QUANTITATIVE THERMOGRAVIMETRIC ANALYSIS
OF BINARY MIXTURES
Magnesium hydroxide and magnesium acetate

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Abstract

Thermogravimetric analysis is used to determine the amounts of Mg(OH)₂ and Mg(CH₃COO)₂ in a mixture thereof. The application and suitability of different analysis methods are discussed. In the first method the mass losses in the temperature ranges as indicated by the decomposition of the pure compounds were used. Results obtained using these temperature ranges were unusable. The percentage mass losses due to the decomposition of Mg(OH)₂ and Mg(CH₃COO)₂ were then determined in a second method using the minimum in the derivative mass vs. temperature curves. The results obtained by this method compared well with the actual values for mixtures containing more than 15% magnesium acetate. The third method employed the total experimental mass loss of both decomposition reactions. The results obtained using this method compared well to the actual values, giving a R² value of more than 0.99. This method of using the total mass losses can however only be used for binary mixtures that consist only of magnesium hydroxide and magnesium acetate.

Keywords: magnesium acetate, magnesium hydroxide, quantitative determination, TG

Introduction

The preparation of hydromagnesite from both magnesium hydroxide and magnesium oxide have been studied previously [1]. It was found that the reaction has not gone to completion when MgO is used as starting material, and that the preparation from Mg(OH)₂ is preferred. The influence of experimental conditions during the preparation of hydromagnesite from Mg(OH)₂ is critical, and influences the characteristics of the product formed, especially the number of carbonate vs. hydroxide groups in the final product. The rehydration characteristics of a commercially available and two synthetically produced basic magnesium carbonates have been studied previously to obtain the chemical compositions of the products that were formed for vari-
ous experimental conditions [2]. MgO is available as a by-product during the synthesis of magnesium carbonates in the local industry.

Thermogravimetric analysis can be applied to determine the degree of hydration of magnesium oxide to magnesium hydroxide by comparing the experimental mass loss to the theoretical mass loss of the decomposition of Mg(OH)₂. This decomposition reaction takes place between 300–400°C according to the following scheme:

$$
\text{Mg(OH)}_2(s) \rightarrow \text{MgO}(s) + \text{H}_2\text{O}(g)
$$

Magnesium acetate can be used to enhance the degree of hydration of magnesium oxide [3]. The magnesium hydroxide product obtained from the hydration of magnesium oxide in magnesium acetate solutions usually contains some magnesium acetate. Magnesium acetate decomposes in the same temperature range as magnesium hydroxide, which complicates the quantitative analysis of hydrated samples.

According to [4], magnesium acetate decomposes following the next scheme:

$$
\text{Mg(C}_2\text{H}_3\text{O}_2)_2(s) \rightarrow \text{MgO}(s) + \text{CO}_2(g) + \text{CH}_3\text{COCH}_3(g)
$$

In this paper, suitable methods to determine the amounts of magnesium hydroxide and magnesium acetate in a mixture thereof are discussed.

**Experimental**

Pure Mg(OH)₂ and Mg(CH₃COO)₂.₄H₂O was obtained from Merck. To remove moisture and water of crystallization, the samples were dried at 200°C for 2 h. Different mass percentage ratios of the two compounds were mixed and ground together.

A Q500 TG (TA Instruments) was used to perform the thermogravimetric analysis of the pure compounds and mixtures. A heating rate of 10°C min⁻¹ was used in an oxygen atmosphere. Platinum pans were used, and the sample masses were between 8–11 mg. Three thermogravimetric curves were obtained for each sample.

**Results and discussion**

The TG curves of some of the mixtures are shown in Fig. 1. Decomposition of the sample containing only Mg(OH)₂ revealed a mass loss of 26.8% between 200–450°C. The difference between this mass loss percentage and the theoretical value (30.9%) can be ascribed to the presence of MgO and some impurities.

All samples containing magnesium acetate have shown a small mass loss between 30 and 150°C. Although both the Mg(OH)₂ and Mg(CH₃COO)₂.₄H₂O was dried at 200°C before mixing, it was clear that by the time the thermal analysis runs were performed, the magnesium acetate in the samples have already started to rehydrate again.

The theoretical mass loss for the decomposition of Mg(CH₃COO)₂ to MgO is 71.7%. To determine the mass loss of the decomposition of the Mg(CH₃COO)₂ sample, the mass loss due to the uptake of water of crystallisation had to be subtracted first.