COAL DESULFURIZATION USING ALKYL ALGINATE (SURFACTANT)

Mahreni, Danang Jaya, Guntoro, Anggara Setya Wibawa
Department of Chemical Engineering, Faculty of Industrial Engineering
Universitas Pembangunan Nasional "Veteran" Yogyakarta
Email: mahreni@upnyk.ac.id

Abstract

Sulfur is a component present in coal whose composition is about 1-2% by weight. When coal is used as an energy source it will liberate sulfur oxide or SOx gas. SOx is a highly toxic gas and one of the gases that causes acid rain. Therefore, coal desulfurization is very important to reduce the environmental impact caused by SOx. In this research, coal desulfurization has been conducted using Alkyl-alginate surfactant as surface tension reduction agent in coal washing process. The objective of this study was to determine the concentration of surfactant in washing water and to determine the rate of water flow containing surfactant on the percentage of sulfur reduction. The material used in this research was Indonesian coal from South Sumatera. The selected flow rate variations were 750, 1250, 1500, 2500 and 3750 (ml/min) and surfactant concentrations in range of (0.0625, up to 0.375) grams/liter). The results showed that the largest percentage of coal sulfur reduction obtained at a flow rate of 750 ml/min resulted in a decrease in sulfur content of 71.9%. At a flow rate of 750 ml / min and a surfactant concentration of 0.375 g/l, the percentage reduction of sulfur was 82%. From these data it can be concluded that the alkyl alginate surfactant is one of the new surfactants having considerable capability as an agent to decrease the sulfur content of coal

Key words: Alkyl alginate, biodegradable, coal , desulfurization, surfactant,

1. Introduction

Sulfur in coal consists of organic sulfur and inorganic sulfur. Organic sulfur can be oxidized to produce SOx gas which is highly toxic and pollutes the environment. Inorganic sulfur such as pyrite (FeS) and other sulphide metals can not be oxidized and precipitate as crust on the surface of the combustion chamber. Both types of sulfur are detrimental. Therefore it is necessary to remove sulfur from coal. Research to eliminate sulfur or desulfurization has been done using chemical, physical and biological methods.In the physical desulfurization method, the sulfur which can be taken is inorganic sulfur only. From the research that has been done this method can reduce sulfur by 72%. While in chemical desulfurization can take organic and inorganik sulfur, but requires a high cost. In biology desulfurization method, the sulfur which can be taken is organic and inorganic but have weakness that this process take a long time and costly because wearing bacteria so this method is rarely performed. In this research, desulfurization process has been done using

combination of physics-chemical process. The desulfurization process is carried out by a washing method in which washing water is added with a chemical (surfactant). The parameters to be tested are the flow velocity and the surfactant concentration on the total sulfur reduction that can be separated from coal.

2. LITERATURE REVIEW

2.1. Sulfur on Coal and its effects on the environment

Sulfur in coal is present in three forms, namely pyrite sulfur, sulfur sulfate and organic sulfur. Sulfur in the form of pyrite and sulphate is part of the minerals contained in coal which is the amount still can be reduced by washing techniques. Meanwhile organic sulfur is present in all carbon materials in coal and the amount can not be reduced by washing technique. The presence of sulfur sulfate in coal is often used as an indication that coal has been oxidized, while pyrite sulfur is considered one of the causes of spontaneous combustion.

Sulfur is the main impurity that is a stable material in coal, The negative effect of sulfur in coal is corrosivity and air pollution. Moisture and sulfur (especially as pyrite) can support the occurrence of spontaneous combustion. Until now all organic sulfur in coal can not be eliminated in the washing process.

2.2. Coal Desulfurization and desulfurization methods

Coal desulfurization is needed not only to minimize environmental pollution caused by emissions from sulfur dioxide during combustion, but also to improve coal quality for Clean Coal Technology (Ahmed et al, 2008)

Based on the process, coal desulfurization can be done by chemical (Guangyuan Xie, 2017), (Ehsani, 2006), (Samit Mukherjee, 2001), (Reningtyas & Mahreni, 2015), physical (Subandrio, dkk. 2010), and biological methods (Andi aladin et al, 2009) has conducted a desulfurization research of coal from Pattuku region of South Sulawesi, by way of Flotation (physics method), it is proven that only inorganic sulfur type is effective for reducing. While chemical and biological methods can separate (reduce) both inorganic sulfur and organic sulfur but require chemicals (expensive). Biological methods use the help of microbes that work at low temperatures so that the relatively long time compare to chemical methods (Fikret Kargi, 1986).

