

Recycling Waste Product via Pyrolysis Method to Produce Marine Fuel



Md Redzuan Zoolfakar, Arvinth A/L Tanggabello, Nurul Asyikin Badir Noon Zaman, Noridah Binti Osman

Abstract: A Transportation industry is a worldwide working system. Water transportation is the biggest known medium to human. In such immense task, many costing variables should be mulled over so as to pick up benefit. Real costs included are fuel utilization, send upkeep and fix, officials' workmanship, port charges, protection inclusion, and some more. These kind of costing are fundamental and can't be stayed away from as it will influence the whole activity. Anyway numerous examinations and inquires about are done every now and then to improve and to have an upgraded activity. As told before fuel utilization is an exceptionally critical viewpoint. It is imperative to advance the voyage activity, or toward the end it will cause a flood in fuel costs. For the duration of the time architects had attempted their best to limit the fuel utilization by having a streamlined ship activity. Be that as it may, in any case it yet still stays as an unsolved astounded. Then again contamination via pollution is an insulting issue which is corresponding to the development of human exercises. An irrefutable truth is this is for the most part brought about by people which are results identified with the quick advancement innovation. Numerous harms had and will happen if the issue isn't visited. Numerous endeavors have been made to turn out with an answer for the issue.[1] Numerous improvements had been done to the waste administration framework where waste items can be recycled and to be utilized in the first structure or in another one. Having an appropriate reusing strategy will guarantee a superior and much productive way of life. This exploration is predominantly expected to tackle both of these issues simultaneously. By utilizing pyrolysis strategy, waste products are thermally treated so as to create three kinds of by-products. These results are char, bio oil, and syngas which are fuel in three states. Later the results can be utilized as an elective fuel source to be utilized in delivery industry. The fundamental result that is engaged in this exploration was the bio oil, which is a bio diesel that can be utilized as fuel source locally available ship. The last decision was to decide an entirely appropriate recommendation of waste item that can be pyrolysed to deliver a superior marine fuel at much lower cost. In the end toward the finish of this exploration a solitary recommendation will be especially helpful in taking care of both the issues referenced previously.

An extraordinary commitment to the earth and to the entire transportation industry will be accomplished.

Keywords: transportation, contamination, by-products, coast

I. INTRODUCTION

Pollution is the acquaintance of contaminants with the common habitat which causes negative effects. This sullying is destructive to the nature and the living life form that relies upon it. Contamination harms and debases the nature of living and makes it be hurtful to be utilized. Land, water, air, and as of late commotion contamination are the normal and real kinds of contamination happening. A measurements by WHO (2005) says that about 9 million individuals were influenced because of different contamination in the time of 2003. [2].WHO likewise included that the number will increment in future time if the issue is unattended.

The current technique for recycling just ready to limit the issue as opposed to illuminating it until the end of time. The present methodology of recycling will just keep up the amount of waste items instead of diminishing it. This is on the grounds that the waste items may be handled with the goal that it tends to be reused once more. This demonstrates another technique for reusing is required to defeat the issue. To give a superior answer for this issue, a superior proposal is vital. Pyrolysis is case of technique that is especially reasonable in conquering the issue. Recycling is a cycle or a treatment procedure that comprises of a few activities, for example, reducing, reusing, and lastly recycling an item. Recycling had been a piece of people action since old time even without our insight. Through recycling we have some way or another figure out how to avert an extreme harm to the nature. That is the reason we should proceed with this respectable activity.

The current technique for recycling just ready to limit the issue as opposed to illuminating it until the end of time. The present methodology of recycling will just keep up the amount of waste items instead of diminishing it. This is on the grounds that the waste items may be handled with the goal that it tends to be reused once more. This demonstrates another technique for reusing is required to defeat the issue.

To give a superior answer for this issue, a superior proposal is vital. Pyrolysis is case of technique that is especially reasonable in conquering the issue.

In oceanic industry a similar issue happens where the exercises completed causes distress particularly to nature. So as to have a legitimate and universal institutionalized task, the International Maritime Organization (IMO),

Revised Manuscript Received on October 30, 2019.

* Correspondence Author

Md Redzuan Zoolfakar*, Marine and Electrical Engineering Technology Section, Universiti Kuala Lumpur, Marine Institute of Marine Engineering Technology, Lumut, Malaysia.

Arvinth A/L Tanggabello, Marine and Electrical Engineering Technology Section, Universiti Kuala Lumpur, Marine Institute of Marine Engineering Technology, Lumut, Malaysia.

