

The analysis of quantitative methods for renewable fuel processes and lubricant of materials derived from plastic waste

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Abstract. Plastic has become an important component in modern life today. Its role has replaced wood and metal, given its advantages such as light and strong, corrosion resistant, transparent and easy to color and good insulation properties. The research method is used with quantitative and engineering research methods. Research objective is to convert plastic waste into something more economical and to preserve the environment surrounding. Renewable fuel and lubricant variables are simultaneously influenced significantly to the sustainable environment. This is based on $F_h > F_t$ of $62.101 > 4.737$) and its significance is $0.000 < 0.05$. Then H_0 concluded rejected H_a accepted which means that the variable of renewable fuels and lubricants or very large effect on the environment sustainable, the value of correlation coefficient 0.941 or 94.1% which means there is a very strong relationship between renewable fuel variables and lubricants to the sustainable environment. And utilizing plastic waste after being processed by pyrolysis method produces liquid hydrocarbons having elements of compounds such as crude oil and renewable fuels obtained from calculations are $\text{CO}_2 + \text{H}_2\text{O} + \text{C}_1\text{-C}_4 + \text{Residual substances}$. Then the plastic waste can be processed by isomerization process + catalyst to lubricating oil and the result of chemical calculation obtained is CO_2 , H_2O , $\text{C}_{18}\text{H}_{21}$ and the rest.

Keywords: fuel processes and lubricant, plastic waste, quantitative methods

1. Introduction

Nowadays, plastic as an adequate new material is increasingly needed. The common black colouring materials for plastic carry some dangerous substances which can cause cancer in a particular hot temperature. In spite of those facts, plastic waste forms will make renewable fuel and lubricants. The plastic cannot be decomposed naturally and have no economic value [1]. It even has negative economic value when we consider the costs of waste management. The increasing number of plastic use will also increase that will give negative impacts to the environment. But the use of plastic is increasing especially in industry and household [2].

Plastic waste has accumulated up to 6 million tons [3] so that plastic waste management has become an increasingly urgent issue. Technological advances will increase the quantity and quality of waste, as the increasingly diverse use of feedstocks, packing methods and manufacturing products can influence the amount and type of waste. Therefore, if it is not handled properly, it will cause some unexpected changes of environmental balance. It can pollute the soil, water and air.

Inorganic waste is divided into metal waste and its processed products, plastic waste, paper waste, glass and ceramic waste, detergent waste. Most inorganic cannot be parsed by the natural/whole



microorganisms (non-biodegradable). Meanwhile, others can only be degrade in a long time. This type of waste at the household level for example plastic bottles, glass bottles, plastic bags, and cans [4].

Table 1. Type of polymer, code and its usage [5].

Code No	Type of Polymer	Usage
1	PET (polyethyleneterephthalate)	Bottled mineral water, bottle of cooking oil, juice, chili bottle, medicine bottle and cosmetic bottle; drug,
2	HDPE (High-density polyethylene)	Liquid milk, lubricant jerry can and cosmetic bottles
3	PVC (Polyvinyl Chloride)	Liquid milk, juice jelly and cosmetic bottles, table cover, shower bottles
4	LDPE (Low-density polyethylene)	plastic bag, plastic cover wrap frozen meat wrap & various other tips
5	PP (Polypropylene) or Polypropene PS (Polystyrene)	plastic cup, plastic bottle caps, toys and margarine CD boxes, spoons, plastic and food, Styrofoam, transparent food place
6	Others	Baby bottle, Plastic packaging, and gallons of drinking water, auto parts, household appliances, computers, electronic appliances, toothbrushes, and lego toys.

Qualities Polymers is a full strength, compressive strength, flexural strength, Impact strength. Polymers stairs has a higher thermal stability than open-chain of the polymers, aromatic polymers are characteristically exhibit glass transition temperatures were very high, very high melt viscosity and low solubility. So it is difficult than most other polymer types.

