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THE PROCESSING OF PLASTIC WASTED INTO FUEL OIL IN THE KALANG ANYAR VILLAGE IN SERANG

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Abstract

Currently, plastic waste pollution has become a prominent global issue, as well as in Indonesia, where the situation is increasingly concerning. This is likely due to the escalating production of plastic waste, originating from both households and industries, without proper waste management practices. In fact, some studies suggest that if plastic waste production remains unchecked, by 2050, there could be more plastic waste in the oceans than fish. To address this plastic waste problem, various innovations are being pursued by diverse groups, including academics, as an effort to safeguard the Earth for future generations. One such effort involves integrating knowledge with practical activities through the Student Work Lecture Program at Universitas Bina Bangsa, held in the Pekijing Village of Kalang Anyar Subdistrict, Serang City. The outcome of this initiative is that the community gains alternative skills in plastic waste processing to fuel through the student-led activities, with the hope that these skills will eventually be implemented widely in other areas. The technology employed in this process is pyrolysis, where plastic waste is heated at high temperatures and subsequently cooled to extract its oil content. Developments like this aim to enhance the value of waste by transforming it into usable liquid fuel that can benefit daily life, especially in rural communities. Although relatively new in Indonesia, several advanced countries like Japan have already applied similar approaches on an industrial scale. Thus, there is value in fostering early awareness and initiating change at the grassroots level, progressing from villages to a global scale.

Keywords: Innovation, Plastic Waste, Liquid Fuel, Pyrolysis

INTRODUCTION

This program aims to assist the community in managing plastic waste in the Pekijing Village, Kalang Anyar Subdistrict, Serang City, focusing on proper waste management, particularly plastic waste. Plastic waste poses a significant environmental challenge that necessitates immediate solutions. This holds true for Kalang Anyar Village, where plastic waste persists as a non-degradable residue accumulating in various corners of the village. Unfortunately, plastic materials do not decompose or degrade easily in the soil, posing environmental hazards.

Considering the severity of plastic waste pollution, research becomes crucial for finding effective solutions. The development of technologies to process plastic waste into valuable resources is pursued by a wide array of individuals, including scientists, academics, and students. One such solution is converting plastic waste into liquid fuel using pyrolysis, a technique being installed for plastic waste processing.

As the population increases, plastic consumption also rises year by year. Plastic packaging growth increases by 10 to 13 percent annually. According to InSWA researchers, on average, each Indonesian generates 0.5 kg of waste daily, with 13 percent of it being plastic waste. With appropriate technology, plastic waste can be managed effectively. One ongoing development we are working on is converting plastic waste into liquid fuel equivalent to diesel and gasoline.

This innovation-based program is expected to run smoothly with support from various parties and proper funding. Youth involvement and collaboration with village officials engaged in waste collection will greatly assist the team in procuring ample supplies of plastic waste. This endeavor aims to ultimately generate economic value from plastic waste.

IMPLEMENTATION METHOD

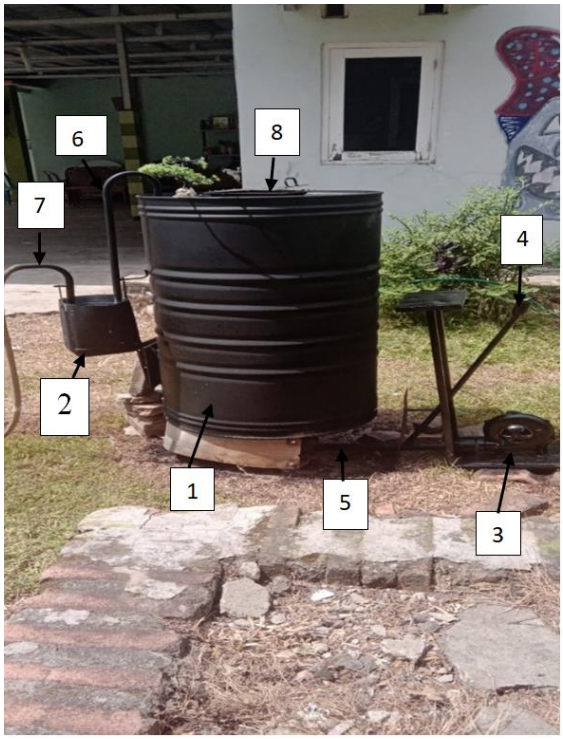
The chosen method is pyrolysis, where plastic waste is heated above 300°C to create vapor, which is then condensed by a cooling fluid to obtain oil. Pyrolysis originates from two words, “pyro” meaning heat and “lysis” meaning decomposition or degradation. Therefore, pyrolysis refers to the decomposition of biomass due to heat, at temperatures exceeding 150°C (Kamaruddin et al, 1999). Kalang Anyar Village was selected as a pilot project location for this community engagement program due to its collaboration in the Universitas Bina Bangsa's Student Work Lecture Program. Empowering the Kalang Anyar community represents the academic community's concern for society, manifested through applied science and appropriate technology.

