Terra Systems pH Buffers and Buffer Capacity Test

Emulsified Vegetable Oil Substrates, lactate and other carbon substrates are added to the groundwater to rapidly generate reducing conditions and provide the necessary carbon and hydrogen to support native or introduced microorganisms (*Dehalococcoides*) for the biodegradation of chlorinated solvents such as tetrachloroethene (PCE) and trichloroethene (TCE) to innocuous end products including ethene and ethane. Often pH at a site is below optimal levels of 6.5 to 8.5 and a buffer needs to be added to the aquifer for complete dechlorination to occur.

Key Communication Points

1. A combination of laboratory and field studies has indicated that the optimal pH range for anaerobic bioremediation of chlorinated solvents is between 6.5 and 8.5.
2. Based upon laboratory studies at Terra Systems, between 76.4 to 99.1% of the buffer demands (average 93.3%) are associated with the soil phase rather than the groundwater phase.
3. Since the pH of just the groundwater is an unreliable determinant of the buffer demand, if possible, we strongly recommend that a saturated soil sample be collected and sent to Terra Systems Treatability Lab for a pH Buffer Capacity Test.
4. Terra Systems will recommend a buffer to counter the natural drop in pH due to the acids produced during the reductive dechlorination process and to optimize pH conditions at the site

Table I: pH Buffer Options

Buffer	Effective in pH Range	Benefit
pH Buff-Up	3.0-5.5	Liquid slurry, easy to mix, long-lasting
Sodium Bicarbonate Powder	5.0-6.0	Can't take the pH to high, maximum pH is 8.3. Inexpensive.
Calcium Carbonate Powder	4.0-6.0	Low solubility contributes to enhanced longevity. Inexpensive.
Sodium Carbonate Powder	4.0-6.0	Higher solubility but can take pH to high if overdosed. Inexpensive.
Magnesium Oxide or Magnesium Hydroxide Powder	3.0-5.0	Higher solubility but can take pH to high if overdosed. Moderately expensive.

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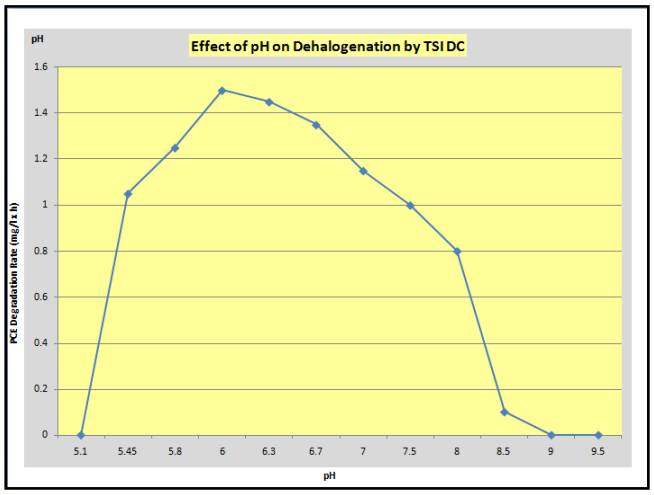
Terra Systems, Inc. (TSI) will conduct a test to determine the quantity of several potential amendments to neutralize the acidity of the groundwater at a potential bioremediation site. The objective of the evaluation is to select a buffering agent that can be added to increase the groundwater and soil pH and maintain neutral conditions needed for biological reductive dechlorination. The criteria for selecting the pH buffering agent are the following:



1. Increases the pH to between 7 and 9
2. Does not exceed pH 10
3. The lowest price (either the lowest cost per unit or lower price for a larger quantity)
4. Is relatively soluble or has fine particles that can be suspended in the chase water

The quantities of the following buffering agents necessary to increase and maintain a neutral pH at the site will be determined:

1. Sodium bicarbonate or baking soda
2. Calcium carbonate or crushed limestone
3. Sodium carbonate or soda ash
4. Magnesium oxide

Technical References for the benefits of optimizing pH for in-situ bioremediation.

Alexander, M. L., R. Cronce, and T. Battenhouse. 2011. Differential Adjustment of pH for Optimal Reductive Dechlorination Conditions. *A-65*, in: H.V. Rectanus and R. Sirabian (Chairs), *Bioremediation and Sustainable Environmental Technologies—2011*. International Symposium on Bioremediation and Sustainable Environmental Technologies (Reno, NV; June 27–30, 2011). ISBN 978-0-9819730-4-3, Battelle Memorial Institute, Columbus, OH.

Lee, M. D., E. Hauptmann, R. L. Raymond, D. Ochs, R. Lake, and M. Selover. 2010. Buffering Acidic Aquifers with Soluble Buffer to Promote Reductive Dechlorination. *F-031,* in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010.* Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). ISBN 978-0-9819730-2-9, Battelle Memorial Institute, Columbus, OH, **www.battelle.org/chlorcon**.

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