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Design and Constructions an Environmentally Friendly Waste Destruction Incinerator Machine for Environmental Cleanliness of The University of Mataram Campus

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ABSTRACT: Waste is a problem that is widely discussed by all groups about the management system to become useful materials and provide added value for the community around the final disposal site (TPA), [8]. Waste management is a systematic, comprehensive, and continuous activity that includes waste reduction and handling. The solution offered by the waste disposal system uses an environmentally friendly waste incinerator machine used around the campus environment to reduce piles and piles, [2]. Waste disposal using the incinerator system is waste management using a combustion system in a closed space so that the smoke pollution caused can be cleaned by filtration which is sprayed through a nozzle, [3].
Research Objectives: 1. Designing an environmentally friendly waste incinerator machine; 2. Knowing the performance of an environmentally friendly waste incinerator machine; 3. Knowing the level of cleanliness of the curve on the machine's chimney; 4. Knowing the efficiency of the work of an environmentally friendly waste incinerator machine.
Benefits of the research: 1. Application of practical technology for the community in the use of environmentally friendly waste incinerator machines; 2. Obtain specific information related to the design of an environmentally friendly waste incinerator machine. Time and Place: The research was conducted from June to November 2024. The activities were carried out at the Agricultural Power and Machinery Laboratory, Faculty of Food Technology and Agroindustry, University of Mataram.
Research Materials and Tools: The materials needed for the research include: Waste and Tools used: Waste incinerator machine, digital vernier caliper, digital thermometer, pollution measuring instrument, etc.
Research Method: Carried out in several stages, namely observation of waste destruction activities and direct data collection in the field (Experimental).
Results and Discussion: Carrying out a design with a process of describing in detail the design of an environmentally friendly waste incinerator machine; Incinerator mechanical engineering construction is a construction that involves a structure that has been planned or designed specifically so that it will be made to meet the needs of the community. Incinerator is a waste recycling tool that uses a combustion method to reduce the volume of waste and turn it into ash, waste is burned at a temperature of around 850°C, the combustion process produces heat energy that can be used for other energy.

KEYWORDS: Design, Environmentally Friendly, Incinerator Machine, Waste Destroyer.

INTRODUCTION

Waste is one of the most urgent problems in polluting the environment, both urban environments also occur in rural areas and on educational campuses due to the activities and population growth and increasing development so that it can result in a very high increase in waste production. This is due to the increasing development of campus community activities and activities. In line with the dynamics of development and campus community activities that are increasing rapidly, it can make a very large contribution to producing waste [2]. This condition has had an impact on the quality of environmental cleanliness and even conflicts often occur between communities regarding the placement or disposal of the waste [1].

B3 Waste Management is an activity that includes reduction, storage, collection, transportation, utilization, processing, and/or landfill (https://www.google.com, Ministry of Environment B3 Waste accessed on January 18, 2022), [1]. With this problem, a solution is needed for handling waste processing so that it can provide added value and even livelihoods for the community around the Temporary Disposal Site (TPS) and Final Disposal Site (TPA), [8]. Waste is unwanted residual material after the end of a production/consumption process, but in the natural process, the term waste is not known. Waste is material that has no value or is

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worthless for the usual or primary purpose in the manufacture or use of goods that are damaged or defective in manufacturing production or excess or rejected or discarded material, [3].

Waste management that has been ongoing until now is predominantly based on the perspective that waste has not been managed as a resource, but rather on the perspective of disposing of waste at the final waste disposal site. Waste generated from daily activities is disposed of at the final waste disposal site which is then left in the natural cycle process. This condition places a heavy burden on the final waste disposal site. This process requires funds, energy, time and space to manage it, [4].

Various activities and technical studies that have been carried out by the government and the community for the processing and placement of this waste, but have not been able to be addressed properly for its handling because the level of increase in waste volume is still a problem that requires effective, environmentally friendly and sustainable alternative solutions that can have an impact on reducing waste accumulation and can provide positive impacts both from the economic and socio-cultural aspects of the community, including the conversion of waste into energy sources, [5]. Thus, it is necessary to carry out waste management that is formulated and designed into a model and mechanism in the form of waste management that is more environmentally friendly, so it is necessary to handle waste management with the principles of sustainable and environmentally aware development. In this case, it is necessary to support policies and regulations that support, cooperation between parties and community participation, [6]. The solution offered in dealing with this waste is one of the waste processing methods, namely by burning it in a closed space with an incineration machine, [9]. Incineration is used because there will be environmental pollution at the landfill and there is also limited land as a final disposal site. The incineration combustion system has the advantage of using waste materials as fuel and does not require large energy as a burner, [10]. The incineration system has the advantage of being more environmentally friendly, capable of reducing waste volume by more than 90% in a relatively short time, and can detoxify pathogenic materials up to 100%. In addition, the incineration system also has heat from combustion that can be used as an energy source, [11]. This incineration combustion system is carried out in an environmentally friendly waste incinerator machine designed with smoke cleaning system equipment that will be processed into water vapor, [12].

