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Article

Design and Construction of a Stove Using Used Oil

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AB S T RA CT

The tool design stage uses the help of the AutoCAD application. The next stage is the manufacture of used oil-fueled stoves. Followed by testing the used oil-fueled stove. Based on the results of the two stoves that have been tested above, it is concluded that the time to boil 5 liters of water in a used oil-fired stove is 2 minutes faster than a gas stove, this can be proven in the results, namely the time to boil water in a used oil-fired stove is 7 minutes, while the time it takes to boil water in a gas stove is 9 minutes. The stove that is produced is able to be an alternative when the price of fuel in the form of gas burns so that it can be a solution for cooking with fuel at an affordable price. Researchers need to pay more attention to the selection of stove wall coating materials so as not to conduct excessive heat.

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1. BACKGROUND

1.1 Introduction

The increasing use of motor vehicles is the main factor causing the increasing volume of waste oil.

Used oil waste from motor vehicles in quite large quantities can be used as fuel either directly or through recycling, both on a small and large industrial scale.

The above explanation is one of the causal factors in the increasing volume of waste oil, which requires effective waste management to prevent environmental pollution (Pratama et al. 2020) . One way to manage used oil waste is to use it as an alternative fuel for cooking stoves.

Meanwhile, kerosene can currently be considered a rare commodity, and subsidies on it are likely to be reduced or even stopped due to the switch to gas. This is expected to be difficult, especially for low-income people, considering that kerosene prices tend to rise, especially in areas far from urban areas.

Efforts continue to be made in the search for alternative energy to reduce fuel consumption, especially in motor vehicles. Some alternative fuels that have been used to overcome dependence on fossil fuels include *gas fuel* , *biofuel*, and *cell fuel* . However, even though these efforts have been made, the number of alternative energy sources is still insufficient to meet the world's energy needs, especially with the continued development (Arif et al. 2021) .

One of the treatments that can reduce the waste oil is to make it as fuel for the stove as an alternative energy. Used oil stove is a stove that uses used oil fuel, this stove mechanism is not much different from other stoves, because this stove needs to heat the furnace first and requires *a blower* as a tool to blow the wind so that the fire is stable.

1.2 Research Purposes

a. Developing a prototype stove using used oil as fuel.
b. Evaluate its efficiency compared to conventional stoves.
c. Assess its potential in reducing environmental waste.

2. LITERATURE REVIEW

2.1 Design

Design is a series of procedures to translate the results of a system analysis into a programming language, with the aim of describing in detail how the components of the system will be implemented. Meanwhile, system development includes activities to create, replace, or repair existing systems, either in whole or in part. Design is closely related to system design, which is a unity in the process of designing and building an application, Taufik Ramadhan in (Siregar & Sari 2018) .

So, design is a planning process that describes a systematic sequence of activities related to a program or application. Design is also related to system design, where it functions as a translator of analysis results into software used to create or improve the system.

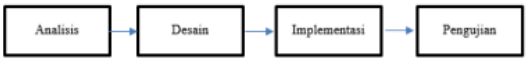


Figure 1. Design and Construction Flow
(Source: Rahardi and Aminuddin 2021)

2.2 Used Oil and Its Potential

Used oil is included in the category of B3 waste, which can be used but can harm the environment if not managed properly **.** According to Government Regulation No. 101 of 2014, B3 waste is the remains of businesses and/or activities that contain hazardous and/or toxic materials that can pollute and/or damage the environment and/or endanger health, human survival, and other living things. In addition, waste that is included in B3 waste is waste that has one or more of the following characteristics: explosive, flammable, reactive, toxic, corrosive, infectious, and others.