Classification of polymers consisting of natural polymers are polycondensation and polymerization reaction itself and synthetic polymers are polymers that deliberately at the plant as needed and do not exist in nature and synthetic polymer was molded as desired and resistant to microorganisms (Table 1). Polymer based composition microstructure are (1) homopolymers, the polymer formed from the merger of similar monomers with repeating units are the same, (2) copolymers, i.e., polymers that are formed from several different kinds of monomers. These copolymers are subdivided into four groups: random copolymers, regular cross copolymers, block copolymers and copolymer branch/Graft copolymers.

2. Research Method

The tools and materials are plastic waste consist of drink bottles, plastic cups, plastic plate rack, etc. The method used is engineering and quantitative methods while the methodological steps of research preparation of final task proposal described in Figure 1. Alkalinity, detergency properties, dispersancy and oxidation resistance [6].

Research steps are as follows: (1) All types of waste plastic (making mixed oil for diesel fuel apparently does not need to choose what type of plastic to get the best diesel mix, but in the type of waste research is PET (polyethyleneterephthalate), (2) pyrolysis process, as shown in Figure 2. Then the plastic waste put into the pyrolysis machine. Pyrolysis itself is a chemical decomposition process of a material to produce hydrocarbons through high temperature heating with little oxygen, (3) heated waste (once the waste put into the machine, it will be heated until melted) (4) The first gas (when the waste is heated to melt, this plastic waste will produce gas) and (5) condensed into oil (after plastic waste into gas, the gas is condensed through the condensation process so it can produce oil that can be a mixture of diesel fuel) [7].

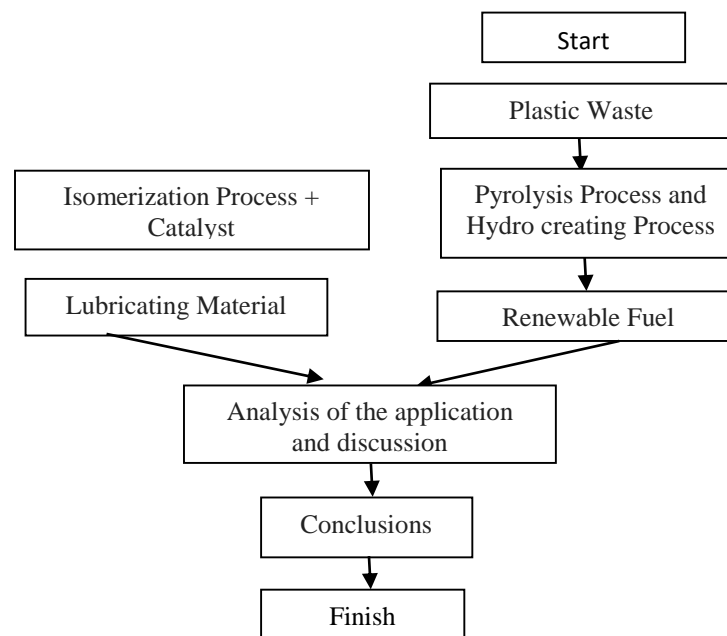
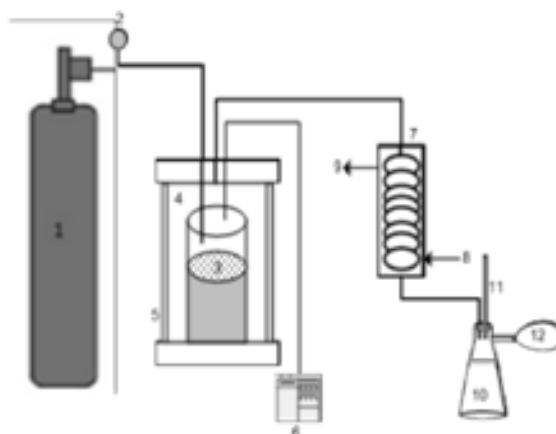


Figure 1. Flow chart research.



Caption:

1. Nitrogen tube
2. Rotameter
3. Place of catalyst
4. Pyrolysis reactor
5. Electric furnace
6. Thermocouple temperature reading device
7. Reflux condenser
8. Inlet cooling water
9. Water outlet
10. Liquid-gas separator
11. Thermometer
12. Gas container

Figure 2. Schematic of a series of pyrolysis tools [8].

