EVALUATION OF THE ABSORPTION CAPACITY OF THE SOLID PRODUCT(CHAR) OBTAINED FROM THE WASTE TYRE RUBBER VIA CHEMICAL DEGRADATION TO REMOVE LINEAR ALKYL BENZENE SULPHONIC ACID(LABSA) FROM AQUEOUS SOLUTION

BALBAY S.[1] and ACIKGOZ C.[2]

[1]Bilecik Şeyh Edebali University, Vocational School, Department of Chemical and Chemical Process Technologies,11030 Bilecik, Turkey, [2]Bilecik Şeyh Edebali University, Faculty of Engineering, Department of Chemistry and Process Engineering, 11030 Bilecik, Turkey
E-mail: senay.balbay@bilecik.edu.tr

ABSTRACT

Linear alkylbenzene sulphonates (LABSA) are highly water soluble surface active agents widely used in synthetic laundry detergent formulation and household cleaning products. Other industrial activities involve handling sulphate ion-bearing effluents found in the production of fertilizers, dyes, glass, paper, soaps, textiles, fungicides, leather and metals. Sulphate can cause various kinds of problems depending on its concentration and on the earth alkaline cation. Common examples include an altered taste of water, digestion troubles in animals and humans, soil acidification and corrosion of metals.

The aim of the present study is to investigate the absorption capacity of the solid product (CHAR) obtained from the waste tyre rubber via chemical degradation by our research team to remove linear alkyl benzene sulphonic acid (LABSA) from aqueous solution, and also compare the its absorption capacity with the some commercial adsorbent's absorption capacities such as activated carbon (AC), multi-wall carbon nanotubes (MWCNTs), carbon blacks (CBs) under the same experimental conditions. The absorption capacity of (CHAR) experimental results were compared with those of (AC), (MWCNTs) and (CBs) under the same experimental conditions(LABSA concentration 100mg/L, 0.05 g/100ml adsorbent dose, contact time 40 minute, pH 8 and temperature 20^0C).The adsorption generally followed the order MWCNTs> CHAR = CBs > AC. This study showed that the solid product (CHAR) obtained from the waste tyre rubber via chemical degradation has a high adsorbent capacity.

Keywords: Adsorption, LABSA, Adsorbent, Wastewater, Char

1. Introduction

Surfactants sometimes called surface active agents, which contain both hydrophobic group (hydrocarbon chain) and hydrophilic group (polar head) in the same surfactant molecule (Mahmood and Al-Koofee, 2013). The hydrophobic part is generally a long hydrocarbon chain whereas the hydrophilic part consists of an ionic or polar group (Mihali *et al*, 2008). Adsorption of anionic surfactants onto a surface generates charge, anionic surfactants will give a negatively charged surface (Malvern Instruments Inc., 2006).

Linear alkylbenzene sulphonates (LABSA), is an anionic surfactant, are highly water soluble surface active agents widely used in synthetic laundry detergent formulation and household cleaning products. LABSA frequently present in domestic and civil wastewater (HERA, 2013).
In recent years, investigations have been carried out for the effective removal of organic and inorganic contaminants from wastewater and drinking water using adsorbents that are activated carbon (AC), multi-wall carbon nanotubes (MWCNTs), etc (Aguayo-Villarreal *et al*, 2013 and Liu *et al*, 2014).

The adsorption properties of ACs are determined by their textural characteristics and surface chemistry (Aguayo-Villarreal *et al*, 2013). Almost all materials containing a high fixed carbon content can potentially be activated. The most commonly used raw materials are coal (anthracite, bituminous and lignite), coconut shells, wood (both soft and hard), peat and petroleum based residues. All activated carbons contain micropores, mesopores, and macropores within their structures but the relative proportions vary considerably according to the raw material (Cameron Carbon Incorporated, 2006).

Recently, carbon nanotubes (CNTs) have already been investigated extensively and multi-disciplinarily due to their superior properties (Liu *et al*, 2014). Carbon nanotubes have highly porous structure and large specific surface area (Bayazit and İnci 2014). CNT adsorbents can be classified into three types: single-walled CNTs (SWCNTs), multi-walled CNTs (MWCNTs) and functionalized CNTs (f-CNTs) (Yu, 2014). MWCNTs have been chosen as the porous matrix for the composite sorbent due to its macroporous structure and the large specific surface areas (Yan *et al*, 2014).

