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A review on synergistic coexisting pollutants for efficient photocatalytic reaction in wastewater remediation

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ABSTRACT

With the tremendous development of the economy and industry, the pollution of water is becoming more serious due to the excessive chemical wastes that need to remove thru reduction or oxidation reactions. Simultaneous removal of dual pollutants via photocatalytic redox reaction has been tremendously explored in the last five years due to effective decontamination of pollutants compared to a single pollutants system. In a photocatalysis mechanism, the holes in the valence band can remarkably promote the oxidation of a pollutant. At the same time, photoexcited electrons are also consumed for the reduction reaction. The synergistic between the reduction and oxidation inhibits the recombination of electron-hole pairs extending their lifetime. In this review, the binary pollutants that selectively removed via photocatalysis reduction or oxidation are classified according to heavy metal-organic pollutant (HM/OP), heavy metal-heavy metal (HM/HM) and organic-organic pollutants (OP/OP). The intrinsic between the pollutants was explained in three different mechanisms including inhibition of electron-hole recombination, ligand to metal charge transfer and electrostatic attraction. Several strategies for the enhancement of this treatment method which are designation of catalysts, pH of mixed pollutants and addition of additive were discussed. This review offers a recent perspective on the development of photocatalysis system for industrial applications.

1. Introduction

In recent years, with the rapid development of many industries, water resources environment has become a common challenge faced by aquatic organisms and humans worldwide (Hlongwane et al., 2019; Gholami et al., 2021). The primary source of pollutants in water are partially or fully untreated industrial and domestic wastewater, mainly consisting of inorganic and organic pollutants (Ghasemi et al., 2020; Gholami et al., 2020a). World Health Organization has highlighted the need for coordinated action to minimize the emergence and spread of inorganic and organic pollutants in the water environment (Cabrera-Reina, 2019). The matrix of pollutants in wastewater becomes very complicated due to their different properties and concentrations. Common organic pollutants detected including pharmaceutical, dyes and phenolic compounds can be excreted by traditional biochemical degradation technique to attain fully mineralization (Gholami et al., 2020b; Hassandoost et al., 2019; Rad et al., 2022; Liu et al., 2016). However, unlike organic pollutants, heavy metals are non-biodegradable and accumulate in living organisms, making them impossible to excrete from water. In addition, this method is not favorable due to the long time consuming and less effective (García-Mateos et al., 2015; De Gusseme et al., 2011).

An advanced oxidation processes (AOPs) by heterogenous photocatalysis is an excellent technique to remove heavy metals and organic contaminants from wastewater (Azami et al., 2021; Aziz et al., 2021; Fauzi et al., 2020; Hassan et al., 2020; Wang et al., 2020b). The reduction and oxidation process thru heterogeneous photocatalysis of those pollutants are considered as an outstanding approach owing to its

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