Production and characterization of wax and grease from waste plastic

P R Kumbar\textsuperscript{1}, V S Patil\textsuperscript{1}, *S R Kumbar\textsuperscript{2}, R B Kumbar\textsuperscript{3} and Dr. P Bhange\textsuperscript{2}

\textsuperscript{1}Sanjay Ghodawat International School, Atigre - 416118, Maharashtra.
\textsuperscript{2}Sanjay Ghodawat University, Atigre - 416118, Maharashtra.
\textsuperscript{3}Sanjay Ghodawat Polytechnic, Atigre - 416118, Maharashtra.

* Corresponding author Email address: shobha.kumbhar@sanjayghodawatuniversity.ac.in

Abstract: World has opened up to start a plastic-free zone. Plastic reusing is the greatest test for us all. During reusing it is important to avoid the potential risk of environmental degradation and hazard. Consuming plastics makes it perilous to the general public. The major focus is to utilize waste grade 4 plastic and generate grease and wax so efficiently that there is no release of harmful oxides (CO\textsubscript{2}, CO) in the environment and it is very economical. Utilizing waste plastic, the creation of grease and wax is completed. It is valuable to the general public without making the risk to condition. The portrayal of the grease and wax is featured right now. Results show that grease can be utilized for substantial vehicles and with certain added substances, it may be very well utilized for some applications.

Keywords: Production; Characterization; Plastic; Wax; Grease.

1. Introduction

The use of plastic nowadays is constantly decreasing but the plastic which already exists in the world is very difficult to manage and the industrial processes are not much economical and neither are eco-friendly. An alternative approach to processing plastic solid waste is chemical recycling, the success of which relies on the affordability of processes \cite{1}. Many processes are followed to get the useful product out of waste like wax and grease out of waste plastics. Plastic derived diesel is suitable as a blend component for petroleum diesel fuel \cite{2}, oil \cite{3, 4}, wax and grease are the main. Production of grease and additives to be added must be realized for the purpose. Proper thickener in the grease will exhibit the service characteristics \cite{5}. Grease can be more than a lubricant; it is often expected to perform as a seal, corrosion inhibitor, shock absorber and a noise suppressant \cite{6}. Different characteristics like FTIR and SEM is performed to check the material produced.

Objectives & Motivation:

The major focus of the paper is to use grade 4 plastic (Low-Density Polyethylene) and generate useful products more economically and in an eco-friendly method where there is no release of harmful oxides during the procedure (Ex: CO\textsubscript{2}, CO). The release of toxic oxides is cut due to the addition of camphor to the mixture while heating, which when reacts with the mixture, the oxides are consumed by the camphor, as camphor requires oxides to burn out. When the oxides are exhausted the remaining camphor remains in the mixture and becomes a part of the products. So, if the products (wax and grease) are heated in the future the camphor will also burn hence preventing toxic oxide production in the future. After the oxides are consumed there is a byproduct formed which is carbon settlement, this can be used in making inks, etc. When the mixture is heated at the end, we get a combination of solid particles and semi-liquid below. The solid particles are the wax and the semi-liquid turns into grease after cooling down. The process is very economical compared to the industrial process and can be completed with the materials available at home.
2. Methodology

2.1. Collection, Sorting, and Washing

Plastics are collected from surroundings. After plastics are collected, they are sorted to obtain the grade-4 plastic. Just like with clothes, fruits/vegetables, and many other things, plastics must be washed before they are further processed. The goal of this step is to remove impurities and everything that is not made from plastic.

2.2. Heating Process and Collection

Engine oil is taken and boiled at 150°C and grade-4 plastic is added into the oil. To reduce the environmental hazards camphor is added to the mixture. The end product is having two forms. The solid one is wax and semi-liquid after cooling is grease. The final step is the collection of wax and grease into glass jars. Cost analysis of the material is tabulated in the table.

