XIV ENCAT
Encontro de Catálise do Norte, Nordeste e Centro-Oeste
Catálise: Impulsionando a transição energética para um futuro mais sustentável
17-19 novembro 2024 • Fortaleza

SBCAT
SOCIEDADE BRASILEIRA DE CATÁLISE

AREA: Catálise Ambiental, fotocatálise e eletrocatálise

Effect of pH on the photocatalysis of wastewater from biodiesel production using BiVO4 as a photocatalyst

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Resumo-Abstract

The production of biodiesel in Brazil has been remarkable in recent years, is one of the largest *commodity* producers in the world, it sees an opportunity to diversify its energy matrix, taking advantage of oilseed resources such as soybeans. As established in Law No. 11.097/2005, the gradual increase in the percentage of biodiesel mixed with diesel began with 2% and is currently 12% [1]. Biodiesel purification process involves several stages, including the water washing process to remove impurities, catalyst residues and glycerol, requiring approximately three liters of water for each liter of biodiesel produced, generating a large amount of effluent rich in organic matter. Methodologies for treating this wastewater must be studied and developed. In this scenario, Advanced Oxidative Processes (AOPs), such as heterogeneous photocatalysis, present an effective approach for the degradation of contaminants present in wastewater [2]. This work proposes the use of bismuth vanadate ($BiVO_4$) as a photocatalyst for the degradation of biodiesel wastewater. The photocatalyst was synthesized via the hydrothermal method using ammonium metavanadate and bismuth nitrate, after which the powder was calcined at 400°C. XRD data reveals that $BiVO_4$ crystallized in the monoclinic scheelite phase.The biodiesel was obtained via methyl transesterification with sodium hydroxide (NaOH), and soybean oil heated at 60°C under stirring for 1 hour. After 24 hours, the glycerin was separated and the biodiesel washed until the residual water reached pH 7. The synthesis was monitored using UV-Vis and Fourier Transform Infrared Spectroscopy (FTIR). The wastewater from washing the biodiesel was collected for the photocatalysis studies. The photolysis and photocatalysis tests were carried out using an 80W mercury lamp in a jacketed reaction cell with the aid of a magnetic stirrer. The pH of the samples was adjusted (in three different experiments) to the values of 3, 7 and 10, at a $BiVO_4$ concentration of 500 ppm. The temperature of the system was controlled by recirculating cold water. Aliquots of 5 mL were taken throughout the experiment and centrifuged for the determination of pH, conductivity and temperature and UV-Vis in the range of 200 to 800 nm, the analyses were carried out and quickly returned to the reaction medium. Representative samples from the initial and final times were preserved for Total Organic Carbon (TOC) analysis in order to gauge the efficiency of the degradation processes. The UV-Vis results indicate that the biodiesel after transesterification has the same optical characteristics as the oil. FTIR analysis showed the efficiency of the transesterification process in biodiesel production, confirming the high level of purity due to the presence of characteristic methyl ester peaks and the absence of free fatty acid and water bands. In the photolysis and photocatalysis tests, neutral pH had the best results, where photolysis showed less degradation than photocatalysis. In photocatalysis at 500 ppm at pH 7, the photocatalyst stimulated the reaction, reducing TOC by 30%. Thus, the results obtained indicate that BiVO4 has a good possibility of being used as a photocatalyst in the degradation process of biodiesel washing effluent, which is a very complex effluent, requiring further tests with variation of parameters such as catalyst concentration to improve the efficiency in the degradation rate.

Keywords: Advanced Oxidative Processes, Transesterification, Photodegradation

References

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Acknowledgements

We would like to thank CNPq; UERN; the Laboratory of Electrochemistry and Analytical Chemistry (LEQA)