Dean&Francis
ISSN 2959-6157

Analysis of the Current Application of Biodiesel and Suggestions for Its Promotion

Chengxi Song

The University of Tokyo, Komaba, Tokyo, 153-8902, Japan
Corresponding author:9821832986@g.ecc.u-tokyo.ac.jp

Abstract:

With global warming and the gradual depletion of traditional fossil energy, it is becoming increasingly urgent to find new green and low-carbon alternative energy sources. Biodiesel is widely regarded as a renewable energy source with development prospects because of its advantages in reducing greenhouse gas emissions and promoting resource recycling. This article aims to briefly explain the preparation methods of biodiesel, the main relevant policies of various countries and the current application status. At the same time, this article puts forward suggestions for the promotion of biodiesel in China from the aspects of reducing the costs of preparation, improving current policies, strengthening publicity and promoting cooperation between local enterprises. Through the active cooperation between the government, enterprises and the public, the huge potential of China's biodiesel consumer market can be developed. Through the promotion of biodiesel, while reducing carbon emissions in transportation, it can promote the recycling of resources in China.

Keywords: Biodiesel, SAF, Energy policy.

1. Introduction

Now, global warming and depletion of traditional fossil energy sources have become important issues. According to the latest research, if the current carbon dioxide emissions continue unchanged, the average temperature rise of the earth may exceed 1.5 degrees in three years [1]. This will have an irreversible and profound impact on the earth's ecosystem and human social activities. Due to population growth, industrialization revolution and urbanization, the current society's demand for energy continues to grow. According to the forecast of the International Energy Agency, the global energy demand will increase by 50% from 2005 to 2030 [2]. In the long run, there will be a shortage of non-renewable fossil energy sources such as oil and coal.

In order to alleviate these problems, the promotion of green and renewable energy sources has been receiving increasing attention globally and has become a priority in the long-term energy strategies of most countries. Among them, biodiesel has been recognized by researchers as a suitable renewable alternative energy source due to its significant ability to reduce emissions of greenhouse gases and other pollutants, as well as the fact that it can be directly applied to existing engines. At the same time, active-

ISSN 2959-6157

ly preparing and promoting biodiesel can also improve the level of energy self-sufficiency and guarantee national energy security [3]. Biodiesel based on waste as raw material can effectively reduce food safety problems, such as gutter oil, while alleviating environmental pollution problems, further solving the problem of crop competition for bioenergy and realizing the recycling of resources [2,3]. The American Society for Testing and Materials (ASTM) defines biodiesel as a monoalkyl ester derived from lipid feedstocks[2]. Currently, countries such as the European Union and the United States have made some progress in the promotion of biodiesel through policy support and mandatory addition requirements. However, the recognition of biodiesel is not very high in China, and it has not been successfully promoted in most areas except Shanghai.

In order to improve the economic benefits of biodiesel and develop the domestic consumer market in China. This paper briefly analyzes the current situation of biodiesel application, and at the same time puts forward suggestions on the promotion of biodiesel in China from the aspects of reducing the preparation cost, improving the policy system, strengthening the publicity, and promoting the cooperation of enterprises. By strengthening the promotion of biodiesel in China, can further reduce China's carbon emissions and promote the recycling of resources.

2. Preparation of Biodiesel

Compared with conventional diesel, biodiesel can reduce greenhouse gas emissions by about 41% due to its higher oxygen content and more complete combustion, as well as reduce harmful pollutants such as sulfur dioxide and hydrocarbons[2]. The environmental performance of biodiesel is not only related to its combustion characteristics, but is also significantly affected by the type of feedstock. The main feedstocks for biodiesel are edible crops (first-generation feedstocks), non-edible feedstocks (second-generation feedstocks), algae (third-generation feedstocks), and genetically engineered microorganisms (fourth-generation feedstocks). Since 1977, when the first industrial biodiesel preparation technology was introduced, biodiesel production and preparation technology has been undergoing tremendous and rapid changes [2]. On this basis, the production of biodiesel continues to surge and is expected to reach 41.4 billion liters globally by 2025 [2].

