INFLUENCING CARBONATE SCALING BY TAILORED DRAINAGE MATERIALS IN TUNNELS - AN EXPERIMENTAL APPROACH

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Unwanted calcium carbonate mineral deposits (scaling) in technical drainage systems result in high costs for cleaning and maintenance works for operators, in particular for large underground infrastructures like motor- and railway tunnels. Appropriate pre- and postdepositional measures for scaling reduction require a detailed knowledge on individual types and physicochemical reaction mechanisms of their formation at the precipitate–drainage substrate material interface. Therefore, the applied research project *PolyDrain (with contributions of the OeBB Infrastruktur AG, ASFINAG and BMVIT)* envisages an experimental approach developed to critically assess the crystal nucleation, growth behavior and textures of different $CaCO_3$ polymorphs and crystal shapes of precipitates on distinct plastic pipe surfaces, i.e. PVC, PE, PP and PE + various additives, designed as draining materials. The overall aim of the project is to evaluate and develop site-specific and tailored materials in terms of scaling reduction on surfaces exposed to tunnel waters (heterogeneous crystallization) and/or within the bulk solution (homogeneous crystallization in suspension), as well as to trigger precipitate textures with relatively soft consistency to ease cleaning.
The experimental laboratory setup allows to simulate scaling progress based on case-specifically adapted aqueous solution compositions interacting with the different surface materials at different temperatures, flow rates, etc.. The aqueous reaction solution – continuously generated by mixing of two stock solutions – is flowing (laminar) through a 2 m long pipe, where the hydrochemical evolution of the solution and related carbonate precipitates are monitored in-situ and by time-resolved sampling, various fluid- and solid-phase analytical techniques and modeling approaches.

Preliminary results show that the mineral precipitates consist of various forms of calcite and that there are significant differences in the nucleation (crystallite abundance and size) and overall amounts and even in the crystal shapes on the different plastics. This makes it possible to provide a ranking of the tested plastic materials with respect to carbonate scaling tendency. This classification indicates that common materials used in drainage systems (mainly PVC, PE and PP) are not suited as well as previously thought, whereas tailored plastics perform much better in the dynamic laboratory tests.