Carbon black (CB) is a material produced by the incomplete combustion or thermal cracking of a hydrocarbon raw material. CB is a form of amorphous carbon that has an extremely high surface area to volume ratio (Pekşen Özer, 2008). CB is utilized world-wide on a huge scale, primarily as rubber modifiers and pigments (Mezgebe *et al*, 2012). This structure varies depending on the production process and differences in the particle size. Particle size, size of structure and surface chemistry are the basic properties of carbon black (Pekşen Özer, 2008).

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2. Materials and methods

2.1. Materials

MWCNTs was suplied by Sigma Aldrich. In experimental study was used commercial activated carbon. CBs was provided from a tyre product plant. CHAR was obtained from the waste tyre rubber via chemical degradation by our laboratory. All these adsorbents were used as such without any further purification. A commercial mixture of linear alkylbenzene sulphonic acids (LABSA), with purity > 96 %, was used without further purification for this study.

2.2. Methods

LABSA were determined by finding out the absorbance characteristic wavelength using UV-spectrophotometer. The experiments have been evaluated under different process conditions such as the particle size of char (0.85-1.60 mm; 0.18- 0.85 mm), adsorbent dose (0.1g/100ml; 0.05g/100ml) and contact time (10-90 minute) while maintaining the LABSA concentration 100mg/L, pH 8 and temperature 20^0C. A specific amount of adsorbent of a particular particle size was added into each flask and was periodically agitated at 300 rpm, until the equilibrium was reached (approximately 60-90 minute). Each experiment was carried out three times. LABSA has been adsorbed over under batch measurements and adsorption process is monitored using UV spectrophotometer by measuring absorbance at λmax of 286 nm for LABSA.

Determination of ash, moisture and volatile matter, adsorbent's such as commercial activated carbon (AC), multi-wall carbon nanotubes (MWCNTs), carbon blacks (CBs), was performed according to ASTM Standards.

3. Results

Proximate analysis of commercial activated carbon (AC), multi-wall carbon nanotubes (MWCNTs), carbon blacks (CBs) and CHAR (solid products obtained obtained from the waste tyre rubber via chemical degradation) was given in table1.

Table1: Proximate analysis of commercial (AC), (MWCNTs), (CBs) and CHAR

Property (%w)	CHAR	CBs	Commercial AC
Fixed carbon	34,7	83,46	76,3
Volatile matter	52,14	5,65	6,33
Ash	8,5	10,69	11,77
Moisture	4,66	0,2	5,6

A standard solution of the LABSA was taken and the absorbance was determined at different wavelengths (200-600 nm) to obtain a plot of absorbance versus wavelength (Fig.1). The wavelength corresponding to maximum absorbance (λ_{max}) was determined from this plot. The λ_{max} for LABSA found to 286 nm.