2.1 Preparation Methods of Biodiesel

Physical methods of preparation include micro emulsion method which forms an oil dispersion by adding fats and solvents to vegetable oils and the direct blending method, which mixes regular diesel, solvents and natural fats and oils in a certain ratio [4]. In addition to physical preparation methods, there are more chemical methods. The current preparation process is a more mature and widely used biodiesel production method, is the transesterification method. That is, three molecules of alcohol (methanol or ethanol) and one molecule of triglyceride are gradually converted to alkyl esters (diesel fuel) and glycerol as a by-product under the action of a catalyst [4][5]. The reactants prepared by the transesterification method are often referred to as first-generation biodiesel and are often used as a blend material for fossil fuels [6].

As can be seen in Table 1, the catalysts for this method can be categorized into three main groups, namely homogeneous catalysts, multiphase catalysts and enzyme catalysts [4]. Relatively suitable catalysts can be selected according to the conditions of the reaction, the nature of the feedstock.

Table 1. Types of catalysts for biodiesel preparation

Types of catalysts	Advantages	Disadvantages
Homogeneous acidic catalysts	Transesterification and esterification can occur simultaneously, no saponification, suitable for low-grade feedstock oils, milder reaction, lower energy consumption.	Long reaction time, easy to corrode equipment, low catalytic activity, difficult to recover the catalyst after reaction
Homogeneous alkaline catalyst	Fast reaction, high catalytic activity, mild reaction conditions, low energy consumption	Easy to saponify, anhydrous conditions, low conversion when saponified, non-reusable catalyst
Solid acidic catalyst	Non-corrosive, environmentally friendly, reusable, applicable to the synthesis of biodiesel from a variety of feedstocks, catalyzes esterification and transesterification at the same time Reaction	Sensitivity to water, small specific surface, thermal instability, etc. lead to lower catalytic activity
Solid alkaline catalyst	with high catalytic activity	slower reaction speed, catalyst leaching, not suitable for high free fatty acid

Acid-base bifunctional catalyst	free fatty acid reduction of feedstock oils, increase catalytic activity	active site leaching
enzyme catalyst	no saponification, inexpensive, mild reaction conditions	catalyst is easily deactivated due to impacts, Lower yield, not easy to realize industrial production.

In addition to the traditional transesterification method, the preparation process of hydrodeoxygenation (HDO) for the production of second-generation biodiesel is currently receiving attention. Its main production principle is to prepare biofuels by deep hydrogenation and isomerization reactions in the presence of a non-homogeneous catalyst. The biofuel obtained is very close to the properties of fossil fuels and improves the problem of high oxygen content of biodiesel prepared by transesterification [6].

2.2 Reducing the Preparation Cost of Biodiesel

One of the important challenges of the biodiesel industry is the preparation cost. The high preparation cost greatly reduces the competitiveness of biodiesel in the market and hinders the popularization of biodiesel application. In order to reduce the preparation cost, we can start from improving the preparation technology of biodiesel, improving the catalyst, improving the recycle of raw materials and utilizing the by-products.

Firstly, from the perspective of improving the preparation technology of biodiesel, the development of more excellent reaction equipment such as similar intermittent and continuous reactors, reactive distillation reactors and membrane reactors, is essential. Through the ultrasonic radiation, plasma discharge, microwave and supercritical and other new technologies to reduce or provide the activation energy required for the reaction, the above methods can effectively improve the production efficiency of biodiesel, thereby reducing the cost of preparation [4]. Among them, the supercritical process is relatively good for industrial applications. It has the advantages of high reaction efficiency and no pretreatment, but still has the problems of lower yield, higher reaction conditions and more complicated production equipment [6].

