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Pollutant Absorber Design to Minimize Air Pollution Emissions from Industry

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Abstract. Pollutants emitted from industries vary depending on the type of fuel and the height of the chimney used. The higher the chimney used, the further the pollutant distance emitted. In this research, Pollutant Absorber was made with a condensation system using activated coconut shell charcoal. The research method uses Research & Development with the Design for Production (DFP) approach. In developing the model, pollutant emission analysis is carried out: before entering the chimney, during the chimney, and after exiting the chimney. Then, in designing tools to design absorbent devices, chimney designs with coconut shells are made as absorbent. In creating and making tools, it is done in two ways, namely simulation and testing. The results of the research are models of the distribution of air pollutants from industry, air pollutant absorbent designs emitted from industry, and prototype devices capable of absorbing SO_2 of pollutants emitted through the chimney.

1. Introduction

Industrial development in Indonesia continues to increase every year. Industry spread throughout Indonesia by using the capacity and type of fuel is different. The difference in size will have implications for the amount of pollutant concentration, while the difference in fuel will have impacts on the types of pollutants emitted [1]. Based on observations in industry Cilegon, capacity and type of fuel used was indeed different. The greater the size of the fuel used, the higher the chimney used. The type of fuel used include High-Speed Diesel (HSD), Marine Fuel Oil (MFO), Pyrolysis Fuel Oil (PFO), solar, residue, coal, and Fuel Gas (CNG). The various types of fuel used have implications for the types of pollutants emitted. Based on the results of ambient air measurements at 24 sample points in the Cilegon industrial area in the period July 2019, the types of pollutants emitted with these fuels, namely: nitrogen dioxide (NO_2), particles/ dust, sulfur dioxide (SO_2), carbon monoxide (CO) hydrocarbons (HC) and lead (Pb). The pollutant concentration varies between 0,03 -5600 µg/m^3, while the dust particles ranged from 102-686 µg/m^3. The type of pollutant with high concentration is CO and the smallest Pb, while the type of pollutant whose concentration shows an increase in SO_2. This increase occurred because, in the region, there are industries that use coal fuel with a capacity of 170-255 tons/hour. The large fuel capacity is assumed to have implications for the amount of pollutant concentration and the distribution distance emitted from the industry. SO_2 pollutants emitted from the Cilegon industrial area reach the Pulomerak region with concentrations ranging from 3,387-51,058 µg/m^3 [2].

The concentration of pollutants emitted, not only depends on the capacity of the fuel, will however depend also on the stability of the atmosphere, whereas the spreading distance depends on the height of chimney used. The higher the stack used, the further the pollutant distance emitted. In atmospheric stability A (very unstable), the concentration of pollutants emitted is very large, conversely, if the atmospheric stability is E (rather stable), the level of pollutants emitted is small [3]. The amount of

pollutant concentration and the distance emitted by the industry needs to be done to prevent the prevention of air quality. In terms of maintaining air quality, it is necessary to minimize pollution without disturbing the speed of industrial development. This can be done by making tools or modifying the chimney so that polluted emitters can minimized.

At this time, chimney modifications to reduce pollutants emitted had limited to industries that use coal fuel. Chimney modification had done by installing Electricity Catalytic Oxidation (ECO) SO_2 and electric coagulation. ECO-SO_2 functions to reduce sulfur (SO_2) waste and can reduce levels of NO_x, Hg (mercury), and particles that pollute water and fish and soil by up to 90% [4].The electrical coagulation function can coagulate smoke. before coming out of the chimney by using metal [5]. The metal edges in this tool will ionize the molecules in air. The smoke particles will be adsorbed into charged ions. The disadvantage of an electric coagulation device that requires a voltage of between 20,000-75,000 volts Minimizing the concentration of pollutants through chimney modification has inspired researchers to correct various weaknesses, including by making pollutant absorbent devices. Research related to the absorption of contaminants, including; gas treating with chemical solvents [6]. Pollutant detection by absorption using scattering noodles and topographic targets as retroreflectors [7], Effects on air pollutant removal by plant absorption and adsorption [8], Environmental Samples Analysis by atomic absorption spectrometry and inductively coupled plasma-optical emission spectroscopy [9], and Light absorption by pollution, dust, and biomass burning aerosols: a global model of study and evaluation with AERONET measurements [10]. Most of the previous studies focused on the reaction research, absorption rate, and CO_2 absorption efficiency system, which was carried out using absorber columns. Furthermore, anu researcher made a simulation of Air Pollutants Minimalization of Pollutant Absorber with Condensation. The simulation was carried out to determine the absorption of pollutants and absorbent endurance in absorbing air pollutants [11].