To distinguish the three types of oil are the temperature and distance on the oil flow pipe produced on the machine pyrolysis or cracking machine such as the following:

- 1) A kind of solar is the result of warming between 250-340°C with the pipe closest to the pyrolysis furnace.
- 2) Kerosene is the fuel of the oil stove which is generated from the heating process of the pyrolysis furnace with a temperature of 170-250°C up to 2 hours with the oil flow pipe being in the middle or between the diesel and gas pipes.
- 3) Gasoline is generated from the heating process at temperatures between 350-750°C. It takes 4 hours where the gasoline oil pipeline is farthest from the pyrolysis furnace or at the front.

Then the process of plastic material into lubricating oil is the result of the pyrolysis process into the condenser to be cooled through the connecting pipes. In this process the plastic material heated using pyrolysis process by burning the garbage at the same time with the distillation at high temperatures. The catalyst (Al_2O_3) is heated with a temperature of $200^\circ - 1000^\circ\text{C}$ CO_2 , H_2O , $\text{C}_{18}\text{H}_{21}$, and Residual. This method is environmentally friendly because it produces CO_2 and H_2O gases. In addition when it heated also produces a liquid hydrocarbon compound ranging from C1-C4 and long chain compounds such as paraffin and olefins which have wax or wax like forms [3].

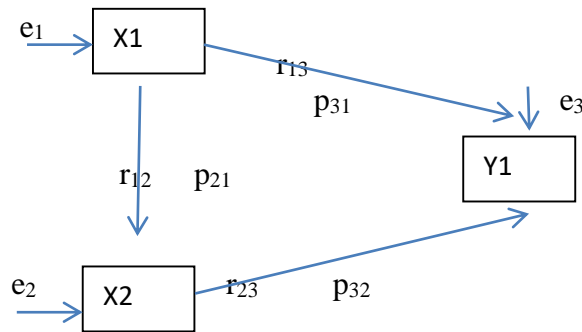


Figure 3. Research model.

The Figure 3 explains that: X1 is an exogenous variable for X2 and Y1; X2 is an exogenous variable for Y1; X1 and Y1 are endogenous variables X1; Y1 is endogenous variable X2; E1 other variables outside the system (residual variables); R12 = the correlation coefficient between X and Y and p_{ij} = path coefficient (influence). The data obtained by the test result with the temperature parameter X1 (SP), in the plastic waste forming process resulting in the renewable material X2 (B. BT), the lubricant Y1 ((BP) to the Y2 (LB) environment as Table 2. The picture also explains that X1 is an exogenous variable for X2 and Y1; X2 is an exogenous variable for Y1; X1 and Y1 are endogenous variables X1; Y1 is endogenous variable X2; E1 other variables outside the system (residual variables); R12 = the correlation coefficient between X and Y and p_{ij} = path coefficient (influence). The data obtained by the test result is with the temperature parameter X1 (SP), in the plastic waste forming process resulting in the renewable material X2 (B. BT), the lubricant Y1 ((BP) to the Y2 (LB) environment as shown in Table 2.

Table 2. Temperature parameters of each variable.

No	X1 (S.P.)	X2 (B.BT)	Y1((BP)
1	170	200	200
2	175	220	500
3	178	235	600
4	180	240	500
5	190	243	550
6	200	245	600
7	210	250	650
8	220	300	700
9	230	325	800
10	250	350	1000

3. Results and Discussion

The calculation procedure in this hypothesis test using the SPSS Statistics 21.0 Program. Autocorrelation is used to test for the presence of internal correlations among the variables arranged in the time series. To detect the presence or absence of autocorrelation in a regression model using Durbin-Watson method, the autocorrelation test of the linear regression model can be stated no symptoms, if probability Durbin-Watson > 0,05 and from the above table Durbin-Watson value is

1.324. So that shows $1.324 > 0.05$ concluded regression model did not experience autocorrelation symptoms.

The results of regression coefficient test showed that the nature of probability (significance), when $0.401 > 0.05$ means experiencing symptoms of heteroscedasticity. It turns out that Plastic Waste variable is 0,000 whereas plastic waste is 0.000. Thus the results above the regression model experienced symptoms of Heteroscedasticity. The linearity will be fulfilled with the assumption that the plot between standardized residual values and standardized prediction values does not form a specific pattern (random).