2.3 Waste Oil Handling

Decree of the Head of the Environmental Impact Management Agency (Bapedal) Number Kep-03/BAPEDAL/09/1995 of September 5, 1995 concerning the processing of B3 waste Technical Requirements for the Processing of Hazardous and Toxic Material Waste: B3 waste is processed in the following manner: collected in the laboratory, taken from the laboratory, temporarily stored in a temporary storage warehouse, and transported to the final processor, which is an authorized institution appointed by the government (Minister of Health of the Republic of Indonesia 2014)

Given the many potential hazards of B3 waste, the process of storing and transporting B3 waste temporarily to the final processor must follow several storage and transport requirements. This is done to ensure the safety and security of the process.

Storage and transportation requirements can be followed by looking at the characteristics and

potential hazards of each B3 waste. This B3 waste characterization will later be used to determine the treatment in the temporary storage process and packaging when the transportation process will be carried out .

As defined by the Republic of Indonesia Regulation no. 101 of 2014, B3 waste management includes all actions such as reduction, storage , collection, transportation, utilization, processing, and/or landfill of waste.

2.4 Used Oil Fueled Stove

A stove is a cooking tool that produces high heat. The stove has a closed/isolated space from the outside as a place where fuel is processed to provide heating for items placed on it. Some examples of existing research designs:

Figure 2. Aluminum Melting Stove with 5 kg Capacity Using a Combination of Vaporizing and *Air Atomizing Burners* with Waste Oil Fuel

Source: (supriyadi)

Figure 3. Research on Stoves Using Used Oil Fuel and Addition of Water Vapor

Source: (Mafruddin Et Al. 2022)

Figure 4. Stove made from used oil

Source: (Akmal, Turmizi, and Yusuf 2023)

Based on the image above, the design, design and dimensions of the stove are quite large and difficult to move and use a blower with quite a large power.

3. METHODOLOGY

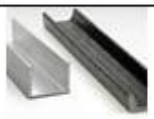
Research on making used oil stoves was carried out in stages. The research began with literature studies and observations carried out simultaneously to obtain a selection of tools, materials and processes for making used oil stoves. The design stage of the tool was carried out using the AutoCAD application . The next stage was making used oil stoves. Followed by testing used oil stoves .

The data analysis technique was carried out by testing the stove by boiling 5 liters of water, testing the blower fan speed, and comparing a used oil-fueled stove with a gas stove.

3.1 Material Selection

a. Morphology of Used Oil Fueled Stoves

Table 1. Stove Morphology Fueled by Used Oil

No.	Sub Komponen	Varian yang mungkin	
		A	B
1.	Profil Rangka Kompor	 (Profil U)	 (Profil L)
2.	Sistem Penggerak Angin	 (*Blower Mini High Speed DC 12 v*)	 (*Blower* AC 220 v)
3.	Ruang pembakaran	 (Tanah Liat/Tembikar)	 (Potongan Pipa 4 Inch)
4.	Tabung Oli	 (Terbuat Dari Pipa Besi)	 (Jerigen)
5.	Sambungan pipa buang	 (Sambungan *elbow*)	 (*Socket ½ inch*)

b. Tools and materials

Table 2. Tools and Materials

Tool	Material
a. Welding machine b. Ground cable c. Mass clamp d. Electrode Cable e. Electrode f. *Holder* g. Welding hammer h. Steel brush i. Meter j. Grinding k. Electric drill l. *Spray gun* m. Compressor n. Screwdriver	a. Iron plate b. Pipe galvanized c. Galvanized iron socket d. 12v mini blower e. Hollow iron f. Stop the tap g. Sandpaper h. Bolt

3.2 Design Planning Process

In this design, more effective and efficient materials are used to facilitate the cooking process and utilize used oil waste. The design dimensions will be designed using the *AutoCAD application* .

