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Deep oxidative desulfurization of dibenzothiophene with POM-based hybrid materials in ionic liquids

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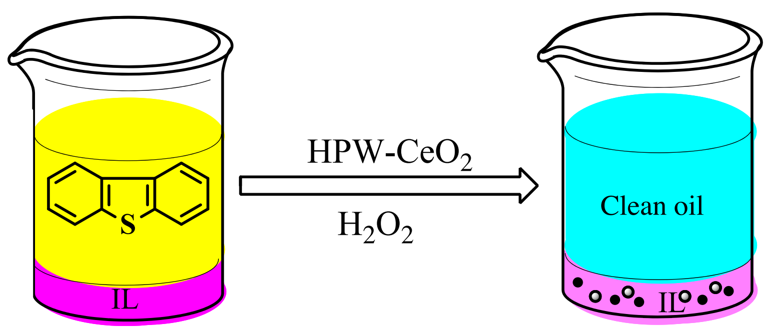
HIGHLIGHTS

- POM-based hybrid materials were firstly combined with ionic liquids on the removal of DBT.
- The catalyst demonstrated high performance in the deep desulfurization.
- The mechanism and kinetic of oxidation desulfurization process was proposed.
- The structure–activity relationship reactivity of samples was systematically investigated.

GRAPHICAL ABSTRACT

(A) Before oxidation, (B) during oxidation, (C) after oxidation and (D) catalytic oxidation process of DBT.



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ABSTRACT

A series of POM-based hybrid materials: phosphotungstic acid supported ceria (HPW-CeO$_2$) have been synthesized and characterized by X-ray diffraction (XRD), Thermogravimetric-differential scanning (TG-DSC) analysis, Scanning electron microscopy (SEM), FT-Raman, FT-IR, UV–vis, and BET analysis. Combined with [C$_8$mim]BF$_4$, the catalyst was very efficient on the removal of DBT by using H_2O_2 as the oxidant under mild reaction conditions, which could reach a sulfur removal of 99.4%. The amount of catalyst, O/S molar ratio, reaction time and temperatures were evaluated in detail, and the favorable operating condition was obtained as well as the kinetic study of substrates. The structure–activity relationship was systematically investigated. Oxidative desulfurization system could be recycled for ten times without significant decrease in activity. A mechanism was proposed to investigate the oxidation process of DBT.

1. Introduction

With the development of the automobile industry, the demand for petroleum has been increasingly large in the world. It is well known that sulfur compound removal from petroleum is extremely necessary for industrial and environmental reasons. Sulfur in transportation fuels is a major air pollution source. Besides, the worldwide increasingly stringent fuel specifications require reducing the sulfur content of the fuels to an ultra low level [1].

At present, the conventional process for the removal of organosulfurs in industry is known as hydrodesulfurization (HDS), which is carried out under high hydrogen pressure and temperature over a suitable catalyst. The HDS technology is highly efficient in removing aliphatic and acyclic sulfur-containing compounds [2], but less effective for dibenzothiophene (DBT) and its derivatives [3,4]. To overcome those drawbacks, it is essential to introduce non-HDS approaches for desulfurization, such as extraction [5–13],

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