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Abstract

Given the scenario of difficulty of equalizing treatment and disposal costs, environmental risks and reduction of mass and volume of waste, the pyrolysis process presents itself as a promising option of heat treatment for the most varied types of waste. The present work aims to enable the transformation of plastic waste into combustion engine fuels. And specifically, perform the pyrolysis process for fuel generation through plastic waste, and describe the benefits generated by the transformation process. The methodology used is the case study, with qualitative approach. To obtain the fuel, it was necessary to use equipment that can degrade the plastic waste by heating it, being possible with the use of a pyrolysis oven. Heating the plastic residue inside the oven without the presence of oxygen causes the residue to melt without burning, releasing vapors, which upon exiting the heating chamber and finding the condensation chamber turns the vapor into liquid, more precisely into fuel oil. However, it was noticed that the transformation of plastic waste into fuel through pyrolysis causes the reduction of the impacts generated by solid waste disposal in the environment, water and air. In addition, it enables a new form of fuel generation, since previously it could only generate fuel from oil.

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1. Introduction

Since 2000, the plastics industry has produced the same amount of plastic as in all previous years combined. Virgin plastic production has increased 200-fold since 1950, and has grown at a rate of 4% per year since 2000 [1].

In 2016, the most recent year for which data are available, production was 396 million metric tons. This is equivalent to 53 kg of plastic for every person on the planet. Plastic production in 2016 resulted in approximately 2 billion metric tons of carbon dioxide emissions, equivalent to almost 6% of global carbon dioxide emissions per year [2].

Plastics are made from petroleum, an increasingly scarce resource on the planet, however, plastic is widely used in virtually all types of equipment such as phones, computers, appliances, cars, etc. [3]

In Brazil, the improper disposal of plastic waste has created another problem, the well-known community of waste pickers in open-air dumps, where people are exposed to all kinds of contamination in search of plastic waste for their livelihoods [4].

In Manaus, one of the main capitals of northern Brazil, has its industrial pole based on segments, electro-electronic, two-wheeled, naval, mechanical, metallurgical and thermoplastic, where with more than 600 industries, wedged in the Amazon Forest, all segments are large plastic waste generators [5].

The waste generated at the Manaus Industrial Pole (PIM) is mostly derived from packaging, which has high turnover, as it turns into urban solid waste after the consumption of the product of interest. For this reason it is important that the packaging bears the material identification symbol in order to facilitate the recycling chain [6].

In addition to the Industrial Pole, the population of Manaus is also a major generator of plastic waste, and contributes to both the plastic recycling industry and the irregular disposal of waste in inappropriate places [6].

However, with the use of new technologies, it is possible to have new destinations for this waste, with the possibility of generating other products, such as combustion engine fuels.

Given the current scenario and the difficulty of equalizing treatment and disposal costs, environmental risks and waste mass and volume reduction, the pyrolysis process presents itself as a promising option of heat treatment for the most varied waste. Pyrolysis is characterized by thermal degradation of organic material in an oxygen-deficient atmosphere, thus minimizing emissions of pollutants formed in the oxidizing atmosphere, such as dioxins and furans [7].

In addition, due to the huge variety of plastics on the market and the large volume disposed of, plastic waste management is complex, and the destination chosen will depend on a number of factors, such as the type of polymer or waste product [8].

With the need to think about sustainability, any alternatives that enable the reduction of waste in the environment becomes an alternative for preservation and concern for the environment and future generations [9].

However, with plastic waste being generated in large quantities by PIM, recycling the plastic and turning it into diesel or gasoline is an alternative source for both spreading the large mass of existing waste and creating fuel through burning. of plastic.

The present work aims to enable the transformation of plastic waste into combustion engine fuels. And specifically, perform the pyrolysis process for fuel generation through plastic waste, and describe the benefits generated by the transformation process.

2. Material and Method

2.1 Study area

The study was conducted in a private company in the city of Manaus - Amazonas, as delimited in figure1.

Figure 1 - Area of study.
Source: Google Earth, 2019.

At the site operates a company operating in the field of gas distribution, provided by the owner to carry out the transformation of plastic waste into fuel through pyrolysis. It is a vast physical space.

2.2 Data collect

The methodology used in this work is the case study. Case studies have been increasingly used by social researchers as they serve research with different purposes, such as: exploring real-life situations whose boundaries are not clearly defined; describe the situation of the context in which a particular investigation is being conducted; and explain the causal variables of a given phenomenon in very complex situations that do not allow the use of surveys and experiments [10].