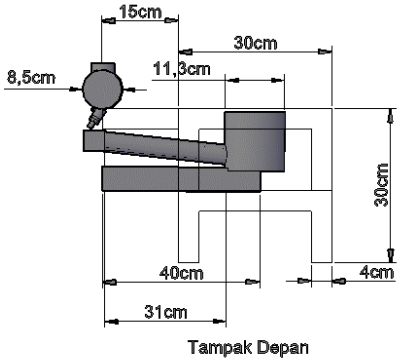


Figure 5. Front View Dimensions

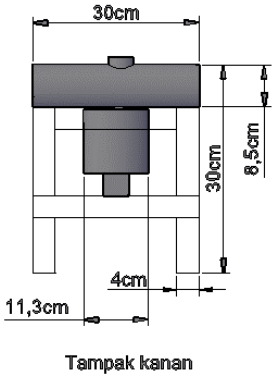


Figure 6. Right View Dimensions

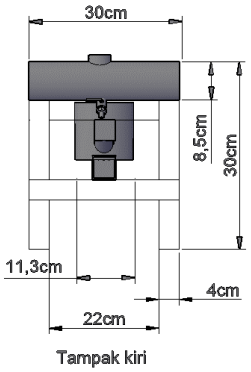


Figure 7. Left View Dimensions

4. RESULT AND DISCUSSION

4.1 Process of Making a Stove Using Used Oil

1. Stove frame

The frame of the used oil stove is the main structural component that supports the entire stove, ensuring stability and safety during use. There are components attached to the stove frame such as the combustion chamber, air duct, oil duct and oil tube. The function of this component is as the main frame. The frame of this stove is made of 4cm x 4cm L-angle iron with a height, width and length of 30cm each. Shown in the following picture:

Figure 8. Stove Frame Construction Results

2. Combustion chamber

The combustion chamber of a used oil stove is one of the key components that functions to convert chemical energy from used oil into heat energy that can be used for cooking or other purposes. There are two inlet pipes and one air outlet pipe, namely the used oil inlet and the air outlet from the blower which are directly connected to the combustion chamber, and the air outlet which is inside the combustion chamber. This combustion chamber is made of 4-inch iron pipe with a height of 15 cm, the oil inlet is made of 1.5 cm hollow pipe with a length of 40 cm, the air outlet is made of 4 cm hollow pipe with a length of 40 cm, and the air outlet is made of ½ inch iron pipe with a length of 13 cm.

Figure 9. Combustion Chamber

3. Oil Tank

The oil tank on a used oil stove is an important component that functions as a container for storing and distributing used oil to the combustion chamber. There is a stop valve with a ball valve type that functions as a regulator of oil flow from the used oil storage tank to the oil line that is directly connected to the combustion chamber of the stove.

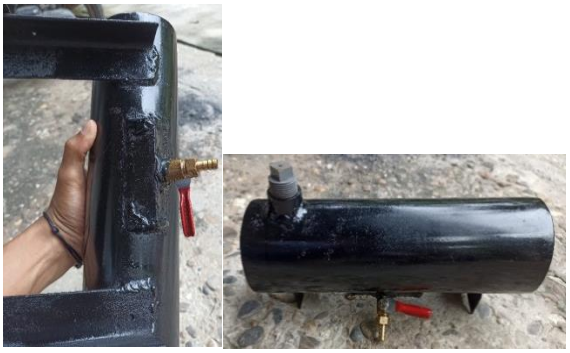


Figure 10. Oil Tank

4. Finishing

After all parts of the stove are finished, enter the next stage, namely the painting process of the stove. This is done so that the frame and parts of the stove are protected from corrosion.

Figure 11. Finishing

4.2 Design Result

The results of this research design can be seen in the following image:

Figure 12. Used Oil Fuel Stove

Component description:

1. Combustion chamber
2. Used oil tank
3. Stop valve (*ball valve*)
4. *Hollow* pipe for oil inlet line
5. *Hollow* pipe wind path
6. Stove frame
7. *Blower* air outlet pipe

4.3 How the Stove Works

The combustion chamber is filled with used oil by opening the stopcock on the oil tank, the oil will flow into the combustion chamber through a hollow pipe that is directly connected to the combustion chamber, insert tissue or paper as a fire starter then burn the tissue or paper until the combustion chamber is hot then turn on the mini blower at low speed, after the flame turns blue then adjust the blower fan speed .