Secondly, developing more efficient and stable catalysts can also reduce the cost of preparation. For example, in the preparation process of the HDO method, the mos2 catalyst has been successfully improved by introducing acidic sapo-11 molecules, which can achieve the dual effect of hydrogenation and isomerization at the same time, improve the efficiency of preparation, and can be considered for industrial application in the future [7].

In addition, the choice of feedstock will also have a greater impact on the cost of biodiesel preparation. At present, the feedstock of biodiesel in China is mainly waste oil and grease. China produces a large amount of waste oil and grease every year, but the recovery of which is used for biodiesel preparation is low, resulting in a series of problems, such as insufficient supply of raw materials for production and high production and preparation costs. In order to increase the recycling rate of waste oil and grease, we can try to build a relatively complete waste oil and grease recycling chain, for example, placing professional collection equipment near residential areas and commercial streets, and then the government or relevant enterprises will regularly collect the waste oil and grease and clean up the equipment, so as to facilitate the recycling of residents. For example, the German company Münzer has installed waste oil and grease collection bins in several cities, and successfully recovered more than 400 tons of kitchen waste oil in Styria in 2024 through this method [8]. In densely populated rural and inaccessible areas, mobile recycling methods such as garbage trucks can also be tried to increase the recovery rate of waste oil and grease.

In addition to waste oils and fats, attempts can be made to develop diversified feedstocks for biodiesel preparation to increase the feedstock availability. For example, Ricinus communis L. has a high oil content and is resistant to salinity and drought, and can be grown in areas where it is difficult to grow food [9]. The third generation of feedstock, algae, has a higher energy content, is fully renewable, and can also absorb carbon dioxide and pollutants from the surrounding environment. However, the current production is low and has not been industrialized and commercialized on a large scale [9].

Finally, attempts can also be made to improve the economics of biodiesel preparation methods by utilizing by-products, thus indirectly reducing the cost of biodiesel preparation. For example, glycerol produced by the transesterification method can be used for heating and cosmetic preparation; microalgae can be used to produce a variety of different commodities such as pharmaceuticals, cosmetics, and animal feeds in addition to biodiesel preparation [2].

3. Biodiesel Application Market

3.1 Key Relevant Policies in Various Countries

Due to energy security concerns and the setting of targets

ISSN 2959-6157

for reducing carbon emissions in the transportation sector, several countries have successively clarified specific plans regarding biofuels. In June 2023, the Renewable Fuel Standard (RFS) of the United States stipulated the production requirements for biofuels in the period of 2023-2025 and the related percentage requirements [10]. The EU's Renewable Energy Directive (RED) policy has undergone a number of adjustments in recent years, and in a new regulation adopted in 2023, it increased the renewable energy target for transportation to 29% or a 14.5% reduction in Greenhouse Gas (GHG) intensity and set sub-targets related to reaching a 5.5% share of advanced biodiesel and renewable hydrogen [11]. Meanwhile, the EU's ReFuelEU plans to reach a 2% share of Sustainable Aviation Fuel (SAF) at EU airports by 2025 and 70% by 2050 [12].

3.2 Current Application Status

At present, biodiesel plays an important role in road transportation, aviation and shipping. Governments and enterprises are actively promoting the practical application of biodiesel, SAF and biofuel oil.

In road transportation, B100 (pure biodiesel) is usually used as a blending feedstock, while B5 (5% biodiesel content) and B20 (20% biodiesel content) are commonly used as transportation fuels. According to a life cycle analysis completed by Argonne National Laboratory, B100 can reduce carbon dioxide emissions by 74% compared to petroleum diesel; in practice, biodiesel can also improve the lubricity of the fuel. In addition, due to its low flammability, biodiesel is safer to transport and store compared to petroleum diesel [13].

The research and application of SAF have also received extensive attention from countries around the world. According to the Life Cycle Assessment(LCA), using SAF to instead of traditional aviation fuel can significantly reduce carbon dioxide emissions. According to a news report on China's Guangming website, Airbus uses more than 14 million liters of SAF throughout the year, accounting for 16% of its total fuel use and reducing about 35 million tons of CO2 emissions [14]. On June 5, 2024, China's domestically produced C919 large airliner successfully completed a test flight refueled with domestically produced bio aviation fuel, marking an important progress in China's application of green aviation technology[15]. With the implementation of the ReFuelEU program in the European Union, the application market of SAF may expand rapidly.

