國立臺北科技大學
資源工程研究所

碩士學位論文

利用轉爐石粉料處理含銅廢水之研究

A Study on Treatment of Wastewater Containing Copper Species by Using Powdered BOF Slag

研究生：李敏菱

指導教授：柯明賢

中華民國 100 年 1 月

摘　要

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畢業時間：100 年 1 月　　學位：碩士

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關鍵詞：轉爐石粉料、含銅廢水、去除行為、顯微特性、溶出特性

本研究為評估利用轉爐石粉料去除含銅廢水之可行性，分別以不同粒徑之轉爐石粉料(原粉料、>900 μm、150-900 μm 及<150 μm)及液固比(200、500、1000 及 2000)等操作參數在反應時間 5、10、30 及 60 分鐘下進行處理含銅廢水之試驗，以探討轉爐石粉料對含銅廢水之處理效率。

由轉爐石粉料之化學組成特性分析結果得知，轉爐石粉料主要含有 46.0-51.6%之三氧化二鐵及 35.3-42.0%之氧化鈣。本研究首先探討不同粒徑轉爐石粉料在液固比 1000 及反應時間 30 分鐘條件下對水中 Cu(Ⅱ)及 Cu-EDTA 之去除效率，由實驗結果顯示，粒徑越小之粉料對於含銅廢水之去除效率越佳，當<150 μm 之轉爐石粉料在反應時間 30 分鐘、液固比 1000 的條件下，含銅廢水之去除可達 100%。接著再以不同液固比(200、500、1000 及 2000)在不同反應時間(5、10、30 及 60 分鐘)下探討轉爐石粉料對含銅廢水之去除效率，由結果得知去除率隨著液固比的降低而增加，且當反應時間越長，對於銅廢水之去除效率越高。<150 μm 之轉爐石粉料在液固比 2000、反應時間 60 分鐘的條件下，對含 Cu(Ⅱ)及 Cu-EDTA 廢水之可達 100%及 90%的去除率。由以上實驗結果得知，轉爐石粉料對含銅廢水之去除具有可行性。

由於轉爐石粉料主要含有 CaO 等鹼性物質，故進一步探討粉料中 Ca(Ⅱ)的溶出濃度與含銅廢水去除效率之關係，由分析結果可以發現，隨著轉爐石粉料中鈣離子的溶出濃度增加，而對銅離子的去除率也隨之增加。而以等溫吸附模式探討轉爐石粉料對含銅廢水之去除行為，可以發現轉爐石粉料對水中 Cu(Ⅱ)及 Cu-EDTA 之去除行為較符合 Freundlich 模式。最後，將處理後的轉爐石粉料進行 XRD、SEM 等顯微特性分析，可以得知處理後之轉爐石粉料在顯微結構上沒有明顯的變化。再將處理後的轉爐石粉料進行 TCLP 溶出試驗以探討其重金屬的溶出特性，由分析結果顯示 Pb、Cr、Cr、Cu、Ba、As、Se、Hg 等重金屬溶出濃度皆符合法規標準。綜合上述研究結果顯示利用轉爐石粉料去除廢水中 Cu(Ⅱ)及 Cu-EDTA 應具可行性，不僅廢水處理成本低廉，且可提升轉爐石粉料資源再利用之附加價值。

ABSTRACT

Title：A Study on Treatment of Wastewater Containing Copper Species by Using Powdered BOF Slag Pages：86

School：National Taipei University of Technology

Department：Institute of Mineral Resources Engineering

Time：January, 2011 Degree：Master

Researcher：Min-Ling Lee Advisor：Ming-Sheng Ko

Keywords：powder BOF slag, copper, wastewater, removal, microstructrue, leaching property

The purpose of this study was to investigate the feasibility of using powdered BOF slag to remove the copper species in wastewater. The powdered BOF slag respectively divided into raw powdered BOF slag and particle size of >900 μm, 150-900 μm, <150 μm. The experimental parameters including L/S (liguid/solid) ratio and treating time period were designed to evaluate the removal efficiency of copper species containing in wastewater by utilizing the powderde BOF slag.

Powdered BOF slag is heterogeneous oxide materials and the experimental results show its resules show that composition contains Fe_2O_3 46.0-51.6% and CaO 35.3-45.0%. The BOF powder with different particle sizes on L/S ratio 1000 and 30 min were tested for removal of Cu(Ⅱ) and Cu-EDTA solution. The results indicated that the smaller size of the powdered BOF slag the better for the copper species removal. When the <150 μm size slag was used under the conditions of 30 min and L/S ratio 1000, nearly 100% of the total Cu(Ⅱ) in water solution was removed. The tests of different L/S ratio (200, 500, 1000 and 2000) at the

treatment time of 5, 10, 30 and 60 min showed that the increase in L/S ratio and time period were generally the better results. For other tests of that <150 μm powdered BOF slag in L/S ratio 2000, it was determined to be 100% and 90% of Cu(Ⅱ) and Cu-EDTA solution, respectively. There results will be useful for future scale-up runs for further studies on the powdered BOF slag removal of the waste water containing copper species.

The experiments also showed that the powdered BOF slag had the main constituent CaO and other alkaline metals. Further investigation regarding of the released calcium and copper removal for powdered BOF slag was performed. It was found that the calcium component is responsible for the removal of copper species. In the Cu-EDTA solution, the TOC concentration decreases if the treatment time increases. Both of Freundlich and Langmuir Isotherm Equations were followed and found that the data could be successfully described by the Freundlich Isotherm Equations.

The recovered BOF slag powder from the treatment with copper speciess was examined by using X-ray Diffraction (XRD) and Scanning Electronic Microscopy (SEM). The XRD pattern remained the same but the surface smoothness had increased in the case of Cu-EDTA solution treatment. By comparison, the Cu(Ⅱ) solution did not affect the powder particle surface. Furthermore, the solution after treatment was analyzed for the metal concentration to detect the possibility of metal leaching from the powdered BOF slag. According to the TCLP test, the leaching concentration of Pb, Cr, Cr, Cu, Ba, As, Se and Hg was minimum.

Overall, the evaluation of using the powdered BOF slag has proven to be useful and low-cost material for removing Cu(Ⅱ) ions from waste water.