The approach used is the qualitative approach, that is, a research strategy that comprises a method that covers everything in specific approaches to data collection and analysis [11]. It is a device that deepens an individual universe, that is, it analyzes subjects that the researcher has little control over events and when the focus is on contemporary phenomena inserted in some real life context.

The work was carried out in four stages: bibliographic research, data collection and data analysis on the pyrolysis process and the transformation of plastic waste into fuel; analysis facilities, where the physical structure necessary to produce fuel from the burning of plastic waste was verified; the transformation of plastic waste into fuel via pyrolysis trying to indicate as a mitigating measure the use of solid waste.

2.3 Collection instruments

To obtain the fuel, it was necessary to use equipment that can degrade the plastic waste by heating it, being possible with the use of a pyrolysis oven. Heating the plastic residue inside the oven without the presence of oxygen causes the residue to melt without burning, releasing vapors, which upon exiting the heating chamber and finding the condensation chamber turns the vapor into liquid, more precisely into fuel oil. This transformation process can be an alternative to conventional fuels and the reduction in the waste disposal charge in landfills, rivers, seas and the environment in general.

In this way, the sequence followed as shown in figure 2.

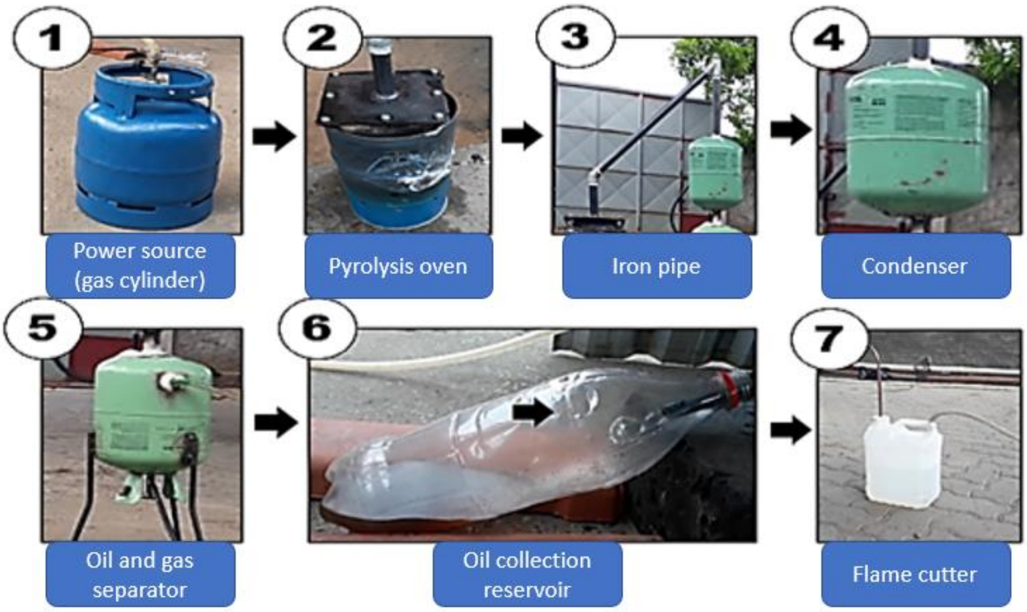

Figure 2 - Process for transformation via pyrolysis.
Source: Own authorship, 2019.

To understand the transformation procedure we have:

1. Energy source (gas cylinder) (item 1): This is used to heat the pyrolysis oven, using a 5 kg gas cylinder attached to a hose that is connected to the pyrolysis oven, accompanied by a valve to control gas output;

2. Pyrolysis Oven: Internally consists of a reused gas cylinder for air conditioning (R22), and externally we have a 20 liter steel drum that surrounds the pyrolysis oven. Therefore, the pyrolysis oven is heated by a 4-burner stove. And at the top of the pyrolysis oven, it has an opening for the introduction of plastic waste, which is closed by an 8 bolt flange.

3. Iron Piping: Iron piping for gas vapor conduction (Item 3), where piping attached to the flange is connected to the condenser.

4. Condenser: The iron pipe runs through the condenser inside which has water to cool the steam coming from the pyrolysis oven. With steam condensation, we obtain the liquefaction of plastic oil.