The plastic waste processing activity was chosen after the team conducted an observation of the village environment. The results of the situational analysis led to the identification of a problem, which is the accumulation of plastic household waste at a specific point in the village where, up to the point of this activity, no solution had been implemented. The solutions offered to the local community are as follows:

1. Enhancing the community's understanding of plastic waste and efforts to increase its market value.
2. Utilizing plastic waste for the production of kerosene-type liquid fuel (BBM).
3. Developing pyrolysis techniques to process plastic waste into kerosene-type liquid fuel (BBM).
4. Improving the household-scale management of plastic waste BBM businesses.

The Pyrolysis Implementation Process in Kalang Anyar Subdistrict, Serang City. The conversion of Plastic Waste into BBM follows the procedures and protocols as follows:

1. Equipment This equipment has been established through the collaboration between PT. Djarum and the local community of Pekijing Village, Kalang Anyar Subdistrict, to create a device for the process of distilling plastic waste into Liquid Fuel (BBM), comprising:
    - A modified 3.5-meter iron pipe.
    - A medium-sized tank or drum.
    - A blower for the heating process.



Equipment Description:

1. Drum/Reactor
2. Condenser/Cooler
3. Combustion Blower
4. Used Oil Inlet for Combustion
5. Combustion Stove
6. Outlet of Vapor from Plastic Waste Combustion into Liquid Fuel (BBM)
7. Outlet of Vapor from Combustion through Condenser and collected in a container as Liquid Fuel (BBM)
8. Distillation Reactor Inlet

Figure 1. Equipment for the Plastic Waste Pyrolysis Process into BBM

2. Materials Plastic waste or plastic scraps, including

   Various plastic items, small-cut beverage bottles (for easy insertion into the modified equipment), and used oil for combustion in the reactor/drum.

3. Working Procedure
   a. Wash the plastic waste thoroughly multiple times until clean, then dry it and subsequently expose it to sunlight.
   b. After sun exposure, cut the plastic waste into smaller pieces using scissors.
   c. Once turned into smaller fragments, introduce the plastic waste into the distillation tube/reactor and seal it tightly. Place the distillation tube in the combustion furnace.
   d. The tube/reactor (a large drum is used in this case) is heated to temperatures of 250°C - 400°C, and at least one condenser is necessary to separate vapors containing short-chain molecules from those containing long-chain molecules. A condensate delivery pipe is fitted to each condenser to collect condensate from the produced vapors.
   e. The vapor is channeled through iron pipes to endure high temperatures.
   f. Droplets of condensate are collected in bottles.
   g. After obtaining the oil, the container is opened. To verify the results, any remaining oil in the container is ignited; if it reacts, the experiment is considered successful.

RESULTS AND DISCUSSION

From a series of trials as documented in the previous pages, it can be concluded that the obtained result is a dense liquid resembling a type of liquid fuel assumed to be kerosene. Despite the success in creating a simple pyrolysis machine prototype, further testing is still needed. Producing crude oil requires a relatively long evaporation time, and the purity of the oil is not yet perfect. Combustion tests have been conducted, and the results have been highly satisfactory. The materials tested in the combustion process burned completely. However, the duration of the flame and the longevity of the ignition point resulting from burning the oil extracted from plastic waste have not yet been observed.

The test results from the Plastic Waste Processing Reactor have not provided a specific type of fuel, such as gasoline or kerosene. However, based on the initial outcomes, it is close to kerosene. Initial observations indicate that certain types of plastic and the temperature used in the processing process should be taken into consideration. As known, the pyrolysis technique is a method capable of breaking down and melting plastic waste into a type of oil by heating the machine to a specific temperature. This means that higher temperatures produced result in faster waste distillation processes.

The process of converting plastic waste into oil starts with the collection of selected waste, particularly plastic waste. The plastic then proceeds to the process of introducing it into the chopper machine (pyrolysis). The subsequent heating is conducted using the chopper machine at an undetermined temperature. Theoretically, the distinction among the three types of oil lies in the temperature and distance in the oil flow pipe produced by the pyrolysis machine:

1. Diesel is produced by heating between 250°C to 340°C, with the pipe closest to the pyrolysis machine.
2. Kerosene is the fuel produced by heating the pyrolysis machine between 170°C to 250°C, with the oil flow pipe positioned in the middle or between the diesel and gasoline pipes.
3. Gasoline is produced by the heating process at temperatures between 35°C to 75°C, with the gasoline oil flow pipe positioned farthest from the machine or at the front.