Hypothesis testing in this research was done by using statistical analysis tools in the form of correlation coefficient, determinant coefficient, F test and t test. In the level of significance or probability (α) is 0.05 or 5%. The value shows that the value of Adjusted R Square r^2 is 0.941, this means simultaneously influenced by renewable fuel and lubricant material 94.1 while the rest of 5.9% influenced by other factor not examined in this research.

The results of regression coefficient test showed that the nature of probability (significance), when $0.401 > 0.05$ means experiencing symptoms of heteroscedasticity. It turns out that Plastic Waste variable is 0,000 whereas plastic waste is 0.000. Testing equations simultaneously, using between count with the ratio of F arithmetic $>$ F table or by using the value of significance. Basic decision-making is H_0 will be rejected or H_a accepted. If the significance value is less than 0.05; below shows the value of F arithmetic is $>$ F table ($62.101 > 4.737$) the value of significance is $0.000 < 0.05$. Then concluded H_0 rejected H_a accepted which means plastic waste materials, renewable fuels and lubricants simultaneously affect the environment sustainable. And partial testing or t test is performed to determine whether partially or individually significantly affects the dependent variable. T-test can be done by comparing t count $>$ with t table ($23.738 > 2.262$), or by using the value of significance. The basis for making a decision is H_0 is rejected or H_a is accepted if the significance value t $0,000 < 0.05$, (1) Variable X_1 to Y: The variable of TB on the effectiveness of CO_2 emissions of its significant value is $0.000 < 0.05$ significant. Then H_0 concluded rejected H_a accepted which means that the variable of plastic waste, fuel lubricants to the environment that is sustainable ($10.725 > 2.262$), (2) Variable X_2 to Y is 0.784), the variable of lubricant to the environment is sustainable, its significant value is $0.000 < 0.05$ significant. Then concluded H_a accepted H_0 rejected which means that the variable of renewable materials influential or on the environment sustainable. In multiple linear regression analysis, we can see the constants $a = -461.186$; $B_1 = .784$ and the value $b_2 = 3.580$, the linear regression equation is $Y = -461.186 + 0.784 X_1 + 3.580 X_2$. For the above multiple regression formula can be concluded through the following statement: If the variable plastic waste increase, an increase of one unit ratio scale, then the renewable fuels and lubricants variables value decreases less with pollution so that a sustainable environment was reduced to contamination.

4. Conclusion

Renewable fuel variables significantly affect the environment sustainably, it is based on the significance value $0.000 < 0.05$ and the partial variable value; $t_{th} > t_t$ ($23.738 > 2.262$). Then H_0 concluded the rejected H_a accepted which means that the variable renewable fuels have an effect or have big influence on the sustainable environment. Lubricant variable has significant effect on the sustainable environment, it is based on its significance value $0.000 < 0.05$, but the value of the lubricant variable compared to the continuous environment ($10.725 > 2.262$). Then concluded H_a accepted H_0 is rejected which means that the variable of lubricant ingredients have small effect on the environment. Renewable fuel and lubricant variables are simultaneously influenced significantly to the sustainable environment, this is based on $F_h > F_t$ of $62.101 > 4.737$) and its significance is $0.000 < 0.05$. Then H_0 concluded rejected H_a accepted which means that the variable of renewable fuels and lubricants or very large effect on the environment sustainable, the value of correlation coefficient 0.941 or 94.1% which means there is a very strong relationship between renewable fuel variables and lubricants to the environment Sustainable. With determinant coefficient $R = 0,941$ influenced by factor of independent variable. Hence H_0 concluded H_a refused acceptable which means that the variable of renewable fuels and lubricant ingredients influence or very big influence on environment sustainable. Utilizing plastic waste after being processed by pyrolysis method produces liquid hydrocarbons having elements of

compounds such as crude oil and renewable fuels obtained from calculations are $\text{CO}_2 + \text{H}_2\text{O} + \text{C}_1\text{-C}_4$ + Residual substances. Then the plastic waste can be processed by isomerization process + catalyst to lubricating oil and the result of chemical calculation obtained is CO_2 , H_2O , $\text{C}_{18}\text{H}_{21}$ and the rest.

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