

TECHNOLOGICAL PROSPECTION OF BIOLUBRICANT ADDITIVES AND ECOLOGICAL DRILLING FLUIDS BASED ON VEGETABLE OILS

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Abstract: Drilling fluids with biolubricating additives based on vegetable oil esters are an effective and ecological alternative for oil and gas well drilling operations. However, this approach is still little examined in the oil sector. Technological prospecting is an important tool that provides innovative insights to expand knowledge and promote technological transformations, which facilitates decision-making in research centers and industries. Thus, the present study aims to fill this gap and presents a prospective analysis of scientific articles about the use of vegetable oils as a starting material for the production of biolubricating additives applied in drilling fluids. The research was carried out in the Web of Science databases. Data was retrieved from patent documents from the last 30 years using a combination of the keyword “drilling fluid” and “vegetable oil”.

Keywords: Oil, well drilling, drilling fluids, vegetable oils.

INTRODUCTION

Drilling is an essential operation for oil and gas recovery. Confirmation of the presence of recoverable crude oil can only be confirmed by penetration of the formation by the drill bit. To this end, all elements involved in drilling must be designed to properly drill different types of rock materials, but at the same time they must ensure that their imposing loads do not alter the integrity of the rock formation and affect the stability of the drilled well. Therefore, efficient drilling depends on different parameters and the drilling fluid is one of the most important (FANCHI et al., 2016).

Drilling fluids are critical for transporting drill cuttings from the bottom of the hole to the surface, while stabilizing the formation, controlling the pressure in the wellbore, as well as cooling and lubricating drill pipes and drill bits.). Drag friction between the

drill string and the well walls is an important issue in drilling operations. Thus, the addition of lubricating additives to the drilling fluid is an effective strategy to reduce frictional resistance in oil and gas drilling applications (LAN et al., 2020).

However, conventional drilling fluids are often formulated with toxic chemical compounds that cause environmental problems. Current drilling fluid requirements and ecological demands have spurred scientists to develop environmentally friendly drilling fluids that are less harmful to the environment. Biolubricants – biodegradable lubricants – derived from organic sources provide valuable friction-reducing properties: high lubricity, high thermal stability, high flash point, wide viscosity range, among others (SYAHIR et al., 2017; BARBOSA et al., 2021).

Recent research has revealed potential drilling fluids and/or lubricating additives based on sustainable raw materials, such as vegetable oils. In addition to being renewable sources, drilling fluids and biolubricating additives based on vegetable oil esters may have similar or superior properties to fluids based on hydrocarbons and minerals. The use of drilling fluids with biolubricating additives based on organic esters allows for faster drilling with reduced friction, greater biodegradability, a lower volume of waste, in addition to being able to reduce the total cost of the drilling operation (KANIA et al., 2015).

In this context, a prospective analysis was carried out to investigate what has been published about ecological drilling fluids and/or biolubricant additives based on vegetable oils. For this purpose, a bibliographic search was carried out in order to map the scientific publications published in scientific journals indexed in the Web of Science database, applying the combination of the keywords “drilling fluid” and “vegetable oil”.

MATERIAL AND METHODS

The prospective investigation for scientific articles was carried out on December 12, 2021, filtering the records of publications between January 1, 1990 and December 31, 2021, taking as a reference the Web of Science database, which is significant in several areas. of knowledge. Initially, the keywords “drilling fluid” were used. As a result of this prospective search, it was possible to obtain 3,202 documents. However, as the focus of the work is to gather studies that evaluated the potential of vegetable oils for the formulation of biolubricating additives and drilling fluids, a new search was performed using the combination of the keywords “drilling fluid” and “vegetable oil”. Using this filter, different information was collected from 17 records of scientific publications.

RESULTS AND DISCUSSION

ANNUAL EVOLUTION OF SCIENTIFIC ARTICLES

The industry has recognized the need to develop environmentally friendly drilling fluids and additives that meet technical criteria and meet environmental regulations. As a consequence, drilling fluids based on renewable raw materials are being developed to combine practical advantages and minimize environmental risks (LAN et al., 2020). In this scenario, vegetable oils are preferred for the formulation of biolubricating additives and/or drilling fluids for application in different oil well conditions. As a result, figure 1 shows that there was an exponential growth in the number of scientific articles that address this topic between the years 2013 and 2021, with the highest number of publication records in 2017.

