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RESEARCH ARTICLE
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Chimney Filter Model Wet Scrubber to Reduce Air Pollutant Emissions on the Incinerator

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ABSTRACT

In general, inpatient health care facilities produce infectious and non-infectious waste 0.3 m^3 / day. Non-infectious waste that is burned in an incinerator without a chimney filter, can cause particles, CO, SO2, NOx (air pollutants) and cause environmental pollution. This study aims to make a chimney filter design with a Scrubber model on an incinerator at the Public Health Center, Maospati District, Magetan Regency to reduce the amount of air pollutants emitted. This type of research is experimental research. This research designed a particle trapping device, gas by spraying water into the scrubber. The independent variable of this research was the variation of the water flow sprayed in the scrubber (3.2 liters / minute, 4 liters / minute, 5.6 liters / minute). The dependent variables of this study were particles, SO_2, NO_x, CO. Data collection using a digital gas detector method in the form of a UV spectrophotometer. Data were analyzed descriptively, in the form of frequency distribution, and percentage, presentation of data in a table based on air emission quality standards from thermal waste processing. The results illustrate that the use of a chimney scrubber filter with water spraying 3.2 liters / minute, 4 liters / minute, 5.6 liters / minute can reduce air pollutants, emission of SO_2, CO to below the air quality standard. In addition, this tool can also reduce NO_x gas and particles, but not yet below the quality standard. The conclusion from the results of this study is particulate emission air pollutants, gas SO_2, CO, NO_x. the incinerator can be lowered by modifying variations by spraying water 3.2 liters / minute, 4 liters / minute, 5.6 liters / minute on the chimney scrubber filter on the incinerator.

Keywords: incinerator; scrubber; water discharge variations; particle; gas

INTRODUCTION

Background

The waste problem is a crucial problem that impacts the side of life. The process of burning municipal waste through an incinerator will produce hot steam which can be used to generate electrical energy, but this process also produces an output in the form of flue gas which is dominated by particles (fly ash) and toxic gases such as: HCl, SO2, NOx, HF, Hg, Cd and Dioxin. Before being discharged into free air, the flue gas must be treated to meet environmental quality standards [(1)]. The Community Health Center as a health service facility that organizes public health efforts and first-level individual health efforts are also considered as a contributor to a source of waste [(2)].

Air pollution differs from one place to another because of it differences in lighting conditions, humidity, temperature, wind and rain that will behas a major influence in the spread and diffusion of air pollutants emitted either on a local scale (the city) or a regional scale (city and surrounding areas) [(3)]. According to Permenkes number 7 of 2019, it is stated that to achieve compliance with environmental health quality standards and health requirements and to protect health workers, patients, visitors including the community around the hospital from various diseases and / or health problems that arise due to environmental risk factors it is necessary organized hospital environmental health [(4)]. Therefore, based on these regulations, environmental health facilities must

always pay attention to air quality in the environment. Moreover, health facilities that carry out waste processing using incinerators.

Based on the results of a preliminary study at the Public Health Center, Maospati District, Magetan Regency, data on the volume of non-infectious waste (medical waste and non-medical waste) were obtained about 0.3 m^3 per day. Waste production is processed by burning it with an incinerator. The results of the combustion process in the form of particles, CO, SO_2, NO_x (Emission Air) are discharged into the air, polluting the ambient air. Based on these conditions, this study seeks to help solve problems that may be caused by incinerating waste burning. This study modifies the reduction in the amount of emitted air pollutants (particles, CO gas, SO_2, NO_x) resulting from the combustion process which is discharged into the air by installing a Scrubber-style chimney filter device on the incinerator.

Purpose

The purpose of this research is to design a chimney filter with a Scrubber model on an incinerator and to describe the level of reduction in the amount of air pollutants emitted after using the Scrubber chimney filter on the Incinerator.

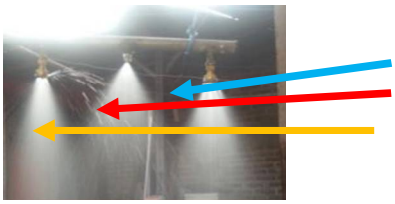
METHODS

This type of research was experimental research. This research designed a particle trapping device, gas by spraying water into the scrubber. The design of this research was a One-shot case study, in which the researcher designs the chimney scrubber filter and tests its ability to capture particles, polluting air pollutants[5]. The independent variable of this research was the variation of the water flow sprayed in the scrubber (3.2 liters / minute, 4 liters / minute, 5.6 liters / minute). The dependent variables of this study were particles, gas SO_2, NO_x, CO. Data collection using a digital gas detector method in the form of a UV spectrophotometer. The data were analyzed using descriptive statistics, comparing the research data with the emission quality standard data and thermal waste processing activities. Presentation of data in the form of frequency distribution, and percentage, presentation of data in a table based on air emission quality standards from thermal waste processing.