In the field of shipping, the International Maritime Organization (IMO) proposes that the total annual greenhouse gas emissions from international shipping should be reduced by at least 20% in 2030 compared with 2008, and strive to reduce them by 30%. By 2040, total annual greenhouse gas emissions from international shipping should be reduced by at least 70% compared with 2008, and strive to reduce by 80%. In the face of the International Maritime Organization's decarbonization and emission reduction requirements, more and more shipping companies have begun to pay attention to the application of biofuel oil (including biodiesel) [15]. Therefore, the demand for biodiesel in shipping will also be expanding.

4. Suggestions for the Promotion of Biodiesel in China

4.1 Current Existing Policies in China

China has been actively supporting the development of the biodiesel industry for a long time. The Renewable Energy Law has begun to require that petroleum enterprises incorporate bio-liquid fuels complying with national standards into their fuel marketing systems. In 2014, the Biodiesel Industry Development Policy clarified the requirements for relevant industrial specifications. The "14th Five-Year" Renewable Energy Development Plan emphasizes the support of technology research and development and application promotion in biodiesel-related fields, and in November 2023, the "Notice on the Organization of Pilot Demonstration of Biodiesel Promotion and Application" will further support the development of the biodiesel industry. However, despite the frequent introduction of policies, which mostly focus on strategic guidance, specific implementation details and supporting measures are still insufficient, lacking mandatory requirements and clear sales path. These problems may lead to a situation where enterprises are not highly motivated and the domestic market is difficult to open.

At present, the most successful of China's biodiesel promotion and application pilots is Shanghai. Since 2018, Shanghai has released a series of relevant management methods to support the promotion and application of waste oil and grease biodiesel, and has formed a relatively complete system of the whole industrial chain, price guarantee, and smooth promotion of the product from the recovery of raw materials, processing, and application at gas stations [16]. As of 2021, Shanghai has 300 gas stations selling B5 diesel in the city, with a daily average of 19,000 refueling vehicles and a daily sales volume of about 1,600 tons [17]. The successful promotion model of Shanghai provides valuable experience for various provinces in China, and also reflects the existence of large-scale biodiesel consumption potential that has not yet been activated in China.

4.2 Improve policy support

Overall, China's biodiesel is mainly exported, and the domestic consumption market is small. Data show that after 2020, China's biodiesel consumption is only about 50 tons per year. On the other hand, from 2019 to 2023, China's biodiesel exports have been steadily increasing, and the proportion of exports to production has been higher [3].

With the strengthening of the European Union's policy on biofuels, it has gradually become one of the major exporters of biodiesel in China. European Biodiesel Board statistics show that in 2023, China exported about 1.8 million tons of biodiesel to the EU, accounting for about 90% of China's exports; about 60% of the EU's biofuel feedstocks are from China [18]. However, the EU started to take anti-dumping measures against China on biodiesel in August 2024, and according to the information of China Trade Remedy Network, the anti-dumping duty is currently adjusted to 10.0%~35.6% [19]. This policy will have a certain impact on China's biodiesel exports, but also reflects the necessity of developing the domestic biodiesel market.

In order to change the center of biodiesel industry from export to domestic demand, the support of national policy is indispensable. In the promotion of biodiesel in Shanghai, it is especially important to set up an effective price emergency bottom-up guarantee mechanism, which can try to protect the basic interests of the biodiesel industry. In order to further strengthen the market competitiveness of biodiesel and mobilize the enthusiasm of enterprises in manufacturing and sales, the government can also try to follow the example of the Feed-in-Tariff of solar power to adjust or formulate relevant policies. At the same time, in order to guarantee the sales channels of biodiesel, China can try to require mandatory consumption or introduce the promotion method of Kyoto in Japan (the government applies biodiesel to municipal garbage collection trucks and buses), so as to open up the consumer market.

