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# The Importance of Viscosity Analysis in Biodiesel

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**Abstract:**
One of the primary motivations for studying biofuels is to meet global energy needs. Biodiesel, as a promising renewable energy source, has the potential to reduce dependence on fossil fuels if implemented effectively. It is derived from chemical reactions (transesterification) in vegetable oils or animal fats, facilitated by a catalyst that accelerates the reaction. Currently, industrial processes employed by biodiesel plants predominantly utilize homogeneous catalysts. However, heterogeneous catalysts are emerging as promising alternatives in biodiesel production, distinguished by their environmentally friendly nature and the ability to regenerate and be reused. This study aims to investigate the viscosity of biodiesel through the methylic route, employing geopolymers with added magnetic nanoparticles as a heterogeneous catalyst. Kinematic viscosity measurements of biofuels were conducted to assess their impact on combustion efficiency and engine performance. The results obtained indicate that the values fall within the parameters established by the National Petroleum Agency (ANP).

**Keywords:** Biofuel, heterogeneous catalyst, Viscosity.

**Adherence to the BJEDIS' scope:** This article explores viscosity testing as a crucial parameter for assessing the performance of biofuel in diesel engines. The biodiesel produced underwent analysis in line with the standards of the American Society of Testing and Materials (ASTM), specifically kinematic viscosity (ASTM D-445 and D-446). Furthermore, the evaluations were conducted by the specifications established by the National Petroleum Agency (ANP) in Brazil.

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## 1. PRESENTATION

The substitution of petroleum derivatives with biofuels has become an inevitable option. The pursuit of ecological balance drives this shift, as discussions around high carbon dioxide emissions in the atmosphere intensify. The production of biodiesel plays a key role in the quest for more sustainable energy sources. Unlike fossil fuels, biodiesel is derived from renewable sources such as vegetable oils and animal fats, reducing dependence on non-renewable resources. Its production contributes to the reduction of greenhouse gas emissions, promoting the transition to a cleaner energy matrix.

Biodiesel is a fuel produced through the chemical transformation of vegetable or animal fat via the transesterification reaction into methyl or ethyl esters, either as pure fuel or blended with diesel oil. As an energy source and an alternative to petroleum-derived fuels, biodiesel is an important energy resource evaluated through various parameters.

According to the National Agency of Petroleum, Natural Gas, and Biofuels (ANP), several factors are relevant for evaluating a fuel, including acidity, fluidity, flash point, density, and, notably, viscosity. Viscosity refers to the resistance a fluid presents to flow. In other words, it is directly related to its ability to flow. Viscosity is a crucial factor in determining the forces that must be overcome when fluids are used in lubrication.

The analysis of biodiesel viscosity plays a fundamental role in assessing and improving the characteristics of this biofuel, with significant implications for efficiency, operational safety, and compliance with standards and regulations (Table 1). Viscosity directly affects combustion and engine performance, influencing fuel flow within the injection system and the spray pattern in the cylinder. Establishing viscosity limits through standards and specifications is fundamental to ensuring fuel quality and mitigating potential legal issues.

In the field of production and processing, a comprehensive understanding of viscosity is crucial as it affects operational conditions and process efficiency (see Figure 1 and 2). Consequently, a profound understanding of biodiesel viscosity is essential for seamlessly integrating it into existing fuel systems and optimizing its performance throughout its entire life cycle.

**Table 1: Values of density, and kinematic viscosity, of biodiesel activated with NaOH, geopolymers, and magnetic geopolymers.**

| Sample | Molar Ratio | Type of | Magnetite | Catalyst | Reaction | Density | Viscosity |
|---|---|---|---|---|---|---|---|
| | (oil/ álchool) | catalyst | (%) | (% oil mass) | time (min) | (g/cm3) | (mm2/s) 40°C |
| Biodiesel Conv I | 1/9 | NaOH | 0 | 1% | 60 | 0.84 | 2.9 |
| Biodiesel Conv II | 1/9 | NaOH | 0 | 1% | 60 | 0.87 | 3,00 |
| Biodiesel Conv III | 1/9 | NaOH | 0 | 1% | 60 | 0.9 | 3.1 |
| Biodiesel Geo Pure I | 1/9 | Geopolymer | 0 | 6% | 180 | 0,83 | 3,02 |
| Biodiesel Geo Pure II | 1/9 | Geopolymer | 0 | 6% | 180 | 0,86 | 3,03 |
| Biodiesel Geo Pure III | 1/9 | Geopolymer | 0 | 6% | 180 | 0,89 | 3,04 |
| Biodiesel Geo Mag(3%) IV | 1/9 | Geopolymer | 3% | 6% | 60 | 0.85 | 3.02 |
| Biodiesel Geo Mag(3%) V | 1/9 | Geopolymer | 3% | 6% | 60 | 0.88 | 3.03 |
| Biodiesel Geo Mag(3%) VI | 1/9 | Geopolymer | 3% | 6% | 60 | 0.91 | 3.04 |


**Figure 1:** biodiesel synthesis: Homogeneous catalysis (a) and heterogeneous catalysis (b)

**Figure 2:** Viscosity assessment performed on Cannon Fenske.

## 2. CONCLUSION

The physicochemical analyses of biodiesel by heterogeneous catalysis presented results that are by the parameters of the National Petroleum Agency – ANP.

## CONFLICT OF INTEREST

There is no conflict of interest.

## ACKNOWLEDGMENTS

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