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Hydration Characteristics of Different Cementitious Materials in presence of Some Heavy Metals

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قَالُوا سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ
مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ
الْحَكِيمُ

صدق الله العظيم

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Symbol	Description
C_3S	Tricalcium silicate (Alite)
$\beta - C_2S$	β – dicalcium silicate (Belite)
C_3A	Tricalcium aluminate
C_4AF	Tetracalciumaluminoferrite
OPC	Ordinary Portland cement
B	Bentonite
B-250˚C	Bentonite fired at 250˚C
B-500˚C	Bentonite fired at 500˚C
B-800˚C	Bentonite fired at 800˚C
K	Kaolinite clay
MK	Metakaolin
XRD	X- ray diffraction
DTG	Differential thermal gravimetric
TG	Thermal gravimetric
SEM	Scanning electron microscope
CSH	Calcium silicate hydrate
CH	Calcium hydroxide
CAH	Calcium aluminate hydrate
CASH	Calcium aluminate silicate hydrate
$(C_3A.CaCl_2.11H_2O)$	Mono chloro aluminate hydrate (fredil salt)

Hydration Characteristics of Different Cementitious Materials in presence of Some Heavy Metals

Abstract:

The hydration characteristics of different cementitious materials in absence and presence of Ni(II) or Cr(III) as chlorides were investigated by determination of compressive strength, combined water content, free lime content, XRD analysis, thermal analysis and microstructure investigation at different time intervals from 1 up to 90 days. In addition, the immobilization of nickel and chromium ions in the hardened OPC and blended cement pastes was examined. The different cement pastes used in this study were neat Portland cement, Portland cement blended with 20% bentonite caly and 20% bentonite fired at 250˚C, 500˚C and 800˚C. Also, kaolin and metakaolin were used as blending materials with the ratios of 20, 40 and 80%. One ratio of each heavy metal ions (1.0%) of solid was used. The used metal salts caused acceleration effect for the hydration of most of the investigated cement pastes. The results of compressive strength, combined water, free lime contents and X-ray diffraction analysis were correlated to a good degree. The degree of immobilization of the added heavy metal ions is evaluated by determining the leached ion concentration after time intervals extended up to 30

days. The leachability experiments are carried out by using the static mode of leaching process. It has been noticed that all the investigated cement pastes showed a high degree of immobilization for Ni^{2+} and Cr^{3+} ions.

Key words: Portland cement, heavy metals, hydration characteristics, Immobilization and leachability.

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EFFECT OF NI (II) AND CR (III) ON THE HYDRATION CHARACTERISTICS OF PORTLAND CEMENT

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Key Words: Ordinary Portland Cement (OPC), heavy metals, Solidification /stabilization, Hydration characteristic of cement, Immobilization, phase composition and microstructure.

ABSTRACT

The hydration characteristics of ordinary Portland cement (OPC) in absence and presence of Ni(II) or Cr(III) are investigated as well as the immobilization of nickel and chromium ions in cement pastes is examined. The different cement pastes used in this study are Portland cement in absence and presence of $NiCl_2$ or $CrCl_3$. One ratio of Ni(II) and Cr(III) is used (1.0% by weight of the solid binder). The hydration characteristics of cement pastes are tested via the determination of the compressive strength, combined water content and free lime content at different time intervals from 1 up to 90 days. In addition; X-ray diffraction (XRD), Thermal analysis (DTG and TG) and scanning electron microscope (SEM) of some selected samples are investigated. The results show that the presence of $NiCl_2$ and $CrCl_3$ caused acceleration for the hydration of Portland cement paste. $CrCl_3$ caused acceleration more than $NiCl_2$. The degree of immobilization of the added heavy metal ions is very high in the investigated cement pastes.

INTRODUCTION

With the increasing contamination of the natural environment, the problem of heavy metal immobilization becomes more and more significant. Heavy metal pollution has become a major global problem, which threatens the environment and human life by its toxicity. Development of novel low-cost adsorbents for heavy metals removal has attracted great attention[1]. Due to the increasing amount of usage of various metals in industries, their discharge into the environment has also increased steadily. This has led to the growing concern about polluting the overall environment and thus increasing the human intake of toxic elements such as cadmium, lead, mercury, arsenic, chromium, nickel, and antimony etc.

Various technologies have been developed to render a waste non-toxic or to reduce the potential for the release of toxic species into the environment. Cr^{3+} and Ni^{2+} are examples of these toxic heavy metals.

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