3. EXPERIMENT AND METHODS

3.1. Materials

The main material used in this research is coal from South Sumatra with initial sulfur content of 884,3 ppm. The materials used in this research are Aquadest and Biosurfactant derived from brown algae (Sargassum sp).

3.2. Aparaus

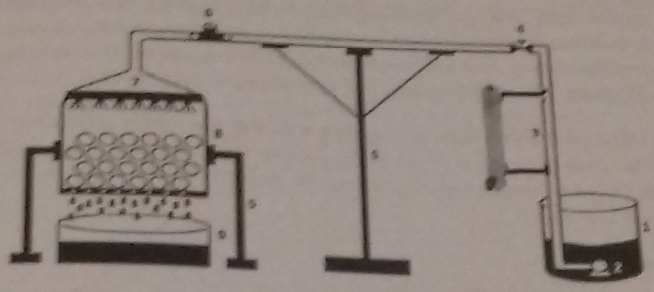

Figure 3.1. Coal desulfurization using spray method

1. Water storage water contains surfactant, 2. Pump, 3. Flow meter, 4. Faucet 5. Buffer, 6.Kran, 7. Spray, 8. Washing water container

3.3. Exprimeni

3.3.1. Preliminary Experiment

Coal is reduced in size using a crusher and separated by size with ± 3-4 mesh diameter. a mixture between surfactant and water with concentration (0.0625; 0.125; 0.1875; 0.375) gram/liter was made. After that flowmeter calibration to determine water flow rate to be used that is 750; 1250; 1500; 2500; 3750 (mL/min) was performed.

3.3.2. The desulfurization process using spray

Variation of Washing water Flow Rate

Coal of the same size is 3-4 mesh inserted into the sample place. The thickness of the sample is made the same in the sample space. The water containing the surfactant is flowed using the pump at a certain flow rate and into the spray. Where the water will wet coal from the surface down to the bottom and finally out of the sample chamber. Coal of the same size is 3-4 mesh inserted into the sample c. amber. The wash water containing the surfactant is flowed using the pump at a certain flow rate and into the spray. Water out of the spray through nozle will wet the coal. During contact with coal there will be an interaction between the surfactant molecule and the molecule inside the coal. Surfactants will interact with hydrophobic or hydrophobic molecules. Where hydrophilic group surfactants will bind hydrophilic molecules such as inorganic sulfur molecules. After the washing is done, the coal is drained. Drying of coal ends when the weight of drained coal was constant. Subsequently coal was analyzed to determine the sulfur content using UV visible spectroscopy.

Variation of Surfactant Concentration

In the same way, for the variation of surfactant concentration. Variation of concentration at 0 gram / liter, 0.0625 gram / liter, 0.125 gram / liter, 0.1875 gram / liter, 0.375 gram / liter. Washing water flow rate 750, 1 / min.

4. RESULT AND DISCUSSION

In this study, the coal feedstock used in the desulfurization process is a material that has been made into the even size and is cleaned of impurities that do not support the research. Before desulfurization, coal analysis have the following results: The same sample weight per run is 100 grams. The sulfur content before washing is 884,3 ppm.

4.1 The effect of the flow rate of washing water to the sulfur reduction

The result of analysis of the sulfur content after washing process with sample weight 100 gram, in the flow rate variation from 750 until 3750 ml/minute and coal size 3-4 mesh can be seen in Figure 3.2