RESEARCH DESIGN AND METHODOLOGY

Research Materials and Tools: The materials needed to support this research include: Waste and Tools used are Waste Incinerator Machine, digital vernier caliper, digital thermometer, pollution measuring tool, etc. Research Methodology: This research will be conducted in several stages, namely observation of waste destruction activities and direct data collection in the field (Experimental). Then continued with the design of an environmentally friendly waste incinerator machine with the following stages:

1. Designing and drawing and determining the dimensions of an environmentally friendly waste incinerator machine.
2. Constructing an environmentally friendly waste incinerator machine.
3. Testing an environmentally friendly waste incinerator machine.

RESULTS AND DISCUSSION

Designing and determining the dimensions of an environmentally friendly waste incinerator machine.

Making a design by describing in detail the design of an environmentally friendly waste incinerator machine. Drawing the design of this environmentally friendly waste incinerator machine using the Autocad program which can display detailed machine dimensions which are poured into complete engineering drawings with: planning machine elements, determining the description of the dimensions and size of the incinerator machine. Designing an environmentally friendly incinerator machine, there are several important aspects that need to be considered, namely: 1. Energy Efficiency: Ensuring that the energy generated from the combustion process can be utilized optimally, for example to generate electricity or steam. 2. Emission Reduction: Using an air pollution control system (Air Pollution Control system) to minimize emissions of hazardous gases such as sulfur dioxide, nitrogen oxide, hydrochloric acid, and dioxin. 3. Ash Processing: Ensuring that the ash generated from the combustion process is clean and can be recycled or used for other purposes.

Image: Design and dimensions of an environmentally friendly waste incinerator machine.

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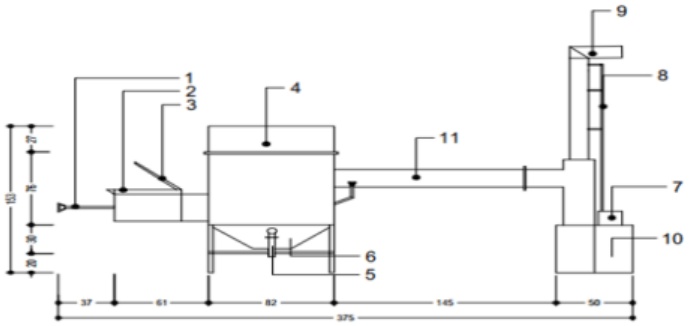

NO :	KETERANGAN :
1	PENDORONG BAHAN
2	INPUT BAHAN
3	HOOPER/PENUTUP
4	REAKTOR GASIFIKASI
5	TEMPAT BLOWER
6	OUTPUT BERUPA ABU
7	MESIN AIR
8	PIPA DISTRIBUSI AIR
9	OUTPUT SYNGAS
10	TAMPUNGAN AIR
11	PIPA SALURAN UDARA

Construction of an environmentally friendly waste incinerator machine.

The construction of an incinerator machine is a construction that involves a structure that has been planned or designed specifically so that it will be made to meet the needs of the community. An incinerator is a waste recycling tool that uses a combustion method to reduce the volume of waste and turn it into ash. This machine has several stages in its process: 1. Pre-treatment: Waste is managed according to the type of incinerator before being burned. Fluidized bed incinerators require a waste sorting process to calculate waste calories and determine the quality of the waste. Movable grate incinerators do not require sorting, but require waste to be shredded first; 2. Combustion: After the pre-treatment stage, the waste is burned at a temperature of around 850 ° C; The combustion process produces heat energy and bottom ash.; 3. Energy Recovery: The process of burning waste at high temperatures not only destroys waste, but also produces heat energy. This energy can be used as an energy source in the form of heat, electricity, and steam; 4. Exhaust Gas Handling: In addition to heat energy, the incineration process produces exhaust gas containing hazardous substances. Modern incinerators are equipped with exhaust gas processing technology to minimize air pollution. Although incinerators can help solve the waste problem, there are still pros and cons regarding the benefits and environmental impacts caused. Therefore, careful consideration is needed in its use.