RESULTS

Kinds of Nozzle

The results of the first phase of research covering the design of a chimney filter for a scrubber model, manufacturing of tools, assembling tools, prototyping tools were as follows:



Water volume 5.6 liters/minute
Nozzle 1 = 1.6 L/m
Nozzle 2 = 2.4 L/m
Nozzle 3 = 1.6 L/m
Material from Copper

Figure 1. Kinds of Nozzle, a spray device on the chimney filter in the scrubber model

Figure 1 shows that there were 3 nozzles used in the chimney scrubber filter. The nozzle was made of copper material, each nozzle had a different spray power every minute. The volume of water flowing from the three nozzles was 5.6 L / minute.

Scrubber body

Scrubber Size:
1. Inlet diameter 4 dim
2. The diameter of the cone is 4 dim
3. The height of the carriage is 0.2 m
4. Scrubber diameter 0.5m
5. Scrubber height 1.2 m
6. Wastewater tanks
7. Body material from Galfanis with a thickness of 0.5 ml.

Figure 2.The chimney filter scrubber body

Figure 2 is the scrubber body shape which shows the body sizes which include, inlet diameter, chimney diameter, chimney height, scrubber diameter, scrubber height, waste water tank and scrubber body material.

Scrubber Prototype

1. Air outlet emissions
2. Scrubber body
3. Chimney
4. Wastewater tanks
5. Water pump, water distribution pipe and water spray nozzle
6. Clean water tub

Figure 3. Scrubber prototype

Figure 3 is an image of the Scrubber Prototype which includes the important parts, namely the emission air channel, scrubber body, chimney, waste water tank, water pump, water distribution pipe and water spray nozzle, clean water tub.

Air Emission Observations

Table 1. Observation results of smoke color before and after spraying based on the volume of water in liters / minute

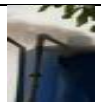
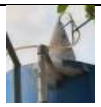
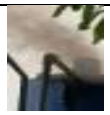
No	Spray volume	Before spray	After spray
1	3.2 l/m	 Black Smoke Color	 White Smoke Color
2	4.0 l/m	 Black Smoke Color	 White Smoke Color
3	5.6 l/m	 Black Smoke Color	 White Smoke Color

Table 1 shows the results of observations of the change in the color of the chimney smoke after being sprayed with water 3.2 l / m, 40 l / m, 5.6 l / m. The chimney smoke released before being sprayed with water was black and after spraying with water there is a change in color, namely the resulting chimney smoke is white.

Laboratory Examination Results

Table 2 is the result of research from laboratory examination of air emissions after spraying. From the results of laboratory examinations, it was known that the chimney emission air after being sprayed with water as much as 3.2 liters / minute contains a total of 832 mg / Nm^3 of particulates. This particulate value was above the emission quality standard parameter for the thermal waste processing business or activity, which was 120 mg / Nm^3. Sulfur Dioxide (SO_2) 182 mg / Nm^3 is lower than the parameter, which was 210 mg / Nm^3, Nitrogen Oxide (NO_x) 875 mg / Nm^3 was higher than the parameter, namely 470 mg / Nm^3, Carbon Monoxide (CO) 415 mg / Nm^3 was lower of the parameter, namely 625 mg / Nm^3. However, NO_x gas and particulate matter could not decrease until it was below the emission air quality standard value.

Table 2 Laboratory inspection results for air emissions after spraying

No	Spray volume	Emission air parameters	Laboratory results mg / Nm^3
1	3.2 l/m	Particulate	832
		SO_2	182
		NO_x	857
		CO	415
2	4.0 l/m	Particulate	756
		SO_2	160
		NO_x	784
		CO	308
3	5.6 l/m	Particulate	687
		SO_2	136
		NO_x	736
		CO	210

Emission Air Quality Standards

Table 3. Emission Air Quality Standard Regulation of the Minister of Environment and Indonesian Forestry NUMBER P.70 / MENLHK / SETJEN / KUM.1 / 8/2016

No	Parameter	Maximum limit (mg / Nm^3)
1	Particulate	120
2	SO_2	210
3	NO_x	470
4	CO	625

Table 3 is the standard of emission air quality according to the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia NUMBER P.70 / MENLHK / SETJEN / KUM.1 / 8 / 2016. The parameters set for particulate matter were 120 mg / Nm3, SO2 is 210 mg / Nm3, NOx of 470 mg / Nm3, CO of 625 mg / Nm3.