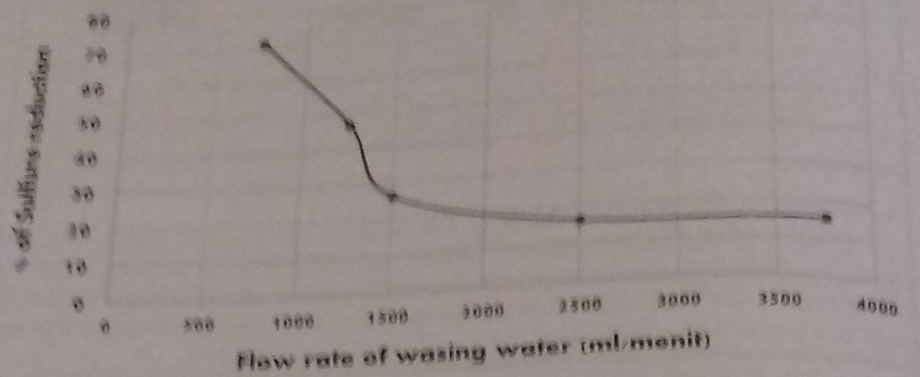

Figure 3.2. Effect of washing water flow rate containing surfactant to the sulfur content decreased in the coal.

The results show the longer contact time between coal and washing water, or the slower the flow rate of the washing water, the larger the separated sulfur. The maximum percetage of sulfur decreased at a flow rate of 750 ml/min with a sulfur reduction up to 71,9%. This variation in flow rate indicates that the reduction of sulfur increases with decreasing flow rate of washing water. At the flow rate of 750 ml/min with a concentration of 0,25 gram liter surfactant can reduce sulfur content up to 71,92%. This can be explained to separate organic (hydrophobic) sulfur and inorganic (hydrophilic) sulfur from coal using washing method required sufficient contact time between coal and washing water. (Andi Aladin, 2009). This is evidenced in accordance with Figure 3.2. Sulfur that can be separated from coal is smaller when contact time increases. The flow rate of 750 ml/min has the longest contact time with the coal, and obtained separate sulfur is increasing and obtained separate sulfur increased until the sulfur decrease reached 71,9%.

4.2 The effect of the surfactant concentration to the sulfur reduction

In this experiment, done by varying concentration of surfactant amount to redusce of sulfur content in a coal, with flow rate of the wasing water is 750 ml/min, 100 grams of coal. Figure 3.3 shows a decrease in the coal sulfur content at the concentration of the varied

surfactant. In the variation in the amount of surfactant concentration in the highest percentage of sulfur was obtained at concentrations of 0.375gram/liter with a decrease to 82.08%.

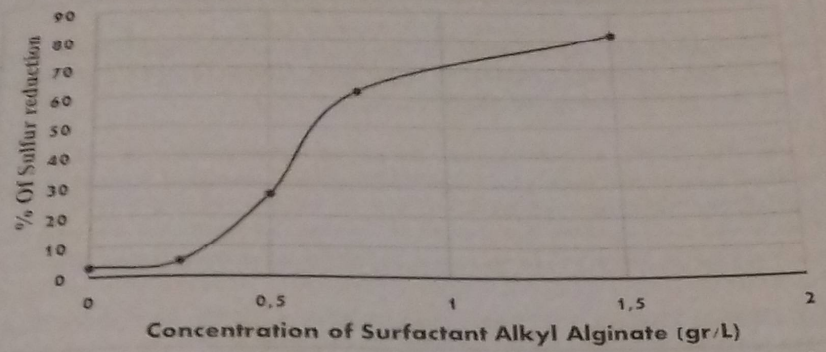

Figure 3.3. The effect of variations surfactant concentration in the percent of sulfur reduction

The experimental results using the variation of surfactant concentration was showed that the reduction of sulfur increased with the increase of the surfactant concentration. The maximum percentage of sulfur reduction at a surfactant concentration of 0.375 grams/liter with a flow rate of 750 mL/min is 82.06%. The greater the surfactant concentration, the greater surfactant contacting and entering the coal pores, So that the sulfur can be separated more and more. As shown in Figure 3.3. At a low surfactant concentration of 0.0625 gr/l, the sulfur can be separated only 4.98%. At the concentration of surfactant 0 gram/liter or as pure water can decrease sulfur content just equal to 2,97%. This happens because water is hydrophilic, while organic sulfur was dominated by alkyl groups that bind to Sulfur and are hydrophobic. The difference polarity between organic sulfur and water causes no interaction between the two components and thus organic sulfur can not leach out from the coal structure. Therefore, the sulfur content in coal remains high.

5. CONCLUSION

Surfactants Alkyl alginate can reduce the sulfur content of coal up to 82 percent at a surfactant concentration of 0.375 grams/liter. The flow rate of washing water is 750 ml/minut can reduce total sulfur of 82.06%.

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