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Catalytic conversion of glucose using nano-anatase TiO_2 catalyst: kinetic studies

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Abstract

Glucose can be transformed in to important chemicals such as fructose and HMF. In this work, nano-structured anatase TiO_2 catalyst was synthetized and applied in to glucose conversion, investigating it's kinetic model. However, the reduced number of identified products avoided a good correlation between the experimental data and kinect model.

Key words: TiO_2 catalyst, glucose conversion, hydroxymethylfurfural (HMF), kinetic model.

Introduction

The catalytic conversion of glucose to biofuels and other value added chemicals is one of the most promising routes for the future. However, the challenge of developing green chemical methods based on heterogeneous catalysis relies on a deep investigation of the physical and chemical properties of the catalyst as well as the kinetics mechanism of the catalytic reaction. Glucose, obtained from the residual cellulose hydrolysis, can be converted in to fructose and hydroximethylfurfural (HMF) via titania due to acid and basic properties. Thus, this project aims to synthetize TiO_2 catalyst to apply in the glucose conversion reactions and to study the reaction mechanism and it's kinetic model, performing a numerical regression

Results and Discussion

The nano-anatase titania was prepared by hydrothermal synthesis using $TiCl_4$ as precursor. The physisorption of nitrogen analysis using BET showed a specific superficial area of the 376 m²/g. The X-ray diffraction analysis (XRD) confirmed the anatase structure and broad diffraction peaks, which indicates nanosized particles[2].
The catalyst was applied in the glucose conversion reaction using a batch reactor and water as solvent. Reactions were carried out at three different temperatures and samples of the liquid phase were taken during the reaction. Conversion and products were used to determine the reaction model[1] using the maximum-likelihood method. It was observed that the data diverge from the model for long reaction times. This might be related to the unknown reaction paths, since the products identified with HPLC analysis were ≈ 50% of the total organic compounds formed. HMF was the major product formed in the three reactions temperatures studied in this work.

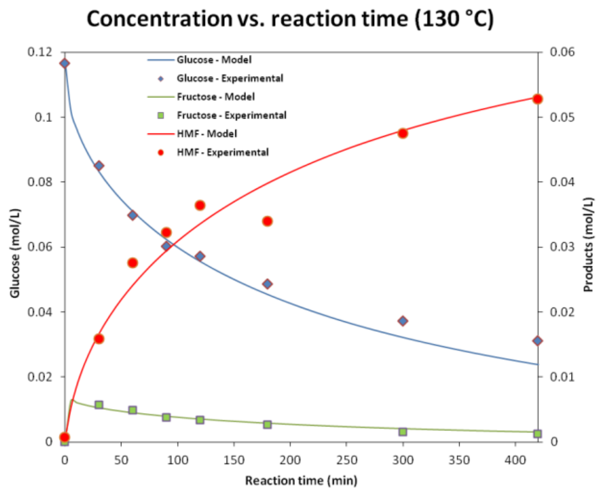

Image 1. Regression model for experimental data.

Conclusions

The nano-anatase titania synthesized hydro-termally presented promising results on glucose conversion to obtain HMF. However, further analysis for a larger selection of products and improvements on the kinetics model are needed to investigate its performance and future applications.

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