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Preparation of Activated Carbon by Physical Activation with Rotary Autoclave

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ABSTRACT

The aim of this research is to produce activated carbon from Indonesian coal with rotary autoclave and the rotation of rotary autoclave is ± 6 rpm. In this research, after fill in the raw material to autoclave, activated carbon were produced with following processes: carbonization; coal were pyrolysed at temperature 300°C for 6 hour with flowed of oxygen and physical activation. After carbonization process coal were pyrolysed at temperature 950°C for 6 hour and CO_2 were flowed into autoclave as activating agent up to 300 ml/minute. Iodine Number is a quality parameter of activated carbon was done at laboratory. The result of this research is the iodine number of activated carbon with vertical autoclave is higher than rotary autoclave. The maximum iodine number with vertical autoclave is 589.1 mg/g and with rotary autoclave is 247.63 mg/g.

Keywords: Activated Carbon, Physical Activation, Rotary Autoclave and Iodine Number

1. INTRODUCTION

Activated carbon consumption is continuously being increased because they are used in important areas such as waste, drinkable water treatments, atmospheric pollution control, poisonous gas separation, solvent recovery etc [1].

Generally, there are two main sources for the production of commercial activated carbons: coal and lignocellulosic materials [2]. A current trend in the preparation of activated carbons is the use of various kinds of natural coals, because they are cheap and readily available [2].

As indicated by the Directorate of Coal, Ministry of Energy and Mineral Resources, Indonesia has significant coal resources. Major coal resource areas are Kalimantan and Sumatra [3].

In this research, sub bituminous coal were used as starting material to producing activated carbon. The modern manufacturing processes to produce activated carbon basically involve of the following steps: raw material preparation, carbonization, and physical or chemical activation [4]. In this research carbonization process was done with O_2 flowing up to temperature 300°C for 360 minute. Physical activation with CO_2 as activating agent were done up to temperature 950°C for 360 minute. The previous research was used vertical autoclave as shown in figure 1 [5], present research was using rotary autoclave as shown in figure 2 and 3.

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2. EXPERIMENT SECTION

Coal Characteristics. Sub Bituminous coal were use as the starting material and the analysis of coal as shown below [6]:

- Total Moisture : 5,88%
- Moisture : 3,56%
- Ash Content : 18,2 %
- Volatile Matter : 34,81%
- Fixed Carbon : 43,43%
- Total Sulphur : 1,82 %

Calorific Value (kcal/kg) : 6158

Experiment Procedure. The as-received coals were crushed and sieved to a particle size of 10 x 20 meshes before being treated. The production of activated carbons by a physical activation technique was completed in a rotary autoclave activation reactor with a furnace.

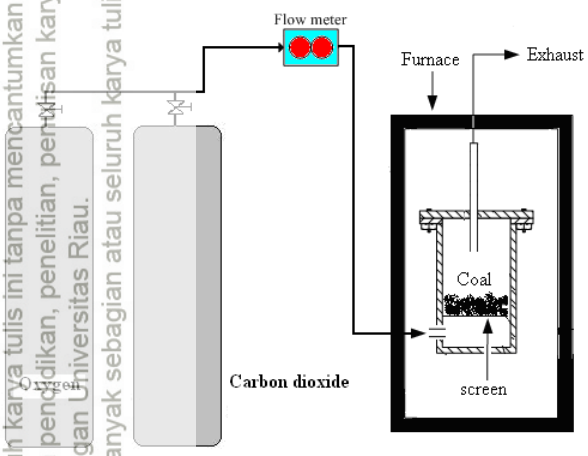

Figure 1. Scheme of vertical autoclave

The processing to produce activated carbons was as follows:

1. Carbonization or Oxidation; Pyrolysis of fresh coals were performed in a furnace under a stream of high purity of O_2 up to 200 ml/minute. The samples were heated from room temperature to maximum heat treatment temperatures in 300°C for 6 hour.
2. Physical Activation; Following the carbonization process the char samples were gasified also in the furnace in a stream of CO_2 up to 300 ml/minute. The samples were heated from room temperature to maximum heat treatment temperatures in 950°C also for 6 hour. Scheme of this procedure as shown in figure 1.
3. During Carbonization and Activation processes, rotary autoclave was rotated using electro motors where the speed was reduced with gear reduction up to 6 rpm.