Picture of the incinerator machine part:

Testing of waste incinerator machines.

Incinerator machine testing is carried out by implementing a combustion technology system in a closed space which is used to reduce the volume of waste by burning at high temperatures of up to 1200 0C. This Incinerator machine can process various types of waste, including solid waste and B3 waste (Hazardous and Toxic Materials). The working process of the incineration machine can be carried out in several activities such as pre-treatment, combustion, energy recovery, cleaning the environment from smoke and the process of handling exhaust gas and utilizing soot and ash waste from the combustion results. Testing of waste incinerator

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machines involves several important aspects to ensure the efficiency and safety of the combustion process. Some of the main points carried out in the test:

1. Combustion Temperature is the high temperature needed to ensure that the waste burns perfectly to reach a combustion temperature ranging from 800 ° C to 1200 ° C.
2. Combustion Time is the duration of combustion to ensure that all materials are burned completely.
3. Combustion Efficiency is measuring the effectiveness of the incinerator in reducing the volume of waste and producing minimal ash and high combustion means less residue remaining.
4. Gas Emissions are Testing gas emissions such as CO, CO2, SO2, NO2, and other particles is also very important to ensure that the incinerator does not pollute the air and environment because the technology of filtering and pollution control, is used to reduce the negative impact on the environment.
5. Pollution Control is a modern Incinerator system is equipped with technology to control air pollution, such as filters and scrubbers, to ensure that gas and dust emissions remain at safe levels.
6. Waste Volume Reduction is the combustion process converts waste into ash and gas, which significantly reduces the volume of waste and helps reduce the burden on landfills.

This test is very important to ensure that the incinerator is functioning properly and safely, and complies with applicable environmental standards.

Data on the results of the combustion pollution level test from the waste incinerator machine.

No	Weight of waste material (Kg)	Burning time (Menit)	Nominal Value	Air pollution level from Incinerator chimney (sensor co_2).		
				Nozzle 1	*Nozzle* 2	*Nozzle* 3
1	30	10	Maximum	602	613	530
2			Minimum	598	610	528
3		20	Maximum	596	585	515
4			Minimum	564	583	513
5		30	Maximum	563	554	511
6			Minimum	562	552	509
7	30	10	Maximum	604	582	538
8			Minimum	601	581	536
9		20	Maximum	552	551	526
10			Minimum	551	550	525
11		30	Maximum	546	559	514
12			Minimum	545	557	513
13	30	10	Maximum	611	571	528
14			Minimum	610	570	527
15		20	Maximum	546	526	517
16			Minimum	545	525	513
17		30	Maximum	531	512	510
18			Minimum	530	511	511

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Knowing the performance of environmentally friendly waste incinerator machines.

Incinerator

An incinerator is a waste recycling tool by burning waste at very high temperatures. This tool is used to recycle waste on a large scale and is capable of burning solid waste such as plastic, B3 waste, and residual waste. The waste burning process with an incinerator involves several stages: Pre-treatment: Waste is managed according to the type of incinerator before being burned, [13]. Fluidized bed incinerators require a waste sorting process to calculate waste calories, while movable grate incinerators do not require sorting, but require waste to be shredded first. Combustion: After the pre-treatment stage, waste is burned at a temperature of around 850°C. The combustion process produces heat energy and bottom ash. Energy Recovery: The process of burning waste at high temperatures not only destroys waste, but also produces heat energy. This energy must be cooled using a boiler, and can then be used as an energy source in the form of heat, electricity, and steam. Exhaust Gas Handling: In addition to heat energy, the incineration process produces exhaust gas. Modern incinerators are equipped with waste processing technology to minimize air pollution. This technology removes hazardous compounds such as sulfur dioxide, nitrogen oxides, hydrochloric acid, and dioxins. However, it should be noted that incinerators also have environmental impacts that need to be considered: Emissions: Incinerators emit a variety of air pollutants, including nitrogen oxides, sulfur dioxide, particles, lead, mercury, dioxins, and furans. These pollutants have an impact on public health and the environment, but this waste incinerator is designed to be equipped with water spray nozzles to clean pollutants. Impact on Recycling: The use of incinerators can affect the amount of waste recycled. Some areas with incinerator contracts have low recycling rates, [14]. Efficient and environmentally friendly waste management must be a priority in an effort to maintain a balance between sustainability and human and environmental well-being.

