Development Trend Analysis of High Density Aviation Fuels Based on Web of Science

Shuo Wang [1a*], Weiyu Duan [1], Piyao Jia [2], Huanming Lv [1]

[a*]sekiwangedward@163.com

[1]LiaoNing Inspection, Examination & Certification Centre, Shenyang, 110032, China
[2]Shenyang University of Technology, Liaoning, Shenyang, 110870, China

Abstract—In order to find out the research hotspots and development trends of high-density aviation fuel, the research methods of information visualization and network analysis are adopted, and the papers in the field of high-density aviation fuel research in Web of Science (WoS) from 2009 to 2022 are used as data sources to draw a social network map, and analyze the development trends, research hotspots and frontier trends in the research field. The results show that since 2009, the number of documents issued has shown a significant upward trend. China is the country with the largest number of documents, followed by the United States and the United Kingdom; According to the cooperation of the authors, there are mainly three cooperative groups, among which Zou jijun is the core group with the largest number of papers; The keyword results show that catalytic conversion and hydrodeoxygenation of high-density aviation fuel are the current research focus, and biomass based high-density aviation fuel is the future research focus.

Keywords-Bibliometrics; VOSviewer; Biomass; High density aviation fuels

1. Introduction

With the rapid development of aerospace technology, how to load more fuel into a limited volume container has become a common topic for researchers all over the world. The density of high-density aviation fuel is high, and the same volume can load more fuel of mass, providing greater power and longer flight distance for aircraft. High density aviation fuel has the characteristics of high density and large volume calorific value. At present, its source is still petroleum refining. With the development of the world and the progress of human life, low-carbon and environment-friendly fuels should be used for human activities as much as possible. Therefore, high-density aviation fuels also tend to be obtained through biomass conversion. In order to understand the current research situation of high-density aviation fuel, we used the bibliometric analysis software to sort out the published relevant literature, and through visual analysis, we learned about the research status and the next research hotspot, providing reference and basis for the research and development of relevant personnel.

MSEA 2023, May 26-28, Nanjing, People's Republic of China

DOI 10.4108/eai.26-5-2023.2334230

2. Data sources and research methods

2.1. Data sources

The research literature data is from Web of Science (WoS). From 2009 to 2022, we searched the Web of Science core collection (WoS) database for documents with the research theme of "High Density Aviation Fuel" or "High Density Jet Fuel", and finally selected 55 papers. The VOSviewer visualization research software and Origin software are used to analyze the authors, countries, institutions, keywords and highly cited papers in the field of high-density aviation fuel research, and objectively analyze and reflect the development status and research trends of high-density aviation fuel at home and abroad from a multi-dimensional scale [1].

2.2. research methods

This study adopts a mixed research method combining quantitative and qualitative analysis, and uses the software VOSviewer developed by the Science and Technology Research Center of Leiden University in the Netherlands as a research tool[2] to understand the general situation of high-density aviation fuel research at home and abroad. Use the bibliometric analysis function of VOSviewer to analyze document coupling, co citation, cooperation and co words[3]. By means of keyword co-occurrence, collaboration visualization and other means, this study visually interprets 55 English literatures from the core collection database of Webof Science, mainly including research hotspot analysis, discipline distribution characteristics analysis, literature co citation analysis, research trend exploration and other aspects.

3. Trend Analysis of High Density Aviation Fuels

3.1. Trend Analysis for Article Outputs

The research subjects have 55 papers in total, including 48 research papers (87.27%), 6 review papers (10.91%) and 1 other paper (1.82%). The main language of the thesis is English, with 53 papers in total, and the other languages are Chinese, with 2 papers in total. The number of documents issued in the field of high-density aviation fuel research over the years from 2009 to 2022, as shown in Figure 1. It can be seen from Figure 1 that the number of documents issued in the research field has grown rapidly since 2015. The number of documents issued in 2020 is about five times that of 2015. The top three countries in the number of documents issued are China, the United States and the United Kingdom, among which China has seen the fastest growth in the number of documents issued in recent three years, which is closely related to China's economic and social development, scientific and technological research progress in recent years, and the country's investment in research and governance of aerospace industry [4-10].

