Faculty of Civil, Geo and Environmental Engineering
Chair of Urban Water Systems Engineering

Dissertation Fact Sheet

Detection and Analysis of Biogenic Sulfuric Acid Corrosion in Sludge Digesters

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Referees	-

Several billions of dollars are spent for the reparation and maintenance of sewage systems every year, whereupon the deterioration of concrete due to biogenic sulfuric acid corrosion (BSA) is one of the most serious problems. The corrosion is caused by the activity of sulfate reducing and sulfur/sulfide oxidizing bacteria (SRB and SOB, respectively). The aggressive sulfuric acid which is finally produced by aerobic SOB growing on the moist concrete surface leads to the degradation of concrete. While the corrosion process is well studied in sewer pipes, a lack of understanding exists concerning BSA in sludge digesters. The predominant anaerobic conditions in a digester would suggest no sulfuric acid production by SOB which need oxygen for growth. However, characteristic BSA damage patterns were also detected in different digesters in Germany (see Figure 1).

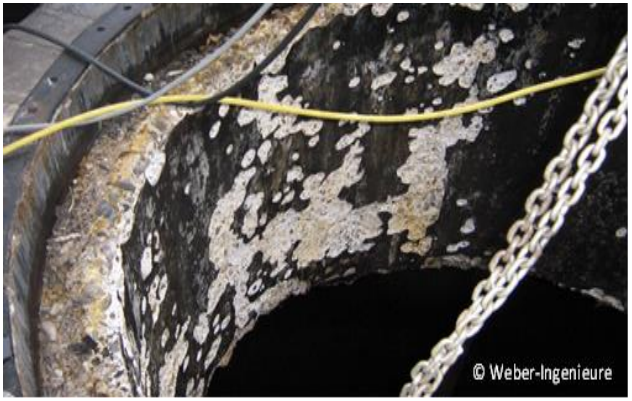

Figure 1. Concrete corrosion within a digester.

For that purpose the Bundesministerium für Wirtschaft und Energie (BMWi) granted a 3-year research project which is conducted in collaboration with "Weber-Ingenieure". The central theme of this project is to verify BSA in different full-scale digesters by identifying both SRB and SOB communities. Furthermore, the concrete corrosion potential shall be determined in specific simulation chambers inoculated with SRB and SOB and concrete specimens. As a result, quantified information shall be gained about the extent of damage so that further evaluations about the structure stability can be made.

For the analysis of the microbial communities, six different digesters showing corrosion damage regarding the occurrence of BSA were investigated (see Figure 1). SRB and SOB diversities were analyzed within digester sludge and biofilm/concrete samples, respectively, using polymerase-chain-reaction (PCR), denaturing gradient gel electrophoresis (DGGE) and sequence analysis.

DsrB gene based PCR-DGGE from the different sludges showed similar DGGE fingerprinting profiles demonstrating comparable SRB communities within the different digesters. Sequence analysis revealed the presence of various uncultured SRB (*Deltaproteobacteria*) indicating SRB activity and H_2S- production.

With SOB diversity studies six typical SOB species relevant for the BSA process could be detected: *Acidithiobacillus thiooxidans* (Figure 2), *Acidithiobacillus ferrooxidans*, *Thiomonas intermedia*, *Thiomonas perometabolis, Thiobacillus thiooparus,* and *Paracoccus* sp.

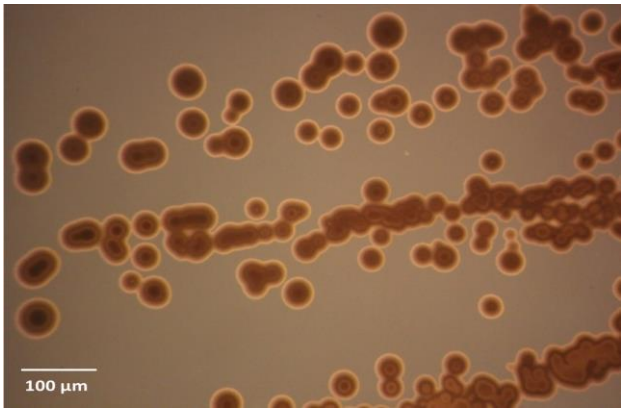

Figure 2. *A. thiooxidans* pure culture isolated from the concrete surface of a digester.

Finally, the identification of these bacteria demonstrates that BSA is not only a problem occurring in sewer pipes, but also in sludge digesters.

References

Huber, B., Drewes, J. E., Lin, K. C., König, R., & Müller, E. (2014). Revealing biogenic sulfuric acid corrosion in sludge digesters: detection of sulfur-oxidizing bacteria within full-scale digesters. *Water Science & Technology,* 70(8), 1405-14.

Huber, B., Drewes, J. E., König, R., & Müller, E. (2014). Diversity of Sulfur Oxidizing Bacteria involved in the Biogenic Sulfuric Acid Corrosion within Sludge Digesters in International Conference on Microbiology (VAAM), Dresden.