A device to absorb pollutants from the chimney continues to be strived to be able to minimize the concentration of polluted pollutants. In this research, a prototype of the Pollutant Absorber will be made with a condensation system, and the material used as an absorber is activated charcoal from a coconut shell. The charcoal is activated carbon, which is assumed to be able to absorb air pollutants before leaving the chimney. To keep the charcoal from burning, it is carried out by a condensation system.

2. Method

The research method uses Research & Development techniques with a Design For Production (DFP) approach. The DFP approach uses a multilevel system perspective from manufacturing activities to highlight the product development process. An important aspect of the DFP approach is the estimation of manufacturing system performance for products. Product design and manufacture of activated charcoal is carried out at the Sultan Ageng Tirtayasa University Laboratory of Engineering, while for testing, the equipment is carried out at UPB Suralaya. The research began by making activated charcoal derived from coconut shells. After the activated charcoal is finished, the charcoal is taken to the trial site, the UPB Suralaya chimney. The design of the prototype application of pollutant absorber in the UPB Suralaya chimney is presented in Figure 1.
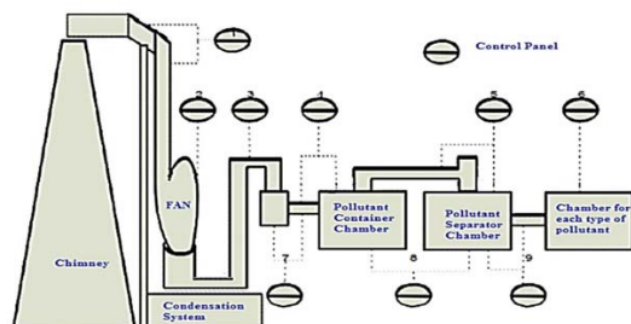
Figure 1. Pollutant absorber design

Based on the pictures 1, pollutants coming out of the chimney is absorbed by the filter and then accommodated in chamber 1. And then contaminants are separated in chamber 2, then every kind of pollutants are stored in the chamber 3. Activated charcoal is placed before the chamber 3. The flow of contaminants at any sub tools detected using a control instrument. To keep the flow of particles in each pipe made with a condensation system by maintaining the humidity tool. The working method of the device is to absorb all types of pollutants that come out of the chimney. Contaminants captured by the absorber filter are collected in chambers through capillary tubes. To maintain the change of separating and changing smoke particles into charged ions created by a condensation system by supporting energy through the enthalpy process. SO_2 concentration measurements were carried out for ten weeks.

3. Results and Discussion

In this research, the manufacture of pollutant absorber using local raw materials of coconut shell charcoal. This natural material is used as absorber because the cost is relatively inexpensive and easy to obtain in the Banten area. To maintain the resilience of the device to absorb pollutants is done by condensation. This is done to cool and dissolve pollutants. Coconut shell, as an absorber base, is first made into charcoal or called carbonization. The furnace used to make charcoal is a traditional ground furnace with a curing time of 3 days. Massa shell made charcoal is 100 kg. The charcoal produced is around 30 kg. Then the charcoal is broken into granular 2-3 cm diameter using a bat. The second step is to process dehydration using 2% NaOH salt. Charcoal that has been in granular form is put into a wall pond containing NaOH salt solution. Charcoal is soaked for 24 hours. After going through the process of immersion, then the charcoal is drained. Charcoal already drained then insert it into the activation space to be converted into activated charcoal. The principle in this third step is to open the pores of the charcoal to become more extensive. This activation is carried out for 48 hours. The dried charcoal is then put in a plastic bag to be transported to UPB Suralaya .

