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Master Thesis on Cement Recycling

"Thermodynamic Modelling of Belite Clinker Process"

Background:

In recent years, the usage of cement has increased significantly and therefore the CO_2 emissions related to the production of Ordinary Portland Cement (OPC) clinker. On the other hand, increasing large quantities of construction and demolition waste are generated every year by the construction sector. Continued attempts are being made to explore new technologies to increase the sustainability of the cement industry.

We, at the Institute for Technical Chemistry (ITC), are working on the chemical recycling of cementitious wastes, e.g. post demolition autoclaved aerated concrete or cementitious fines from crushing of waste concrete, by a new KIT process, which yields recycled cement (RC) clinker as a substitute for OPC clinker. The synthesis process is based on the formation of the clinker mineral belite Ca_2SiO_4 at temperatures below those of OPC clinker generation: 1000°C instead of 1450°C. This saves primary raw materials and reduces the total environmental impact of the building sector by reducing the cementitious waste disposal to landfills. In particular, the production of belite cement reduces energy demand as well as CO_2 emissions compared to OPC.

In order to optimize the conditions for belite clinker processing and comprehend their impact on the final product properties, it is crucial to investigate the main reactions calcination, and clinker formation in contact with melts which allow for rapid reaction through contact of the reactants. In this context, thermodynamic simulations can provide useful insight into the formation and stability of phases, as well as their transformations across a range of temperatures. Therefore, in this work, thermodynamic equilibrium simulations will be performed to improve our understanding of the process using FactSage.

Tasks:

The thesis work begins with conducting literature research and familiarization with FactSage. First, a good understanding of the belite process and software should be gained. As described above, the clinker formation takes place in contact with melts; Therefore, in this work, you will focus on identifying the parameters that have an impact on the melt formation. This is done by simulating the phase diagrams over a certain temperature range. You will begin with a simple system such as a binary system and then move on to complex systems, containing more than two components. The main aim of this work is to study how the addition of different components and changes in temperatures affect melt formation and finally compare it with experimental data.

Personal qualifications:

- Master's student in chemical/process engineering or similar disciplines
- Interest in interdisciplinary topics, research, and simulations

Language:	English and German
Start of work:	According to the arrangement
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