5. Oil and gas separator: This container separates the plastic oil and the gas produced.

6. Oil collection container: Plastic oil will be delivered through a hose to the oil reservoir.

7. Flame arrester: The gas will be intended for flaring in the flame arrester.

3. Results and Discussion

Pyrolysis is a set of decomposition reactions of carbon-containing materials by heat in the partial or total absence of an oxidizing agent [12].

One way of separating plastics takes into account the physical and thermal degradation characteristics of plastics. For the purpose of the recycling process, it is convenient to use packaging made up of as few different resins as possible.

The better separated these wastes are, the higher their added value. After separation, the material is sent to the recycling process, where it will be transformed into a new product [13].

Thus, the transformation of plastic waste into combustion engine fuel is in the projection as shown in Figure 3.

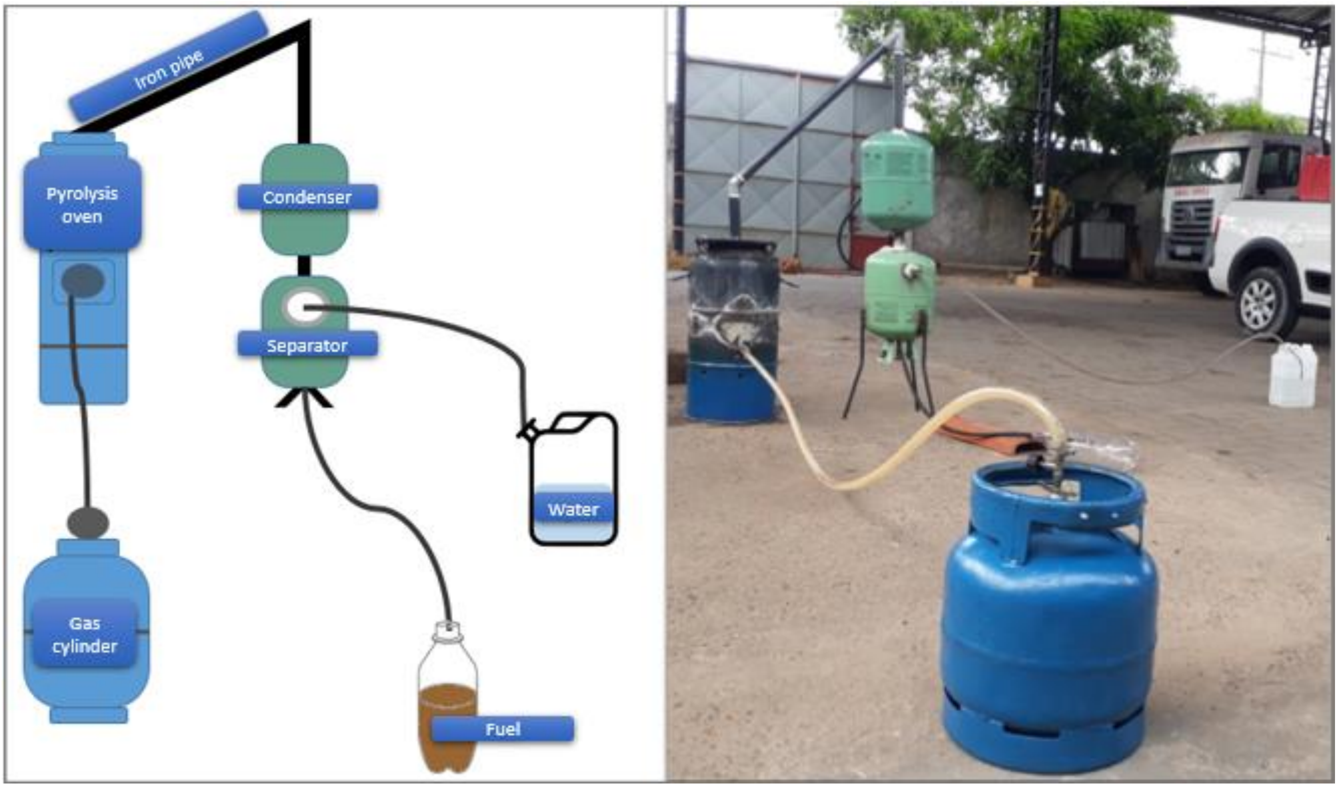

Figure 3 - Assembly process of transformation via pyrolysis.
Source: Own authorship (2019).

