UNIVERSITI TEKNOLOGI MARA

REMOVAL OF HEAVY METALS BY IRON REDUCTANTS AND COBALAMIN IN ANAEROBIC ENVIRONMENT

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ABSTRACT

This study highlights the removal of Cr and Zn by iron reductant with the present of Cobalamin under various experimental condition that is significant in the engineered or natural anaerobic environment. New findings on the role of enzymatic compound that significantly contribute to the removal of heavy metals in anaerobic environment was also reported. SEM analyses verify that particles size of synthesized nZVI and nFe_3O_4 were in the range of 25-70 nm (< 100 nm). Iron (Fe) is reported as dominant composition in both nZVI (73.87%) and nFe_3O_4 (58.88%). Batch experiments were carried out to elucidate the removal kinetics of Cr and Zn by nZVI and Co for the effects of metal concentration, pH, nZVI amount and Co concentration. From the effects of metals concentration, both Cr and Zn attained highest removal under nZVI-Co suspension at 0.5ppm having removal kinetic, k=1.0560 min^{-1}, R^2=0.9981for Cr and k=1.4409 min^{-1}, R^2=0.9996 for Zn. Effects of pH reveal highest removal of Cr was obtained under nZVI-Co suspension at pH 7 and pH 9 for Zn under nZVI-Co suspension. From the effects of different nZVI amount, both Cr and Zn removal increases with the increase of nZVI amount in the system having removal kinetic, k =1.1462 min^{-1}, R^2=0.9975 for Cr and removal kinetic, k= 1.5035 min^{-1}, R^2=0.9997 for Zn. From the effects of Co concentration, highest removal of Cr and Zinc was best achieved in nZVI-Co suspension having Co concentration of 1.5 mM where removal kinetic, k =1.0324 min-1 min^{-1}, R^2=0.9965 was attained for Cr and removal kinetic, k =1.1950 min^{-1}, R^2=0.9963 for Zn. Second sets of batch experiment were carried out to elucidate the removal kinetics of Cr and Zn by nFe_3O_4 and Co under different effects of metal concentration, pH, nFe_3O_4 amount and Co concentration. Effects of metal concentration reveal, highest Cr and Zn removal was obtained under nFe_3O_4-Co suspension having metal concentration of 0.5ppm with removal kinetic, k =1.4215 min^{-1}, R^2=0.9978 for Cr and removal kinetic, k= 0.3162 min^{-1}, R^2= 0.9996 for Zn. Effects of pH reveal both Cr and Zn shows highest removal at pH 9 under nFe_3O_4-Co having removal kinetic, k =0.8741 min^{-1}, $R^{2=}$0.9963 for Cr and removal kinetic, k=1.3553 min^{-1}, R^2=0.9976 for Zn. The effects of different nFe_3O_4 amount towards the removal of Cr and Zn shows highest removal was obtained under nFe_3O_4-Co suspension having nZVI amount of 0.15g of nFe_3O_4 with removal kinetic, k=1.2916 min^{-1}, R^2=0.9944 for Cr and removal kinetic, k=1.4437 min^{-1}, R^2=0.9954 for Zn. Effects of Co concentration reveal, highest Cr and Zn removal was obtained under nFe_3O_4-Co suspension having Co=1.5mM with removal kinetic, k=0.7869 min^{-1}, R^2=0.9965 for Cr and removal kinetic, k =1.0942 min^{-1} R^2 =0.9930 for Zn. All of the removal kinetics, k of Cr and Zn removal fit the pseudo-first-order rate law having R^2>0.95. Results strongly imply that the presents of Co is significant in enhancing removal of Cr and Zn by iron reductant.

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CHAPTER ONE

INTRODUCTION

1.1 Background of study

To date, heavy metals contamination due to anthropogenic factor has become national and international concern. Laboratory studies proven heavy metals such as lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), mercury (Hg) cadmium (Cd) and nickel (Ni) are the most common contaminants found in soil and groundwater (Jose et al., 2011; Zhang, Pu, 2011; Peng et al., 2009). A groundwater quality monitoring in Malaysia reported arsenic (As), iron (Fe), manganese (Mn), lead (Pb) and chromium (Cr) exceeds the benchmark of National Guideline for Raw Drinking Water Quality (NGRDWQ), 2000 (Department of Environment (DoE), 2012). In small amount, these metals are common and naturally found in our environment. However in large amount, acute or chronic toxicity is very much significant. Exposure of heavy metals toxicity may contribute to damage of nervous function, blood composition, lungs, kidneys and other vital organs. Concentration of most heavy metals when introduce in soil may persists for long duration but however changes of their speciation and bioavailability are possible (Wuana and Okieimen, 2011; Bradl, 2004; U.S.EPA, 2000). Chromium for example is very mobile and toxic in the form of Cr^{6+} but however through reduction process Cr^{6+} will be converted to Cr^{3+} that is less toxic and less mobile thus making it presents safer in the environment.

Soil and groundwater contaminations have been a great environmental challenge over the past decades. The root of contaminations often relates with anthropogenic factor such as industrial activity, agricultural or improper disposal of waste (Borch et al, 2010; Amarasinghe and Williams, 2007; Bahadir et al., 2007). Such activities produce pharmaceutical wastes, persistent organic pollutants, hydrocarbons, pesticides and heavy metals which were discharged directly to soil or being washed off by runoffs will enter our surface water or infiltrate to the ground and thus further contaminate the groundwater.