國立臺北科技大學
資源工程研究所

碩士學位論文

脫硫石膏應用於產製煉鋼爐石水合磚之研究

A Study on the Application of Flue Gas Desulfurization Gypsum for Producing Steelmaking Slag Hydrated Blocks

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摘要

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關鍵詞：脫硫石膏、鈣基活化劑、煉鋼爐石、煉鋼爐石水合磚

本研究以脫硫石膏、鈣基活化劑及高爐石粉合成膠結材料，探討不同脫硫石膏添加量及養護條件對膠結材料性質之影響，以評估脫硫石膏結合鈣基活化劑及高爐石粉合成膠結材料之可行性。接著以最佳膠結材料配比結合轉爐石產製煉鋼爐石水合磚，探討不同水膠比、膠結材料與骨材比及添加程序對於煉鋼爐石水合磚性質之影響，最後進行煉鋼爐石水合磚之環境相容性試驗，以評估脫硫石膏作為鈣基活化劑結合轉爐石為骨材產製煉鋼爐石水合磚之可行性及最適操作條件。

由研究結果顯示，脫硫石膏與轉爐石重金屬溶出量皆符合 TCLP 溶出試驗之法規標準。而鈣基活化劑中脫硫石膏含量 20%結合高爐石粉合成膠結材料，於飽和石灰水中養護，具有最高之 28 天抗壓強度 28 MPa，且由 XRD、SEM 及 FTIR 等顯微分析結果顯示，鈣基活化劑中脫硫石膏含量 20%結合高爐石粉合成之膠結材料含有鈣礬石，且結構較為緻密。以鈣基活化劑中脫硫石膏含量 20%結合高爐石粉合成之膠結材料，進一步結合轉爐石產製煉鋼爐石水合磚，在預先添加轉爐石、水膠比 0.53 及膠結材料與骨材比 1:3 之組別，其抗壓強度高於其他組別，最高抗壓強度可達 18 MPa。另外由 XRD 分析顯示，經預先添加與水攪拌及浸泡之轉爐石表面，氧化鈣含量有降低之趨勢，而由 SEM 分析顯示，

轉爐石表面則由層狀堆疊之結構，逐漸轉變為片狀及板狀等結構參雜其中。

在鹼性物質溶出方面，於海水環境中煉鋼爐石水合磚鹼性物質溶出較低，不會造成 pH 值過度的變化而對環境造成影響，而由煉鋼爐石水合磚的酸可萃取物含量及無機可溶出成分分析發現皆具有些微 Pb 及 Ba 的溶出量，但以毒性特性溶出程序試驗及多重毒性特性溶出程序試驗進行萃取，其溶出值皆遠低於我國法規規範之標準，因此煉鋼爐石水合磚應具環境相容性，為一低成本、對環境友善及資源循環的再生材料。

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ABSTRACT

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The aim of this study was to evaluate the feasibility of flue gas desulfurization gypsum, calcium activator, and ground granulated blast furnace slag used as binder materials and producing steelmaking slag hydrated blocks with blast oxygen furnace slag. The effect of the flue gas desulfurization gypsum addition level and curing conditions on the characteristics of binder materials would be investigated. Furthermore, the effect of the water to binder ratio, binder to aggregate ratio, and adding program on the characteristics of steelmaking slag hydrated blocks would be also investigated. Finally, the environmental compatibility of the steelmaking slag hydrated blocks would be evaluated.

The results indicated that flue gas desulfurization gypsum and basic oxygen furnace slag contained trace heavy metal, but the leaching concentration were under the regulatory limits of TCLP test. The analysis results of the binder material showed that the binder material prepared by using 20% of flue gas desulfurization gypsum into

calcium activator and cured in lime-contained water could reach higher compressive strength 28 MPa, and the microstructures of the binder material was compact. The optimal water to binder ratio, binder to aggregate ratio, and adding program of the steelmaking slag hydrated blocks were 0.53, 1:3, and pre-adding basic oxygen furnace slag, respectively. The compressive strength of the steelmaking slag hydrated blocks could reach 18 MPa. The environmental compatibility of the steelmaking slag hydrated blocks showed that the leaching concentration of the heavy metal were under the regulatory limits of TCLP test. Based on the above results, producing steelmaking slag hydrated blocks by using the flue gas desulfurization gypsum would be feasible.

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