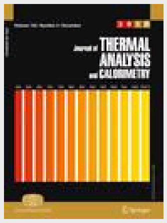
期刊文章



Some thermal characteristics of a mineral mixture of palygorskite, metahalloysite, magnesite and dolomite

期刊	Journal of Thermal Analysis and Calorimetry
出版社	Akadémiai Kiadó, co-published with Springer Science+Business Media B.V., Formerly Kluwer Academic Publishers B.V.
ISSN	1388-6150 (Print) 1572-8943 (Online)
学科	Chemistry, Sciences, Polymer Sciences, Physical Chemistry, Inorganic Chemistry, Measurement Science, Instrumentation
期	Volume 89, Number 1
文章类型	Regular Papers
页	169-174
DOI	10.1007/s10973-006-7561-y
Subject Group	化学和材料科学
在线日期	2006年8月16日

PDF (196.0 KB) First Page Preview

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摘要

Abstract An industrial raw material taken from Sivrihisar (Eskişehir, Turkey) region was heat-treated at different temperatures in the range of 100 – 1000 C for 2 h. The volumetric percentage of the particles having a diameter below 2 μm after staying in an aqueous suspension of the material was determined as 67% by the particle size distribution analysis. The mineralogical composition of the material was obtained as mass% of 32% palygorskite, 10% metahalloysite, 35% magnesite, 20% dolomite and 3% interparticle water by using the acid treatment, X-ray diffraction and thermal analysis (TG, DTA) data. The temperature ranges were determined for the endothermic dehydrations for the interparticle water as 25 – 140 C, for the zeolitic water as 140 – 320 C, and for the bound water as 320 – 480 C, in the palygorskite. The temperature range for the endothermic dehydroxylation and exothermic recrystalization of the palygorskite is 780 – 840 C. The temperature range for the endothermic dehydroxylation of the metahalloysite and calcinations of magnesite are coincided at 480 – 600 C. Dolomite calcined in the temperature range of 600 – 1000 C by two steps. The zig-zag changes in the specific surface area ($S/m^2\ g^{-1}$) and specific micro and mesopore volume ($V/cm^3\ g^{-1}$) as the temperature increases were discussed according to the dehydrations in the palygorkskite, dehydroxylation of palygorskite and metahalloysite, and calcinations in magnesite and dolomite.

Keywords

dehydration, dehydroxylation, metahalloysite, palygorskite, thermal analysis, XRD

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SOME THERMAL CHARACTERISTICS OF A MINERAL MIXTURE OF PALYGORSKITE, METAHALLOYSITE, MAGNESITE AND DOLOMITE

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An industrial raw material taken from Sivrihisar (Eskişehir, Turkey) region was heat-treated at different temperatures in the range of 100–1000°C for 2 h. The volumetric percentage of the particles having a diameter below 2 μm after staying in an aqueous suspension of the material was determined as 67% by the particle size distribution analysis. The mineralogical composition of the material was obtained as mass% of 32% palygorskite, 10% metahalloysite, 35% magnesite, 20% dolomite and 3% interparticle water by using the acid treatment, X-ray diffraction and thermal analysis (TG, DTA) data.

The temperature ranges were determined for the endothermic dehydrations for the interparticle water as 25–140°C, for the zeolitic water as 140–320°C, and for the bound water as 320–480°C, in the palygorskite. The temperature range for the endothermic dehydroxylation and exothermic recrystalization of the palygorskite is 780–840°C. The temperature range for the endothermic dehydroxylation of the metahalloysite and calcinations of magnesite are coincided at 480–600°C. Dolomite calcined in the temperature range of 600–1000°C by two steps. The zig-zag changes in the specific surface area ($S/m^2\ g^{-1}$) and specific micro and mesopore volume ($V/cm^3\ g^{-1}$) as the temperature increases were discussed according to the dehydrations in the palygorskite, dehydroxylation of palygorskite and metahalloysite, and calcinations in magnesite and dolomite.

Keywords: *dehdyration, dehydroxylation, metahalloysite, palygorskite, thermal analysis, XRD*

Indroduction

In general, an industrial raw material is a mixture of minerals [1]. The application areas of the raw material were determined according to their chemical and mineralogical compositions [2]. Monomineralic materials are seldom found in the nature [3]. Clays, used over hundred areas, are among the most important industrial raw materials [4–6]. Many clays are the mixture of the clay and nonclay minerals [7]. One or more clay and nonclay minerals can be found in any clay [8–11].

The clays with the major clay mineral palygorskite or sepiolite include generally carbonates such as magnesite ($MgCO_3$), calcite ($CaCO_3$) and dolomite ($MgCO_3$, $CaCO_3$) as nonclay minerals [12]. Fibrous and other types of clay minerals are seldom found together in the clays. For example, few clays contain palygorskite and metahalloysite together as fibrous and layer types of clay minerals, respectively.

Several structural models for palygorskite (attapulgite) have been discussed in [13–19]. The theoretical half unit-cell formula of palygorskite is given as $Si_8O_{20}Mg_5(OH)_2(OH_2)_4{\cdot}4H_2O$ [20]. Palygorskite is 2:1 type phyllosilicate and derived from talc-like tetrahedral-octahedral-tetrahedral (T–O–T) ribbons, expanded infinitely along the z-direction of the fibrous crystal, with a width of two pyroxene chains. The $8Si^{4+}$ and $5Mg^{2+}$ cations are located at the tetrahedral and octahedral positions of each ribbon. Some of the Mg^{2+} cations are replaced principally by Al^{3+} and Fe^{3+} cations. Palygorskite has di- or trioctahedral character depending on the divalent/trivalent cation ratio, distribution of cations, and occupancy of the octahedral sites [21, 22]. Two hydroxyls are bonded to the third Mg^{2+} among the $5Mg^{2+}$ cations of each palygorskite ribbon. The ribbons are connected to each other by Si–O–Si bridges by each four corners to form continuous tetrahedral sheets and discontinuous octahedral sheets. The discontinuity of the octahedral sheets allows to form of rectangular channel-like nanopores with the cross-section of 0.37·0.64 nm.

Four water molecules are bonded two per two to the first and the fifth Mg^{2+} cations at the both ends of each ribbon and located in nanochannels. These molecules are called bound (structural or crystal) water in palygorskite [23]. Furthermore, four water molecules per half-unit cell are located two per two with in the nanocahannels in the both side of each other ribbon. These water molecules in hydrogen bonded with bound water and each other are called zeolitic water. One water molecule per half-unit cell of palygorskite formed from two hydroxyls on the third Mg^{2+} cation

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1388–6150/$20.00

Akadémiai Kiadó, Budapest, Hungary
Springer, Dordrecht, The Netherlands