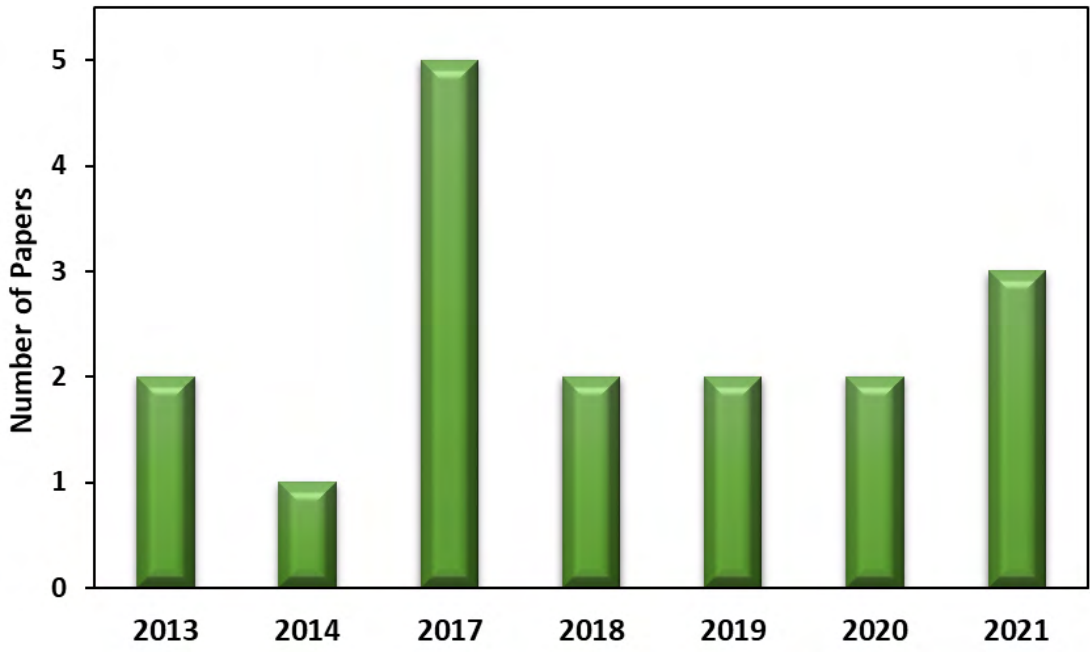


Figure 1 - Annual evolution of scientific articles.

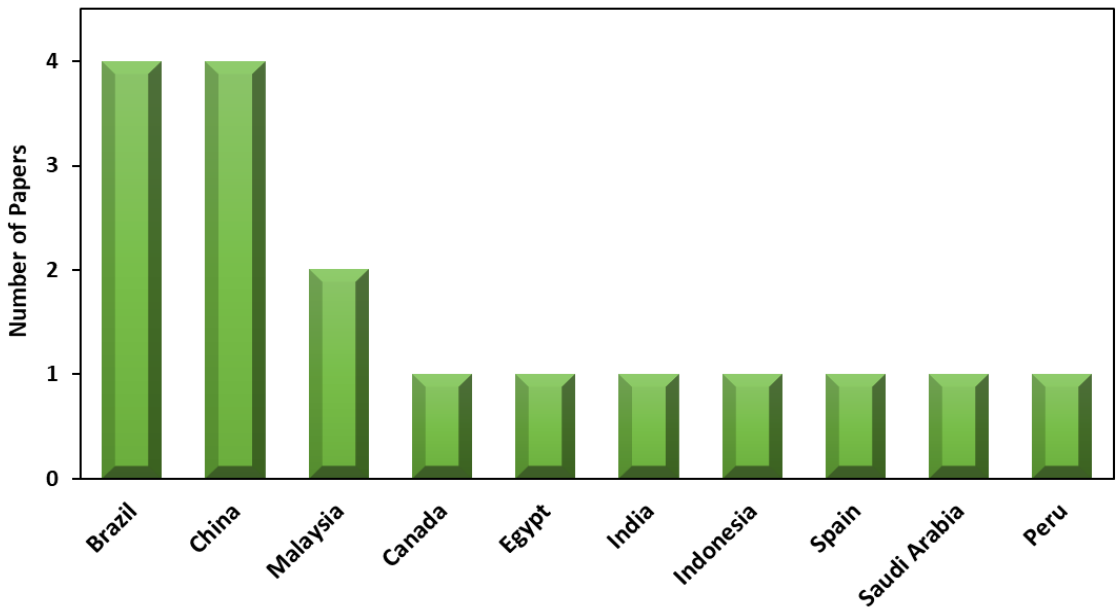


Figure 2 - Countries holding scientific knowledge.

