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Cyclone Dust Collector Model Filter Design on Incinerator PHC to Reduce the Number of Particles and Air Pollutant Gas Emissions

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ABSTRACT

Community Health Center organizes inpatient health services, producing infectious, non-infectious waste 0.3 m^3 / day. Non-infectious waste is burned in an incinerator without a chimney filter, so that the particles, CO, SO2, NOx (emission air pollutants) that are disposed of pollute the ambient air. This research aims to make a cyclone dust collector model of a chimney filter on a public health center incinerator to reduce the amount of air pollutants emitted. Type of experimental research. Implemented at the Maospati Community Health Center, Magetan Environmental Health. This research makes a means of trapping particles and gases with a cyclone dust collector. The independent variable is the depth of the chimney pipe that is inserted into the filter as deep as 0.2m, 0.4m, 0.6m from the starting point of the emission air entering the filter. The dependent variable, the number of particles, gas SO2, NOx, CO. The results of the test tools are presented in the table, analyzed descriptively based on the quality standards of business emissions and / or thermal processing activities. Result:The result, the cyclone dust collector model chimney filter that uses a chimney pipe that is inserted into the filter as deep as 0.2m, 0.4m, 0.6m is able to reduce the amount of particulate emission air pollutants, gas SO2, NOx, CO, but has not been able to reduce it to below the emission air quality standard. The conclusion is that a cyclone dust collector model of a chimney filter on a public health center incinerator can reduce particulate matter, SO2 gas, NOx, and CO emissions.
Keywords: incinerator; cyclone dust collector; chimney pipe; particles; pollutant gases

INTRODUCTION

The Community Health Center is the technical implementing unit of the district/city service which is responsible for organizing health development in a work area [(1)]. The Community Health Center functions as a referral center for emergency patients before being taken to the hospital[(2)]. The Maospati health center provides health services such as limited operative measures such as traffic accidents, complicated deliveries and other diseases of an emergency nature. The impact that occurs is medical and non-medical waste products with a fairly high volume. The waste problem in the Community Health Center is managed by the incinerator method[(3)]. The combustion method with the Incinerator still causes problems related to air pollution as a result of the process of burning waste in the form of smoke containing gases and particles so that it pollutes the ambient air around[(2,4)].

The incinerator at the Community Health Center is an example of an incinerator used for waste processing. The incinerator model developed is a simple incinerator which is made of a brick building with a length of 1.2 m, a width of 1.2 meters and a height of 1 meter, there are two doors: one door for entering garbage and two doors for taking ash or particles from burning waste[(3,5,6)].The incinerator has one waste combustion chamber and one chimney as high as 2 meters without a chimney filter. Garbage burning is carried out every 2 days, the volume of waste is about 1m, the types of waste that are burned are medical waste and non-medical waste, do not use additional materials to facilitate combustion, such as diesel, premium. The burning process is carried out until all the waste is burned. During the combustion process the floating particles and combustion gases are discharged through the chimney so that they pollute the ambient air around the incerator[(7)]. Dust or combustion particles deposited in the incinerator are discharged through the incinerator door and disposed of in the trash[(6,7)].

The purpose of this study is to design an incinerator that can reduce the number of particles, air pollutant gases emitted from the combustion process which is discharged into the ambient air so as not to pollute the ambient air by installing a chimney filter device with a cyclone dust collector model at the incinerator of the inpatient health center.

METHODS

This type of research is experimental, with a One-shot case study design [(8)]. This research makes a chimney filter design with a cyclon dust collector model and tests are carried out in capturing polluting particles and air pollutant gases[(9)]. The research location is the Community Health Center, Maospati District, Magetan Regency.

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The independent variable is the depth of the pipe that is inserted into the chimney filter as deep as: the first 0.2 m, the second 0.4 m, the third 0.6 m from the starting point of the emission air entering the filter. The dependent variable is particulate matter, air pollutants (CO, SO2, NOx) emissions are discharged into the ambient air through the chimney.

