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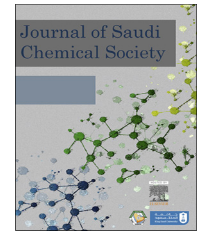

ORIGINAL ARTICLE

Interaction of adsorption of reactive yellow 4 from aqueous solutions onto synthesized calcium phosphate

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KEYWORDS

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Dye;
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Mechanism

Abstract The interaction of reactive yellow 4 with Apatitic Tricalcium Phosphate (PTCa) has been investigated in aqueous medium to understand the mechanism of adsorption and explore the potentiality of this phosphate toward controlling pollution resulting from textile dyes. Transmission electron microscopy (TEM) analysis demonstrates that the adsorbent is composed of needle-like nanoparticles and the SAED pattern exhibits spotted sharp and continuous rings that evidence polycrystalline grains. X-ray diffraction results showed that, the crystallinity of the dye decreased after interaction with RY4 indicatating incorporation of the dye into the micropores and macropores of the adsorbent. The results of Fourier transform infrared (FTIR) spectroscopy indicate that the adsorption is due to the electrostatic interaction between the $-SO_3^-$ groups of dye and the surface of the Phosphate. The desorption efficiency was very high at about 99.4%. The presence of calcium ions favored the adsorption of the dye, while the phosphate ions inhibited it.

1. Introduction

The problems of water resources and pollution are increasingly on the agenda. Many industries like textile or cosmetic industry use end products of organic compounds for obtaining particular colors. In Morocco the textile industry, represents 31% of all Moroccan industries whose reactive dyes are widely used for dyeing wool and nylon. In the textile industry, about 1000 l of water is used per 1000 kg of clothes processed in ‘dyeing [14]. Thus the this industry releases loaded dyes [26] which present a real danger to the environment due to the high water consumption and the important wastewater discharges are rejected without any treatment. Therefore, many technologies, such as reverse osmosis [8], nanofiltration [18], coagulation and precipitation [28],

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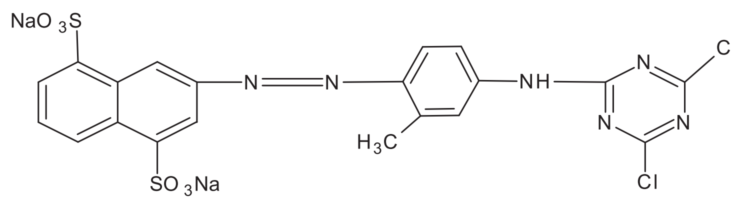
electrodialytic membrane technologies [6] and adsorption [1] are proposed for controlling the concentrations of dye in rejected wastewater discharges.

Among the above technologies, adsorption is a common technique used for dye removal from aqueous solution, mainly because it is relatively low in cost, environmental friendly and simple. Recently, calcium phosphates are very much studied in the removal of heavy metal ions [20], fluoride [21–23], dyes [10,11,5] and amino acids [12,13].



Chemical structure of dye (C.I. Reactive Yellow 4).

In our laboratory, the work is in process to evaluate the possibility of the use of synthetic calcium phosphates for wastewater pollution management. Our previous study has shown that the synthesized calcium phosphates can remove the reactive dye; Reactive Yellow 4, from aqueous solutions [10]. The aim of the present study was to determine the mechanism of interaction for the removal of an azo reactive dye, Reactive Yellow 4 (CI) from aqueous solutions by synthesized Apatitic Tricalcium Phosphate (PTCa).

2. Materials and methods

2.1. Adsorbent

The PTCa was prepared at room temperature by a double decomposition method [15]. The solution A (47 g of calcium nitrate $Ca(NO_3)_2{\cdot}4H_2O$ (Scharlau, Spain) in 550 ml of distilled water + 20 ml of ammonia solution) was added quickly at room temperature into the solution B (26 g of di-ammoniumhydrogenphosphate (NH_4) 2 HPO_4 (Riedel-de Haën, Germany) in 1300 ml of distilled water + 20 ml ammonia solution). The precipitate was filtered, washed, and dried at 80 °C for 24 h.

2.2. Adsorbate

The Reactive Yellow 4 (C.I) was obtained from a textile firm as a commercially available dye formulation and was used without further purification. It is a soluble dye in water due to the presence of two solubilizing groups (SO_3H).

The yellow color is due to the grouping diphenylparazolonique. The grouping dichlorotriazinique ensures reactivity of the molecule with the textile fiber. The solutions were prepared by dissolving the required amount of dye in distilled water .The concentration of the dye was determined at 385 nm, using UV spectrophotometer (‘‘UV-2005’’, Selecta, Spain).

2.3. Effect of pH on the analysis of dye

We carried out by absorption UV/VIS, a study of electron delocalization in the molecules of the dye to see if the pH has an effect or not on the electronic transition of the dye molecules. The procedure is as follows: In a series of flasks containing 100 ml dye 10 mg/L, pH is varied from 1.56 to 12. The acidification or alkalinization of colored solutions is made respectively by HCl or NaOH at various concentrations. The mixture is stirred at room temperature and then absorbance is measured as a function of wavelength 300–800 nm.

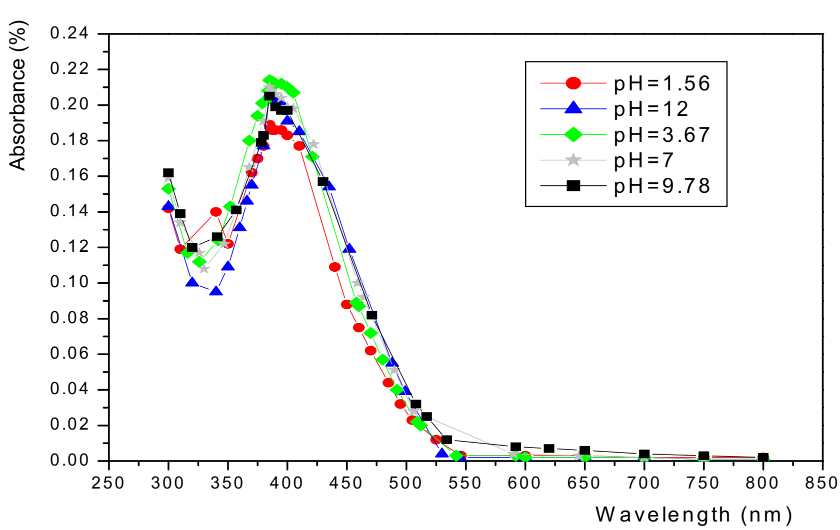


Figure 1 absorption spectrum of an aqueous solution of the dye (RY4) 10 mg/L.