



## Waste products from the phosphate industry as efficient removal of Acid Red 88 dye from aqueous solution: their regeneration uses and batch design adsorber

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### ABSTRACT

Two waste products of the phosphate industry, phosphogypsum and phosphate waste rocks (PWR), were valorized for their use in wastewater treatment from the textile industry. Natural phosphate (PN) was also studied for comparison. First, these materials were characterized by chemical analysis, powder X-ray diffraction, Fourier-transform infrared spectroscopy, thermogravimetric analysis–differential thermal analysis, scanning electron microscopy, and N<sub>2</sub> adsorption isotherms. Next, they were tested as removal agents for Acid Red 88 (AR 88) dye from aqueous solution. The conducted experiments show that among the three materials, the PWR has the highest retention capacity of the dye (123.4 mg g<sup>-1</sup>), and a decrease in the amount of removed AR 88 dye occurs with an increase in pH. The kinetics data on the reaction between AR 88 and the three materials are described well by a pseudo-second-order model, and the Langmuir model is successfully applied to the experimental data. The removal process is spontaneous and exothermic, accompanied by a greater distribution order of the dye molecules on the surface of the materials. Regeneration of the spent byproducts was performed by an environmentally method, and there is about an 80% removal efficiency after four cycles, depending on the spent byproducts. A single-stage batch adsorber design for AR 88 removal has been suggested and based on the Langmuir isotherm model equation.

**Keywords:** Natural phosphate; Phosphogypsum removal; Acidic Red 88; Regeneration; Batch design

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