The research implementation stage; (1) Designing the cyclon dust collector chimney filter tool; (2) Making the cyclon dust collector chimney filter device; (3) The assembly stage of the cyclon dust collector chimney filter device; (4) The tool prototype stage chimney filter cyclone dust collector model; (5) The testing phase of the cyclone dust collector chimney filter tool. Data collection was carried out by observing and measuring: 1) The process of burning medical and non-medical waste in the incinerator, 2) Testing the chimney filter model of the cyclone dust collector.

Data analysis with descriptive statistics describes the ability of the cyclone dust collector chimney filter design to reduce polluting particles, air pollutant gas emissions analyzed by particles, pollutant gases that are allowed to be discharged into ambient air, based on quality standards for business emissions and/or waste processing activities.[10]

RESULTS

Cyclone Dust Collector Chimney Filter Design

Cyclone Dust Collector Prototype

Dimensions:
1. Inlet diameter (Emission air duct) = 4 dim
2. Chimney Diameter out let = 4 dim
3. Chimney Height = 2.2 m, 2 m, 1.8 m
4. Diameter of Cyclon Dust Collector Body = 0.5 m
5. Cyclon Dust Collector Height = 1.2 m
6. Emission air duct: Diameter 4 dim,
Length 1.1 m, Height 0.2 m
7.Height of dust collector cone = 0.1 m
8. Diameter of dust collector cone = 4 dim

Figure 1. Cyclone dust collector prototype

Cyclone Dust Collector and Incinerator Prototype

Dimensions:
1. Inlet diameter (Emission air duct) = 4 dim
2. Chimney Diameter out let = 4 dim
3. Chimney Height = 2.2 m, 2 m, 1.8 m
4. Diameter of Cyclon Dust Collector Body = 0.5 m
5. Cyclon Dust Collector Height = 1.2 m
6. Emission air duct: Diameter 4 dim,
Length 1.1 m, Height 0.2 m
7.Height of dust collector cone = 0.1 m
8. Diameter of dust collector cone = 4 dim

Figure 2. Cyclone dust collector and incinerator prototype

From the results of the research in Figure 2 Prototype of Cyclone Dust Collector and Incinerator), the chimney filter body of the cyclone dust collector model has a diameter of 0.5 m, a height of 1.2 m, it is possible for a more perfect centrifugal air movement.

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Body Cyclone Dust Collector

Dimensions:
1.Inlet diameter = 4 dim
2. Diameter of the outlet Chimney = 4 dim
3.Diameter of Body cyclone dust collector = 0.5m
4. Diameter of dust collector cone = 4 dim
5.Height of the outlet cone = 0.2 m
6.Height of Body cyclone dust collector= 1.2 m
7.Height of dust collector cone = 0.1 m

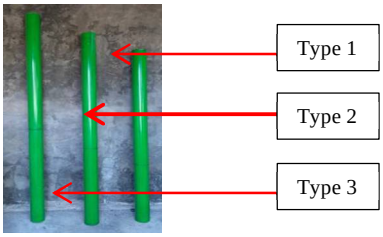
Figure 3. Cyclone dust collector

Emission Air Line / Dirty Air

Dimensions:
1. Diameter 4 dim
2. Length 1.2m
3. Height 0.2m

Figure 4. Air emissions

Cerobong Asap Tipe 1, 2, 3



Dimensions:
a. Diameter 4 dim
b. Type 1, Length 1.8 m
c. Type 2, Length 2 m
d. Type 3, Length 2.2 m

Figure 5. Chimney type 1, 2, 3

Observation of Air Emission from Chimney Filter Model Cyclone Dust Collector

Table 1. Observation of air emission from chimney filter model cyclone dust collector

No	Chimney filter	Observation result
1	Do not use the chimney pipe	Black smoke
2	Using the chimney pipe inserted into the chimney filter:	
	a. 0.2 m depth from the starting point of the emission air entering the filter	Gray smoke
	b. 0.4 m depth from the starting point of the emission air entering the filter	Gray smoke
	c. 0.6 m depth from the starting point of the emission air entering the filter	Gray smoke

From the results of observations of the emission air on the chimney filter without the chimney pipe (table 1) it is blackish. From the results of laboratory examinations (table 2) it is known that the chimney emission air without the chimney pipe contains a total particulate matter of 330 mg/Nm^3. From the results of observations of air emissions in the chimney filter using a chimney pipe as deep as 0.4 m (table 4.1) it is grayish in color.

