IOP Conference Series: Earth and Environmental Science

Comparison of the efficiency (flash point, freezing point, and viscosity test) of biodiesels from *Sargassum* sp.

Comparison of the efficiency (flash point, freezing point, and viscosity test) of biodiesels from *Sargassum* sp.

M B Santanumurti[1*], M R Royan[2], S H Samara[1], S Sigit[3] and M A Alamsjah[34]

[1]Department of Fish Health Management and Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Indonesia 60115
[2]Department of Biological Science, Faculty of Mathematics and Natural Sciences, University of Bergen, P.O. Box 7800, NO-5020, Bergen, Norway
[3]Department of Veterinary Basic Medicine, Universitas Airlangga, Indonesia 60115
[4]Department of Marine, Faculty of Fisheries and Marine, Universitas Airlangga, Indonesia 60115

*Corresponding author: m.browijoyo@fpk.unair.ac.id

Abstract. Biodiesel, an alkyl ester compound produced through an alcoholysis process (transesterification) between triglycerides and methanol or ethanol with the help of alkaline catalysts into alkyl esters and glycerol, is an alternative renewable fuel. A total of 75 ml of used cooking oil and 5 kg dry *Sargassum* sp. was used. Five different treatments, namely P0 (Commercial Biosolar), P1 (100% *Sargasssum* sp. Biodiesel), P2 (75% *Sargasssum* sp. Biodiesel + 25% Biosolar), P3 (50% *Sargasssum* sp. Biodiesel + 50% Biosolar) and P4 (25% Sargasssum sp. Biodiesel + 75% Biosolar) were tested according to the biodiesel efficiency parameters. The efficiency test of the biodiesel included the flash point, freezing point and viscosity test. The tests were conducted with the help of the panelists prior to laboratory testing the best biodiesel sample. The panelist tests were conducted by involving 9 panelists with a replication of 5 treatments each. Seaweed oil from *Sargassum* sp. and used cooking oil were proven to be capable of being used as materials to produce biodiesel. Based on the study results, the most efficient combination was 75% *Sargassum* sp. biodiesel and 25% biosolar.

1. Introduction

Indonesia is experiencing an energy crisis due to the country's reliance on only one type of energy source. Petroleum will eventually run out due to its increasing use. Over time, fuel reserves in the earth will become increasingly scarce due to their continuous use [1]. One alternative of renewable fuel is biodiesel. Biodiesel is an alkyl ester compound produced through an alcoholysis process (transesterification) between triglycerides and methanol/ethanol with the help of alkaline catalysts and glycerol. There is also the esterification of (free) fatty acids with methanol or ethanol with the help of alkaline catalysts, transforming into alkyl esters and water [2].

Biodiesel is known as an environmentally friendly and renewable fuel. Biodiesel produced from plant oils or animal fats is usually more expensive than conventional diesel from petroleum [3]. Biodiesel is possible to produce from used vegetable oil, namely used cooking oil. Biodiesel can also be made from seaweed. Among the seaweed types, *Sargassum* sp. can be used as a raw material to process into bioethanol because it has several advantages, namely a relatively short harvesting age, it does not interfere with the food supply and its cultivation system does not sacrifice food production, animal feed and other plant-derived products [4]. Further research is needed to produce biodiesel from *Sargassum* sp.

2. Material and methods

2.1 Materials

The used cooking oil was taken from fried food vendors around Surabaya. The *Sargassum* sp. samples were obtained from Talago Island, Madura, and the research was conducted in the Education Laboratory in the Faculty of Fisheries and Marine, Airlangga University in Surabaya. A total of 75 ml of used cooking oil and 5 kg of dry *Sargassum* sp. were used. The used equipment includes a soxhlet, flat bottom glass beaker, bottle, magnetic stirrer, heater, measuring cup, micro pipette (0.1 ml and 1 ml), thermometer, funnel, pH tester, thermometer, glass beakers, blenders, scales, timers and lighters.

2.2 Method

2.2.1 Experimental design

The main parameters observed in this research were the flash point, freezing point and viscosity of the biodiesel. This research used 5 different treatments, namely P0 (Commercial Biosolar), P1 (100% *Sargasssum* sp. Biodiesel), P2 (75% *Sargasssum* sp. Biodiesel + 25% Biosolar), P3 (50% *Sargasssum* sp. Biodiesel + 50% Biosolar) and P4 (25% *Sargasssum* sp. Biodiesel + 75% Biosolar). The seaweed was extracted using the soxhlation method to obtain the oil. The samples were wrapped in filter paper to ensure that there was continuous extraction with a relatively constant amount of solvent in the presence of a condenser [5]. The oil obtained from the soxhlet process was esterified and transesterified to obtain the biodiesel from the seaweed. A similar procedure was also applied on the cooking oil to obtain the biodiesel.

