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OXIDATION COMMUNICATIONS

Oxidation Communications

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Biological and biochemical oxidation processes; medical image processing; neural networks and fuzzy logic techniques

KINETIC, MECHANISTIC AND THERMODYNAMIC STUDY OF Ir(III) CATALYSED OXIDATION OF LEUCINE BY HEXACYANOFERRATE(III) IN AQUEOUS ALKALINE MEDIUM

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ABSTRACT

Kinetics of oxidation of leucine by hexacyanoferrate(III) abbreviated as HCF(III) in presence of Ir(III) in aqueous alkaline medium has been investigated spectrophotometrically at 35 ± 0.1°C and constant ionic strength of 0.50 mol dm^{-3} in order to elucidate the mechanism of the reaction. Experimental results reveal that the rate of oxidation increases with increase in the concentration of oxidant, HCF(III) and catalyst, Ir(III), and shows first order dependence while the order of the reaction was found to be one at the lower substrate concentration tending towards zero at its higher concentration. The reaction shows positive salt effect with KCl. The stoichiometry between [HCF]:[leucine] is 2:1. To evaluate the activation parameters, the reaction has been studied at four different temperatures, i.e. 35, 40, 45 and 50°C. A mechanism involving the complex formation between catalyst, substrate and oxidant has been proposed. α-Keto isocaproic acid has been identified as the ultimate product of the reaction. Based on the experimental results, reaction stoichiometry and product analysis, a suitable mechanism consistent with the observed kinetics has been proposed and rate law has been derived.

Keywords: HCF(III), leucine, Ir(III), α-keto isocaproic acid, kinetics, mechanism.

AIMS AND BACKGROUND

Amino acids, derived largely from protein in the diet or from the degradation of intercellular proteins, are the ultimate class of biomolecules whose oxidation makes

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* For correspondence.

J. Water Environ. Nanotechnol., 8(2): 108-120 Spring 2023

ORIGINAL RESEARCH PAPER

Polyvinylpyrrolidone and Brij-35 Stabilized IrO_2 Nanoclusters As Highly Effective Catalyst In The Degradation Of Acid Orange 10: A Comparative Study

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ABSTRACT

In this study, the degradation of azo-dye acid orange 10 (AO 10) has been investigated using Polyvinylpyrrolidone (PVP) and Polyoxyethylene Lauryl Ether (Brij-35) stabilized Iridium oxide (IrO_2) nanoclusters as catalysts. A simple chemical reduction method was used to synthesize the above-mentioned nanoclusters. The characteristics of the nanocatalysts were determined by UV-visible spectrophotometer, TEM, and XRD. The kinetic study has been carried out at λ_{max} of the reaction mixture i.e. 479 nm spectrophotometrically. The degradation follows first-order kinetics concerning oxidant and catalyst concentration while an order is one at lower substrate concentration tending towards zero at higher concentration. The degradation kinetics has been supported by the derived rate law. The results showed that PVP-stabilized IrO_2 nanoclusters outperformed Brij-35 stabilized IrO_2 nanoclusters, exhibiting the fastest degradation rate. The progress of the degradation process was monitored by UV-vis spectroscopy. Using PVP-stabilized IrO_2 nanoclusters as a catalyst is a very promising approach for the remediation of acid orange 10 due to the fast degradation rate and high degradation efficiency. In addition, PVP-stabilized IrO_2 nanoclusters can be easily recovered and recycled for three consecutive cycles. It can be inferred from this study that catalytic oxidation methods are active and environment-friendly for the remediation of dyes.

Keywords: Degradation, Kinetics, PVP, Brij-35, Rate law, Acid orange10

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INTRODUCTION

Synthetic dyes have been widely used in various fields, especially in the textile and printing industries. Azo dyes which constitute a significant proportion of synthetic dyes pose a significant threat to the environment and eco-biology because of their non-biodegradability and potential genotoxic and carcinogenic nature [1,2]. Dye removal or degradation from wastewater has been extensively studied to reduce its impact on the environment [3,4]. Several physicochemical and biological methods, such as adsorption, ozonation, photocatalysis, Fenton, reductive and oxidative degradation, and two or more combination methods have been successfully applied to the treatment of various dyes [5–7].

Among these methods, oxidative degradation is a fast, simple, and low-cost method, which is easy to implement in industries for the degradation of dyes [8]. Conventional chemical oxidation of dyes typically involves the use of oxidizing agents such as chlorine in the form of sodium hypochlorite, ozone (O_3), hydrogen peroxide, and permanganate

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Oxidation Communications 46, No 4, 810–820 (2023)

Oxidation reactions in the presence of homogeneous, heterogeneous, immobilised and enzymic catalytic systems, combustion, fires, explosions

DETERMINATION OF Ir(III) IN THE OXIDATION OF VALINE BY HCF(III) IN AQUEOUS ALKALINE MEDIUM BY KINETIC SPECTROPHOTOMETRIC METHOD

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ABSTRACT

The present paper deals with a novel method for the determination of iridium based on the Ir(III) catalysed oxidation of valine by hexacyanoferrate(III) in an aqueous alkaline medium by kinetic spectroscopic method. By this method, the Beer's law is obeyed in the range of 1.99–19.98 μg ml^{-1} of Ir(III). The Sandell's sensitivity and molar sensitivity are found to be 0.216 to 0.213 μg cm^{-2} and 0.9×10^3 to 1.2×10^3 l mol^{-1} cm^{-1}, respectively. The value of the correlation coefficient lies between (–0.9993 to 0.9978) which indicates the high precision involved in the determination and almost perfect correlation of the data. The effect of a few interfering ions has also been worked out for developing the calibration curves in terms of absorbance or initial rate or pseudo-first-order rate constant versus Ir(III) at λ_{max} of 420 nm. The results show the method is simpler, more sensitive, selective and inexpensive than the reported method. This method avoids the use of hazardous solvents as the reaction occurs in aqueous medium.

Keywords: microgram determination, oxidation, hexacyanoferrate, Valine, Ir(III).

AIMS AND BACKGROUND

Oxidation reactions of amino acids are among the most interesting and useful chemical processes. Basically amino acids are used in parental and enternal nutrition, medicine, feed, food, cosmetics and raw materials for the chemical industry. Poly (amino acids) as biodegradable polymers have attracted attention in connection with environmental protection[1]. Thus due to their biological significance and selectivity towards the oxi-

* For correspondence.