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The Leachate of Lead from the Crucibles Undergone Ruby Heat Treatment with Lead Glass Additive

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Abstract

Heat treatment with lead glass additive is developed to improve the quality of rubies. The alumina crucibles which were used as containers are not subjected to the hazardous waste laws. Therefore, this research constituted a study to characterize and determines lead contents in the leachate from these crucibles by two methods, the toxicity characteristic leaching procedure (TCLP) and synthetic precipitation leaching procedure (SPLP) as simulation of leaching conditions of landfill and acid rain, respectively. Discarded crucibles from 6 factories gives lead concentrations ranging from 0.58 to 335.73 (TCLP) and 0.35 to 312.17mg /l (SPLP), with a positive correlation between them. For the pH values, the leachates by TCLP seem to be constant at 5.00-5.17 while those by SPLP seem to be fluctuated, ranging from 6.64 to 9.73. The increasing in pH value doses not correspond with the increasing in lead concentration level.

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Keywords: Lead glass additives, Ruby heat treatment, Crucible, Leachate

1. Introduction

Heat treatment is a common practise for quality improvement of gem corundum, both ruby and sapphire.

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Lead glass material, which is mainly composed of lead oxide, is often added in alumina crucibles along with being treated stones during the treatment to enhance clarity quality of the stones. When these crucibles are not in use any longer, they normally are heaped up around as junk or discarded together with the municipal waste. Kanjanabut et al., [1] found that leachate from this kind of lead-contaminated crucibles, either by the threshold total limit concentration (TTLC) and the soluble total limit concentration (STLC) method, contains lead concentrations higher than the safety standard level; consequently, these crucibles can be classified as hazardous waste in accordance with the description in the Notification of Ministry of Industry, Industrial Waste Disposal 2005.Currently, the heat treatment process with lead glass addictive which manufactured in the house is not classified as an industrial practise by the announcement of the Ministry of Industry. Thus, the raw materials and wastes from this treatment factory are not yet regulated to be treated and managed as hazardous waste.

As mentioned, the crucibles are normally contaminated by lead compounds after being used for the treatment and whenever they are disposed and exposed to an active leachant such as organic acids i.e., acetic acid from the decomposition of organic waste in landfills, inorganic acids i.e., nitric acid, sulphuric acid from acid rain or even the water, the leaching of lead may occur naturally. This leads to the transportation of the contaminating lead to the environment [2]. Lead is a heavy metal that is toxic to human's health by both chronic and acute effect. If the amount of accumulation is high enough, lead may be toxic to all kind of organisms [3]. In addition, lead is classified as a human carcinogen type 2B by International Agency for Research on Cancer [4].

This research constituted a study on the (1) determination of lead concentrations leached out from discarded crucibles obtained from ruby heat treating factories and (2) characteristics of the leachate given by two leaching tests: the toxicity characteristic leaching procedure (TCLP) and synthetic precipitation leaching procedure (SPLP). TCLP (SW-846 Method 1311) emulates the landfill condition whereas SPLP (SW-846 Method 1312) imitates the acid rain condition [5].

2. Material and Method

2.1. Sample source and preparation

Total of thirty lead-contaminated crucibles (discarded crucibles) from 6 different factories (five crucibles from each factory) were selected together with five new (blank) crucibles from a control factory. All of these factories have used lead glass additives in the ruby heat treatment procedure. All the studied crucibles were crushed by disc mill to the size of about 9.5 mm before employing to the leaching tests.

2.2. Leaching experiment

The toxicity characteristic leaching procedure (TCLP: SW-846 Method 1311) and synthetic precipitation leaching procedure (SPLP: SW-846 Method 1312) are standard testing methods recommended by the United State Environmental Protection Agency (U.S. EPA) [6]. The procedures were performed as reported below.

2.2.1. TCLP

1) The preparation of extraction solution (acetate buffer): Mixing 5.7 ml of glacial acetic acid (CH_3COOH) in 500 ml water with 64.3 ml of 1N sodium hydroxide (NaOH) in 1 litre of water. Subsequently, the solution pH was adjusted to 4.93±0.05 by 1N sodium hydroxide (NaOH).

2) Leaching test: The proportion of crucible sample to the extraction solution is 20:1. After mixing, the solution was transferred to plastic bottles. The filled bottles were, then, put into a rotator to be rotated with set speed of 30-rpm for 18±2 hrs. Then, the mixed solution was filtrated and the leachate was preserved at pH <