COUNTRIES HOLDING SCIENTIFIC KNOWLEDGE

Researchers and managers from different countries have been looking for strategies to produce ecological drilling fluids that meet the most different oil well projects. Figure 2 shows the 10 countries that generated the most scientific knowledge between 1990 and 2021. Brazil and China stand out as the countries that published the most scientific studies addressing the use of vegetable oils as an input for the manufacture of biolubricating additives and/or drilling fluids, representing around 23.53% of the total number of published articles. In recent years, Brazil has gained prominence on the world stage for using renewable resources to produce sustainable technologies. In the oil sector, in particular, companies in the country have been directing their investments in clean technologies, such as ecological drilling fluids. Other countries that invested in research on this topic were Malaysia (11.76%), Canada (5.88%), Egypt (5.88%), India (5.88%), Indonesia (5.88%), Spain (5.88%), Saudi Arabia (5.88%) and Peru (5.88%).

SCIENTIFIC CONTRIBUTIONS BY UNIVERSITY AFFILIATIONS

During the prospective analysis, the scientific contributions by higher education institutions around the world during the period 1990 and 2021 were evaluated. As shown in Figure 3, the Federal University of Rio Grande do Norte (UFRN) led in scientific contributions with the theme, with 3 publications records. In fact, researchers from the Graduate Program in Chemical Engineering at UFRN have directed their scientific studies to the development of drilling fluids that are less aggressive to the environment. The Federal University of Paraíba was another teaching institution that

contributed to the topic in question, with 1 publication. With 2 scientific articles, the China University of Geosciences (China) and the Universiti Teknologi Petronas (Malaysia) also promoted the use of vegetable oils during the production of biolubricating additives and/or drilling fluids.

JOURNALS INDEXED WITH MORE SCIENTIFIC ARTICLES

The scientific articles collected were published in 9 journals indexed in the Web of Science database and in 1 international conference. Figure 5 shows the indexed journals and the conference and the respective impact factors attributed to these journals. Journal of Petroleum Science and Engineering was the journal that published the most articles promoting studies on the use of vegetable oils in research aimed at the synthesis of biolubricating additives and/or drilling fluids. With 2 publications related to the theme, the journals Applied Clay Science and Holos also promoted the theme to their readers. Among the journals that published the most articles, Applied Clay Science has the highest impact factor. Therefore, scientific articles published in this journal have an average number of citations compared to the others.

CONCLUSION

Drilling fluids with less environmental impact are highly desired over diesel-derived fluids, especially with regard to increasingly stringent environmental laws. In this perspective, the present prospective study mapped the scientific productions involving the use of vegetable oils as raw material for the production of biolubricating additives and/or drilling fluids applied during the drilling of oil wells. From then on, the countries, universities and journals with the greatest scientific production on the subject were

