A Low-Cost Bio-Coolants Production and Characterization

Ateequr Rahaman[1], V S K Lokesh G [1], Ramesh CH[1], Mohan Kumar G[1], Vijay Raju S[1]

[1] *Department of Mechanical Engineering, Raghu Engineering College (A), Visakhapatnam, India.*

Corresponding Author: rahaman.ateeq6777@gmail.com

Abstract: - Cutting fluids plays a significant role in machining operations. They are widely used during metal removal operations to remove the heat from the workplace and at the same time provide better lubrication. Currently petroleum derived cutting fluids are widely use due to availability and marginally low cost. However, their applications lead to increase in environmental pollution and cause health hazards to the workers. Therefore, bio-cutting fluids are gaining significant importance as a substitute to the conventional cutting fluids. In this study three different low cost oils such as waste cooking oil, waste engine oil and waste transformer oil are chosen and their tribological properties are evaluated. From the experimental results it is observed that waste cooking oil tribological properties shows better than the other oils.

Key Words— ***Cutting fluids, Tribological Properties and Waste Cooking Oil.***

I. INTRODUCTION

With the advancement of industry 4.0 [1] there is a rapid transformation in the industrial sectors epically in the manufacturing sectors. With the advent of the technology especially the artificial intelligence (AI) [2] more focus has been given to the safety of the worker and provide environmental friendly working conditions. As the manufacturing sectors plays a significant role on the economy by their exports and imports. The environmental safety is also considered as a top priority at the manufacturing sectors. Different studies [3-4] shows that, during the machining operations the health of the worker is deteriorated due to the toxic inhalation. Furthermore, the petroleum based coolants which are currently in use are difficult to dispose and increase the risk of contamination which they are in contact.

Bulky work pieces are shaped, sized, and formed to the desired specifications by the use of machining operations like drilling, turning, milling, and grinding. Where cutting tools and work pieces suffer significant heat stress, machining operations cause plastic deformation of the work piece materials.

Manuscript revised July 09, 2022; accepted July 10, 2022. Date of publication July 11, 2022.

This paper available online at www.ijprse.com

ISSN (Online): 2582-7898; SJIF: 5.59

In addition, the quality of newly created surfaces is always impacted by chip formation during the machining process, which also affects performance. Therefore, during machining processes, coolants in a variety of forms, such as solid, liquid, or gaseous, are utilised to reduce friction and heat created in the contact zones between cutting tools and work pieces.

Various coolant delivery techniques, including flooding, misting, and spraying, are employed depending on the needs of the machining process. Coolants play four key roles in the machining process: (I) lowering the machining temperature; (ii) causing lubrication to reduce friction; (c) facilitating chip evacuation from the machining zone; and (d) preventing corrosion. As a result, coolants improve machining efficiency, offer higher surface quality, and lengthen the life of cutting tools. The effectiveness of the machining process and the quality of the finished work piece may both be increased by selecting the proper type of coolants, which could result in lower overall machining costs. Due to its high specific heat and thermal conductivity, water was the first coolant utilised during machining [4-5]. However, because of the corrosion process that low viscosity induces, water has less of a lubricating impact. In this situation, water rarely reduces the friction that occurs during the machining process. According to reports, the European Union uses about 320,000 tonnes of coolants annually. Coolants have a range of harmful effects on the environment, including the contamination of soil, surface water, and groundwater, which damages agricultural products.

Moreover, coolants cause skin diseases and health issues to the person/operator when in close and frequent contact. Therefore plant and animal oils are being widely used as a bio coolants [6-8] due to its excellent lubricity and flash point. In this study, three different oils such as waste cooking oil, waste engine oil/gear oil, waste transformer oil are used to evaluate the tribological properties.

II. METHODOLOGY

For conducting the tribological experiments, three different oils are chosen. One is waste cooking oil which is obtained from the restaurant another is waste engine oil or gear oil which is obtained from the Maruti Suzuki sales and service center near Visakhapatnam. The final oil is waste transformer oil which is obtained with the permission from the electricity board.

Initially, all the oils are cleaned and filtered to remove any unwanted particles presence. As the waste cooking oil contains many food particles therefore it has to be priory filtered and cleaned. All the oil samples are heated to pre-requests temperature to evaporate any water molecules presence in the oils. The oils are filtered with Watman filter paper and also with surgical cotton. After the filtration process the three oil samples are stored in an air tight glass beakers for the further oil property characterization. Figures from 1 to 3 represent the clear and transparent view of three oil samples.

The tribological properties like kinematic viscosity, density, thermal conductivity, flash point, specific heat, pour point and pH are tested at our fuel laboratory and the required standards are followed while measuring.

Fig.1. Used Cooking Oil

Fig.2. Used Engine Oil

Fig.3. Used Transformer Oil

III. RESULTS AND DISCUSSION

The main drawbacks of petroleum-based oils are those that result from improper use and disposal, which pollute the environment. Furthermore, exposure to or close contact with petroleum-based oils may have a negative impact on the operators' health, including respiratory issues and skin conditions.

