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ORIGINAL PAPER

Application of economical models for dye removal from aqueous solutions: cash flow, cost–benefit, and alternative selection methods

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Abstract Although there are numerous adsorption studies performed by using various adsorbents, there is no deterministic knowledge about selection of appropriate adsorbent type from present alternatives. In order to evaluate the advantages of the selected adsorbent species mathematically, researchers may use economical models such as cash flow diagrams, cost–benefit analyses, and alternative selection methods. In spite of the fact that these models have been used in many other engineering branches they are rarely applied in environmental research. In this study we have aimed to investigate usability of the mentioned economical models in adsorption of reactive azo dyes from aqueous solutions. Activated ash, a waste material, and commercial granular activated carbon were decided to be adsorbent alternatives. By applying economical models appropriate adsorbent type was selected considering both adsorption efficiencies and economical conditions. Although similar tendencies were monitored in cash flow diagrams; considering the amount of expenses activated ash exhibited remarkable advantages compared to granular activated carbon. Furthermore, results of cost–benefit analyses showed that activated ash has been advantageous when total costs and profits were evaluated together. Results of this study suggest usage of these economical models even in adsorption studies in order to provide accurate information on the selection of appropriate adsorbent type. These methods enable evaluation of economical conditions, which is generally neglected, together with the obtained removal efficiencies.

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Introduction

In recent years wastewater treatment has become a challenging environmental problem all over the world. As a result of continuously increasing population, huge amounts of waste waters coming from numerous sources have been discharged. As a result of diversity in water pollutant species many conventional and advanced treatments methods have been developed.

Selection and design of the ideal technique and process equipments for treatment are among the major problems in environmental engineering. As well as the targeted removal efficiency, economic costs of the process are also important in the decision (Yuan et al. 2010). In spite of the fact that overall cost of waste water treatment has a significant importance in wastewater management strategies, there are relatively few empirical studies on economical analyses in environmental engineering science (Friedler and Pisanty 2006). Although "cost–benefit" has been a well-known and widely used concept in many engineering fields (Ko et al. 2004), it is generally underestimated especially in scientific research within the environmental engineering field.

It is mandatory to apply economical analyses especially for projects demanding serious costs such as design of treatment plants (Yuan et al. 2010). Engineering economics applications provide opportunities to evaluate the status of cash throughout the project and by this way an important portion of the economical risks could be forecasted and prevented (Kahraman et al. 2002). Furthermore, by engineering economics applications ideal source and time

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