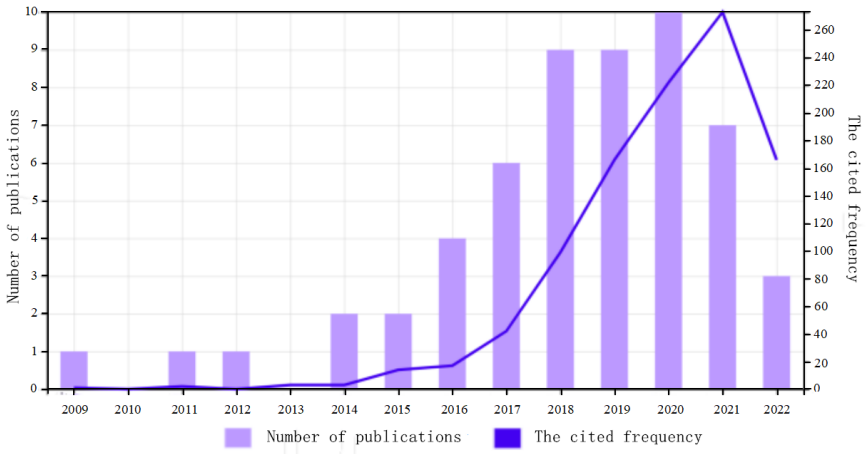

Fig.1 Number of published papers in the field of high-density aviation fuel from 2009 to 2022 in WoS

3.2. Analysis of countries and institutions publishing articles

More than 10 (including 10) publications published on high-density aviation fuel research came from two different countries. The VOSviewer software is used to analyze the cooperation network (i.e. co authors) of high-density aviation fuel research among countries. The size and color of the node indicate the number of publications and the cluster to which the node belongs. The thickness of the link represents the strength of collaboration. The thicker the line, the stronger the cooperation between countries. It can be seen that if only the largest sub network is considered, the cooperation network can be divided into three main clusters: China, the United States and the United Kingdom, of which China and the United States have closer exchanges. The United States is an early country to carry out relevant research. As countries around the world attach importance to the development of aerospace, more and more countries begin to pay attention to the research of high-density aviation fuel [11-16]. The literature searched involved 23 institutions in total. Among the top three institutions in terms of literature publication, Tianjin University and the Chinese Academy of Sciences ranked the top two, followed by the Dalian Institute of Chemical Physics (CAS) of the Chinese Academy of Sciences, as shown in Table 1.

Table 1 The top 3 publishing institutions in the field of high-density aviation fuels in WoS

No.	Organization name	Country	Number of papers	%
1	Tianjin University	China	15	27.28%
2	Chinese Academy of Sciences	China	12	21.82%
3	Dalian Institute of Chemical Physics, CAS	China	9	16.36%

3.3. Analysis of publishers

According to the statistical results, there are about 194 authors in the field of high-density aviation fuel research, including 3 authors with more than 10 articles. The number of papers issued by the top five authors in the field of high-density aviation fuel research is shown in

Table 2. Zou jijun ranks the first in terms of the number of documents issued, and has published 15 papers. The VOSviewer software should be used to analyze the map of cooperation network among authors in the field of high-density aviation fuel research. The map of cooperation network is shown in Figure 2.

Table 2 Papers issued by the top 3 authors in the field of high-density aviation fuel in WoS from 2009 to 2022

No.	First author	Country	Affiliated organization	Number of papers
1	Zou jijun	China	Tianjin University	15
2	Zhang xiangwen	China	Shanghai University	14
3	Pan Lun	China	Collaborat Innovat Ctr Chem Sci & Engn	14