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Emission Air Quality After Passing Through Chimney Filter Cyclone Dust Collector Model

Table 2. Emission air quality after passing the chimney filter cyclone dust collector model

No	Emission air parameters	Laboratory examination results (mg/Nm³)				Quality standards (mg/Nm³)
		No chimney pipe	With the chimney pipe inserted into the chimney filter as deep as:			
			0.2 m	0.4 m	0.6 m	
1	Total Particulate	330	250	180	125	120
2	Sulfur Dioxide (SO2)	397	316	251	195	210
3	Nitrogen Oxide (NOx)	586	522	490	450	470
4	Carbon monoxide (CO)	831	753	693	630	625

From the results of laboratory examinations (table 2), it is known that the chimney emission air using a chimney pipe is inserted into the chimney filter as deep as 0.6 m, containing a total of 125 mg/Nm³ of particulates.

Percentage of Decrease in Amount of Emission Air Pollutants After Passing Chimney Filter Cyclone Dust Collector Model

Table 3. Percentage of decrease in the amount of air pollutants emissions after passing the chimney filter cyclone dust collector model

No	Emission air parameters	Percentage of reduction in amount of air pollutants emissions % (Laboratory examination results (mg/Nm³)			
		No chimney pipe	Using a chimney pipe inserted into the chimney filter as deep as:		
			0,2 m	0,4 m	0,6 m
1	Total particulate	330	24 / 250	45 / 180	62 / 125
2	Sulfur dioxide (SO2)	397	20 / 316	37 / 251	50 / 195
3	Nitrogen oxide (NOx)	586	10 / 522	17 / 490	23 / 450
4	Carbon monoxide (CO)	831	10 / 753	17 / 693	25 / 630

The results of the laboratory examination showed that there was a decrease in total particulates in the chimney filter by using the chimney pipe compared to not using the chimney pipe (table 3). The percentage reduction is 24% for the chimney pipe that is inserted into the 0.2 m deep filter, 45% for the chimney pipe that is inserted into the 0.4 m deep filter and 62% for the chimney pipe that is inserted into the 0.6 m deep filter.

The results of laboratory examinations showed a decrease in Sulfur Dioxide (SO2) in the chimney filter by using the chimney pipe compared to not using the chimney pipe. The percentage reduction is 20% for the chimney pipe inserted into the 0.2 m deep filter, 37% for the chimney pipe inserted into the 0.4 m deep filter and 50% for the chimney pipe inserted into the 0.6 m deep filter.

The results of laboratory examinations showed that there was a decrease in Nitrogen Oxide (NOx) in the chimney filter using the chimney pipe compared to not using the chimney pipe (table 3). The percentage reduction is 10% for the chimney pipe inserted into the 0.2 m deep filter, 17% for the chimney pipe inserted into the 0.4 m deep filter and 23% for the chimney pipe inserted into the 0.6 m deep filter.

The results of the laboratory examination revealed that there was a decrease in Carbon Monoxide (CO) in the chimney filter using the chimney pipe compared to not using the chimney pipe (table 3). The percentage reduction is 10% for the chimney pipe inserted into the 0.2 m deep filter, 17% for the chimney pipe inserted into the 0.4 m deep filter and 25% for the chimney pipe inserted into the 0.6 m deep filter.

