram of blood clams shell, it has an optimum mechanical hardness of 98.65 N/m². However, the addition of a shellfish filler shell with a composition of 70% or 7 g zeolite and 30% or 3 gram blood clam shell has decreased mechanical hardness properties to 50.52 N/m². Composition with mechanical hardness properties at 60% or 6 gram of zeolite composition and 40% or 4 gram 48.10 N/m² shell clams. This is because the Ca content of CaCO₃ filters that have been compacted increases the higher mechanical hardness.
3.2 Porosity Test
Porosity is defined as the ratio between the amount of pore volume (the volume of free space) in a solid with the total volume amount of a solid.

![Figure 3](image3.jpg)

**Figure 3.** Graph Relation Between Composition and Porosity Level

The results of data analysis on porosity test showed the highest porosity percentage was shown in the third sample of zeolite composition 8 gram and 2 gr gram shells and the lowest in composition of zeolite 10 gram and composition of zeolite 6 gram, shell of 4 gr blood calms shell. The composition of samples having low porosity is due to mixed pores of zeolite with the composition of mussel shells not yet fully formed and there is still a lot of impurity on the pore surface of the hydrogen purification filter.

The adsorption test is a test in which the occurrence of the event attracts a certain molecule of fluid (liquid or gas) on the surface of a solid (adsorbent). Molecules or substances absorbed will occupy the pore position. The test results are identified from the results of hydrogen sensor readings, where the hydrogen sensor is very sensitive to hydrogen (when there is hydrogen passing through the sensor). Here are the results of hydrogen sensor readings.

![Figure 4](image4.jpg)

**Figure 4.** Graph Hydrogen of Zeolite + Blood Clams
In Figure 4, the above graph shows that 80%: 20% has the greatest purification capacity compared to 100% zeolite composition at 850°C burning temperature. It is known from the increase of hydrogen gas reading value with 10 gram zeolite composition capable of reading 885 ppm while in zeolite composition 80%: 20% capable of reading 980 ppm.

3.3 SEM Test
Scanning Electron Microscope (SEM) analysis of a modified zeolite hydrogen purification filter from a shell of burned mussels in padtan form at a temperature of 850°C is intended to determine the difference in the morphology of the hydrogen purification filter.

(a) Zeolite                       (b) Zeolite and Blood Clams

Figure 5. Results of SEM with 300 times magnification

Figure 6. Results of SEM with 600 times magnification

Figure a with the composition of zeolite and figure b with the composition of zeolite mixed with blood clams. Figure 5b with 300 times magnification and figure 6b with 600 times magnification shows hydrogen filter solids with zeolite mixtures and blood clam shell powder have been equally distributed compared to figure 5a and 5b with zeolite composition.
4. Conclusion
Variations of compositions which produce optimum hydrogen purification are present in the zeolite composition of 80%: 20% by 980 ppm, the best result of hardness test in the zeolite composition of 80%: 20% by 98.65 N/mm², and the best result of SEM test with magnification 300 times.

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