Development of a suitable treatment system for hazardous Leather Industry dye (Acid Yellow 2GL) removal from simulated wastewater

A Thesis submitted
In Partial Fulfilment of Requirements
for the Degree of
Doctor of Philosophy
Submitted by

Manish Chandra Kannaujiya
(Registration No: NITD/PhD/ChE/2014/00468)

Under the supervision of

PROF. TAMAL MANDAL
Department of Chemical Engineering
National Institute of Technology Durgapur
West Bengal

PROF. MONOJ KUMAR MONDAL
Department of Chemical Engineering and Technology, Indian Institute of Technology (B.H.U.), Varanasi

PROF. ANANTA KUMAR DAS
Department of Environmental Science, Maulana Abul Kalam Azad University of Technology, Nadia, West Bengal



DEPARTMENT OF CHEMICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY, DURGAPUR
DURGAPUR-713209, WEST BENGAL, INDIA

2022

Abstract

Due to the discharge of many dyes and heavy metals from various sectors, water contamination is a serious concern for environmental engineers today. Hence, the elimination of such types of waste from natural water reservoirs is important in order to minimize its counter-impact on animal health and the environment. Due to its wide surface area and pore volume, activated carbon is recognized for its high adsorption capacity among the many adsorbents used. Agricultural and other lignocellulosic waste materials have been converted to activated carbon in recent years, as this method not only solves the problem of waste disposal but also has the potential to convert the waste into a useful product that can be used as a catalyst for industrial wastewater treatment. The current study investigates at how to remove leather industrial dyes from simulated wastewater using an adsorbent made from brinjal plant waste, ozonolysis, and an integrated process (adsorption integrated with ozone). The chemically active adsorbent was morphologically characterised using SEM, FTIR, XRD, and BET analysis, indicating that the adsorbent has a high potential for removal from leather industry effluents. Maximum dye removal of 98.2% in the integrated treatment process for 15 mg/L of dye solution at 7.5 pH after 30 min of treatment time. The experimental kinetic data were well validated using the pseudo-second-order kinetic model, and the Langmuir model was best suited according to the correlation coefficient R^2 value. The toxicity assessment with the help of the *Vigna radiata* seed germination test was also observed and regeneration of adsorbent after treatment is also observed in these works. According to the cost estimates, the preparation of adsorbent from agricultural waste is inexpensive and environmental friendly, and the entire cost of treatment with an integrated process is Rs. 230/-.

Keywords: Adsorption, Integrated treatment process, adsorption Isotherms and kinetics, Toxicity assessment, Cost estimation