DISCUSSION

Prototipe Cyclone Dust Collector

The prototype design of the Cyclone Dust Collector and Incinerator is shown in Figure 2. Making the chimney filter body of the cyclone dust collector model with a diameter of 0.5 m, a height of 1.2 m, allowing for more perfect centrifugal air movement. The results of research by Muhammad F, et al., 2019, stated that the work of a cyclone is to utilize the principle of centrifugal rotation, where air particles are flowed and rotated in a conical circular tube, so that particles with a greater density will move away from the center of the circle and then

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experience gravitational force to the bottom of the cone. [11,12]. Another source also stated that centrifugal air movement made it possible for the binding of emission air pollutants or primary pollutants (particles, CO, SO2, NOx) to be more perfect. Elements of carbon, sulfur, nitrogen will combine with oxygen or element O to form carbon monoxide (CO), sulfur oxides (SO2), nitrogen oxides (NOx). With the movement of centrifugal air, it is possible for a binding reaction to occur between the particles and will form larger-sized particles and with the influence of earth's gravity, the particles will settle on the dust collector [13]. With the movement of centrifugal air, it is possible for particles and gases of CO, SO2, NOx to collide with the body wall of the cyclone dust collector so that the particles and gases will stick to the body wall of the cyclone dust collector. Particles and gases that are not attached to the body wall of the cyclone dust collector will be discharged into the ambient air through the chimney pipe [13,14].

Emission Air Quality After Passing Through Chimney Filter Cyclone Dust Collector Model

The results of the research on the results of air emissions (table 2) showed that the exhaust air from the chimney without the chimney pipe contained a total particulate matter of 330 mg/Nm³. This particulate value is above the required particulate emission quality standard for thermal waste processing business and/or activity, which is 120 mg/Nm³, Sulfur Dioxide (SO2) 397 mg/Nm³ higher than required. which is 210 mg/Nm³, Nitrogen Oxide (NOx) 586 mg/Nm³ is higher than the required 470 mg/Nm³, Carbon Monoxide (CO) 831 mg/Nm is higher than that required by the MoEF Regulation, which is 625 mg/Nm³. The results of this study indicate that the cyclone dust collector chimney filter without the chimney pipe has not been able to reduce the amount of air pollutants emitted by particulates, SO2, NOx and CO gases below the emission air quality standards required by the Minister of Environment and Forestry RI NUMBER P.70/MENLHK/SETJEN/ KUM.1/8/2016[4,9,15-17].

The results of the observation of the emission air on the chimney filter using a chimney pipe as deep as 0.2 m (table 1) are grayish in color. The results of laboratory examinations (table 4.2) revealed that the flue emission air using a chimney pipe was inserted into the chimney filter as deep as 0.2 m, containing a total of 250 mg/Nm³ of particulates. This particulate value is above the required particulate [4,9]. Regarding the emission quality standard for business and/or thermal waste processing activities, namely 120 mg/Nm³, Sulfur Dioxide (SO2) 316 mg/Nm³ higher than the quality standard, which is 210 mg/Nm³, Nitrogen Oxide (NOx) 522 mg/ Nm³ is higher than the required 470 mg/Nm, Carbon Monoxide (CO) 753 mg/Nm is higher than the required 625 mg/Nm³. The design results of making a cyclone dust collector chimney filter using a chimney pipe that is inserted into a chimney filter as deep as 0.2 m have not been able to reduce the amount of air pollutant emissions of particulates, SO2, NOx and CO gases below the emission air quality standards required by the Ministerial Regulation. LHK RI NUMBER P.70/MENLHK/SETJEN/KUM.1/8/2016[4,9,18].

The results of observations of chimney emission air using a chimney pipe inserted into the chimney filter as deep as 0.4 m, (table 2) total particulates 180 mg/Nm³. This particulate value is above the required particulate quality standard for business and/or thermal waste processing activities, which is 120 mg/Nm³. The yield of elemental Sulfur Dioxide (SO2) 251 mg/Nm³ is higher than the required 210 mg/Nm³, Nitrogen Oxide (NOx) 490 mg/Nm³ is higher than the required 470 mg/Nm³, Carbon Monoxide (CO) 693 mg /Nm³ is higher than the required 625 mg/Nm³. The design of the cyclone dust collector chimney filter using a chimney pipe inserted into the chimney filter as deep as 0.4 m has not been able to reduce the amount of air pollutant emissions of particulates, SO2, NOx and CO gases below the emission air quality standards required by the LHK Ministerial Regulation. RI NUMBER P.70/MENLHK/SETJEN/KUM.1/8/2016 [4,17,19].