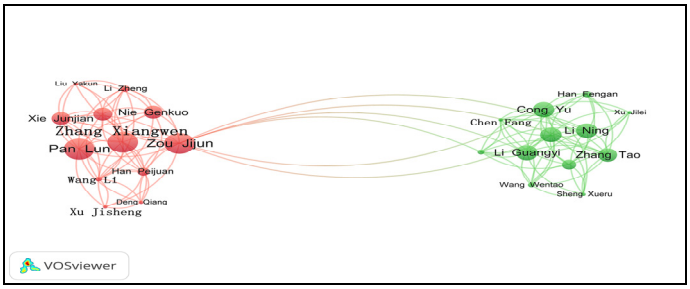

Fig.2 Map of the inter author collaboration network in high-density aviation fuel in WoS

3.4. Keyword analysis

The key words of the affiliated institution summarize the main contents of the paper and are usually used to analyze the emerging trends in a research field. The darker the node color is, the earlier the research is. The lighter the node color is, the more novel the research is. It can be seen from Figure 3 that the research with the keyword "Hydrodeoxygenation" is earlier. "lignin" and "high Density Biofuel" are more popular in recent years [17-24].

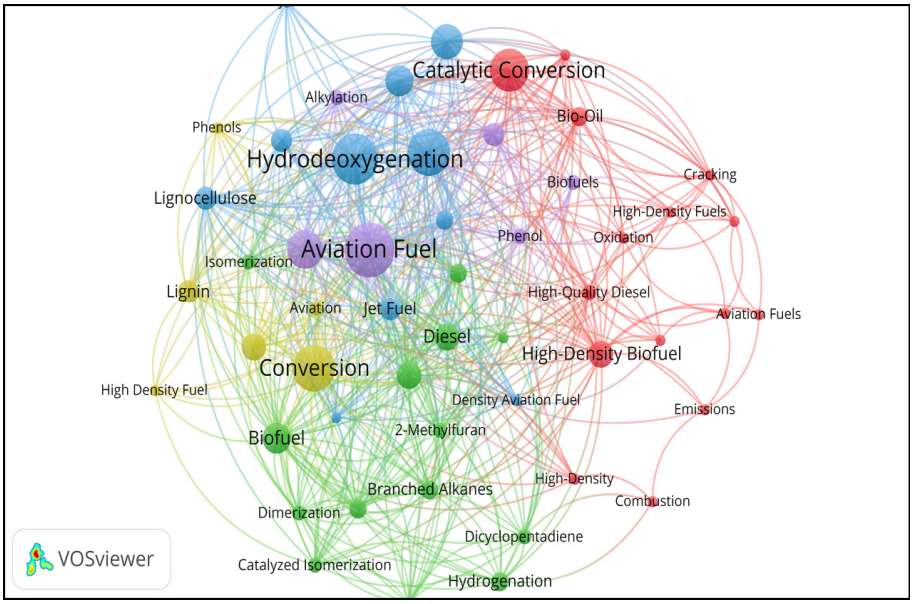

Figure 3 Keyword network map of high-density aviation fuel research field in WoS

3.5. Analysis of highly cited papers

The highly cited papers reflect the focus and development direction of this field. From 2009 to 2022, in the high-density aviation fuel research field, 669 papers were cited, 631 papers were removed from self citation, 1008 times were cited, 856 times were removed from self citation, and 18.33 times were cited. The top 5 papers cited are shown in Table 3 [25-30]. It can be seen from Table 3 that Deng Qiang from Nanchang University published a research paper in FUEL PROCESSING TECHNOLOGY in 2016 with the largest number of citations. The total number of citations of the paper reached 669, and the annual average number of citations reached 80.

Table 3 Top 5 papers cited in the field of high-density aviation fuel in WoS from 2009 to 2022

No.	Title of thesis	Year of publication	Annual average cited times
1	Efficient synthesis of high-density aviation biofuel via solvent-free aldol condensation of cyclic ketones and furanic aldehydes	2016	80
2	An overview on performance characteristics of bio-jet fuels	2019	77
3	Hydrophobic mesoporous acidic resin for hydroxyalkylation/alkylation of 2-methylfuran and ketone to high-density biofuel	2017	60
4	Combustion, performance and emissions of a diesel power generator fueled with biodiesel-kerosene and biodiesel-kerosene-diesel blends	2017	59
5	Integrated Conversion of Cellulose to High-Density Aviation Fuel	2019	54
6	Synthesis of high density aviation fuel with cyclopentanol derived from lignocellulose	2015	4

4. Conclusion

By using the method of bibliometrics, based on the statistical analysis of 55 research literatures on biomass high-density aviation fuel in the Web of Science database from 2009 to 2022, this study identified the research trend of biomass high-density aviation fuel. The results showed that the research on biomass high-density aviation fuel was on the rise as a whole.