4.4 Results and Testing of Used Oil Fueled Stoves

1. Used Oil Stove Testing Process

The purpose of the water cooking test in a 5 liter water boiler is to find out how many minutes it takes to cook 5 liters of water using a used oil-fueled stove and how much used oil is needed to cook 5 liters of water.

Figure 13. Stove Testing

The testing phase of the used oil stove aims to ensure the temperature and boiling time of water, the temperature of the fire and the duration of the flame, and the amount of air pollution produced by used oil waste. The first step in burning this fuel is to open the tap so that the oil fills the combustion chamber. Next, light the fire by placing paper in the combustion chamber as a preheater. After the oil in

the combustion chamber has heated evenly, the blower fan can be turned on to ensure that the stove fire is perfectly lit.

The iron plate used in each part or component of the stove system in a used oil stove is heated by the fire formed at the beginning of the combustion process. The parts of the used oil stove work to flow oxygen-rich air into the stove system after the iron plate component is heated. After that, oxygen will start working to help the combustion process, so that fire will appear when the blower fan is turned on at low speed.

This flame is evidence that gasification is taking place in the combustion chamber during the combustion process of the stove system. Until it reaches the base or bottom of the pan that holds 5 liters of water from each raw material for combustion, this flame will continue to rise. The fire will touch more than just the bottom of the pan if it is very large. Regarding the heat transfer process that occurs in the used oil-fueled stove system, heat passes through the empty space between the stove and the bottom of the pan which is less than 5 cm thick, starting with heat in the form of flames from the combustion of the raw materials used. In addition, heat is transferred to the inner surface of the pan from the outer surface of the base. Five liters of water in the pan are then heated. Because the five liters of water in the pan are in contact with the sides of the pan and the inner walls, convection occurs. After this water rotates into the pan, fresh water from the top and middle of the pan will replace it. Until the water temperature reaches 100 ° C uniformly, this circulation continues.

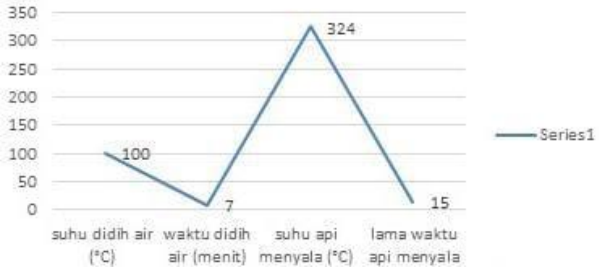
Table 3 Blower Fan Speed Test Results

No.	Fuel Mass (L)	blower fan speed	Boiling Time (minutes)	Boiling Temperature (°C)	Water Volume (L)
1	1	3	7	274	5
2	1	2	10	271	5
3	1	1	13	245	5

The results of the air velocity test for the used oil stove are shown in Table 3. First, the highest speed uses one liter of used oil as fuel. With five liters of water and a temperature of 274°C, it takes seven minutes. Second, medium speed uses one liter of used oil as fuel. It takes ten minutes, five liters of water, and a temperature of 271°C. Third, using one liter of used oil at low speed. It takes thirteen minutes and a temperature of 245°C, and 5 liters of water. The fan air velocity test graph can be seen in the following graph:

Graph 1Air Speed Testing Blower Fan

2. Analysis of Test Results of Used Oil-Fueled Stoves



Graph 2. Stove Test Results Fueled by Used Oil

a. Flame temperature

The flame temperature is the heat energy resulting from the combustion of raw materials in the form of used oil. The used oil waste raw material used is radiated upwards from the fuel to the outer side of the bottom of the pan. The flame temperature is measured with an industrial thermometer at the mouth of the combustion chamber of the used oil-fueled stove or under the surface of the bottom of the pan. After the data is arranged in a table and depicted in a graph, the flame temperature is 324℃ for the treatment of used oil.

