Temperature and additive coconut shell charcoal effect on density and porosity of ceramic membrane based on zeolite and clay

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Abstract. Temperature and additive coconut shell charcoal effect on density and porosity of ceramic membrane based on zeolite and clay have been analysed. By the addition of the additive in the form of charcoal can lower the density of the ceramic membrane. It can also increase the porosity of the zeolite membrane-based ceramic and clay. From scanning electron microscopy (SEM) images can be seen that the largest pore size owned by the sample that contains 80% zeolite and 10% additives. As for the large number of pores generated depends on how much the content of additives contained in the sample. There is a tendency with the rising temperatures and a growing number of additives contained in the sample, the more the pores generated.

1. Introduction

Up to 2000s, ceramic was most importantly known as traditional clays. It is considered the most ancient and manmade non-metallic material composed of clay (plastic material), silica i.e. quartz and sand (nonplastic properties), and feldspar (K₂O.Al₂O₃.6SiO₂, Na₂O.Al₂O₃.6SiO₂, and CaO.Al₂O₃.6SiO₂) as principal raw ingredients and is hardened by firing at a high temperature varying from 600 to 1400°C [1]. Usually, ceramics are ionic or covalent bonded materials. It can be crystalline or amorphous. A material held together by either type of bond will tend to fracture before any plastic deformation takes place, which results in poor toughness. Additionally, because these materials tend to be porous, the pores and other microscopic imperfections act as stress concentrators, decreasing toughness further and reducing tensile strength. Porous ceramic materials actually adsorb substances into their porous space, and for that reason they are widely used in industrial fields [2]. Nowadays, the ceramic membrane has developed based on clay, which is abundant and requires a lower firing temperature in comparison with metal oxide materials. Clay minerals have a well-known structural adsorption, rheological, and thermal properties [3]. Various kinds of membranes have been tested to remove phenol from wastewaters [4], liquid membranes [5], anion exchange membranes [6], nanofiltration/reverse osmosis membranes [7], and pervaporation membranes [8]. The purpose of this research is reporting the temperature and additive coconut shell charcoal effect on density and porosity of ceramic membrane based on zeolite and clay. Then the samples will be characterized and analyzed systematically.
2. Methods
Materials containing zeolite, clay, and coconut shell charcoal are mashed by grinding for 30 minutes. After that, weigh the material with a total weight of 5 grams for one sample using digital balance. All ingredients are weighed and then mixed and stirred by adding water as a homogenization process for additional factors. Comparative materials and water used in mixing all ingredients are 2:3. The drying process is carried out using an oven with a temperature of 140°C for 2 hours to remove the water content contained in the material, so that the total weight of the material approaches an approach similar to the initial weighing. The dried material is then printed using a 2.5 cm diameter mold and hydraulic compactor. Samples were sintered using a furnace for 2 hours with a temperature difference of 400°C, 500°C, 600°C, and 700°C with.

3. Results and discussion
From the measurement results using the SEM pore can be seen that the samples that have the largest pore size zeolite samples containing 80% and 10% additives. However, the amount of the resulting pore size depends on the number of additives contained in the sample. The more additives found in the more porous samples produced. Here is a picture of a porous sample-based additives.

![SEM images of the membrane based on the content of zeolite and additives. (a) 90% zeolite and 0% additive, (b) 85% of zeolite and 5% additive, (c) 80% zeolite and 10% additives, (d) 75% zeolite and 15% additive, and (e) 70% zeolite and 20%.](image-url)
Bed on figure 2 is the comparison of the density of membrane by Heating. The increase in density at 75% zeolite composition with additives of 15% with the Heating temperature of 400°C possible errors in the process of compaction, because drying the moisture content is still high. As results the compaction process easier and less dense than other compositions. Density contained in the ceramic membrane directly affects the amount of porosity contained in a ceramic membrane. The smaller the density estrangement contained in the membrane, so that voids or empty spaces contained in ceramic membrane becomes larger. It can be said, at the smaller density ceramic membranes, the greater the empty space contained in a ceramic membrane so that the greater porosity.

Porosity of ceramic membranes tend to show improvement remains dependent on the amount of additive, except the membrane that Heating 300°C. The membrane at heating, temperature 300°C, the data cannot be retrieved because of membrane decay when immersed in water. Therefore, it cannot count how many wet masses of the membrane. As for the ceramic membrane that sintered at 400°C tend to increase based on the number of additives. The heating temperature of 500 °C, 600 °C, 700°C, the porosity increases as the number of additives contained in the membrane.

4. Conclusion
The conclusion of this research is the addition of the additive in the form of charcoal can lower the density of the ceramic membrane. However, the addition of additives in the form of charcoal also increase the porosity of the zeolite membrane-based ceramic and clay (clay). SEM can be seen from the results of the largest pore size owned by the sample that contains 80% zeolite and 10% additives. As for
the large number of pores generated depends on how much the content of additives contained in the sample. There is a tendency with the rising temperatures and a growing number of additives contained in the sample, the more the pores generated.

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