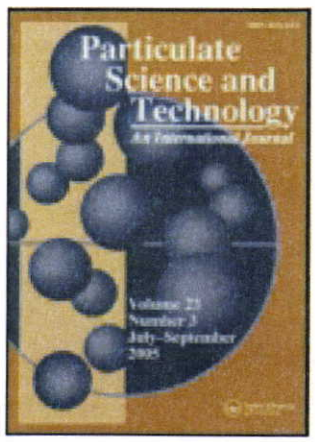

Particulate Science and Technology: An International Journal

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/upst20

Removal of Aniline and Nitro-Substituted Aniline from Wastewater by Particulate Nanoporous MCM-48

Talib M. Al-Bayati [a]

[a] Chemical Engineering Department , University of Technology , Baghdad , Iraq

Accepted author version posted online: 02 Sep 2014.Published online: 30 Oct 2014.

To cite this article: Talib M. Al-Bayati (2014) Removal of Aniline and Nitro-Substituted Aniline from Wastewater by Particulate Nanoporous MCM-48, Particulate Science and Technology: An International Journal, 32:6, 616-623, DOI: 10.1080/02726351.2014.948973

To link to this article: http://dx.doi.org/10.1080/02726351.2014.948973

Particulate Science and Technology, 32: 616–623

ISSN: 0272-6351 print/1548-0046 online
DOI: 10.1080/02726351.2014.948973

Taylor & Francis
Taylor & Francis Group

Removal of Aniline and Nitro-Substituted Aniline from Wastewater by Particulate Nanoporous MCM-48

TALIB M. AL-BAYATI

Chemical Engineering Department, University of Technology, Baghdad, Iraq

The particulate nanoporous material MCM-48 (Mobil Crystalline Material No. 48) was synthesized and characterized in order to use it as an adsorbent for the removal of adsorbate, such as aniline and nitro-substituted anilines, including 2-nitroaniline, 3-nitroaniline, and 4-nitroaniline from wastewater. The characterizations of MCM-48 were investigated by applying XRD, SEM, EDAX, BET surface area, and FTIR. The adsorption kinetics was investigated too. The batch adsorption studies demonstrated that the MCM-48 had a significant ability to the adsorption of aniline and nitro-substituted aniline from wastewater. Langmuir and Freundlich isotherms were used to model the adsorption equilibrium data. The four molecules adsorbed according to type I Langmuir adsorption with a maximum uptake were calculated to be approximately 94 mg g^{-1}. The findings showed that the kinetics of the reaction is very rapid and followed a pseudo-second-order model. It is clearly indicated that the Langmuir model is more suitable for chemical organic compounds adsorption on mesoporous material than the Freundlich model.

Keywords: Adsorption, aniline and nitro-substituted aniline, MCM-48, nanoporous material, wastewater treatment

1. Introduction

Industries, such as food, chemical industry, petrochemical, pharmaceutical and refining industries, pulp and paper and electronics all generate large volumes of waste streams with significant potential for treatment and recycling (Hancock 1999). Aniline is widely used in the manufacture of plastic, paint, pesticides, dyes and intermediates in the chemical synthesis industries (Gürtena et al. 2005). Wastewater containing aniline has caused many serious environmental problems because of its high toxicity and carcinogenic properties. Figure 1 shows the chemical formulae for aniline and nitro-substituted anilines.

Current technologies for waste stream treatment and recycling include membrane technology encompassing reverse osmosis (RO), microfiltration (MF) and ultrafiltration (UF) (Goncharuk 2002; Judd and Jefferson 2003; Ahmad and Tan 2004; Brien et al. 2008; Ko and Chen 2008; Alsalhy et al. 2013). Alternatives to membrane systems include oxidation methods based around the chemical oxidation and the air/oxygen based catalytic (or noncatalytic) oxidation. The first category includes advanced oxidation processes (AOPs), such as the use of ozone, hydrogen peroxide and ultraviolet (UV) radiation to generate hydroxyl radicals used for oxidation (Hirakawa et al. 2007; Amat et al. 2007; Puma and Yue 2002; Bastaki 2004). These processes tend to be limited by their intensive costs. The second category includes dry oxidation, wet air oxidation and catalytic wet air oxidation (Morent et al. 2006; Levec and Pintar 2007; Bhargava et al. 2007).

Adsorption is another example of a physical treatment used in treating wastewater. Adsorption technology has been used for the removal of organics from wastewaters, primarily focusing on the use of activated carbon as the adsorbent of choice. Regeneration of the spent adsorbent can be a costly and intensive process (Morent et al. 2006). This has led to an interest in developing alternative adsorbents for the removal of organic pollutants from aqueous waste streams (Levec and Pintar 2007; Bhargava et al. 2007).

Zeolites have the ability to selectively adsorb or reject molecules based upon molecular size, shape and other properties, including polarity. Therefore, it can function as adsorbents. A number of studies outlining the adsorption of organic compounds from aqueous solution onto organ-clays (Ko et al. 2007), unmodified and modified zeolites (Razee and Masujima 2002; Khalid et al. 2004), silicate (Milestone and Bibby 1981; Narita et al. 1985), and mesoporous materials have been reported. MCM-48 seems to be a more interesting candidate as adsorbent in separation techniques. The discovery of mesoporous material MCM-48, in 1992 by the Mobil Oil researchers has attracted much research attention owing to their potential applications as catalysts, catalyst supports and absorbents. Characteristic properties of this material are large surface areas (1000–1500 $m^2 g^{-1}$), specific pore volume up to 1.2 $cm^3 g^{-1}$, high thermal stability, a narrow pore-size distribution and

Address correspondence to: Talib M. Al-Bayati, Chemical Engineering Department, University of Technology, Alsinaa Street 52, P.O. Box 35010, Baghdad, Iraq. E-mail: talib_albyati@yahoo.com

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/upst.

Particulate Science and Technology - Decision on Manuscript ID UPST-2013-0378.R3 Sunday, July 20, 2014 10:53 PM

From: "mazumder@bu.edu" <mazumder@bu.edu>

To: talib_albyati@yahoo.com

20-Jul-2014

Dear Dr Albayati:

Ref: Removal of Aniline and Nitro Substituted Aniline from Wastewater by Particulate Nanoporous MCM-48.

Our referees have now considered your paper and have recommended publication in Particulate Science and Technology. We are pleased to accept your paper in its current form which will now be forwarded to the publisher for copy editing and typesetting. The reviewer comments are included at the bottom of this letter.

You will receive proofs for checking, and instructions for transfer of copyright in due course.

The publisher also requests that proofs are checked and returned within 48 hours of receipt.

Thank you for your contribution to Particulate Science and Technology and we look forward to receiving further submissions from you.

Sincerely,
Dr Mazumder
Editor in Chief, Particulate Science and Technology
mazumder@bu.edu

Reviewer(s)' Comments to Author: