國立臺北科技大學
資源工程研究所

碩士學位論文

加速碳酸化對焚化底渣特性影響之研究

A Study on Effects of MSWI bottom ash Properties after Accelerated Carbonation

研究生：林佩瑩

指導教授：柯明賢

中華民國 100 年 7 月

摘　要

論文名稱：加速碳酸化對焚化底渣特性影響之研究　　頁數：118

校所別：國立台北科技大學　資源工程研究所

畢業時間：九十九學年度第二學期　　學位：碩士

研究生：林佩瑩　　指導教授：柯明賢

關鍵詞：焚化底渣、加速碳酸化、化學特性、溶出特性、MINTEQA2

本研究以兩種粒徑分布(0.5-4.76mm、0.5-25.4mm)之焚化底渣於 200℃與不同的二氧化碳、水氣組成及反應時間等操作參數下進行加速碳酸化，探討加速碳酸化對焚化底渣特性之影響，以評析焚化底渣加速碳酸化之可行性、最適操作參數及碳酸化之反應行為。由研究結果可以發現，焚化底渣之主要化學組成為 Ca、Si、Al 等氧化物，其中以 Ca 的成分居多。而焚化底渣於最適操作條件(200℃、15%CO_2 及 60%H_2O)下進行加速碳酸化，0.5-4.76mm 及 0.5-25.4mm 等兩種粒徑分布之焚化底渣其 pH 值分別從 12.29 及 10.87 下降至 10.88 及 9.87。

由 XRD 晶相繞射及 FTIR 光譜發現，加速碳酸化後之焚化底渣表層有碳酸鈣晶相及碳酸根吸收峰存在。由 OM 礦物相及 SEM 顯微結構中推測焚化底渣表面應有碳酸鈣成份礦物產生。另外，加速碳酸化後焚化底渣中氯離子溶出下降，且氯離子溶出隨加速碳酸化時二氧化碳組成增加有減少的趨勢。由毒性溶出特性試驗及管柱溶出試驗結果，得知加速碳酸化後焚化底渣之重金屬 Cu、Pb 及 Zn 之溶出量均有明顯下降的趨勢。

進一步利用 MINTEQA2 軟體模擬焚化底渣中 Si、Ca、Zn、Cu、Al、Pb、Cd 及 Ni 之溶出行為，由模擬結果顯示，經過碳酸化後焚化底渣之 Si、Ca、Zn 及 Cu 溶出有明顯下降，由此可推測加速碳酸化可將其金屬穩定於焚化底渣

中。而加速碳酸化後對於焚化底渣中 Al 及 Pb 之溶出沒有顯著地影響，焚化底渣中 Al 及 Pb 之溶出主要受萃取液 pH 值之影響。另外，加速碳酸化前後焚化底渣中 Cd 及 Ni 之溶出均小於偵測極限，顯示加速酸化亦不影響焚化底渣中 Cd 及 Ni 之溶出。綜合以上研究結果顯示，焚化底渣進行加速碳酸化於其表層所形成之碳酸鈣，具有降低焚化底渣高鹼性及提昇其重金屬穩定性之功效，不僅可提昇焚化底渣資源化利用之價值，亦可兼具二氧化碳減量之效果。

ABSTRACT

Title：A study on effects of MSWI bottom ash properties after accelerated carbonation Pages：118

School：National Taipei University of Technology

Department：Institute of Mineral Resources Engineering

Time：July, 2011 Degree：Master

Researcher：Pei-Ying Lin Advisor：Ming-Sheng Ko

Keywords：MSWI bottom ash, accelerated carbonation, chemical property, microstructure, leachability, MINTEQA2

In this study, the effects of accelerated carbonation on the chemical properties, mineral morphologies and microstructures of bottom ash with various accelerated carbonation parameters (such as temperature, time, content of CO_2 and H_2O) are evaluated. Under optimum accelerated carbonation parameters (such as 200℃、15%CO_2 and 60%H_2O), the results indicate that finer bottom ashes(0.5 to 4.76mm) and raw bottom ashes(0.5 to 25.4mm) after accelerated carbonation individually lowered their pH values from 12.29 and 10.87 to 10.88 and 9.87. The XRD patterns of accelerated carbonation bottom ashes show that there were calcite on the surface of carbonation bottom ashes and the spectra of FTIR of accelerated carbonation bottom ashes indicate that there were $\underline{CO_3^{2-}}$ functional groups presenting on surface of carbonated bottom ashes. The solubility of chloride ions reduces with accelerated carbonation. The results in accordance with TCLP and column leaching test indicate that the leaching concentration of Cu, Pb and Zn in bottom ashes obviously decreased with accelerated carbonation.

However, the simulation of leaching behavior for Si, Ca, Zn, Cu, Al, Pb, Cd and Ni in bottom ashes by using MINTEQA2 software is evaluated in this study. The results show that the dissolution of Si, Ca, Zn and Cu in bottom ashes significantly decreased with accelerated carbonation of bottom ashes. It implies that Si, Ca, Zn and Cu could be stabilized in bottom ashes with accelerated carbonation. The accelerated carbonation of bottom ashes insignificantly affects the dissolution of Al and Pb in bottom ashes. The dissolution of Al and Pb in bottom ashes could be affected mainly by the pH of extraction solution. Also, the accelerated carbonation of bottom ashes insignificantly affects the dissolution of Cd and Ni in bottom ashes. Based on the above results, accelerated carbonation of bottom ashes not only reduces high alkalinity of bottom ashes and leachability of heavy metals in bottom ashes, but also promotes the utilization of bottom ashes and reaches the reduction of carbon dioxide.