2.2.2 Biodiesel efficiency test

The biodiesel efficiency test was conducted on the transesterified oil. The efficiency test of the biodiesel was proven by the flash point, freezing point and viscosity test. The tests were conducted with the help of the panelists prior to the laboratory testing on the best biodiesel sample. The panelist tests were conducted by involving 9 panelists with a replication of 5 treatments each.

3. Result and discussion

3.1 Flash point

Based on the tests conducted on the *Sargassum* sp. biodiesel, the flash point ranged from 74.1°C in P0 to 113°C in P2 and P3. The test results have been presented in Figure 1 below.

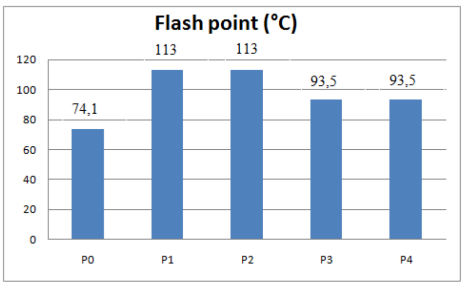

Figure 1. Flash point of the *Sargassum* sp. biodiesel

The decree of the Head of the National Standardization Agency (BSN) Number 73 / KEP / BSN / 2/2006 dated March 15th, 2006 stated that the test parameters for the biodiesel quality standard are flash point and viscosity. In addition to the flash point and viscosity, the freezing point is also an important parameter [6].

The flash point is the lowest temperature where the fuel is still flammable when reacting with air [7]. If the flash occurs continuously at a certain temperature, then it is called the fire point. The higher the flash point of the fuel, then the safer its handling and storage because it is not flammable. The flash point of P1 (figure 1) was in accordance with the flash point of SNI 04-4182-2006. which has a minimum value of 100°C. This shows that the biodiesel made from *Sargassum* sp. is easy to store because it is not flammable at room temperature.

Previous experiments [8] showed that the high biosolar addition to biodiesel can lower the flash point. The low flash point indicates low volatility and the ability to burn from a fuel state. Volatility is the tendency of a material to evaporate [9]. The results of the study showed that *Sargassum* sp. biodiesel and used cooking oil have a high votality, so it is not flammable.

3.2 Freezing point

This study showed that the freezing point of the treatments varied from -5°C (P0) to -30°C (P1), as presented in Figure 2.

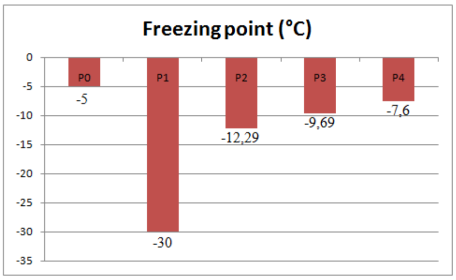

Figure 2. Freezing point of the *Sargassum* sp. biodiesel.

The freezing point is the highest temperature that causes solidification in a liquid substance [10]. The freezing point in biodiesel is an important parameter in several countries [11]. If the commercial fuel has a high freezing point, then the fuel will solidify easily and be unable to flow into the engine. The study results showed that *Sargassum* sp. biodiesel (P1) has a very low freezing point; this is in accordance with the SNI-04-7182-2006 standard at a maximum of 0°C. This shows that *Sargassum* sp. biodiesel can be produced and commercialized in high latitude countries due to its very low freezing point.

3.3 Viscosity

The lowest viscosity value was found in P1 (0.165 mm^2/s) and the highest viscosity was in P0 (3,47 mm^2/s). The test results have further been shown in Figure 3.

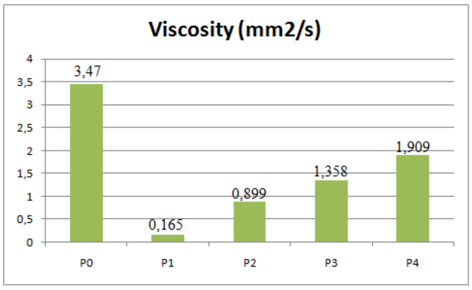

Figure 3. Viscosity of the *Sargassum* sp. biodiesel.

