Contribution ID: **7** Type: **Poster Presentation**

Investigation of reaction rates during microbiologically induced calcium carbonate precipitation

Tuesday, 23 May 2023 10:30 (1h 30m)

With a share of about 8.6 % of anthropogenic CO2 emissions, concrete is a major contributor to global warming. Microbiologically induced calcium carbonate precipitation (MICP) offers the potential of a more sustainable alternative. During MICP calcium carbonate is formed by microbiological activity and can serve as a binder between mineral particles. This calcium carbonate can be an alternative binder to conventional cement mortar used for concrete. The most commonly used mechanism for MICP is ureolysis. In this process, urea is enzymatically degraded to ammonium and carbonate. In the presence of calcium ions and in an alkaline environment, calcium carbonate precipitates. Since the compressive strength after MICP is related to the amount of precipitated calcium carbonate, multiple cycles of treatment with cell suspension and calcination solution are necessary if high compressive strengths need to be achieved. It is therefore of interest to improve treatment times by obtaining knowledge of the reaction speed of ureolysis. Various studies have investigated the rate and kinetics of MICP regarding the concentration of cells, urea and calcium ions. However, only low concentrations of calcium ions (up to 500 mM) and cells (up to OD600 1) have been investigated so far. In order to obtain insight into the efficiency of MICP under conditions during the production of biocement, this study investigated MICP for calcium and urea concentrations up to 1391 and 1492 mM, and cell concentrations with an OD600 up to 10. It was shown that the rate of MICP continuously decreases with the addition of calcium ions. Furthermore, it could be observed that under these conditions the free calcium ions are degraded by formation of calcium carbonate within a few hours. During this time Sporosarcina pasteurii cells encapsulate in calcium carbonate while still maintaining ureolytic activity. Depending on the parameters reaction times under 3 hours were achieved which is significantly shorter than the reaction time of 24 hours often used in literature protocols for MICP treatment. Therefore, these findings make it possible to determine an optimum reaction time for the production of biocement depending on the cell concentration and the composition of the calcination solution used during MICP. Based on these results silica sands with different particle size distributions were treated with several injection methods under these optimised conditions. The resulting samples were scanned by micro computed tomography. Contact points and pore space depending on various parameters during the treatment of MICP were investigated. These findings can be used to further investigate if a reduced reaction time between cycles is applicable concerning compressive strength and homogeneity of the samples.

Participation

In-Person

References

MDPI Energies Student Poster Award

Yes, I would like to submit this presentation into the student poster award.

Country

Germany

Acceptance of the Terms & Conditions

Click here to agree

Primary author: Mr ERDMANN, Niklas (RPTU Kaiserslautern-Landau, Chair of Bioprocess Engineering)

Co-authors: Ms SCHAEFER, Susanne (Trier University of Applied Sciences, Department of Environmental Planning and Technology, Environmental Campus Birkenfeld); Mr BRÖCKEL, Ulrich (Trier University of Applied Sciences, Department of Environmental Planning and Technology, Environmental Campus Birkenfeld); Ms STRI-ETH, Dorina (RPTU Kaiserslautern-Landau, Chair of Bioprocess Engineering)

Presenter: Mr ERDMANN, Niklas (RPTU Kaiserslautern-Landau, Chair of Bioprocess Engineering)

Session Classification: Poster

Track Classification: (MS05) Biochemical processes and biofilms in porous media