

Effect of polymeric surfactants in alumina synthesis used in deep oxidative desulfurization of diesel fuels

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ABSTRACT

A series of alumina powders were synthesized from inexpensive sodium aluminate precursor using cetyl trimethyl ammonium bromide (CTAB) and polyvinylpyrrolidone (PVP) polymeric surfactants with a simple sol-gel method. The various alumina synthesized were used as catalyst supports. Synthesized powders were characterized by X-Ray Diffraction (XRD) which indicates forming of alumina in presence of different types of surfactants. Ni or Mo was loaded on supports by an incipient wetness impregnation (IWI) method due to evaluating the effect of different active phases of Mo and Ni on deep oxidative desulfurization of diesel fuels. The oxidation occurred under moderate reaction conditions (temperature of 60 °C and atmospheric pressure) in presence of H₂O₂ as an oxidizing agent and subsequently S-contents separation by acetonitrile as an effective extracting solvent. The conversion of DBT in presence of provided catalysts measured by UV-Visible. PVP modified synthesis powders showed the highest conversion of 94% toward desulfurization of Dibenzothiophene (DBT) from model diesel fuel.

Keywords: Alumina, Oxidative Desulfurization, Polymeric Surfactant, DBT, Diesel Fuel

1. Introduction

In recent years, sulfur compounds emissions are the major source of air pollution which leads to acid rain [1]. Although the existence of organic s-contents in fuels has the ability to enhance the corrosion of combustion engines. In addition, because of their poisoning abilities, the catalytic converters performance may be affected [2, 3]. Therefore strict environmental regulations have been imposed all over the world to reduce the sulfur content of fuels lower than 10 ppm [1, 4]. Fuel desulfurization techniques are classified into two branches: traditional hydrodesulfurization (HDS) and non-HDS [5]. HDS conventional method is unable to remove some refractory organosulfur compounds such as DBT and its derivatives due to steric effects [6]. Also, severe operational conditions considering high pressure and high temperature besides the requirements of high volume reactors and more active catalysts makes this traditional technology expensive [7-9]. Thus several types of oxidation techniques including adsorption desulfurization (ADS) [9-11], extraction desulfurization (EDS) [12], oxidative desulfurization (ODS) [13] and biodesulfurization (BDS) [14] were introduced to overcome HDS restrictions. Among these alternative techniques, ODS is a promising method due to mild operational conditions [15] and its capability toward removing alkylated aromatic sulfur containing compounds. These compounds are oxidized to sulfones and sulfoxides in presence of an oxidizing agent and subsequently removed in the way of extraction, adsorption, distillation, and decomposition [9, 16-20]. Among the different oxidizing reagents such as oxygen [21], tertbutyl hydro peroxide (TBHP) [22, 23], cyclohexanone peroxide [24], hydrogen peroxide (H₂O₂) [25-28] and ozone [29], H₂O₂ is the most common since it is inexpensive, high selective, accessible and low corrosive [26, 30]. Owing to the