(1) The top three countries in terms of the number of documents issued are China, the United States and the United Kingdom. Among them, the group with Zou jijun as the core in China has the largest number of papers, and more and more papers focus on biomass based high-density aviation fuel research field. In recent years, the number of papers issued in China has been high, but the frequency of citations is relatively low. Chinese research institutions have not yet been at the center of international scientific research cooperation in the field of high-density aviation combustion, and their research in this field lacks depth and influence.

(2) The research of high-density aviation combustion involves many disciplines and fields, and the analysis of its research hotspots from different disciplines is also a content that can be supplemented in the future. According to the key words, catalytic synthesis and hydrodeoxygenation of high-density aviation fuel are always popular research contents, the keyword results show that catalytic conversion and hydrodeoxygenation of high-density aviation fuel are the current research focus, and the biomass of high-density aviation fuel has become a new research focus.

Acknowledgments

This paper is supported by the Key Program of Natural Science Foundation of Liaoning Province (20170520108) and the Youth Talent Innovation and Entrepreneurship Program of Liaoning Inspection and Testing Certification Center (SC20210120).

References

[1]Song xiufang, Chi peijuan.Comparative Study of the Data Analysis Results by Vosviewer and Citespace[J].Information Science,2016,34(07):108-112+146.

[2]Gao kai.Research on the Application of Bibliometric Analysis Software VOSviewer[J]. Journal of Library and Information Science,2015,25(12):95-98.

[3]Zhou xiaofen, Huang guobin. Comparison Between Scientific Visualization Metrology Software and the Data Pretreatment[J].Library and Information Service,2013,57(23):64-72.

[4] Yang X , Helal U M , Zhou X , et al. Production of High-Density Renewable Aviation Fuel from Arid Land Crop[J]. ACS Sustainable Chemistry & Engineering, 2018, 6(8):10108-10119..

[5] Xie J , Zhang X , Nie G , et al. Synthesis of High-Density Jet Fuels from Biomass[J]. Progress in Chemistry, 2018:030(009):1424-1433.

[6] Lun P , Qiang D , Xiutianfeng E , et al. Synthesis Chemistry of High-Density Fuels for Aviation and Aerospace Propulsion[J]. Progress in Chemistry, 2015, 27(11):1531-1541.

[7] Xie J , Jia T , Gong S , et al. Synthesis and thermal stability of dimethyl adamantanes as high-density and high-thermal-stability fuels[J]. Fuel, 2020, 260(Jan.15):116424.1-116424.7.