Measuring the speed of waste input into the Incinerator

Table: Results of measuring the average input speed of waste in the incinerator and capacity.

Treatment	Waste Material Weight (Kg)	Average	
		Input time (minutes)	Working capacity (kg/min)
1	10	3,84	2,60
2	10	3,25	3,09

Measuring the waste input speed (Kg/minute). Measuring the waste input speed in the Incinerator can calculate the amount of waste that enters in a certain unit of time. Here is some information related to measuring the waste input speed in the Incinerator: 1. Measurement Method: The waste input speed can be measured in kilograms per minute (Kg/minute); 1. Measuring the average amount of waste entered into the Incinerator during a period of 3.84 minutes with a waste weight of 10 kilograms and the second 10 kilogram waste input takes 3.25 minutes into the waste incineration chamber. This measurement will help in the planning and management of waste collection. By knowing the waste input speed, it can ensure that the incinerator is used efficiently according to the machine capacity.

Measuring the average blower rotation speed (rpm).

Table 1: First blower rotation speed (1)

Weight of waste (kg)	Air ventilation opening (cm)	Blower Rotation (rpm) time (minutes)			Average blower speed (rpm)
		5	10	15	
10	Full Open	1594,2	1549,1	1634,7	1592,67
10	Half Open	1313,3	1687	1489,2	1496,50
10	Full Close	1289,7	1214,1	1238,5	1247,43

Table 2. Blower rotation speed two (2)

Waste weight	Window	Blower Rotation (rpm) Time/minute	Average

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(kg)	opening (cm)	5	10	15	blower speed (rpm)
10	Full Open	1534,9	1569,1	1533,2	1545,73
10	Half Open	1251,5	1217	1134,3	1200,93
10	Full Close	1074,3	1198,4	1098,2	1123,63

Observation results: The table above shows three variations of ventilation openings at blower rotation speed, namely:
1. Blower rotation speed of one (1) at a waste weight of 10 kg with full air ventilation openings at five minutes (5 minutes) there is an average blower rotation speed of 1594.2 rpm, at 10 minutes there is an average blower rotation speed of 1549.1 rpm and at 15 minutes there is an average blower rotation speed of 1634.7 rpm, so that the average blower rotation speed is 1592.67 rpm. The rotation speed of blower two (2) at a waste weight of 10 kg with full air ventilation opening at 5 minutes there is an average blower rotation speed of 1534.9 rpm, at 10 minutes there is an average blower rotation speed of 1569.1 rpm and at 15 minutes there is an average blower rotation speed of 1489.2 rpm, so that the average blower rotation speed is 1545.73 rpm. 2. The rotation speed of blower one (1) at a waste weight of 10 kg with half air ventilation opening at five minutes (5 minutes) there is an average blower rotation speed of 1313.3 rpm, at 10 minutes there is an average blower rotation speed of 1687 rpm and at 15 minutes there is an average blower rotation speed of 1489.2 rpm, so that the average blower rotation speed is 1496.50 rpm. The rotation speed of blower two (2) at a waste weight of 10 kg with half air ventilation opening at 5 minutes there is an average blower rotation speed of 1074.3 rpm, at 10 minutes there is an average blower rotation speed of 1198.4 rpm and at 15 minutes there is an average blower rotation speed of 1098.2 rpm, so that the average blower rotation speed is rpm. 3. The rotation speed of blower one (1) at a waste weight of 10 kg with closed air ventilation at five minutes (5 minutes) there is an average blower rotation speed of 1289.7 rpm, at 10 minutes there is an average blower rotation speed of 1214.1 rpm and at 15 minutes there is an average blower rotation speed of 1238.5 rpm, so that the average blower rotation speed is 1247.43 rpm. The rotation speed of the blower two (2) at a waste weight of 10 kg with closed air ventilation at 5 minutes there is an average blower rotation speed of 1074.3 rpm, at 10 minutes there is an average blower rotation speed of 1198.4 rpm and at 15 minutes there is an average blower rotation speed of 1098.2 rpm, so that the average blower rotation speed is 1123.63 rpm.