On the other hand, while opening up new markets, the government should also strengthen control to prevent unlawful elements from taking advantage of the situation. For example, one of the main raw materials for biodiesel, used cooking oil (UCO), China used to implement an export tax rebate rate of 13%, but the policy was discontinued in December 2024 due to tax evasion by unscrupulous elements taking advantage of the loopholes in the policy. Therefore, it is important to be more rigorous when improving or formulating policies to minimize the occurrence of such problems.

4.3 Diversified promotion routes

At present, consumers in China do not have a high degree of acceptance of biodiesel, environmental protection awareness is weak, and most of them still prefer to use traditional fossil diesel. In order to improve the current situation, the government and enterprises can strengthen the promotion and publicity through advertisements, lectures, volunteer activities, and commercial promotions to increase the public's acceptance and willingness to consume biodiesel. For example, in Shanghai, bus advertisements are used to publicize biodiesel to the public; around 2007, the Stagecoach car operator in the United Kingdom launched a campaign in which local residents could exchange their household waste oil for a discount coupon on bus rides. All of the above methods can enhance the public's understanding of biodiesel and awareness of protecting the environment, thus strengthening consumer acceptance of biodiesel.

In addition to strengthening publicity, the government can try to promote cooperation between enterprises on biodiesel. In Japan, Seven-Eleven Co. and Mitsui & Co. have entered into a partnership. which will prepare B100 biodiesel from waste cooking oil collected from 711 convenience stores in Osaka, Kyoto, and other areas, and these fuels will be used in transportation vehicles delivering to 711 convenience stores [20]. Through this initiative, carbon dioxide emissions from transportation can be reduced while increasing the recycling rate of used oil. Through business-to-business cooperation, it is possible to secure raw materials while ensuring access to biodiesel and to achieve energy recycling in a given region.

5. Conclusion

This paper briefly describes the current methods of biodiesel preparation, related policies and applications in various countries, and makes suggestions for the promotion of biodiesel in China. With the increased attention to biodiesel preparation and promotion in various countries, the application market of biodiesel in the fields of aviation, shipping and road transportation should be expanded gradually. At the same time, because the European Union has officially begun to adopt an anti-dumping policy on biodiesel exports to China, the importance of China's domestic consumer market will gradually increase, and the center of gravity of the biodiesel industry will gradually change from export to domestic demand. In order to further strengthen the practical application of biodiesel in China, we can try to reduce the preparation cost, improve the current policy system, strengthen the domestic publicity, learn the advanced methods of other countries and improve the cooperation of enterprises. By popularizing the practical application of biodiesel, we can reduce carbon emissions from road transportation, aviation and shipping

ISSN 2959-6157

to achieve China's goal of carbon neutrality by 2060 as soon as possible, and at the same time, we can effectively improve the recycling and reuse of resources.

References

[1] BBC 2025.6.18 Three years left to limit warming to 1.5C,leading scientists warn

[2] Asmaa A. Abdelrahman, Muhammad A. Abo El-Khair, Advanced Biodiesel Production: Feedstocks, Technologies, Catalysts, Challenges, and Environmental Impacts, Journal of Environmental Chemical Engineering,Volume 13, Issue 1,2025,114966,ISSN 2213-3437

[3] LEI, M. FENG, X. (2024). Discussion on the current situation of biodiesel promotion in China

[4] HAN Zong-jiang, JIANG Guo-he, WU Gang, (2023). Research progress of biodiesel production and processing technology. Applied Chemical Industry, 52(6)

[5] Muhammad Ali Ijaz Malik, Sadaf Zeeshan, Muhammad Khubaib, Adeel Ikram, Fayaz Hussain, Hayati Yassin, Atika Qazi, A review of major trends, opportunities, and technical challenges in biodiesel production from waste sources, Energy Conversion and Management: X, Volume 23, 2024, 100675, ISSN 2590-1745,https://doi.org/10.1016/j.ecmx.2024.100675.