Viscosity is a value expressing the amount of resistance of a liquid material to flow or the resistivity of a liquid. Higher viscosity liquids are thicker and more difficult to flow [12]. The results showed that the biodiesel from *Sargassum* sp. is not in accordance with the viscosity standard of SNI-04-7182-2006 at 2.3-6.0 mm^2/s. P1 (100% *Sargassum* sp. biodiesel) had the lowest viscosity value of 0.165 mm^2/s. Based on the study results, the *Sargassum* sp. biodiesel with the best viscosity value was P4. This is because P4 meets the standard of American biodiesel viscosity (ASTM D6751-12) of 1.9-6.0 mm^2/s, despite not meeting the SNI standard. When injected into the combustion chamber, a low viscosity fuel will be atomized more efficiently, resulting in smaller fuel grains [13]. With these conditions, the process of mixing fuel with air will be more homogeneous so then more fuel is burned. Because more fuel is burned, more energy is released, resulting in an increase in the final combustion pressure. Putting the three parameters into consideration, the best efficiency in *Sargassum* sp. biodiesel was found in the P2 treatment.

The use of seaweed for biodiesel has several advantages. Seaweed is highly available, and even abundant at certain times. The greatest abundance of *Sargassum* sp. usually occurs between June and October with the thallus length reaching 200 cm [14]. In these months, the *Sargassum* sp. stock is abundant and can pollute the beach. *Sargassum* sp. biodiesel has high economic efficiency because the raw materials can be found easily in nature and completely unused materials can be utilized.

4. Conclusion

Seaweed oil from *Sargassum* sp. and used cooking oil can be used as the materials to produce biodiesel. Based on the study results, the most efficient combination was 75% *Sargassum* sp. biodiesel and 25% biosolar. Further research is needed to test the other parameters of *Sargassum* sp. biodiesel and used cooking oil. There is a need to develop technology for the coating of diesel engines to promote the prolonged use of even low viscosity biodiesel.

5. References

[1] Zakir M, Raya I 2008 *Optimization of the Synthesis and Characterization Process of Biodiesel from Red Alga Oil (Eucheuma cottonii) with Potassium Hydroxide (KOH) Catalyst* (Makassar: Jurusan Kimia, FMIPA, Universitas Hasanuddin)
[2] Musanif J 2003 *Biodiesel* (Jakarta: Direktorat Pengolahan Hasil Pertanian)
[3] Murniati R 2011 *Characterization of Biodiesel from Used Oil as a Result of Physical Activation of Activated Zeolite* (Padang: Universitas Andalas)
[4] Saputra D R, Ridlo A, Widowati I 2012 *J. Mar. Res.* **1** 145–51
[5] Josep A, Hutahaean N 2010 *Comparison Study Of The Effectiveness Of Rosela Flower (Hibiscus sabdariffa Linn.) Flower Infusion on Cholesterol Levels of Marmut Blood Serum* (Medan: Universitas Sumatera Utara)
[6] Knothe G 2005 *Fuel Process. Technol.* **86** 1059–70
[7] Ritonga M 2011 *Biodiesel from Transesterification of Jatropha curcas Oil with 7 Free Fatty Acids, 78% with Polystyrene Sulfonate Acid Catalyst (Pss) 1% and 4% within 6 Hours Against Physical Properties* (Medan: Universitas Sumatera Utara)
[8] Setiawati E, Edwar F 2012 Teknologi *Ris. Ind.* **VI** 117–27
[9] Lestari E 2010 *Stud. Diploma III* **1** 1–5
[10] European Pharmacopoeia Commission and European Directorate for the Quality of Medicines & Healthcare 2010 *European pharmacopoeia* (Vol. 1) (France: Council of Europe)
[11] Alleman T L, McCormick R L, Christensen E D, Fioroni G, Moriarty K, Yanowitz J 2016 *Biodiesel Handling and Use Guide* (United States: NREL)
[12] Kristianingrum S, Suwardi, Siswani E D 2012 *Synthesis and Characterization of Biodiesel from Used Oil at Various Times and Temperatures* (Yogyakarta: Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Yogya)
[13] Murni 2010 *Examine Experimental Effect of Palm Oil Biodiesel Temperature on Constant*

Injection Direct Diesel Engine Performance (Semarang: Universitas Diponegoro)
[14] Basmal J 2010 *Squalen Bulletin of Marine and Fisheries Postharvest and Biotechnology* **5** 2 59-66