The procedures for obtaining plastic waste oil and gas were given as follows: placing 1 kg of plastic waste inside the pyrolysis oven; pyrolysis furnace closing by tightening flange bolts; To start the combustion, the gas cylinder valve was opened, lighting the stove; soon the condenser should be filled with water to condense the vapors of the molten plastic; the flame-arrester cut half-filled with water; the time to start dripping plastic oil and releasing the gas performed around 1 hour and 20 minutes at a temperature above 300º C.

Among the technologies available and suitable in the market, pyrolysis heat treatment is highlighted by reducing the volume of the waste by up to 90%, in addition to enabling the supply of raw materials in various industrial segments.

Figure 4 - Oil obtained by the pyrolysis process.
Source: Own authorship, 2019.

According to the results obtained, pyrolysis may play a significant role in the energy and organic recovery of these wastes, although some technological aspects are still needed to make it more attractive to implement this technology on an industrial scale [14]. .

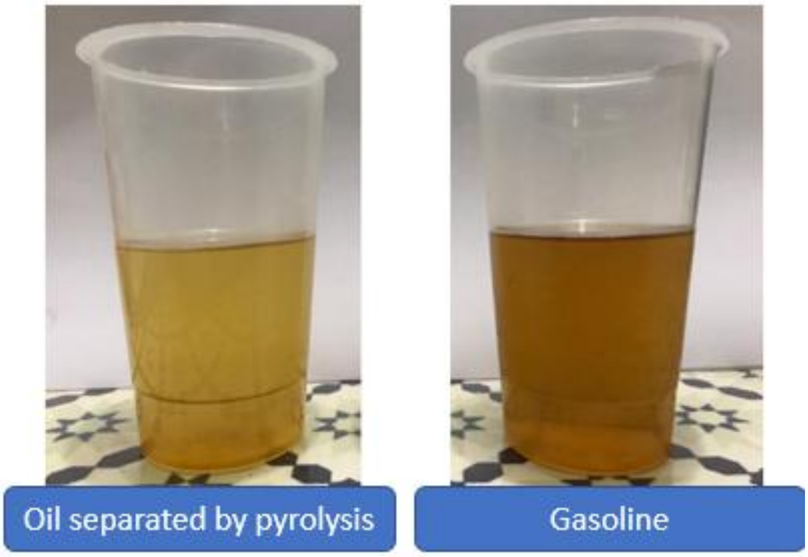

Figure 5 - Gasoline x Fuel obtained
Source: Own authorship, 2019.

As shown in figure 5, the fuel purchased from plastic pyrolysis is the color well associated with gasoline. However, in order to be able to use it, some laboratory tests will be necessary to be performed in the future by the author.

However, it is still possible to highlight some benefits generated with this fuel model:

a) Reduction of the amount of plastic waste destined for dump and landfill;

b) New energy production, since plastic, being made of petroleum derivatives, has a high calorific value - equivalent to gasoline and higher than coal;

(c) improving the energy efficiency of incineration processes;
(d) use to replace the use of conventionally purchased fuels;
e) Considerable changes in relation to climate change and natural resource depletion [15];
(f) recovery of the energy content contained in waste;
g) Massive reduction of weight and volume and complete elimination of biological agents (destruction of molecular organic structures of hazardous substances).

The environmental consequences were favorable to fuels because the displacement of fossil gasoline and fuel oil generates environmental benefits. And from the economic point of view, although producing fuel from biogas is more complex, the economic benefits from its commercialization are greater, since the sales of fuel in Brazil are very high compared to other countries in America [16].

Therefore, investment in the plastic recycling chain is required to optimize input consumption and reduce waste emissions, which reflects production costs and increases competition for the recycled product [16]. Thus, the possibility of turning waste into raw material is viable and will produce a profitable sustainability model.

4. Conclusion

However, it was noticed that the transformation of plastic waste into fuel through pyrolysis causes the reduction of the impacts generated by solid waste disposal in the environment, water and air. In addition, it enables a new form of fuel generation, since previously it could only generate fuel from oil.

Another point to note is that from the fuel generated through pyrolysis there would be a reduction in the sales value of vehicle fuel. Since fuel prices in Brazil are noticeably high compared to other countries in America.

In the context of the article presented, this process is a reverse logistics cycle, in which plastic returns to the production cycle as raw material. Enabling sustainable development, that is, worrying about future generations and reducing the impacts caused by waste.

Thus, with more studies and investment of companies that can mass produce this fuel alternative, it will be possible to improve the expectations of quality of life of people and the environment.

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