UNIVERSITI TEKNOLOGI MARA

REMOVAL OF COPPER METAL THROUGH A HYBRID BIO-CHEMICAL PRECIPITATION PROCESS

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Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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ABSTRACT

Conventionally, heavy metals are being removed by chemical precipitation process using carbonates and hydroxides. Sulphide is one of the alternatives anions added for chemical precipitation to precipitate out copper effectively, but at significantly high costs and not environmental friendly. The uniqueness of this study is sulphide being produced through a biological process using sulphate reducing bacteria (SRB) to precipitate heavy metal. The novelty of this study relies on the significance of using two separate reactors, namely the upflow anaerobic sludge blanket (UASB) reactor and precipitator reactor. The substrates including glucose and sodium sulphate are left under anaerobic condition in the UASB reactor. While, the copper added as a substrate is left in the precipitator reactor. The SRB in the UASB reactor reduce sulphate to hydrogen sulphide gas. Then, the biologically produced hydrogen sulphide gas was used for copper precipitation in the precipitator reactor. The efficiencies of the process can be evaluated separately since these processes take place in two different reactors.This research intends to quantify the amount of methane gas that can be produced in the UASB reactor under limited sulphate condition and to quantify the biological production of sulphide and hydrogen sulphide gas in the UASB reactor under excess sulphate condition. In addition, it is the aim of this study to evaluate the efficiency of copper metal removal through precipitation process using biologically produced sulphide. Results showed that 79.25 % of methane can be recovered and very minimal sulphide was produced under condition of low sulphate concentration. However, when the sulphate concentration is high, only 14.42 % of methane produced with increasing of 76 % sulphide produced. Furthermore, the hydrogen sulphide gas remained in precipitator reactor was 66 %. However, only 14 % of sulphide has been used to precipitate copper with efficiency of 87 % in the precipitator reactor. Therefore, this process has great potential to be adopted in industries to treat industrial wastewater with copper based problems.

Keywords: *anaerobic condition, biological process, copper precipitation, SRB and UASB reactor.*

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CHAPTER 1

INTRODUCTION

1.1 Background

Industrial wastewaters must comply with Environmental Quality Act (EQA) Regulations 2009. Heavy metals constitute one group of contaminants that originate from industrial wastes that may interfere with effluent reuse and result in environmental problems. Cadmium, zinc, copper, nickel, lead, mercury and chromium are often detected in industrial wastewaters, from metal plating, mining, smelting, printing, petroleum refining, tannery processing, battery manufacturing, paint manufacturing and pigment manufacturing (Kardirvelu *et al.*, 2001; Williams *et al.,* 1998). Copper and lead are synergetic when both are present, even in small quantities. Many industries generate wastewaters containing copper and when discharged as untreated industrial wastewater to water bodies, copper may accumulate in microorganisms, aquatic flora, and fauna, which in turn, may enter into the human food chain and result in health problems (Sarabjeet and Dinesh, 2007). Terry and Stones (2002) reported that copper is acutely toxic to aquatic invertebrates, affecting respiration, cell wall integrity and the photosynthesis pathway. Therefore it is important in removing copper from the industrial wastewater to prevent harmful to living things and environment.

In Malaysia, current wastewater standards are specified under the Environmental Quality Act (EQA) Regulations 2009 which is enforced by the Department of Environment (DOE). The standards are divided into two categories, namely Standard A and Standard B.