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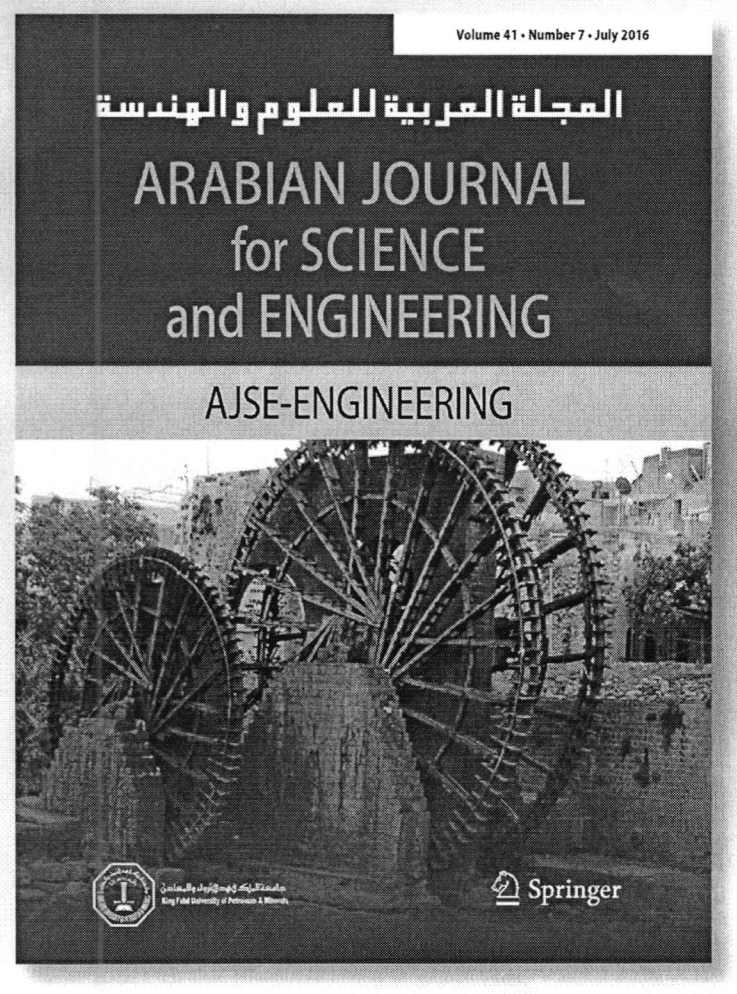

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RESEARCH ARTICLE - CHEMICAL ENGINEERING

Separation of Methylene Blue as Pollutant of Water by SBA-15 in a Fixed-Bed Column

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Abstract A methylene blue (MB) dye pollutant was separated by SBA-15 for the first time in fixed-bed continuous systems. The continuous adsorption experiments were included: the effect of bed height, flow rate and initial concentration on breakthrough curve investigation. Breakthrough performance showed SBA-15 has the most promise for application in continuous adsorption systems. The results illustrate that MB capture is obtained at the maximum uptake (83.6 mg/g) when the bed height was (6 cm), initial concentration (40 mg/L) and flow rate (0.6 mL/min). The mesoporous SBA-15 was recovered effectively by calcinations and employed again for five times in continuous system successfully.

Keywords Separation · Adsorption · Fixed bed · Methylene blue · SBA-15 · Wastewater

1 Introduction

Dyes are an important class of organic pollutants and are well known for their hazardous effects on aquatic life in general and human beings in particular. They are flowed from sources such as, paper, textile, plastic industries and leather [1]. Dyes are components with complex aromatic structure that is vastly wasted to get color to other materials [2,3]. Over 7×10^5 tons and approximately 100,000 different dyes are produced annually worldwide [4]. The level of the dye pollutants is highly visible even in very low concentration and will affect aquatic life as well as food web.

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Methylene blue is a heterocyclic aromatic chemical compound with the molecular formula $C_{16}H_{18}N_3SCl$. The chemical name according to International Union of Pure and Applied Chemistry (IUPAC) is [3,7-bis(dimethylamino) phenothiazin chloride tetra methylthionine chloride].

It has many uses in a range of different fields, such as biology and chemistry. It is used in some medical employs in huge quantities; it can likewise be vastly utilized in dyeing cottons, coloring paper, coating paper of stocks, wools, etc. Methylene blue (MB) can cause some harmful effects even though it was not strongly hazardous. Sharp exposure to MB reasons vomiting, increased heart rate, Heinz body formation, shock, cyanosis, quadriplegia, jaundice, tissue necrosis in humans and quadriplegia [5,6].

Many dyes have high stability to light and temperature, but not biologically degradable [7]. In view of little biodegradability of dyes, a traditional biological remediation operation is not more active in curing a dye wastewater [8]. It is commonly handled by physical and/or chemical methods such as filtration, coagulation, precipitation, adsorption, ozonation, reverse osmosis, ion exchange, and advanced oxidation processes [9–14]. However, these styles are expensive and display operational problems such as lower removal efficiency, higher specificity for a group of dyes and growth of toxic intermediates [15]. Adsorption is the most attractive and vastly applied process of water remediation because of its simplicity of design, low cost, insensitivity of toxic substances, ease of operation, efficiency in treatment and possibility to operate at very low concentration [16–18]. The continuous adsorption process is more applicable in real water remediation industries because of its ability of columns to adapt to versatile processes and low operating cost [19].

Several adsorbents have been tested for dye removal, such as activated carbon, alumina, fly ash, clays, silica gel and zeolite. Zeolites are treated with special attention in sorption