b. Length of time the fire burns

The duration of the flame burning is the duration of the flame burning during the test of the results of the used oil-fueled stove. The duration of the flame burning is measured using a stopwatch. After the data is arranged in a table and depicted in a graph, the duration of the flame burning is obtained, which is 15 minutes.

c. Temperature of Water

Boiling point is the temperature at which the vapor pressure of a substance (liquid) is equal to the outside air pressure, so that the evaporation process occurs throughout the liquid. In graph 2, it has been concluded that the boiling temperature of water in the test results of this used oil stove is 100℃.

d. Water Boiling Time

The boiling time of water is the boiling point of water in the test of used oil stoves. The time required to boil water on this used oil stove is 7 minutes (graph 2).

3. Comparison Test of Used Oil Stove With Gas Stove

a. Stove fueled by used oil

test of used oil stoves with gas stoves began by turning on the previous used oil stove until the stove was completely lit with the maximum blower fan speed, then a pot containing 5 liters of water was raised to the top of the stove with a time calculation using a stopwatch. The results of the used oil stove test can be seen in the table below.

Table 4. Test Results of Waste Raw Materials
Used Oil Used In Stoves
Fueled by Used Oil

No.	Observed Variables	Used Oil Waste Raw Material
1	Temperature of Water (°C)	100
2	Time of Flow Minutes)	7
3	Flame Burning Temperature (°C)	324
4	Length of Time the Fire Burns	15

b. Gas stove

The comparative test of used oil stove with gas stove began by turning on the gas first until the stove was completely lit with the maximum gas stove knob opening, then a pot containing 5 liters of water was raised onto the stove with time calculations using a stopwatch. The results of the oil-fueled stove test can be seen in the table below.

Table 5. Test Results on Gas Stoves

No.	Va ria bel Ya ng mal ti	Ga s
1	Boiling Temperature A ir°C)	100
2	Time of Flow Minutes)	9
3	Temperature A pi Menya la °C)	145
4	Length of Time the Fire Burns	15

It can be concluded that table 4. test results on used oil stoves can be seen that the boiling temperature of water is known to be 100°C, after that the boiling time of 5 liters of water required is 7 minutes, and the temperature of the flame is 324°C. And finally, the length of time the flame burns on a used oil stove takes 15 minutes.

After testing the results on a used oil stove, the researcher tested it on a gas stove, then the results were obtained in table 4.4, that the boiling water temperature of 5 liters was known to be 100°C. Then, the boiling time of the water required was 9 minutes, the last temperature of the fire was 145°C.

Based on the results of the two stoves that have been tested above, it can be concluded that the time to boil 5 liters of water on a used oil stove is 2 minutes faster than a gas stove, this is influenced by the speed of air pressure from the used oil stove blower fan which is greater than the flame pressure from the gas stove, it can be proven in the results, namely the time to boil water on a used oil stove is 7 minutes, while the time required to boil water on a gas stove is 9 minutes. This test is not intended to find which stove is better, but only as a reference for comparison in this study .

5. CONCLUSION

1. The designed stove consists of several parts, namely a stove frame with a height of 30cm and a width of 30cm, a combustion chamber with a height of 15cm and a diameter of 11.3cm, an oil tube with a length of 30cm and a diameter of 8.5cm.
2. This used oil-fueled stove can be an alternative when gas prices soar, offering a cooking solution by utilizing used oil waste as an affordable fuel.
3. Based on the test results of the two stoves, it can be it is concluded that the time required to boil 5 liters of water using a used oil stove is 2 minutes faster than a gas stove. This is caused by the air pressure from the blower fan on the used oil stove which is greater than the flame pressure on the gas stove. The results show that the used oil stove takes 7 minutes to boil water, while the gas stove takes 9 minutes.
4. The stove must be designed with an attractive design so that it has high appeal and selling value in the eyes of the public.
5. Researchers need to pay more attention to the selection of stove wall lining materials so that they do not conduct excessive heat.
6. The need for heat insulation in the combustion chamber such as a layer of clay

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