Measuring the average speed of air flow from the blower (Km / hour).

Table 1: Air speed of the first blower(1)

Waste weight (kg)	Air ventilation opening (cm)	Air flow speed (km/h) and time (minutes)			Average airflow velocity (km/h)
		5	10	15	
10	Full Open	15,94	15,19	15,81	15,65
10	Half Open	12,28	12,84	13,23	12,78
10	Full Close	11,25	10,57	10,24	10,69

Table 2: Air speed at blower two(2)

Waste weight (kg)	Air ventilation opening (cm)	Air flow speed (km/h) and time (minutes)			Average airflow velocity (km/h)
		5	10	15	
10	Full Open	15,44	15,03	15,48	15,32
10	Half Open	13,71	14,48	15,30	14,5
10	Full Close	10,91	10,65	10,80	10,79

Observation results: The table above shows three variations of ventilation openings at the air speed of the blower rotation, namely:

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1. The air flow speed from one (1) blower rotation at a waste weight of 10 kg with full air ventilation openings at five minutes (5 minutes) there is an average air flow speed of 15.94 km/hour, at 10 minutes there is an average air flow speed of 15.19 km/hour and at 15 minutes there is an average air flow speed of 15.81 km/hour, so that the average air flow speed from the blower rotation is 15.65 km/hour. The air speed from the two (2) blower rotations at a waste weight of 10 kg with full air ventilation openings at 5 minutes there is an average air flow speed from the blower rotation of 15.44 km/hour, at 10 minutes there is an average air flow speed from the blower rotation of 15.03 km/hour and at 15 minutes there is an average air flow speed of 15.48 km/hour, so that the average air flow speed from the blower rotation is 15.32 km/hour. 2. The air flow speed from one (1) blower rotation at a waste weight of 10 kg with half the air ventilation opening at five minutes (5 minutes) there is an average air flow speed from the blower rotation of 12.28 km/hour, at 10 minutes there is an average air flow speed from the blower rotation of 12.84 km/hour and at 15 minutes there is an average air flow speed of 13.23 km/hour, so that the average air flow speed from the blower rotation is 12.78 km/hour. The air flow speed from two (2) blower rotations at a waste weight of 10 kg with half the air ventilation opening at 5 minutes there is an average air flow speed from the blower rotation of 13.71 km/hour, at 10 minutes there is an average air flow speed from the blower rotation of 14.48 km/hour and at 15 minutes there is an average air flow speed of 15.30 km/hour, so the average air flow speed from the blower rotation is 11.5 km/hour. 3. The air flow speed from one (1) blower rotation at a waste weight of 10 kg with closed air ventilation at a time of five minutes (5 minutes) there is an average air flow speed from the blower rotation of 11.25 km/hour, at a time of 10 minutes there is an average air flow speed from the blower rotation of 10.57 km/hour and at a time of 15 minutes there is an average air flow speed of 10.24 km/hour, so that the average air flow speed from the blower rotation is 10.69 km/hour. The air flow speed from two (2) blower rotations at a waste weight of 10 kg with closed air ventilation at 5 minutes there is an average air flow speed from the blower rotation of 10.91 km/hour, at 10 minutes there is an average air flow speed from the blower rotation of 10.65 km/hour and at 15 minutes there is an average air flow speed of 10.80 km/hour, so that the average air flow speed from the blower rotation is 10.79 km/hour.

CONCLUSION

This study can be concluded, the results of the trial of an environmentally friendly incinerator machine, there are several important aspects obtained, namely: 1. Energy Efficiency: Ensuring that the energy generated from the combustion process can be utilized optimally to produce perfect combustion that can destroy waste quickly. 2. Emission Reduction: Using an air pollution control system (Air Pollution Control system) to minimize emissions of hazardous gases such as sulfur dioxide, nitrogen oxide, hydrochloric acid, and dioxin. 3. Ash Processing: Ensuring that the ash produced from the combustion process is clean and can be recycled or used for other purposes. This can be seen from the amount of input volume of waste reaching an average of 2.60 and 3.09 Kg/minute at a waste material weight of 10 Kg each with a time of 3.84 and 3.25 minutes. Furthermore, from the test results, the environmentally friendly waste incinerator machine produces a destruction capacity of 156 and 185.4 kg/hour.

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