

ORIGINAL PAPER

Sequestration of supercritical CO₂ by mercury oxide^aKledi Xhaxhiu*, ^bErisa Saraçi, ^cKlaus Bente^aDepartment of Chemistry, Faculty of Natural Sciences, University of Tirana, Blv. Zog I, 1001 Tirana, Albania^bInstitute of Chemical Technology, Faculty of Chemistry and Mineralogy, University of Leipzig, Linnéstrasse 3, D-04103 Leipzig, Germany^cInstitute of Mineralogy, Crystallography and Materials Science, Faculty of Chemistry and Mineralogy, University of Leipzig, Scharnhorststrasse 20, D-04275 Leipzig, Germany

Received 2 August 2012; Revised 4 December 2012; Accepted 16 December 2012

HgCO₃ · 2HgO (mercury oxide carbonate), along with partly unreacted reactants, was obtained by exploring the behaviour of the Hg₂Cl₂/HgO binary system in supercritical CO₂ (scCO₂) at 200 °C, 22000 kPa in the presence and absence of water, using a self-made laboratory-scale system. The reaction of pure HgO with scCO₂ aimed at the synthesis of HgCO₃ (mercury carbonate), also yielded the same product. Meanwhile, with a small amount of water present in the Hg₂Cl₂/HgO–scCO₂ system, at 200 °C, 22000 kPa, the mineral terlinguaite (Hg₄O₂Cl₂) was obtained instead of mercury oxide carbonate. Repeating this reaction under the same conditions, but in the absence of CO₂, again resulted in the synthesis of terlinguaite, leading to the assumption that the scCO₂ had no influence on the synthesis of terlinguaite. This study reveals a new moisture-free laboratory method and conditions for the permanent fixation of CO₂ by HgO. This method bears two benefits: 1) it can be introduced to reduce the Hg content in flue gas and fly ash emitted from coal-burning power plants and municipal waste incinerators; 2) it can contribute to CO₂ mineralisation in montroydite (HgO) geological formations as mercury oxide carbonate.

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Keywords: CO₂ sequestration, supercritical state, mercury oxide carbonate, permanent fixation, terlinguaite, self-made laboratory-scale system

Introduction

Rapid industrialisation results in continuously increased CO₂ emissions in the atmosphere originating from coal-burning power plants, waste incinerators, etc. Besides this major pollutant, which increases concern regarding global warming, heavy metals such as mercury, arsenic, cadmium and many other highly mobile toxic pollutants (López Alonso et al., 2003; Vicente et al., 2012) are also emitted into the atmosphere with the flue gas. In addition, fly ash, as a major by-product of coal combustion, is partly reused in the construction industry (Siddique, 2010; Turgut, 2012) and largely deposited as industrial waste in landfills. Once such waste interacts with rain water, the heavy

metals are easily desorbed in water (Twardowska & Szczepanska, 2002) and dispersed by it, thereby representing a major source of environmental pollution (Sushil & Batra, 2006; Dellantonio et al., 2010). To minimise the increase in these pollutants, two immediate tasks arise: a) CO₂ capture and storage; b) immobilisation of heavy metals in the flue gas and fly ash by the respective carbonation. Many studies have reported attempts to achieve CO₂ capture and storage (Pacala & Socolow, 2004; Charles, 2009) and others are in progress. On the one hand, the process of CO₂ storage and mineralisation itself comprises its subsurface pressure injection, generally in supercritical state, directly into underground geological formations, i.e. rocks (Goff et al., 1997), in the form of mineral car-

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