中文提要

論文名稱：研磨的機械化學作用促進焚化飛灰重金屬穩定化及燒結資源化之研究　　頁數：125

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論文提要內容：

都市垃圾焚化飛灰處理是廢棄物管理中相當棘手的課題，在掩埋場設置不易的情況下，尋求適當的技術將飛灰無害化及資源化是目前的趨勢，本研究使用球磨機對水萃飛灰進行濕式研磨的處理，研磨劑為水、乙醇及磷酸溶液，探討研磨的機械化學作用促進焚化飛灰重金屬穩定的機制及效果；最後再探討將水萃飛灰與調質材料淨水污泥、廢玻璃粉共同研磨後燒結，對促進燒結體工程特性及減小重金屬揮發的影響及作用機制。本研究以粒徑分析儀測定研磨前後粉體粒徑變化，以 TCLP 及序列萃取法(SEP)分析重金屬的穩定性，配合場發射掃描式電子顯微鏡(FE-SEM)、X 光繞射儀(XRD)分別研究粉體表面微觀特性及結晶強度、結晶物種等變化。

實驗結果顯示，濕式研磨能有效減少水萃飛灰粉體的粒徑至 2 μm 左右，濕式研磨對水萃飛灰的鉛最具穩定的作用，使用水研磨 1 小時即可抑制鉛 TCLP 溶出，從 5.2 降至 1.2 mg/L，研磨 96 小時鉛的 TCLP 溶出可減少 96%；序列萃取結果也顯示研磨之後，鉛傾向形成較穩定的重金屬型態；推測研磨穩定鉛的機制是鉛在飛灰顆粒不斷的破碎及團聚的過程中被限制在粉體當中；XRD 分析顯示研磨過程中粉體結晶缺陷會增加甚至趨向無結晶化，而鉛有機會擴散到缺陷組織內而不易溶出。研磨劑的選用對增進研磨穩定鉛效率有很大影響，選用乙醇及 0.2 M 磷酸在 1 小時研磨即有 93%以上的穩定效率，選用水及 0.02M 磷酸則需要 48 小時的研磨時間才能達到 90%以上的穩定效率。水萃飛灰與調質材料共同研磨的燒結實驗結果則顯示燒結體重金屬鉛、鋅、銅、鉻及鎘的揮發率皆可抑制在 20%左右甚至更低，由 SEM 分析發現適當調質研磨能促進液相燒結的形成，使燒結體緻密化，進而促進燒結體的工程特性及降低重金屬揮發作用，是一種深具潛力的飛灰無害化與資源化的處理技術。

關鍵字: 焚化飛灰、濕式研磨、機械化學、重金屬穩定、燒結資源化

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英文提要

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The Mechanochemical Milling Effect on Heavy Metal Stabilization and Sintering Recovery for Municipal Solid Waste Incinerator Fly Ash

Key word:

MSWI fly ash, wet milling, mechanochemistry, heavy metal stabilization, sintering recovery

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Abstract:

Municipal solid waste incinerator (MSWI) fly ash has complex composition and contains plenty of heavy metals, which has become a thorny issue in solid waste management. However, new landfill sites are hardly to be set in Taiwan, looking for suitable technologies to detoxify and recycle the fly ash is a tendency at present. In this study, ball milling technology was applied in the treatment after water-extraction. The different milling solutions included water, ethanol and phosphoric acid were used to explore the mechano-chemical mechanism on the effect of heavy metals stabilization. Finally, the mutual milling of the fly ash, adjusting materials of water-treatment sludge and waste cullet, and sintering process were conducted to investigate the mechanism and effect of the engineering characteristics of sintering specimens and reducing of heavy metals evaporation. Laser particle diameter analyzer was used to analyze the diameter variation of fly ash during milling. The stabilization and leaching behavior of heavy metals were determined by TCLP and sequential extraction procedure (SEP); the surface microstructure was observed by field emission scanning electron microscopy (FE-SEM), and the crystalline structure was identified by X-ray diffraction (XRD).

The results showed that wet milling has great effect to stabilize Pb within the water-extracted fly ash. The TCLP concentration of Pb was inhibited from 5.2 to