CHAPTER I

INTRODUCTION

1.1 Research Motivation

Low-waste or waste-free technologies are widely used in the developed countries. These countries also keep searching for waste treatment methods that would be friendly to the environment and helpful in recovering energy from waste. In conjunction, the cement industry also participates in the efforts to find a solution for the environmental problem in waste mandagement. The energy-intensiveness of cement production processes and increasing fuel prices force the cement industry to search for technologies based on waste-derived and alternative fuels (Mokrzychi, 2003).

Disposing of hazardous waste in the kiln of cement production is the new technology based on waste-derived and alternative fuels. This waste might substitute the material or the fuel in the production process or it can present as the adding material for cement manufacturing without any advantage for process. To utilize waste in cement factory for the disposal purpose, effect of each type of waste on the cement product both in civil works and environmental aspects must be known. This disposal method can be applied if the contaminant either does not appear in the emission from stack or leach from cement product to environment. With these considerations, any cement product deriving from the co-burning of hazardous waste especially heavy metal has to be tested. There are many works study on emission of heavy metal from stack but there are a few work studied on leaching of heavy metal from cement.

Range of co-burning hazardous waste is extremely wide. Not only liquid wastes can be used as a complementary fuel in cement kilns, but also some solid waste can be utilized (Hansen, 1992, 1990; Greco, 1997). Normally, hazardous wastes, which are used as alternative fuel or adding material, include used oil, spent solvent, tires, plastic, and sludge from wastewater treatment plant. These wastes consist of heavy metal such as cobalt, cadmium, lead, zinc, nickel, and chromium (Willitsch and Sturm, 2003; Serclerat et al., 2000). It is noted that the total metal content is not significantly affected by the co-firing of waste derived fuels (WDF), except if a waste exhibits a level of one metal especially higher than the average content of the raw material (Serclerat et al., 2000). This is mainly the case for zinc in old tires, chromium and nickel in sludge from wastewater treatment plant. Thus, the effect of those heavy metals on the quality of cement product in environmental aspects is very valuable to be investigated.

The major purpose of this study was to investigate effect of heavy metals on the leaching behavior of cement product. In this study, the investigated heavy metals, chromium (III), nickel (II) and zinc (II) in an oxide form, were injected to the raw material to produce clinker. After clinker preparation process, the leaching tests were performed to examine the leach ability of each heavy metal from cement product. The leaching tests included Microwave-assisted leach method 3051A, Toxicity Characteristic Leaching Procedure (TCLP), Notification of Ministry of Industry No.6 B.E. 2540 (1997), availability leaching test, and pH static leach test (Hohberg et al., 2000). Results from these tests were used to evaluate the leaching behavior of each heavy metal.

1.2 Research Objectives

The major objective of this study was to investigate the leaching behaviors of each heavy metal (chromium (III), nickel (II) and zinc (II)) from cement by standard leaching tests. There are three specific objectives in this research.

1. To investigate effects of types and initial concentrations of heavy metal on the leaching behavior.
2. To classify the cement derived from co-burning of heavy metal whether it is a hazardous waste or non-hazardous waste by toxicity characteristic leaching procedure (TCLP) test.
3. To study the leaching behavior of each heavy metal in different pH solution.

1.3 Hypotheses

Heavy metal mixed with raw material and co-burning in cement process can be leached out from cement product. The leaching behavior of each type of heavy metal can be investigated by leaching standard test, which are toxicity characteristic leaching procedure (TCLP), availability leaching test, pH static leach test, microwave-assisted leach method 3051A, and Notification of Ministry of Industry No.6.

1.4 Scope of study

1. The five leaching tests implemented in this study included: microwave-assisted leach method 3051 A; toxicity characteristic leaching procedure (TCLP); Notification of Ministry of Industry No.6; availability leaching test; and pH static leach test.
2. The studied heavy metal containing in hazardous waste were: chromium, nickel and zinc. The concentrations of each metal were 0.1, 0.5, 1, and 2 percent by weight.
3. Chromium, nickel and zinc in oxide form were added individually to the clinker raw material before burning step in synthetic cement process. The leaching behavior of each type of heavy metal was discussed separately.
4. In this study, the physical characteristics of cement for construction purposes, such as strength or setting time etc., are of no concern.

1.5 Advantage of this work

The result obtained from this research can be beneficial for disposing hazardous waste containing heavy metals in cement manufacturing. It can be used to establish the initial concentration level of each heavy metal that the cement is not classified as hazardous waste. In addition, it can be applied for the appropriate use of the cement product when contacting with water in different pH.