Most of the charcoal that is so, in the test beforehand whether the sample is in compliance with SNI 06 - 3730-1995 Deng's parameter is missing part in 950ºC, levels of Water, levels of ash and absorption of I_2. The sample used is first converted into granules smooth ya ng sifted by size sieve 30 mesh. Moisture content and ash content are determined using the gravimetric method. Water content influences the absorption quality of activated carbon because high water content will reduce the absorption of activated carbon against gas or liquid. Determination activated carbon ash is done for me Knowing the content of the metal oxide d natural activated carbon. Ash in which obtained from the activated carbon results of research that is 5 % meet the standards SNI standard is a maximum of 10%. The adsorption capacity of activated carbon against I_2 correlates with the surface area of activated carbon. The pore surface area is an essential parameter in determining the quality of an activated carbon as an adsorbent. This is because the pore surface area is one factor that affects the adsorption capacity of an adsorbent. The activated carbon of research results has an absorption capacity of I_2 of 802 mg/g and meets the SNI set standards, which is a minimum of 750 mg/g.

Pollutant absorber of coconut shell charcoal with condensation system serves to absorb all kinds of pollutants emitted from industry, especially in this study is SO_2. By looking at picture 1, the product stored in chamber 1, then flows through the tube in chamber 2. In chamber 2, the absorbed pollutants are then separated with a separator through the enthalpies process by lowering the temperature and keeping energy from being lost. In this process, various types of particles derived from smoke will be obtained. After each particle is formed, the process is continued with adsorbs by the activated charcoal, which is carried out in chamber 3. In chamber 3, the smoke particles will be changed into charged ions. Because the production process takes place continuously, it will be obtained ions with large enough ions that can be used as a source of electrical energy.

The results of testing the activated charcoal on the prototype can be seen in Figure 2.
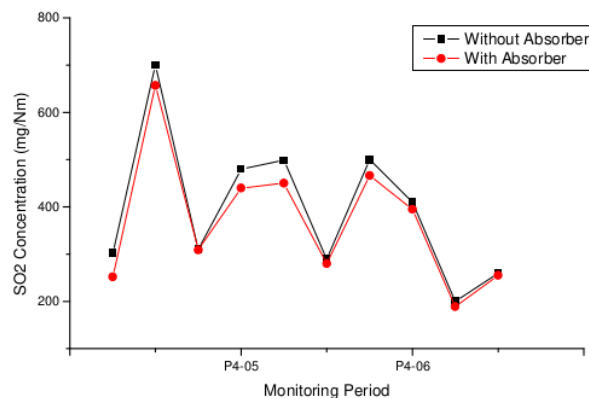

Figure 2. SO_2 concentration with and without absorber

The trial results show that activated charcoal can absorb SO_2. At the beginning of use, activated charcoal functions optimally in absorbing pollutants, especially SO_2, but after passing seven weeks, the charcoal starts to decrease its function. This is caused by a pretty drastic drop in temperature. Charcoal will be optimal at 900ºC heating [12]. Because at that temperature the pores in the charcoal will be opened by the presence of high heat penetration and if there are pores that have opened it will cause an increase in pore diameter which causes complex compounds especially those that close the charcoal pore out so that the pollutant absorption will be higher. But it can be concluded that this prototype can be used as a step to reduce pollution emissions.

Pollutant absorber from coconut shell charcoal with condensation system is a control technique to reduce sea pollution. The difference between this tool and the tool previously seen in the position and function of the instrument. The feature of the previous device was only to absorb or separate coal-fueled pollutants, while this tool was able to absorb and separate pollutants from different fuels. From the function side of this tool can absorb SO_2 emitted. The absorbed products are then separated by a separator; after being separated, the pollutants are then absorbed so that they can be used as an energy source. The factors that influence adsorption include physical and chemical properties of adsorbent and adsorbate, liquid phase (pH, temperature), gas properties (temperature, pressure), adsorbate concentration, and contact time of adsorbent and adsorbate.

4. Conclusion

Coconut shell can be used and used as activated charcoal because it is relatively cheap and easy to obtain. Almost all parameters analyzed on the activated charcoal as a result of the research meet the

requirements of the Indonesian National Standard now active. The use of activated charcoal as an ingredient absorbs SO2 can be applied to the industry, especially the use of coal fuel.

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