Vegetable oils have thus been used in place of petroleum-based oils. There are several desirable qualities that vegetable oils have developed properties such a high viscosity index, good lubricating action, non-toxicity, and high biodegradability. However, because of their poor temperature and oxidative stability, vegetable oils are appropriate for a limited temperature range. Therefore, chemical modification can be used to improve the thermal and oxidative stability of

vegetables. Vegetable oils, like traditional cutting fluids, offer good cooling and lubricating benefits.

Tables from 1 to 3 represents the significant oil properties which are measured by following the international standards.

Table.1. Charaterization of waste cooking oil.

Property	Units	Results
Thermal Conductivity at 30^0C	W/mK	0.192
Kinematic Viscosity at 40^0C	mm^2/sec	42.86
Density at 20^0C	Kg/m^3	910
Flash Point	^{0}C	230
Pour Point	^{0}C	-18
Specific Heat at 40^0C	J/g K	2.014
pH value	-	6.23

Table.2 Charaterization of waste engine oil.

Property	Units	Results
Thermal Conductivity at 30^0C	W/mK	0.175
Kinematic Viscosity at 40^0C	mm^2/sec	39.26
Density at 20^0C	Kg/m^3	998
Flash Point	^{0}C	232
Pour Point	^{0}C	-15
Specific Heat at 40^0C	J/g K	2.905
pH value	-	7.86

Table.3. Charaterization of waste transformer oil.

Property	Units	Results
Thermal Conductivity at 30^0C	W/mK	0.181
Kinematic Viscosity at 40^0C	mm^2/sec	16
Density at 20^0C	Kg/m^3	895
Flash Point	^{0}C	140
Pour Point	^{0}C	-30
Specific Heat at 40^0C	J/g K	-
pH value	-	7.5

The major purposes of coolants are to reduce the temperature of the cutting zone, to lubricate the machining process, to flush away chips, and to prevent corrosion. High stress and friction in high-speed machining operations prevent coolants from penetrating secondary and tertiary deformation zones to produce lubricating effects. However, coolants help to disperse the heat produced in the primary deformation zone and are responsible for around 60% of the total heat produced during machining. Additionally, heat is released through produced chips. In order to lower the temperature of the cutting zones, coolants are delivered onto the chips or are flushed through the chips. Only low-speed machining operations may take advantage of the lubricating effects, which lower friction, prevent BUE from developing, and improve work piece surface smoothness. A key factor in creating a more effective and efficient machining process is the delivery mechanisms and cooling procedures used to supply coolants into the machining operations. A major issue is always involved in choosing the suitable coolants while taking into account the machining operations, the materials of the work piece, and the cutting tools.

IV. CONCLUSION

According to the discussion above, it can be concluded that the main problem is choosing appropriate coolants for a particular application while taking into account potential consequences and making sure that the coolants reach the desired work zones. Additionally, environmental problems brought on by coolants and appropriate disposal methods for each type of coolant are also major concerns. From the experimental study it was observed that waste cooking is dominating the other two oils in terms of better thermal conductivity, high viscosity and flash point and hence it is concluded that waste cooking can be considered as a suitable bio-degradable cutting fluid.

REFERENCES

[1]. Muji Setiyo, Tuessi Ari Purnomo, Dori Yuvenda, Muhammad Kunta Biddinika, Nor Azwadi Che Sidik, Olusegun David Samuel, Aditya Kolakoti, Alper Calam.(2021). Industry 4.0: Challenges of mechanical engineering for society and industry. Vol 1,1: pp.3-6.

[2]. Kolakoti, A. (2021). An experimental based artificial neural network modeling in prediction of optimum combustion, performance, and emission from diesel engine operated with three biodiesels. World Journal of Engineering, Vol. 18 No. 5, pp. 805-814.

[3]. Decoufle, P. (1978). Further analysis of cancer mortality patterns among workers exposed to cutting oil mists. J. Natl. Cancer Inst. 61: 1025.

[4]. Jarvholm, B. and Lavenius, B. (1987). Mortality and cancer morbidity in workers exposed to cutting fluids. Arch. Env. Hlth. 42: 361.

[5]. Uehara, K.; Kumagai, S. (1970) Characteristics of tool wear in cryogenic machining. CIRP Ann. 18, 273–277

[6]. Aditya Kolakoti, Muji Setiyo, Budi Waluyo (2021) Biodiesel Production from Waste Cooking Oil: Characterization, Modeling and Optimization.Vol 1.1, pp 22-30.

[7]. Aditya Kolakoti, Bobbili Prasadarao, Katakam Satyanarayana, Muji Setiyo, Hasan Köten, Metta Raghu (2022) Elemental, Thermal and Physicochemical Investigation of Novel Biodiesel from Wodyetia Bifurcata and Its Properties Optimization using Artificial Neural Network (ANN).Automotive Experiences. Vol 5(1), pp 3-15.

[8]. Basava, V. A., Kolakoti, A., & Kancherla, P. R. (2021). IDI Engine with Alternate Fuels. In L. Burstein (Ed.), Handbook of Research on Advancements in Manufacturing, Materials, and Mechanical Engineering (pp. 25-53). IGI Global.