UNIVERSITI TEKNOLOGI MARA

DEGRADATION OF PHENOL USING PHOTOCATALYTIC AND BIODEGRADATION TREATMENT OF TIO_2/ZNO/N-MIXED CULTURE

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ABSTRACT

Harmful effect of industrial phenolic effluent which heavily toxified drinking water sources prompted scientist and environmentalists to look for ecologically favourable process of this recalcitrant substances. Phenols have been recognized as persistent and toxic pollutant leading to a significant threat to health problem and environmental consequently. The aims of this study were to investigate the possible removal treatments of phenol from synthetic wastewater using two treatment methods, namely photocatalysis and biological degradation. Mixed culture was used for the biodegradation of phenols, while in photocatalysis, dopant based TiO_2-visible light was used. The photocatalytic degradation of phenol was studied by a batch process using TiO_2-ZnO and TiO_2-ZnO-N as the catalyst on irradiation with visible light. The effect of process parameters such as pH, catalyst loading and initial concentration of phenol on the extent of degradation was investigated. The degradation of phenol was found to be effective in the acidic range. The optimum catalyst loading was observed at 3.0 g/L. The process followed the first order kinetics and the apparent rate constant decreased with increase in the initial concentration of phenol. FESEM, XRD, FTIR and BET were used to examine the characteristic of the materials applied. The better degradation of phenol was observed in the presence of doped Nitrogen photocatalyst as compared with undoped Nitrogen sample. Phenol biodegradation using acclimatized mixed culture was investigated in shake flask batch experiment. Prior to biodegradation, the mixed culture isolated from petrochemical wastewater effluent was acclimatized to a concentration of 50 mg/L of phenol over a period of four weeks. The process parameters namely pH, inoculums size, and initial phenol concentration were varied. A maximum degradation of 100% efficiency was achieved at 10 mg/L of initial phenol concentration, pH 7.0 and an inoculums size of10% (v/v) in biological part. The specific growth rate of the culture at various initial phenol concentrations were fitted to Monod models. It has been demonstrated that a sequential biological pretreatment followed by photocatalysis is able to enhance phenol degradation efficiency by 81%, which is 15% higher than the use of single treatment. It has also been pointed out that the photocatalytic pretreatment seem to have no significant impact by making phenol less biodegradable, as total gave essentially only about 68% degradation of phenol.

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INTRODUCTION

1.1 Research Background

Wastewater polluted with phenol is becoming one of the most critical environmental issues plaguing Malaysia today. Phenols have been listed as one of the major hazardous compound found in industrial petrochemical in Malaysia mainly due to its high toxicity, poor biodegradability and ecological aspects. The toxicity properties and the ability for phenols to dwell in the environment for a long duration may alter aspects of the environment in ways that have global effect. Water polluted with phenol can cause a significant harm to biological aquatic life as well as human life. The toxic effects of phenol have been reported, including muscle weakness, induction of corneal opacification, and may even cause cardiovascular disruption. Taken overall, resulting in systematic toxicity. In the light of this, it is necessary to reduce phenol to threshold limit value of 4 ppm since it is impossible to completely remove it from the environment, (Kaleta, 2006). These classes of aromatic compound are becoming critical public issues as the presence of phenol in water may compromise the quality of drinking water and its traces can be found through unpleasant taste and strong odour.

According to El-Ashtoukhy *et.al.*, (2013), the common concentration of phenol in effluent wastewater is 6.8%. In another study by Diya'Uddeen *et.al.*, (2011), the concentration of phenol generated from petrol processing plant detected is 40 mg/L. Phenol can lasts more than one week in water. Many studies have reported the harmful effects of phenol even at a very low concentration. Continuous exposure to 0.001 g/L or more of phenol can cause skin irritation, headache and nausea, (Michałowicz and Duda, 2007). However, World Health Organization (WHO) has set a maximum level of phenol in drinking water at 1mg/L which will cause no harmful effect on a person's health, (Farzadkia *et.al.*, 2014). Due to its well known toxicity, phenol has been listed as one of the control pollutants by the Malaysian government. It is crucial to reduce phenol concentration at least up to 39 ppb (0.039 ppm) before the water can be discharged to the environment, (Othman *et.al.*, 2016).