INFLUENCE OF SN^{4+} IONS ON THE FORMATION OF CALCIUM SILICATE HYDRATES IN A 0.66CaO-SiO_2 -H_2O MIXTURE

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Air pollution is one of the main environmental challenges of the 21st century, and volatile organic compounds (VOCs) are among the most important contributors to this problem [1]. To control VOC emissions, various VOC abatement technologies are employed: destruction methods (catalytic and thermal oxidation) and recovery methods (adsorption, absorption, condensation, and membrane separation). According to the literature, catalytic oxidation is one of the most effective and economical approaches, allowing VOCs to be oxidized to CO_2 and H_2O [2]. However, this technology relies on noble metals (palladium, platinum) as catalysts, which increases its cost and reduces its widespread use. Thus, the development of new environmentally friendly and cost-effective catalysts is in great demand. Such catalysts can be calcium silicate hydrates with intercalated transition metal ions [3]. However, only limited data are available in the scientific literature on the synthesis, properties, and catalytic applications of calcium silicate hydrates with intercalated metal ions. Thus, this work aims to determine the formation sequence of calcium silicate hydrates in a 0.66CaO-SiO_2-Sn^{4+}-H_2O mixture under hydrothermal conditions.

In this work, calcium oxide (produced by calcining calcium carbonate at 950 °C for 2 h), amorphous silicon dioxide ($SiO_2 \cdot nH_2O$), and tin nitrate [$Sn(Cl)_4 \cdot 5H_2O$] were used as raw materials. Calcium oxide and silicon dioxide were mixed to reach a molar ratio of calcium oxide to silicon dioxide (CaO/SiO_2) equal to 0.66. Later, 2 g of the solid mixture was mixed with 20 mL of a tin nitrate solution (c_{Sn} = 5 g/L) to achieve a water-to-solid ratio of 10. It was calculated that 50 mg of Sn^{4+} ions were present per gram of the solid mixture in the resulting suspension. The obtained suspension was hydrothermally treated in PTFE vessels placed in a Parr Instrument autoclave for 0–72 h at 200 °C. The obtained products were characterized by various instrumental analytical methods (XRD, STA, FT-IR, AAS, etc.).

It was determined that Sn^{4+} ions strongly affected the formation of calcium silicate hydrates under hydrothermal conditions. At the beginning of synthesis (up to 16 h), semicrystalline calcium silicate hydrate [C-S-H(I)] and Z-phase [$Ca_9(Si_{16}O_{34}(OH)_{14})(H_2O)_8$] were the dominant phases in the undoped system. Longer synthesis duration (24 h) led to the formation of gyrolite [$Ca_8Si_{12}O_{30}(OH)_4 \cdot 7H_2O$], which remained stable up to 72 h. Meanwhile, Sn^{4+} ions prevented the formation of calcium silicate hydrates because burtite [$CaSn(OH)_6$] was the dominant phase under all investigated conditions. Traces of Z-phase were identified after 4 h of synthesis, while those of gyrolite were observed after 16 h. The analysis of the liquid medium showed that all tin ions were intercalated or formed new compounds after 72 h of synthesis.

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