Table 1: Material and cost of Project 1.

| S. NO. | Material                          | Availability                                      | Cost             |
|--------|----------------------------------|--------------------------------------------------|------------------|
| 1.     | Waste Grade 4 plastic (Low-Density Plastic) | Waste plastic available for free in the environment. | 0 Rs             |
| 2.     | Used oil                         | The oil that is already used for cooking available in homes or used engine oils in garages. | 0 Rs             |
| 3.     | Camphor                          | In shops                                         | 15 Rs – 20 Rs per 100 g |
| 4.     | Gas or electricity for heating    | In-home                                          | Use of resources for heating, 20 min usage of Gas: 1.5 Rs (approx), 20 min usage of electricity: 2 Rs (approx) |
| 5.     | Total Cost                       |                                                  | 21.5 Rs – usage of gas as a heating method. 22 Rs – usage of electricity for a heating method |

3. Results and Discussions

3.1 IR studies

IR spectra of the Grease and wax samples were recorded with FT/IR-4600, Jasco, Japan Spectrometer. FT-IR characterization of wax and grease are done and the graphs are as mentioned in Figure 1 and Figure 2 respectively.
3.1.1 Wax

In Fig. 1. It has been observed that wax which is produced by the Plastic is having wavelength 2916 and 2848, 1744, 1462, 1376, 1239, 1161 cm$^{-1}$ respectively and is compared with biofuel oil by cracking Rice Bran Wax at 600°C, in order to confirm the Py-GC-MS results. It was not liquid at room temperature. When the temperature was elevated to 40°C, liquid material was obtained. which was analyzed using FTIR [7]. The strong peaks at 2916 cm$^{-1}$ and 2848 cm$^{-1}$ were attributed to the presence of methylene groups (CH$_2$) [8, 9]. The peak at 1744 cm$^{-1}$ corresponding to CO was attributed to the presence of aldehydes, ketones, ester groups or carboxylic acids [10]. Liu et al. carried out Py-GC-MS analysis and confirm that C=O mainly arise from the acid and ester compounds in the bio-fuel oil [11]. The peak located at 1462 cm$^{-1}$ was attributed to the asymmetric vibrations of CH$_2$ and CH$_3$ groups. In addition, the weak peak at 1376 cm$^{-1}$ arises due to the bending vibration of CH$_3$. The peak located at 1240 cm$^{-1}$ was CO stretching vibration of acid or ester. Many papers thought the strong peak at 720 cm$^{-1}$ was attributed to aromatic stretching vibration. Another probability was that the vibration at 720 cm$^{-1}$ was attributed to long chain compounds [9]. The vibration located at 910 cm$^{-1}$ was attributed to the di-substituted benzene. The vibration located at 1160 cm$^{-1}$ was attributed to the stretching vibration of saturated ester [9].

| Sr. No. | Wax produced                                                                 | Paraffin Wax                                                                 |
|--------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| 1      | Is more economical and efficient                                             | Is comparatively less economical and efficient                              |
| 2      | Can be made for different uses by changing oil only                          | Has to follow entire procedure to be made for different purposes            |
| 3      | It is less harmful gases when burnt.                                        | It produces comparatively more harmful gases when burnt.                   |
| 4      | Wax does not melt easily and is strong comparatively                          | Melts easily and weak comparatively.                                        |

Table 2: Comparison of wax produced and paraffin wax

Pyrolysis process enlightens a well-organized, clean and operative means of not only removing plastic wreckage from the environment but also explore some innovative ways of turning waste into valuable products like Petrol, High-Speed Petrol, Diesel and Gas etc. [12]. From FTIR results this project confirmed that the pyrolysis products of RBW were main alkane and alkene. Few oxygen containing compounds and aromatic compounds also was found. It needed other experiments to assist confirm
the components of bio-fuel oil. Following are the features of the wax produced and compared with paraffin wax.

3.1.2 Grease

Fig. 2 shows FTIR spectra of a grease sample show the peaks at 2919 and 2851 cm\(^{-1}\) correspond to asymmetrical and symmetrical stretching vibration of CH\(_2\) group. We have observed a new peaks at 1742 cm\(^{-1}\) which is a characteristic of a C=O bond arising from esters formed by oxidation of the sample. The peaks at 1576 and 1540 cm\(^{-1}\) were attributed to the asymmetrical and symmetrical stretching vibration of COO group which arises from the composition of the thickener. The peaks at 1460 cm\(^{-1}\) arises from the C–H asymmetrical vibration of CH\(_3\) group which comes from Base oil, while bands at 1377, 1307, 722 cm\(^{-1}\) correspond to the bending, twisting, rocking vibrations of CH\(_2\) groups [10]. Grease produced tested for lubrication at Siddhartha Grease and Lubricants Pvt Ltd. It is found that with some additives can be used for heavy vehicles as a lubricant.