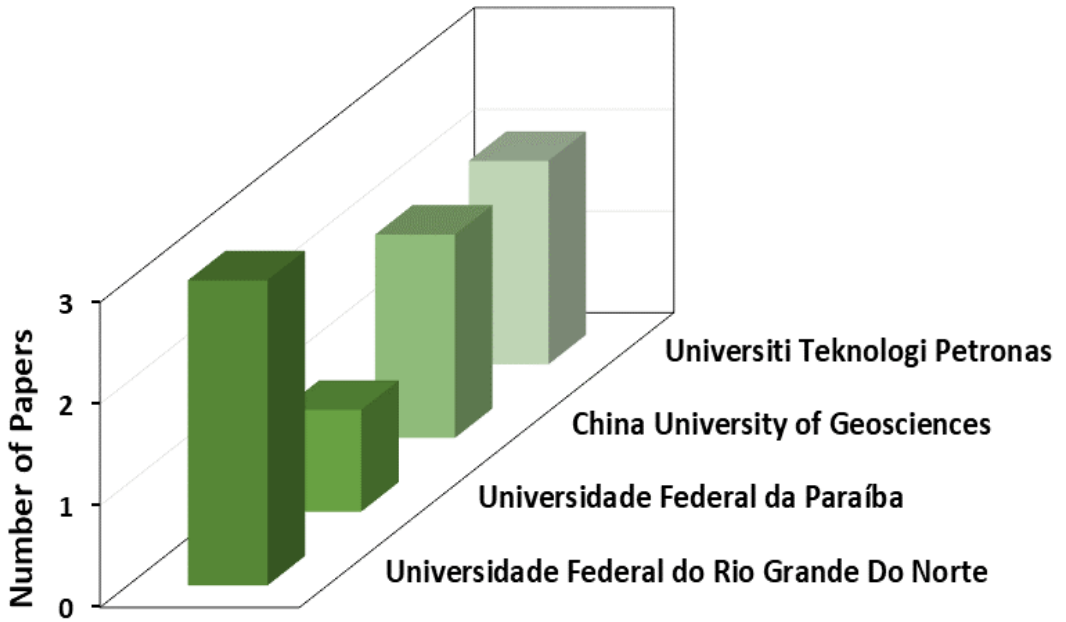


Figure 3 - University institutions with more scientific articles.

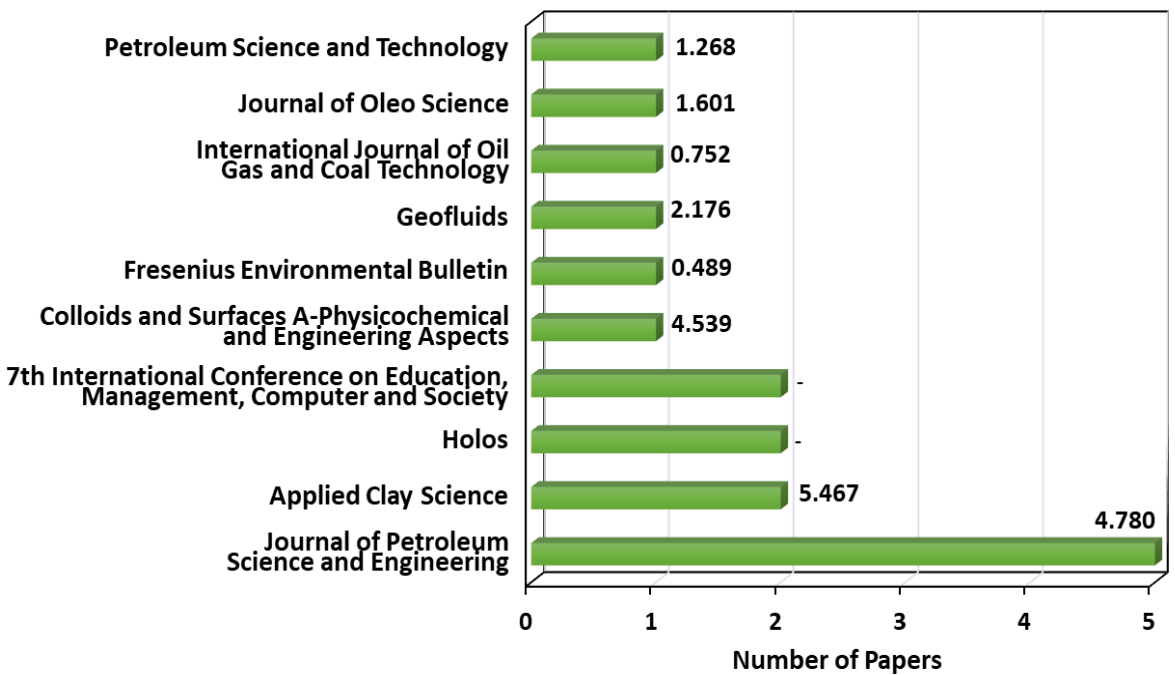


Figure 4 - Journals indexed with more scientific articles.

revealed. As a result, Brazil was the country that most published research in the area, with emphasis on the Federal University of Rio Grande do Norte. The Journal of Petroleum Science and Engineering has published the largest number of articles on the development of vegetable oil-based drilling fluid. In short, the prospected theme proved to be current and innovative, surely, due to the guidelines of sustainable development.

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