[8] Xie J , Zhang X , Liu Y , et al. Synthesis of high-density liquid fuel via Diels-Alder reaction of dicyclopentadiene and lignocellulose-derived 2-methylfuran[J]. Catalysis Today, 2018:319-144.
[9] Bai J , Zhang Y , Zhang X , et al. Synthesis of High-Density Components of Jet Fuel from Lignin-Derived Aromatics via Alkylation and Subsequent Hydrodeoxygenation[J]. ACS Sustainable Chemistry & Engineering, 2021, 9(20):7112-7119.
[10] Sheng X , Li G , Wang W , et al. Dual-bed catalyst system for the direct synthesis of high density aviation fuel with cyclopentanone from lignocellulose[J]. AIChE Journal, 2016, 62(8):2754-2761.
[11] Nie G , Zhang X , Pan L , et al. Hydrogenated intramolecular cyclization of diphenylmethane derivatives for synthesizing high-density biofuel[J]. Chemical Engineering Science, 2017, 173:91-97.
[12] Wang W , Zhang X , Jiang Z , et al. Controllably produce renewable jet fuel with high-density and low-freezing points from lignocellulose-derived cyclopentanone[J]. Fuel: A journal of fuel science, 2022(Aug.1):124114.1-124114.9.
[13] Nie G , Zhang X , Pan L , et al. One-pot production of branched decalins as high-density jet fuel from monocyclic alkanes and alcohols[J]. Chemical Engineering Science, 2018, 180:64-69.
[14]Synthesis of High-Density Aviation Fuel with Cyclopentanol[J]. ACS Sustainable Chemistry And Engineering, 2016, 4(11):6160-6166.
[15] Hwang J J . Review on development and demonstration of hydrogen fuel cell scooters[J]. Renewable & Sustainable Energy Reviews, 2012, 16(6):3803-3815.
[16] Han P , Nie G , Xie J , et al. Synthesis of high-density biofuel with excellent low-temperature properties from lignocellulose-derived feedstock[J]. Fuel Processing Technology, 2017, 163:45-50.
[17] Wang L , Han F , Li G , et al. Direct synthesis of high-density aviation fuel with polycarbonate[J]. Green Chemistry, 2021,23(2):912-919.
[18] Xu J , Li N , Li G , et al. Synthesis of high-density aviation fuels with methyl benzaldehyde and cyclohexanone[J]. Green Chemistry, 2018, 20(16):3753-3760.
[19] Li Z , Li Q , Wang Y , et al. Synthesis of High-Density Aviation Biofuels from Biomass-Derived Cyclopentanone [J]. Energy & Fuels, 2021, 35(8):6691-6699.
[20] Krishnamachary S , Krishna Mohan S , Desingou J , et al. Polycyclic alkanes based high density hydrocarbon fuels preparation and evaluation for LFRJ application[J]. RSC Advances, 2014, 4(85):45407-45414.
[21] Gong Y , Wang P , Wu C , et al. Are fermentation products promising feedstock for high-density bio-fuel? Domino reactions for upgrading aqueous acetone–butanol–ethanol .mixtures[J]. Green Chemistry.,2020,22(18):6317-6147.
[22] Xie J , Zhang L , Zhang X , et al. Synthesis of high-density and low-freezing-point jet fuel using lignocellulose-derived isophorone and furanic aldehydes[J]. Sustainable Energy & Fuels, 2018,2(8):1863-1869.
[23] Kumar A , Dahotia B , Kumar J , et al. Production of High-Density Fuel Precursor from Biomass-Derived Aromatic Oxygenates: Effect of N 2 Pressure on the Alkylation[J]. Industrial & Engineering Chemistry Research, 2019,58(35):16071-16076.
[24] Pan Lun, Xie Junjian, Nie Genkuo , et al. Zeolite catalytic synthesis of high-performance jet-fuel-range spiro-fuel by one-pot Mannich–Diels–Alder reaction[J]. AIChE Journal, 2020, 66(1):16789.1-16789.10.
[25]Qiang, Deng, Jisheng, et al. Efficient synthesis of high-density aviation biofuel via solvent-free aldol condensation of cyclic ketones and furanic aldehydes[J]. Fuel Processing Technology, 2016,148:361-366.
[26]Yang jie, Xin zhong, et al. An overview on performance characteristics of bio-jet fuels [J]. Fuel,

2019,237:916-936.
[27]Xiangwen, Zhang, Qiang, et al. Hydrophobic mesoporous acidic resin for hydroxyalkylation/alkylation of 2-methylfuran and ketone to high-density biofuel[J]. Aiche Journal, 2017,63(2):680-688.
[28] Bayindir, Hasan,Isik Mehmet Zerrakki , Argunhan, ZekiEnergy. Combustion, performance and emissions of a diesel power generator fueled with biodiesel-kerosene and biodiesel-kerosene-diesel blends[J]. Energy,2017,123(15):241-251.
[29] Liu Y , Li G , Hu Y , et al. Integrated Conversion of Cellulose to High-Density Aviation Fuel[J]. Joule, 2019, 3(4):1028-1036.
[30] Sheng X , Li N , Li G , et al. Synthesis of high density aviation fuel with cyclopentanol derived from lignocellulose[J]. Scientific Reports, 2015, 5:9565.