SYNTHESIS AND CHARACTERIZATION OF MAGNETIC NANOPARTICLES BY THE COMBUSTION METHOD USED AS ADSORBENT FOR REMOVAL OF DYES FROM COLORED WASTEWATER

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Abstract

The textile industry plays a role as the largest sources of the presence of dyestuffs in the environment, in which most of the dyes have toxic, mutagenic and carcinogenic properties [1]. About 10–15% of commercial dyes produced from the textile industries are discharged into the environment every year [2]. The direct discharge of colored and toxic wastewater into the environment affects its ecological status by causing various undesirable changes [1,3]. Dyes usually have complex aromatic molecular structures which make them more stable and more difficult to biodegrade [3]. Therefore, the removal of colored components from wastewater is one of the biggest issues of concern [4]. Adsorption is verified to be one of the most promising alternative techniques to remove the nonbiodegradable dyes from wastewater due to its simple
operation, superior adsorption effectiveness, relatively low cost, almost harmless byproducts , and the possibility of reusing the spent adsorbent via regeneration [5,6].

Recently, magnetic nanocomposites are widely used as adsorbent in polluted water treatment. Such types of adsorbents have high adsorption capacity and selectivity as compared to traditional adsorbents, and shows an magnetic character which makes their separation easier after wastewater treatment [4,5].

In this study we set out to obtain nanoparticles which combines very good adsorption ability of the carbon-based materials with magnetic properties of the iron oxides, and to test them as potential adsorbents for the removal of , anionic: Acid Orange 7 (AO7), Chromazurol S (Ch-S) and cationic: Methylene Blue (MB), Basic Red 1 (RB1) dyes from aqueous solutions.

The synthesis of magnetic nanocomposites (CAN) was performed by the combustion method. This method is environmentally friendly and has many advantages such as simplicity, short reaction time, and low energy consumption.

For the synthesis of nanocomposites, sample of activated carbon were impregnated with the precursor solution of iron nitrate nonahydrate and with arginine used as a fuel.

The effect of experimental conditions, such as the specific surface of active carbon, reaction time and magnetite/carbon ratio, on the nanoparticles characteristics was investigated. The resulted powders were characterized by X-Ray diffraction (XRD), FT-IR, energy-dispersive X-ray spectroscopy(EXD), specific surface area(BET), N_2 adsorption–desorption isotherms and thermal analysis (TG/DSC).

The resulting nanocomposites had a magnetite/carbon ratio varying between 2/3 and 1/9. As the magnetite/carbon ratio decreased, the BET surfaces are an increased from 485 m2/g to 1095 m2/g.

In order to evaluate the potential application in dye wastewater treatment, the obtained nanocomposites are employed as the adsorbent for the removal of both anionic and cationic dyes from wastewater.

The adsorption process was optimized by studying the influence of solution pH (2÷12), magnetite/carbon ratio, adsorbent dose (0.25 ÷ 3 g/L), initial dye concentration (10÷300 mg/L), and temperature (298, 318, 328 K) on the dye removal.
The increase of the carbon content increases the removal efficiency. It is also evident that the removal efficiency increases with increasing dose of CAN, and temperature, and by decreasing the initial dye concentration for investigated dyes.
Using an adsorbent mass of 1 g/L, and working at the natural solution pH, the synthesized compounds showed removal efficiency higher than 90.00% for all investigated dyes
The first-order and pseudo-second-order kinetic models were used for the kinetic interpretations, and adsorption isotherm analysis was used to elucidate the adsorption mechanism.
Adsorbents regeneration were performed using ethanol solution (1:1). Even after four adsorption-desorption cycles the nanocomposite presents a good efficiency (greater than 65%) for dyes removal from aqueous solution, indicating the possible industrial application.
The experimental results suggest that the as-prepared nanocomposite with high adsorption capacity, excellent separation capability and short equilibrium time has a potential application in the water purification management.

Acknowledgements
This work was supported by program no 2, Project no. 2.4 from Coriolan Drăgulescu" Institute of Chemistry Timisoara of Romanian

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