DISCUSSION

In this study, the tool used to separate emission air pollutants is a scrubber, by spraying the liquid into the scrubber room. The liquid material that is sprayed to bind CO, NOx, SOx gas from the combustion process is water (H2O). According to Arief R. Soemarno. Eko N is stated that when the gas passes through the packing column (the chimney), water condensation occurs which drops down into the evaporation tank. When it descends, the water will come in contact with the combustion exhaust gases, and can function as a scrubber that can absorb the tar in the exhaust gas. Thus it can reduce the tar in the combustion exhaust gas before being discharged into the outside air [(7)]. Opinion Samsu DN. One effective way to reduce NOx is to use the Exhaust Gas Recirculation (EGR) method with the addition of a venturi scrubber.NOx drops by 32.26% because the moisture content is carried into the combustion chamber so that NOx has decreased [(8)]. The results of Fatkhurrahman's research, explained that the tool used to separate particulate air pollutants is a scrubber, by spraying liquid into the scrubber room. The liquid material that is sprayed for the absorber or to bind the particles from the combustion process is water (H_2O) [(9)]. A venturi packed scrubber using water as an absorber, the water flowing through the throat, can reduce particulate matter as a parameter of air pollutants.

The research results of the chimney scrubber filter with water spraying as much as 3.2 liters / minute can reduce the amount of air pollutants, Sulfur Dioxide (SO_2) and Carbon Monoxide (CO) emissions below the emission air quality standard. However, NOx gas and particulate matter could not decrease until below the emission air quality standard value. This research is an effort to reduce the elements of air pollution due to waste processing by combustion. This is in accordance with the results of research conducted by Trilaksono BP, 2002 which states that the impact of processing waste by burning or incinerators still causes losses, including the exhaust gas from the combustion process which has the potential to pollute the environment due to the content of toxic materials such as dioxin substances. In addition, exhaust gas is the carrier for most of the CO2 that causes global warming [(10,11)].

The results of the research on the chimney scrubber filter model with spraying water as much as 4 liters / minute can reduce the amount of air pollutants, Sulfur Dioxide (SO_2) and Carbon Monoxide (CO) emissions below the emission air quality standard. However, NOx gas and particulate matter could not decrease until below the emission air quality standard value.

The results of the research on the chimney scrubber filter model with spraying water as much as 5.6 liters / minute can reduce the amount of air pollutants, Sulfur Dioxide (SO_2) and Carbon Monoxide (CO) emissions below the emission air quality standard. However, NOx gas and particulate matter could not decrease until below the emission air quality standard value. According to Trisaksono, to overcome environmental pollution due to combustion exhaust gases and ash particles from burning waste, the incenerator is equipped with dust collector equipment and nitrogen oxide or sulfur oxide reduction equipment [12]. The research also explains the advantages and disadvantages of using an incinerator; The advantage of using an incenerator is its ability to reduce a large proportion of the volume of waste from its landfill and generate electrical energy. - The disadvantages of its use are due to the release of large amounts of CO2 which is the cause of global warming as well as the tendency for toxic gases to be released along with the release of exhaust gases into the air [12,13].

CONCLUSION

The conclusion of this research is based on the results of laboratory examinations, it is known that the chimney emission air after being sprayed with water as much as 5.6 liters / minute contains a total of 687 mg / Nm^3 of particulates. The particulate value is above the particulate required quality standard for emission of thermal waste processing businesses and / or activities, which is 120 mg / Nm^3, Sulfur Dioxide (SO_2) 136 mg / Nm^3 is lower than the required standard, namely 210 mg / Nm^3, Nitrogen Oxide (NOx) 736 mg / Nm^3 higher than required, namely 470 mg / Nm^3, Carbon Monoxide (CO) 210 mg / Nm^3 lower than required, namely 625 mg / Nm^3.

The design of the incinerator scrubber chimney filter can reduce the amount of particulate emission air pollutants, SO_2 gas, CO gas, NOx gas.

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