Nurul Asyikin Badir Noon Zaman, Chemical Engineering Department, Universiti Teknologi Petronas, Seri Iskandar, Malaysia.

Noridah Binti Osman, Chemical Engineering Department, Universiti Teknologi Petronas, Seri Iskandar, Malaysia.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](http://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>



Recycling Waste Product via Pyrolysis Method to Produce Marine Fuel

has made a rundown of global shows under its watch which goes about as purview for sea activities. Instances of these shows are:

- i. International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended
- ii. International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto and by the Protocol of 1997 (MARPOL).
- iii. International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW) as amended, including the 1995 and 2010 Manila Amendments.
- iv. Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972.
- v. Convention on Facilitation of International Maritime Traffic (FAL), 1965.

II. EXPERIMENTAL

There are three fundamental classifications in pyrolysis process which are slow pyrolysis, fast pyrolysis and also flash pyrolysis. Table 1 shows the differences of all three types of pyrolysis [4].

Table. 1 The Differences for Types of Pyrolysis

Operating parameters	Slow pyrolysis	Fast pyrolysis	Flash pyrolysis
Pyrolysis temperature (°C)	300-500	600-1000	800-1000
Heating Rate (°C/Sec)	0.1-1	10-200	>500
Particle size (mm)	5-50	<1	<0.2
Solid residence time (Sec)	300-550	0.5-10	<0.5

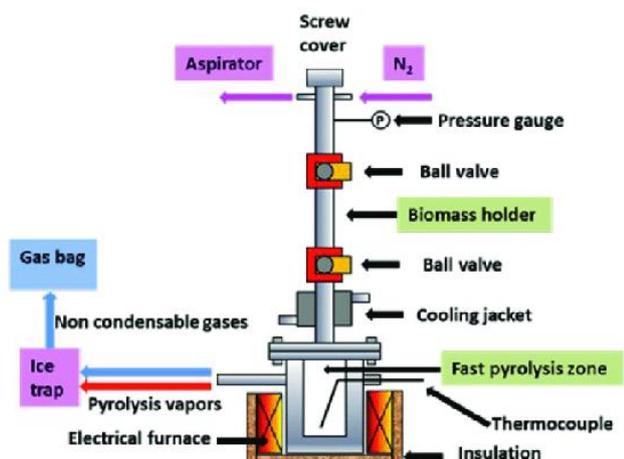


Fig. 1 Drop Type Pyrolyser

Nitrogen is inserted into the pyrolysis chamber in order to replace with air. Electrical furnace was used as the heating element, because the heat transfer rate need to high. The pyrolysis zone been insulated to prevent any heat loss to surrounding. Ice cubes were used as the cooling medium for the condensation process. The char is collected at the end of

the experiment while the bio oil is channeled separately. Through this type of pyrolyser it is possible to obtain a maximum of 85% of bio oil. This is because drop type pyrolyser is a very efficient method of conducting fast pyrolysis. This is because the temperature inside the chamber can be increase rapidly by controlling the electrical furnace.

III. RESULT AND DISCUSSION

Table. 2 By product- Tire tube

	400°C	450°C	550°C
Char (grams)	13.82	13.62	12.71
Bio oil (grams)	3.11	3.45	3.92
Gas (grams)	3.07	2.93	3.37

Table. 3 By product- Coconut grate

	400°C	450°C	550°C
Char (grams)	7.70	8.29	8.71
Bio oil (grams)	1.03	1.87	2.15
Gas (grams)	11.27	9.84	9.14

Table. 4 By product- Ships dirty oil

	400°C	450°C	550°C
Char (grams)	14.22	13.11	12.83
Bio oil (grams)	3.27	5.03	5.77
Gas (grams)	2.51	1.86	1.4

Highest char is produced by tire tube at all three temperatures compared to other samples. Meanwhile bio oil is produced highest by ship dirty oil followed by tire tube and coconut grate. Coconut grate has the highest syngas at all three temperatures followed by tire tube and finally ships dirty oil. But at the same time coconut grate produces the lowest quantity of char and bio oil as per compared to other two samples. All the by-products for all samples are produced highest at 550°C. The rate of by-products produced differs for each sample because each sample has different level of compositions. And the rate of reaction for identical sample differs and produces various results because of different working temperature. For the first part of the analysis it is concluded that quantity of bio oil produced for every type of sample increased as the temperature increase. Ship's dirty oil has the highest bio oil production compared to others. And the maximum of bio oil from ship's dirty oil is at 550°C followed by tire tube and finally coconut grate.