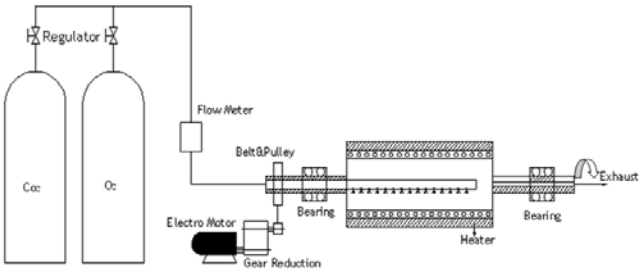

Figure 2. Scheme of Rotary Autoclave

Figure 3. Rotary Autoclave Apparatus

3. RESULT AND DISCUSSION

In this work the result for two type of autoclave (vertical and rotary autoclave) to producing activated carbon were compared.

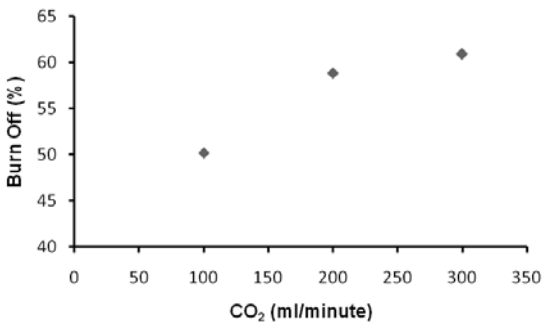

Figure 4. Burn-off Activated Carbon that Produced by Rotary Autoclave

Figure 4 and 5 describe the effect of stream of CO_2 on burn-off and iodine number of activated carbon, where the

activated carbon was produced by vertical and rotary autoclave. It can be seen from figure 4 and 5 in general, more the amount CO_2 was flowed to the autoclave resulting in higher burn-off and iodine number.

It is cause, a lot of CO_2 gas that flowed to the autoclave causing the gasification or activation process in coal will be better.

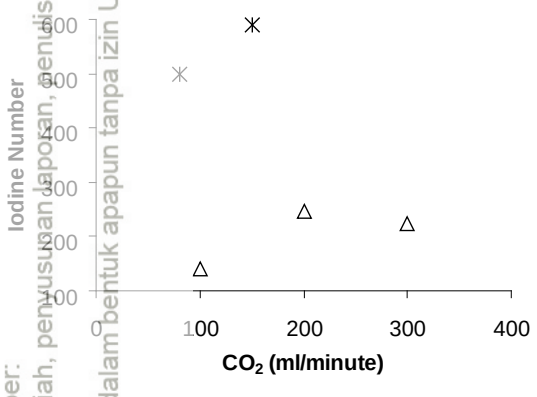

Figure 5. Iodine Number of Activated Carbon; * Vertical Autoclave; Δ Rotary Autoclave

It can be seen also in figure 5, iodine number of activated carbon that produced with vertical autoclave is higher than rotary autoclave. It causes, beside the CO_2 distribution in vertical autoclave is better than rotary autoclave also because the rotation speed of autoclave is too slow so that the CO_2 gas is not evenly distributed in the coal.

CONCLUSION

1. Activated carbon was produced from sub bituminous coal with carbonization and activation process with variation of stream of carbon dioxide.
2. Weight losses or burn off is similiar with iodine number, increasing weight loss will increasing iodine number thus the surface area will be larger too
3. The maximum weight loss or burn off and iodine number of activated carbon in that produced with vertical autoclave is 71,88% and 589,10 mg/g by carbonization (by O_2 stream ±100 ml/minute for 6 hour) and activation process (by CO_2 stream ±150 ml/minute for 6 hour) and 60.9% and 247.63 mg/g for rotary autoclave with speed of rotation is 6 rpm.

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