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Dehydration, hydrolysis and oxidation of cerium chloride heptahydrate in air atmosphere

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Abstract: The thermal decomposition of $CeCl_3 \cdot 7H_2O$ was studied from room temperature to 800°C. Analysis was performed by applying TG-DTA, XRD, FESEM, EDXS, and TG-MS technologies to investigate the thermal decomposition mechanism of $CeCl_3 \cdot 7H_2O$ in air atmosphere. Multiple forms of hydrated cerium chloride compound were observed in the dehydration products. The $CeCl_3$ hydrolysis product was separated by a continuous centrifugation method and the phase composition was identified as CeO_2, $Ce(OH)_3$, and $CeCl_3 \cdot 4H_2O$ by XRD analysis. The evolved gas composition was identified as Cl_2 and HCl by TG-MS system. Based on the analysis of the experimental results, the mechanism of thermal decomposition of $CeCl_3 \cdot 7H_2O$ was proposed with completion of the dehydration reaction at 224 °C, the hydrolysis reaction at 170 ~ 480 °C, and the oxidation reaction of $CeCl_3$ above 480 °C.

Keywords: $CeCl_3$, hydrolysis, oxidation, XRD, MS

1. Introduction

Cerium chloride is one of the most important rare earth compounds that has displayed promising applications in the fields of electro-refining [1, 2], catalysis [3, 4], scintillation [5, 6], and hydrogen storage [7, 8]. In the metallurgy industry, anhydrous cerium chloride ($CeCl_3$) is an important raw materials for the production of cerium metal by electro-winning [9-11]. Cerium chloride hydrates ($CeCl_3 \cdot 7H_2O$) can also be used for the preparation of cerium oxide (CeO_2) by spray pyrolysis [12]. Therefore, understanding the thermal decomposition mechanism of $CeCl_3 \cdot 7H_2O$ is important for the production of both anhydrous $CeCl_3$ and CeO_2.

The dehydration mechanism of rare earth chloride hydrates compounds has been studied by various methods, such as thermal gravimetric analysis [13-16], static membrane method [17], fluidized bed [18] and dynamic thermo-gravimetric transpiration [19]. Previous work [15-17, 20] supported a stepwise dehydration mechanism of $CeCl_3 \cdot 7H_2O$ that followed the pattern of

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