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REMOVAL OF HEAVY METALS FROM SIMULATED WASTEWATER USING MODIFIED RICE HUSKS

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AUTHOR'S DECLARATION

I declare that the work in this dissertation 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 dissertation has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Recently, the problems of heavy metal-contaminated wastewater have been classified as continuous and critical global issues due to toxicity effects of heavy metals towards environment and human health. Therefore, it has been identified that, the most promising technique to treat heavy metal-contaminated wastewater is adsorption by using activated carbon. However, due to major drawback posed by activated carbon particularly in terms of cost, the potential of rice husk as natural and low-cost adsorbent for the removal of heavy metals was investigated in this study. The main objective of this study was to characterize physical and surface properties of modified rice husk by using Elemental Analyzer, FESEM and BET. Besides that, the present study was also designed to determine the adsorption of heavy metals in single- and triple-layered fixed bed columns. In this investigation, the other aim was also to evaluate the effects of mechanical and multi-step chemical treatments on rice husk adsorptivity. The heavy metals being studied are: Be, Ca, Cd, Cr, Cu, Fe, Li, Mg, Mn, Mo, Ni, Pb, Sb, Sr, Tl, V, and Zn. There are four types of rice husk adsorbents prepared in this study, namely Raw Rice Husk, Blended Rice Husk, Acetone-Benzene Treated Rice Husk (ABRH) and Acetone-Benzene-Methanol Treated Rice Husk (ABMRH). Surface morphology and BET analyses of ABRH and ABMRH revealed that the application of acetone, benzene, and methanol solvents able to open up internal surface area of top and bottom part of the pores, predicting a new structure of pore shape termed as *Hypothetical T-shirt Pore Model.* This pore shape exhibited larger pore diameters, higher porous and surface areas, as well as higher adsorption capacity, owing to its middle narrow section which reducing desorption rate. The theory of *Hypothetical T-shirt Pore Model* coincided with results obtained by adsorption studies based on numerical technique of area under the graph and removal efficiency analyses. Accordingly, the area under the graph analysis revealed that, the adsorption of heavy metals was significantly increased in the following order: Raw Rice Husk (Single-layered Bed) < Blended Rice Husk (Single-layered Bed) < Blended Rice Husk (Triple-layered Bed) < ABRH (Triple-layered Bed) < ABMRH (Triple-layered Bed).With respect to Raw Rice Husk in single-layered bed, the highest percentage reduction of area under the graph was demonstrated by ABMRH in triple-layered bed by 94.49%. Meanwhile, comparative study between single- and triple-layered fixed bed columns discovered that, the adsorption performance in triple-layered is notably increased compared to single-layered beds by 82.45% reduction of area under the graph. Hence, characterization analyses combined with demonstration of least total area under the graphs and highest adsorption capacity based on removal efficiency analysis emerged as a promising indication factor to justify the theory of *Hypothetical T-shirt Pore Model.* Thus, it was suggested that, hybrid modification of rice husk via mechanical and multi-step chemical treatments enhanced the adsorptivity of rice husk and thus demonstrated its potential as cost-effective adsorbent for the removal of heavy metals

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CHAPTER ONE

INTRODUCTION

This chapter presents the research background as well as the rationale for the study. It contains a brief review of heavy metal-contaminated wastewater issues and its prevention measures. Besides that, the discussion on the potential of rice husk as adsorbent is also described in this chapter. Furthermore, the main motivation factors that accelerate the significance of this study are also covered in the problem statement section. Finally, research hypotheses and scope of this study are also specifically presented in this introductory chapter.

1.1 RESEARCH BACKGROUND

1.1.1 Heavy Metal-contaminated Wastewater Issues

High development of non-strategically industrialization activities for nation growth contributes to global environmental deterioration as these activities caused depletion and degradation of natural biodiversity and resources. In addition, these activities also indirectly overload water body with thousands of water pollutant as a consequence of untreated wastewater discharge or less efficient wastewater treatment systems. Apart from industrialization, other sources of wastewater generation are from residences, institutions, and commercial activities. Water pollutant that can be found in wastewater can be grouped into biological, inorganic, and organic types.

Among these identified water pollutants, the utmost pressure to environment and human health are inorganic types, particularly the existence of high levels of heavy metal content in wastewater. This is because, unlike organic and biological pollutants, heavy metals have distinguished characteristics which are non-biodegradable into innocuous end products, highly poisonous and noxious to many life forms, as well as accumulate in living cells and tissues. Theoretically, heavy metals can be referred to chemical element