

PRACTICAL ASPECTS OF pH MODERATION, SOIL BUFFERING CAPACITY AND ENHANCED ANAEROBIC DECHLORINATION

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Both electron donor degradation and dechlorination of volatile organic compounds (VOCs) generate acidity during application of enhanced anaerobic dechlorination (EAD). Research has shown the inhibition of cis 1,2 Dichloroethene (cDCE) dechlorination by dehalococoides ethenogens (DE) occurs at a pH less than 6.0 to 6.1, therefore the design of an EAD system needs to account for maintenance of pH above this level. We believe that acidity generation, electron donor selection, soil buffering capacity, and pH adjustment are critical EAD design elements.

Dechlorination of tetrachloroethene (PCE) to cDCE will proceed at pH values in the 5-6 range, however, it is the dechlorination of cDCE (and ethene generation) by DE that is inhibited by low pH. Many microorganism can transform TCE and PCE (to cDCE), such as methanogenes, and sulfate reducers. These microorganisms have lower pH tolerance than DE.

Operation of an EAD system in low pH conditions causes the inhibition of DE and can lead to dechlorination being "stuck" at cDCE. In such cases the EAD process may appear to be working as PCE is being degraded, but cDCE is accumulating. The inhibition of DE at low pH is not well appreciated by many designers, however, and this is another way (in addition to lack of DE) to have the EAD process stall at cDCE degradation.

Electron donor selection in instances where the soil buffering capacity may be exceeded and developing sound pH moderation strategies becomes a critical design item. Our studies and experience indicates that sodium lactate generates the least acidity of all available electron donors since it is an organic acid salt. Complex electron donors such as molasses, whey and oils have multiple breakdown steps, each of which generates acidity. Even when using sodium lactate, sites with very high VOC concentration and low soil buffer capacities can require pH buffering. In the event that pH moderation is required, we have found that a combination of sodium bicarbonate, di-ammonium phosphate and sodium hydroxide can be used to maintain pH. Delivery and distribution of the pH buffers becomes an important design item which can be a more challenging task than electron donor distribution due to variable soil geochemistry. In such instances, use of large volume dilute additives for maximum distribution and active groundwater recirculation become more desirable than batch addition of electron donor solution under static groundwater flow conditions.

We have developed laboratory testing procedures for soil buffering capacity and employed a predictive design procedure for pH moderation for the past 3 years that will be discussed in the paper. We will also present several field and laboratory examples of the dramatic effects of pH moderation on EAD success.