[6] Hongwei Zhang, Jing Zhang, Yongde Ma, Zhenping Cai, Yanning Cao, Kuan Huang, Lilong Jiang, A mini review on catalytic hydrodeoxygenation for biofuels production: catalyst, mechanism and process, Applied Catalysis A: General, Volume 699, 2025, 120278, ISSN 0926-860X, https://doi.org/10.1016/j.apcata.2025.120278.

[7] Yongxin Ding, Jun Lin, Panjie Yu, Hongwei Zhang, Yongde Ma, Zhenping Cai, Yanning Cao, Kuan Huang, Lilong Jiang, An in-situ combo Mo-based ionic liquid and SAPO-11 catalyst for efficient biolipids hydrodeoxygenation and isomerization, Fuel, Volume 362, 2024, 130827, ISSN 0016-2361.

[8] MÜNZER, 1.2 million kilograms of CO2 saved: Münzer and Styrian AWVs collected more than 400 tons of used cooking oil, 2025-5-6 https://muenzer.com/at-en/company/news/muenzer-acquires-majority-stake-in-agra-entsorgungs-gmbh-3.

[9] Kurzawska-Pietrowicz, P., & Jasiński, R. (2024). A Review of Alternative Aviation Fuels. Energies, 17(16), 3890. https://doi.org/10.3390/en17163890

[10] EPA, Final Renewable Fuels Standards Rule for 2023, 2024, and 2025, 2024-7-24, https://www.epa.gov/renewable-fuel-standard-program/final-renewable-fuels-standards-rule-2023-2024-and-2025?utm_source=chatgpt.com

[11] EU energy policy, Biofuels, https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biofuels_en?utm_source=chatgpt.com

[12] EU energy policy, RefuelEU Aviation https://transport.ec.europa.eu/transport-modes/air/environment/refueleu-aviation_en

[13] U.S. DEPARTMENT OF ENERGY, Alternative Fuels Data Center;https://afdc.energy.gov/fuels/biodiesel-benefits

[14] Guangming Online, 2025-6-21, Airbus accelerates exploration of sustainable aviation fuel applications; https://mq.mbd.baidu.com/r/1EU1ueQxh9m?f=cp&rs=2518861927&ruk=QoDg02KifaFNWfL9CIS0pA&u=72755d1bcd3cacbd&urlext=%7B%22cuid%22%3A%22ga2lf0PgH80-a2820aBji_iAvi_IP28L_uSPt0uIB8_f82t3_uS_u_iVWaJHtHurybFmA%22%7D

[15] Guangming Online, 2025-5-20, Gutter oil" into biofuel can be used in the sky and the sea; https://mo.mbd.baidu.com/r/1EU1etiRhZu?f=cp&rs=1084158025&ruk=QoDg02KifaFNWfL9CIS0pA&u=a600a13dfeadbd60&urlext=%7B%22cuid%22%3A%22ga2lf0PgH80-a2820aBji_iAvi_IP28L_uSPt0uIB8_f82t3_uS_u_iVWaJHtHurybFmA%22%7D

[16] Li Ling, What is the difficulty in promoting biodiesel on a large scale? , China Energy News, 2023-10-16 Page 08 http://paper.people.com.cn/zgnyb/html/2023-10/16/content_26022892.htm

[17] National Energy Administration, 2021-08-31, Consultation on Biodiesel

[18] National Energy Administration 2024-09-13 New opportunities for biodiesel development

[19] CHINA TRADE REMEDIES INFORMATION, 2025-02-12; https://cacs.mofcom.gov.cn/cacscms/article/ckys?articleId=183331&type=1

[20] MITSUI&CO. Use of 100% Biodiesel Fuel in 7-Eleven Delivery Truck; https://www.mitsui.com/jp/en/topics/2024/1250506_14380.html