The results of the laboratory examination of chimney emission air using a chimney pipe inserted into the chimney filter as deep as 0.6 m (table 2) revealed that the total particulates were 125 mg/Nm³. This particulate value is above the required particulate emission quality standard for thermal waste processing business and/or activity, which is 120 mg/Nm³, Sulfur Dioxide (SO2) 195 mg/Nm³ lower than the required amount, which is 210 mg/Nm³, Nitrogen Oxide (NOx) 450 mg/Nm lower than the required 470 mg/Nm, Carbon Monoxide (CO) 630 mg/Nm higher than the required 625 mg/Nm³.

Another study on the design of the cyclone dust collector chimney filter using a chimney pipe inserted into the chimney filter as deep as 0.6 m has not been able to reduce the amount of air pollutant emissions of particulates and CO gas below the emission air quality standard required by the quality standard, but has been able to reduce SO2, NOx gas below the emission air quality standard [4,17]. The ability of a cyclone dust collector chimney filter that does not use a chimney pipe and uses a chimney pipe that is inserted into the chimney filter as deep as 0.2 m, 0.4 m has not been able to reduce the amount of air pollutants emitted by particulates, SO2 gas, NOx and CO are below the emission air quality standard (15,16). Only the chimney filter of the cyclone dust collector model uses a chimney pipe that is inserted into the filter deeper so as to reduce the amount of emission air pollutants in the form of SO2 and NOx gases to below the required emission air quality standards [20].

Persentase kemampuan filter cerobong asap model *cyclone dust collector* menurunkan jumlah bahan pencemar udara emisi

The results of the study based on laboratory examinations showed that there was a decrease in total particulates in the chimney filter that used the chimney pipe compared to that which did not use the chimney pipe (table 3). The percentage reduction is 24% for the chimney pipe inserted into the 0.2 m deep filter, 45% for the chimney pipe inserted into the 0.4 m deep filter and 62% for the chimney pipe inserted into the 0.6 m deep filter. The chimney filter design is a cyclone dust collector model with a larger depth that is able to capture emission air pollutants in the form of particulates, Sulfur Dioxide (SO2) gas, Nitrogen Oxides (NOx) and Carbon Monoxide (CO), thereby reducing the amount of air pollutant emissions. which is discharged into the ambient air [14,15,21]. By installing a chimney pipe on this filter, which is inserted into the body of the cyclone dust collector, the deeper the pipe is inserted into the body of the cyclone dust collector, the greater the filter's ability to reduce the amount of air pollutant emissions [4,14,21].

CONCLUSION

The chimney filter of the cyclone dust collector model is able to capture emission air pollutants in the form of particulates, Sulfur Dioxide (SO2), Nitrogen Oxides (NOx) and Carbon Monoxide (CO), thereby reducing the amount of emission air pollutants released into the ambient air. By installing a chimney pipe on the filter body, which is inserted into the body filter (cyclone dust collector), the deeper the pipe is inserted into the filter body, the greater the filter's ability to reduce the amount of air pollutant emissions.

The cyclone dust collector chimney filter that uses a chimney pipe inserted into the filter body as deep as 0.6 m is able to reduce the amount of air pollutant emissions in the form of SO2 and NOx gases to below the required emission air quality standards, but has not been able to reduce particulates and CO gas is below the quality standard.

The recommendation of this study is that the chimney filter of the cyclone dust collector model should use a chimney pipe that is inserted deeper into the filter body, because the deeper the chimney pipe enters the filter body, the greater the filter's ability to capture emission air pollutants.

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