# Substrate Loading Strategies for Enhanced Reductive Dechlorination

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Adding organic substrates to enhance the anaerobic bioremediation of chlorinated solvents has become a widespread remedial option. The general goal of the process is to add sufficient substrate to establish and maintain anaerobic conditions conducive to reductive dechlorination for a period of time sufficient to degrade all constituents of concern and their daughter products. Common substrates used include molasses, lactates, vegetable oil, and solids like wood mulch or whey powder. At issue has always been how much substrate to use for any given site. Early designs were based on a stoichiometric ratio, or the theoretical amount of hydrogen available from the substrate compared to the theoretical amount of hydrogen need to chemically reduce the electron acceptors and the constituents of concern in the treatment zone. It was quickly realized that this method did not provide sufficient substrate to establish and maintain anaerobic conditions so minimal substrate loadings and "additional demand factors" and "safety factors" were added to the calculations. These corrections could represent more than 80% of the calculated mass of substrate required to treat an area.

In many cases where the competing electron acceptors or additional demand factors were high, the systems exhibited reduced microbial activity. The "more-is-better" approach didn't always help as many of these systems were determined to be negatively impacted by a drop in pH most likely due to an over-abundance of carbon. In theory, when a carbon substrate is fermented, a number of processes are set into motion that can reduce the pH of a system. Carbon substrates are metabolized resulting in the formation of various volatile fatty acids (VFA), hydrogen is produced through fermentation of VFAs, and when chlorine is removed from a chlorinated hydrocarbon through reductive dechlorination, free chlorine is released. All of these can impact pH, especially in a poorly buffered system and if the pH dropped enough to stress the dechlorinating microbial populations, the rate of contaminant degradation could be slowed or even stopped. In addition, reduced pH conditions along with a low reductive-oxidation-potential can result in the formation of errant byproducts such as acetone and butanone. One alternative method of determining the substrate "loading rates" is through a simple calculation of minimum and maximum concentrations of any specific substrate needed in a particular system based primarily on substrate dissolution rate and the minimum and maximum substrate mass required to establish and maintain optimal conditions, with contaminant and competing electron acceptor concentrations as secondary considerations. This presentation reviews the problem and compares the two approaches with both a readily soluble and a slow release substrate.