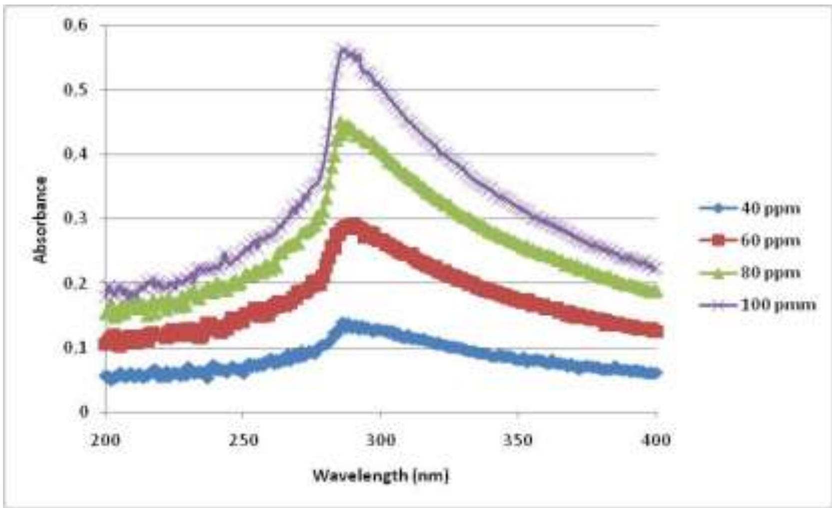

Figure 1: UV-vis adsorption spectra of LABSA solution

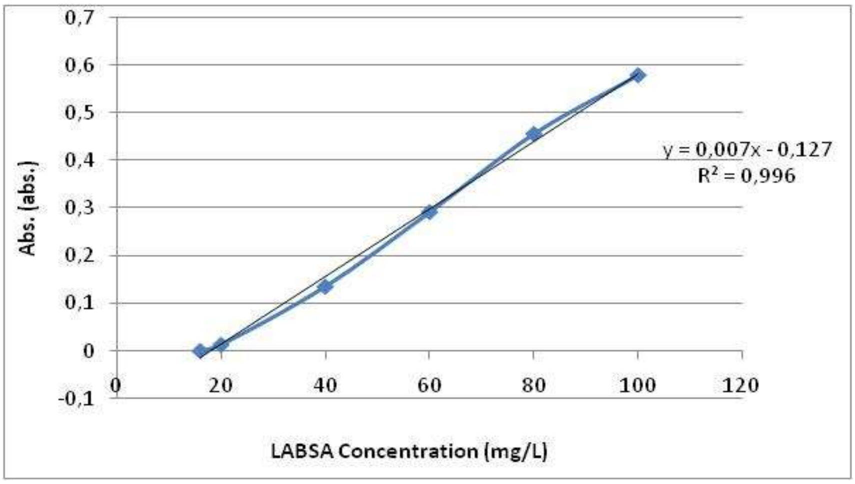

Figure 2: Calibration curves of the LABSA solution

Calibration curves were plotted between absorbance and concentration of the LABSA solution (Fig.2).

It is showed that the adsorption generally followed the order MWCNTs> CHAR = CBs > AC. This study showed that the solid product (CHAR) obtained from the waste tyre rubber via chemical degradation has a high adsorbent capacity. The adsorption generally followed the order MWCNTs> CHAR = CBs > AC. This study showed that the solid product (CHAR) obtained from the waste tyre rubber via chemical degradation has a high adsorbent capacity.

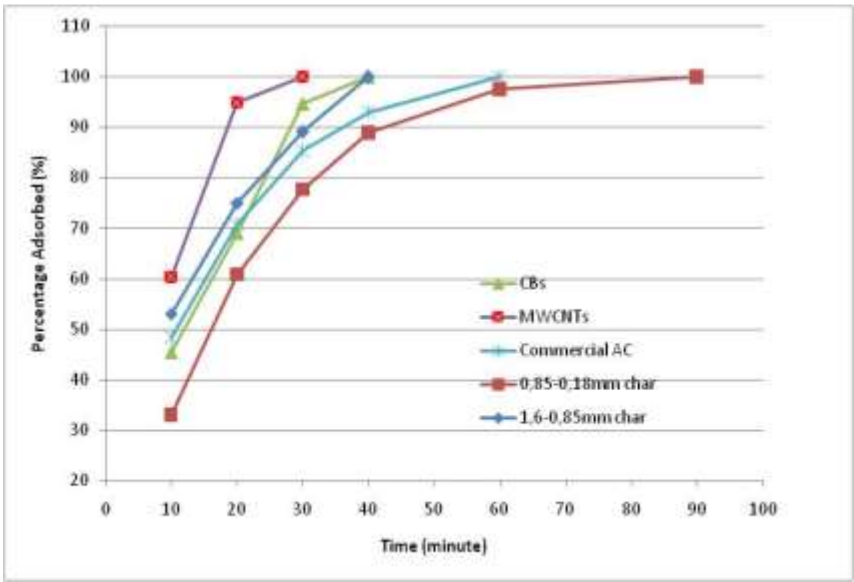

Figure 3: Comparison of adsorbents that are CB, MWCNT, commercial AC and different particle size of char

4. Conclusions

The maximum adsorption of LABSA (>99%) has been achieved in aqueous solutions using 0.05 g/100ml adsorbent dose at 0.85-1.6 mm particle size within 40 minute. The absorption capacity of (CHAR) experimental results were compared with those of (AC), (MWCNTs) and (CBs) under the same experimental conditions (LABSA concentration 100mg/L, 0.05 g/100ml adsorbent dose, contact time 40 minute, pH 8 and temperature 20^0C). This study showed that the solid product (CHAR) obtained from the waste tyre rubber via chemical degradation has a high adsorbent capacity.

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