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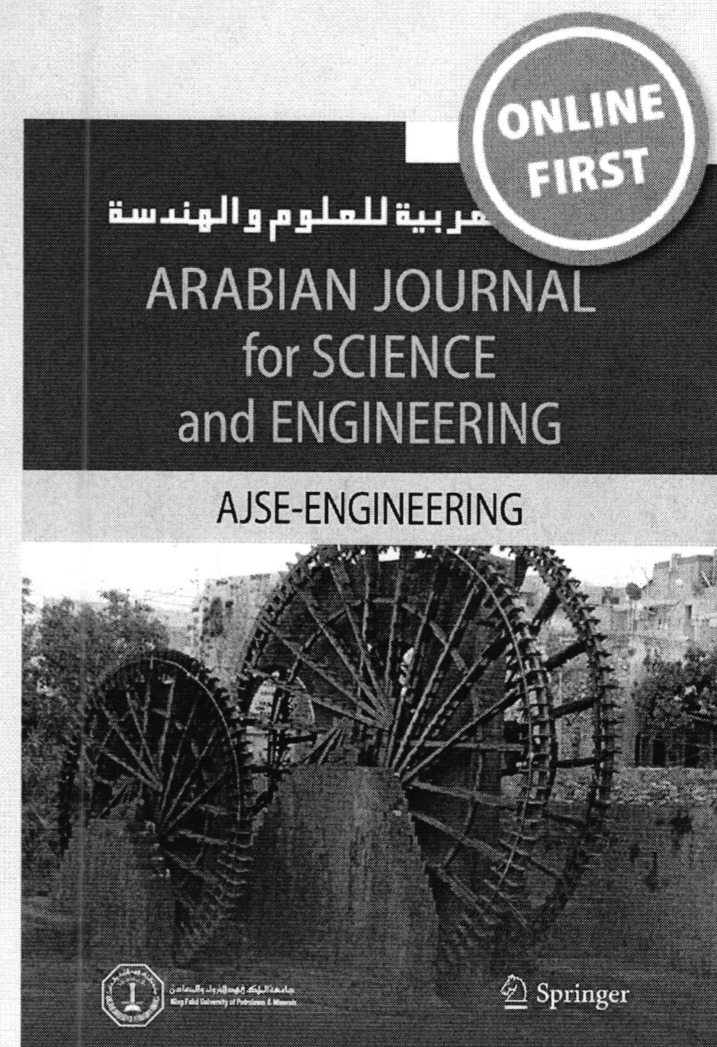

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RESEARCH ARTICLE - CHEMICAL ENGINEERING

Synthesis of Nanocatalyst for Hydrodesulfurization of Gasoil Using Laboratory Hydrothermal Rig

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Abstract This study presents a simple fabrication procedure for obtaining a nanocatalyst by homogeneously implanting CoMo within the structure of multiwall carbon nanotubes. The nanocatalyst efficiency was determined by applying the catalyst in a laboratory hydrothermal testing rig to remove sulfur from gasoil using various methods. The conventional catalyst ($CoMo/Al_2O_3$) was also used as a reference. Scanning electron microscope (SEM), high- resolution transmission electron microscope (HRTEM), an X-ray diffractometer (XRD), and Brunauer, Emmett, and Teller (BET) method were used to study the morphology and the structure of prepared samples, and the X-ray fluorescence technique (XRF) was used to determine the sulfur content in gasoil. After preparation, the nanocatalyst composite structure observed the formation of network structure between metal catalysts and CNTs, and almost all CoMo particles were homogeneously decorated within the bulk of CNTs. Experiments using nanocatalysts reveal better results than the conventional catalyst ($CoMo/Al_2O_3$) in removal of sulfur from gasoil. As a result, an improvement of about 10 % (73.5 % max. HDS) in hydrodesulfurization (HDS) over conventional catalyst was obtained with a 10 h contact time, 280 °C reactor temperature, 10 bar system pressure, and 2 h^{-1} space velocity of gasoil, which may be an optimum condition for removal of sulfur from gasoil within the conditions and design parameters of our experimental system.

Keywords Gasoil · Hydrodesulfurization (HDS) · MWCNTs · Nanocatalyst

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1 Introduction

The concentration of sulfur in crude oil is typically between 0.05 and 5.0 % (by weight), although values as high as 13.95 % have been reported [1].Upon combustion, sulfur in fuels can contribute to air pollution in the form of particulate material and acidic gases, such as sulfur dioxide. To reduce sulfur- related air pollution, the level of sulfur in fuels is regulated and sulfur must be removed from fuels during the refining process. Hydrodesulfurization (HDS) is a catalytic chemical process that typically uses a heterogeneous cobalt- or nickel-doped molybdenum sulfide catalyst supported on alumina [2]. HDS is widely used to remove sulfur compounds from refined petroleum products such as gasoline, jet fuel, kerosene, diesel fuel, and fuel oils.

The purpose of removing sulfur is to decrease atmospheric pollution caused by the emission of sulfur dioxide as a result to fuel combustion [3].

The conventional hydrodesulfurization (HDS) process is usually conducted over sulfidized $CoMo/Al_2O_3$ and $NiMo/Al_2O_3$ catalysts [4]. The performance, in terms of desulfurization level, activity, and selectivity, depends on the properties of the specific catalyst used (concentration of the active species, support properties, synthesis route), the reaction conditions(sulfidizing protocol, temperature, and partial pressure of hydrogen and H_2S), the nature and concentration of the sulfur compounds present in the feed stream, and the reactor and process design [5]. Alumina is the most widely used support among hydrodesulfurization catalysts [6]. A notable feature of alumina supports is their ability to provide high dispersion of the active metal components. However, numerous chemical interactions exist between alumina and transition metal oxides. Some of the formed species are very stable and resist completely sulfidizing; therefore, the catalytic activity of such catalysts is low [7]. Coke for-

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