Table. 5 Chemical composition- Dirty oil

	400°C	450°C	550°C
Calorific value MJ/KG	45.21	45.56	46.20
Carbon value (weight rate wt %)	88.20	87.95	87.60

Table. 6 Chemical composition- Tire tube

	400°C	450°C	550°C
Calorific value MJ/KG	41.97	42.06	42.1
Carbon value (weight rate wt %)	86.1	85.6	85.3

Table. 7 Chemical composition- Coconut grate

	400°C	450°C	550°C
Calorific value MJ/KG	25.60	25.70	26.20
Carbon value (weight rate wt %)	75.31	74.86	74.20

The research is to determine the best suggestion for marine fuel that can be produced using waste product via pyrolysis method. The suggestion is made based on three main factors which are costing, quantity and quality of fuel that is produced.

A good marine fuel should be low in cost, as the major costing in shipping industry is the fuel consumption. In such case producing bio oil from waste products will result a very low costing. Eventually the material costing will be zero as it is not necessary to buy the waste product. The only costing involved is the operating cost in conducting the pyrolysis process, which still will be very much less compared to the existing fuel cost. So cost for all raw materials is the same.

Next factor will be the amount of bio oil that is produced from the waste products. Higher the percentage of bio oil that is produced from the waste product, the better it is. This once again relates to the costing of fuel. Higher the fuel (bio oil) production, lower the costing will be. Based on the results the highest quantity of fuel (bio oil) was obtained from ship's dirty oil at the temperature of 550°C. This shows that bio oil from ship's dirty oil at 550°C will be very much suitable as marine fuel.

The final factor is the quality of bio oil that is produced. Bio oil that is produced via pyrolysis method is very much suitable to be used as marine fuel. From the research done the quality of bio oil is determined based on the fuel's calorific value and carbon content. For choosing a good and suitable marine fuel the bio oil must be high in calorific value but low in carbon content. The bio oil with the highest calorific value is from ship's dirty oil. But on the other hand the bio oil with the lowest carbon content is from coconut grate.

The highest calorific value of bio oil from coconut grate is just 26.20MJ/KG which is nowhere near compared to bio oil from ship's dirty oil which is 46.20MJ/KG. Meanwhile the lowest carbon content of ship's dirty oil is 87.60wt% which is just slightly higher compared to coconut grate which is 74.20wt%. This small difference can be neglected as ship's dirty oil has much higher calorific value. Finally it is concluded that bio oil from ship's dirty oil has the highest quality compared to other two samples.

From the whole experiment, pyrolysis at 550°C using ship's dirty oil will produce the best bio oil compared the other two samples. As to conclude among the three samples, ship's dirty oil is the best and much suitable recycling waste product to be pyrolysed to produce marine fuel.

ACKNOWLEDGMENT

The author wish to express the appreciation to all team members the effort to complete all the experiment.

REFERENCES

1. Bell, S. (2018). The Past 5 Decades of Recycling. Road Runner
2. Mandal, K.K. "Improve desalter control", Hydrocarbon processing, April, 2005.p.77
3. Christine & Scott Gable. (May 14, 2015). Diesel Fuel Cetane Rating.
4. Onay, O. (2003, April 16). Slow, fast and flash pyrolysis of rapeseed. Renewable Energy, 28, 2417–2433
5. Muhammad Naqvi, S. R. (2015, AUGUST). The Role of Zeolite Structure

AUTHORS PROFILE



Associate Prof. Dr. Md. Redzuan Zoofakar is a lecturer in University Kuala Lumpur Marine Institute Of Marine Engineering Technology (UNIKL MIMET). Completed PhD in the field of marine engineering in University of Newcastle UK. Served 15 years in marine department in UNIKL MIMET. Represented Malaysia in many international maritime conferences. Currently working on developing several projects on bigger scale.



Arvinth Tanggabello a student of Bachelor Marine Engineering Technology from University Kuala Lumpur Marine Institute Of Marine Engineering Technology (UNIKL MIMET). Previously received a Diploma of Marine Engineering Technology also from the same institute. Participated and won a number of awards for the final year projects. Currently working onboard ship.



Nurul Asikin Badir Noor Zaman is a second year Chemical Engineering Student at University Teknologi Petronas. She received a bachelor degree in chemistry from University Kebangsaan Malaysia. Her current research focuses on chemicals via pyrolysis process in biomass.



Dr Nooridah Binti Osman is a senior lecturer in Universiti Teknologi Petronas (UTP). Completed her PhD from University of Ohio in the field of chemistry. Served more than 10 years as a lecturer at UTP. Her expertises are in chemistry and biomass. Currently is the main supervisor for a number of postgraduate students.