4. Conclusions

Grade 4 plastic is a great threat to the environment and its process is very complex mainly hazardous to the environment. To overcome such a problem, method mentioned of processing is the efficient and more effective than other processes. Wax and grease produced from waste engine oil and grade 4 plastic are characterized. Further, grease can be used with some additives for heavy vehicles.

Acknowledgement

We are grateful to Mr. Anil Rao, consultant and Dr. E. Sayanna, Chief Technological officer, Siddhartha Grease and Lubricants Pvt Ltd Guragon for his continuous support for testing the grease. Also, special thanks to Mr. Pradeep Patil, HOD Physics, Mrs. Sasmita Mohanty, Director Principal Sanjay Ghodawat International School, Dr. H.M. Naveen Principal, SGIS, Mrs. Shobha Naveen, Dept of Chemistry and Dr. Lohar, Faculty of Chemistry department, Sanjay Ghodawat University for their encouragement.

Conflict of interest

The authors declare that they have no conflict of interest.

References

[1] Rahimi, A., García, J. Chemical recycling of waste plastics for new materials production. Nat Rev Chem 1, 0046 (2017). https://doi.org/10.1038/s41570-017-0046.
[2] Brajendra K. Sharma, Bryan R. Moser, Karl E. Vermillion, Kenneth M. Doll, Nandakishore Rajagopal, Production, characterization and fuel properties of alternative diesel fuel from
pyrolysis of waste plastic grocery bags, Fuel Processing Technology, Volume 122, 2014, Pages 79-90, ISSN 0378-3820, https://doi.org/10.1016/j.fuproc.2014.01.019

[3] Williams PT, Williams EA, Recycling plastic waste by pyrolysis, Journal of the Institute of Energy, Vol. 71, No. 487, 81-93, 1998.

[4] Miller, Stephen J. Shah, Naresh, Huffman, Gerald P. Conversion of Waste Plastic to Lubricating Base Oil Energy Fuels 2005, 19, 4, 1580-1586.

[5] Yu.L. Ishchuk - Lubrication and lubricants New Age International, 2006.

[6] Gow G. (2010) Lubricating Grease. In: Mortier R., Fox M., Orszulik S. (eds) Chemistry and Technology of Lubricants. Springer, Dordrecht. https://doi.org/10.1023/b105569_14

[7] Qing Liua, Peng Liub, Zhi Xiang Xua, Zhi-Xia Hec, Qian Wanga, Bio-fuel oil characteristic of rice bran wax pyrolysis, Renewable Energy. December 2017 DOI:10.1016/j.renene.2017.12.012. M.L.S. Albuquerque, I. Guedes Jr., P. Alcantra, et al., Vib. Spectrosc. 33 (2003) 127.

[8] Xu Junming, Jiang Jianchun, Lu Yanju, Chen Jie, Liquid hydrocarbon fuels obtained by the pyrolysis of soybean oils, Bioresource Technology, Volume 100, Issue 20, 2009, Pages 4867-4870, ISSN 0960-4389, https://doi.org/10.1016/j.biortech.2009.04.055.

[9] Pan Jiaobao, Cheng Yanhai and Yang Jinyong, Effect of heat treatment on the lubricating properties of lithium lubricating grease, RSC Advances, June 2015.

[10] B.S.S. Phanisankar, N. Vasudeva Rao, J.E. Manikanta, Conversion of waste plastic to fuel products, Materials Today: Proceedings, 2020.

[11] Trevor M. Letcher, Chapter 1 - Introduction to plastic waste and recycling, Editor(s): Trevor M. Letcher, Plastic Waste and Recycling, Academic Press, 2020, Pages 3-12, ISBN 9780128178805.

[12] Kundan Kumar Jha, T.T.M. Kannan, Recycling of plastic waste into fuel by pyrolysis - a review, Materials Today: Proceedings, 2020.