The utilization of waste cooking oil (wco) in simple stove as an alternative fuel for household scale

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Abstract. The use of LPG (Liquefied Petroleum Gas) fuel as a substitute for kerosene fuel on the stove has advantages in its excellent combustion process, but there are several weaknesses in its use, namely the risk of gas leakage in the LPG cylinder, and of course the high price of LPG cause increasing the community burden. The purpose of this study was to produce a waste cooking oil simple stove on a household scale. This research used an experimental method which was conducted for 6 (six) months, began from February 2020 to July 2020. The stages of the research were data collection, making waste cooking oil stove design, preparing tools and materials, making waste cooking oil stoves and testing it. The results showed that the flame produced on the waste cooking oil stove was stable, but the resulting fire was still red due to the incomplete combustion process caused by the lack of air/oxygen pumped into the stove. The advantage of this waste cooking oil stove is the simple installation, portable to use, inexpensive manufacturing cost and more safety than using LPG stove.

1. Introduction

The present energy system is heavily depending on the use of fossil fuels. Facing the challenge of depletion fossil fuels reserves and rising world oil price, many countries has undertaken the initiative to promote the development and dissemination of renewable energy. Indonesia is one of the potential countries for the development of renewable energy. There are many potential renewable energy resources to support sustainable development in Indonesia [1]. Waste cooking oil (WCO) can be used as an alternative fuel on the pressure stove even though it has high content of free fatty acid [2]. WCO is waste from cooking oil that has been used twice or more. The quantity of waste cooking oil generated per year by any country is huge. The disposal of waste cooking oil is problematic, because disposal methods may contaminate environmental water. Many developed countries have set policies that penalize the disposal of waste oil through the water drainage [3].

Used cooking oil, also known as waste cooking oil, results from cooking of foods by food cookers, food manufacturers and catering establishments such as fast food chains, restaurants and industrial kitchens [4]. WCO is generated locally wherever food is cooked or fried in oils. These are derived from vegetable oil (i.e. soybean, cottonseed, groundnut, sunflower, rapeseed, sesame, corn, olive, palm, palm kernel, coconut, linseed, castor, and soy among a wide variety of plant sources) and animal fats/oils (i.e. butter, lard, tallow, grease and fish oil) [5]; [6]; [7]. WCOs and fats cause disposal problems in many parts of the world. These problems could be changed into both economic and environmental benefits by
proper utilization and management of WCO as a fuel substitute. Many developed countries have set policies that penalize the disposal of WCO into waste drainage [8]. WCO can be used as fuel of biodiesel because the material readily available, cheap, and its use not only avoids an oil extraction process but also can manage the waste product that is often discarded inadequately with unfortunate environmental consequences [9]. The use of WCO for frying food can increase the risk of several cancers and the incomplete control of nerves in the body because it contains more saturated fatty acids. Some of the diseases caused by consuming used WCO are: coronary heart disease, itching in the throat, dyslipidaemia, obesity, and atherosclerosis. If WCO disposed of carelessly, especially in rivers, it can damage the environment.

The experiments before [10] were initiated with blend samples of WCO blending. Result showed the continuous burner operation for maximum up to 50% WCO blending. Both the stoves exhibited incomplete vaporization for more than 50% blending which lead to unstable flame and finally the burner shutdown. The process of making liquid droplets in the gas phase is called atomization. The purpose of atomization is to increase the surface area of the liquid by how to break the liquid granules into many small granules. WCO has physical characteristics, like flash point and viscosity that much greater than kerosene. The viscosity of WCO can be lowered by pre-heating and giving the certain pressure [11]. Typical of vegetable oils, WCO has a higher viscosity, leading to a general perception that its use is likely to have an adverse effect on the fuel injection system and consequent combustion process [12].

The process of utilizing WCO as an alternative fuel for household-scale stoves can have the same principles as gas stoves in general. The difference is in the fuel and components used. The fuel used is a mixture of used cooking oil and gasoline with a ratio of 4: 1. The size of the fire can be controlled at the end of the pump. Injectors are used for the fuel fogging process so that it is flammable. Through this research, a trial of the use of the fuel will be carried out with the resulting fuel capacity and combustion time. The components of this simple stove WCO are very easy to get and easy to install, beside that the price of its components are cheap so it is more economize than LPG, easy to use and portable to use.

2. Method
The research used experiments method and was conducted for 5 months, starting from July 2020 to December 2020. The places used for this research was in Maintenance Engineering Laboratory, Politeknik Negeri Subang. Materials those used in this research was reaction tube, air pump, fuel hose, camping stove, injector solar, pipe diameter 10 mm x 20 mm, metal glue heat resistant and office stationery. The equipment consist of: drilling machine, tap M 8 x 1.5 mm and drill bit diameter 6 mm.

The step of this research was collecting data, making design of WCO stove, preparing the equipment and materials, manufacturing process of WCO stove and testing the WCO stove. The design of the stove can be seen below:
3. Result and discussion
The result of this study was created waste cooking oil (WCO) simple stove for household scale. Based on experimental result of 0.25 litre of fuel, the stove can burn for 90 minutes with a stable flame but the fire was still red and the combustion is black because it is lack of oxygen. The lack of oxygen caused by the storage tube is small so it contain less oxygen.

The step of making WCO simple stove is as follows:
- Use work safety tools.
- Prepare WCO reservoir or storage tube that was modified with mini pump.
- Fill WCO and gasoline with ratio 4 : 1 as much 0.25 litre, in to reservoir or storage tube.
- The pipe from the storage tube where there was pressure from the pump flew to the injection nozzle on the stove.
- The stove which already had modified with injection sprayer, sprayed the WCO mist in to the furnace and gave the fire by lighter or burner on the furnace.
- Because it was form mist, so the WCO flammable.
The working principle of WCO simple stove is pressurized WCO in storage tube run out from injector so that it is become mist and flammable. The advantages of this simple stove that are cheaper and portable to use. The WCO price is two to three times cheaper than vegetable oils, and it also reduces the cost of waste product removal and treatment [13], beside that using WCO simple stove is more safety than LPG stove. Because of the high viscosity and poor volatility of WCO resulted in slow combustion and increased the hydrocarbon emissions. However, there was a reduction in hydrocarbon emission at all power outputs with oxygen enrichment technique [14]. Since WCO is a slow burning fuel, hydrogen assisted combustion helps in considerable improvements in performance and reduction in emissions [15].

4. Conclusion
The WCO simple stove can burn for 90 minutes using 0.25 litre of fuel. The advantages of WCO simple stove are the materials are easy to get, the installation is so simple and easy, the stove is portable to use and the flame is stable, the price is cheaper than the LPG stove and more safety than LPG stove. The disadvantages of this stove are the flame is still red so it need more time for cooking than using LPG stove, the capacity of storage tube is still little, and so the oxygen is not much and cause the combustion not pretty good and the flame still red.

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