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Synthesis of Nano Ag-La-Co Composite Metal Oxide for Degradation of RB 5 Dye Using Catalytic Ozonation Process

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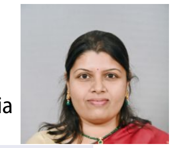

ABSTRACT

Nanoscale composite metal oxide of Ag-La-Co was prepared by co-precipitation method for the treatment of Reactive Black 5 using catalytic ozonation process. Further, the catalyst was characterized by transmission electron microscope, X-ray powder diffraction (XRD), scanning electron microscope - energy dispersive X-ray (SEM-EDX) and Brunauer–Emmett–Teller (BET) surface area analyzer for clarity of the phenomenon. The factors such as amount of catalyst (0.2–1.2 g/L), solution pH (2, 7, and 12), initial dye concentration (100–1,000 mg/L), and ozone flow rate (30–60 LPH) were found to influence the process. The characterization results confirm the formation of the composite metal oxide of Ag-La-Co. The degradation efficiency of catalytic ozonation was 63% compared to 32% and 4% in ozonation without catalyst and adsorption on the catalyst, respectively. Furthermore, it was observed that a pseudo-first-order kinetics model fits well with the experimental data. In addition, the effect of tert-butyl alcohol, a hydroxyl radical scavenger, has been studied. Lastly, the repetitive use of the synthesized catalyst showed that even after three consecutive runs, the catalytic activity is not much degraded, and therefore, the degradation efficiency of the synthesized catalyst was comparatively high; about 95% of Total Organic Carbon (TOC) removal was achieved at solution pH 7, amount of catalyst 1 g/L, reaction time 80 min, and ozone flow rate 30 LPH, indicating an economically viable option for industrial wastewater treatment.

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Introduction

The scarcity of freshwater is ever increasing due to increase in both population and industrial landscape. Therefore, in this era, the focus is more on to reuse or recycle the wastewater to reduce the demand for freshwater. A major part of the wastewater is consisting of dyes coming from various industries such as textile, food, paints, and paper printing(Wu et al. 2015). These colored wastewater reduces the light penetration in water and has an adverse effect on both human health and aquatic life (Turhan et al. 2012); the industry needs to devise and implement ideas to purify their wastewater (Tabrizi, Glasser, and Hildebrandt 2011). It is reported in the literature that conventional wastewater treatment technologies are not capable of complete mineralization of dye molecules. Further, disposal of sludge containing dyes and dye intermediates is an additional issue. Therefore, the researchers are motivated to investigate more advanced processes which are eco-friendly and capable of degrading the organic pollutants completely (Ghuge and Saroha 2018a; Nakhate et al. 2019). Nowadays, advanced oxidation processes (AOPs) have gained the attentiveness for the industrial effluent treatment. The AOPs are relied on the production of hydroxyl radical having the oxidizing potential 2.8 eV, which is comparatively higher than other oxidants like ozone, hydrogen peroxide, etc. Ghuge and Saroha 2018b. The different AOPs like Fenton/photo-Fenton processes, photochemical oxidation, electrochemical oxidation, and ozonation with H_2O_2 or ozonation using catalyst were studied for effluent treatment (Nakhate et al. 2019). Among these, the Fenton process utilizes hydrogen peroxide and Fe (II) ion to generate the hydroxyl radicals. The limitations of Fenton-based processes are pH sensitivity, recovery of Fe ions, and sludge formation which require further treatment (Bello, Abdul, and Asghar 2019). Photocatalytic oxidation processes utilize semiconductor material as catalysts. When semiconducting materials are exposed to light, they will become excited, and the transfer of electrons from the valence band to the conduction band occurs, thus creating the holes in the valence band. These holes act as an oxidizing agent and react with water molecule and produce hydroxyl radicals. But these photocatalytic reactions are slow, less efficient, and expensive (Zangeneh et al. 2015). In wet air oxidation processes, the oxidation of organic pollutants occurs at elevated temperature and

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