Figure 2. Apparatus for Distilling Plastic Waste into Liquid Fuel (BBM)

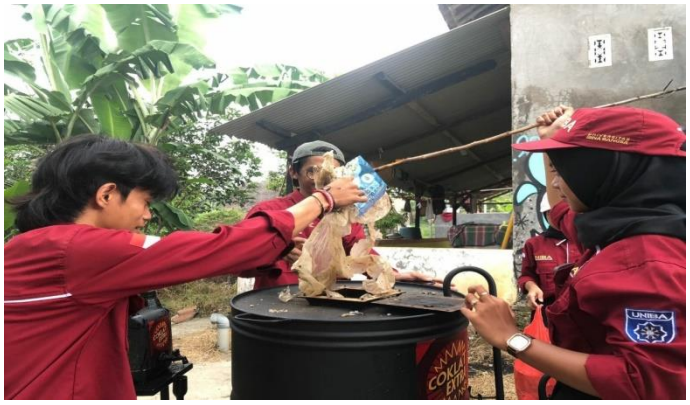


Figure 3. Process of Introducing Dry and Clean Plastic Waste into the Reactor Tank

Figure 4. Process of Heating Plastic Waste Inside the Reactor

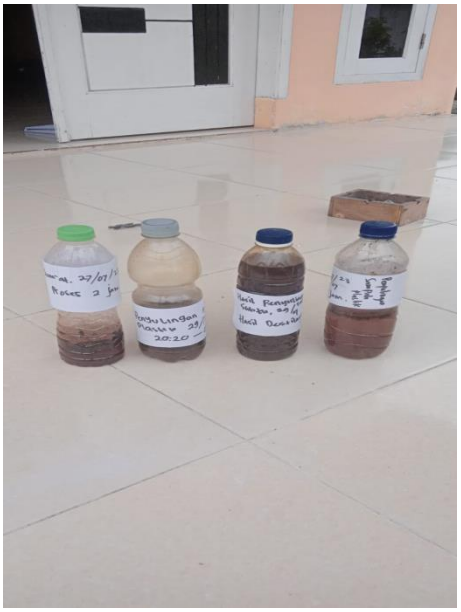


Figure 5. Types of refined fuel

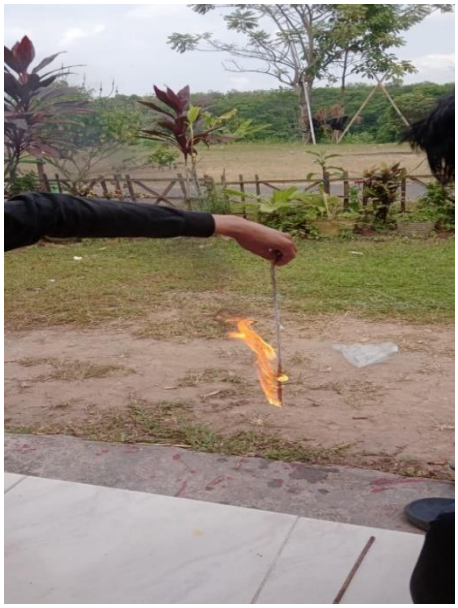


Figure 6. Results of the BBM refining trial

CONCLUSION

This program embodies social and environmental concern, aiming at behavioral changes within the community of Pekijing Village, Kalang Anyar Subdistrict, Taktakan District, Serang City. The

results obtained from the innovative program of converting plastic waste into liquid fuel (BBM) need further examination in the laboratory, particularly concerning the content and safety of the oil produced through pyrolysis. This implies the necessity of conducting periodic training and guidance by experts for communities intending to implement waste processing methods like this in their respective regions.

On the other hand, the implementation of waste management activities is expected to have a positive impact on the community surrounding Kalang Anyar Subdistrict, where this community engagement took place. For instance, it can increase environmental awareness and promote wise waste management practices, particularly for plastic waste. Moreover, in economic terms, the simple processing outcomes can serve as liquid fuel, thus reducing daily household expenses, such as fuel for household stoves or kerosene lamps. The plastic waste management program in Pekijing Village, Kalang Anyar Subdistrict, serves as a model that, hopefully, other communities can adopt in addressing similar waste-related issues.

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