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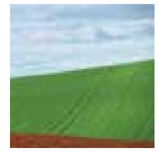
REMEDIATION



Phosphates Used For Remediation Efforts

INFORMATION

Every remediation approach has its own particular inherent advantages and disadvantages. A successful remediation project involves selection of a remedial approach that can maximize the advantages of a particular technology while minimizing the detrimental effects of the disadvantages. A major advantage of an INSITU chemox approach with permanganate is that the reaction with the contaminant proceeds to complete mineralization and there is no reaction stall or formation of daughter contaminant products. At completion of the reaction, the formation of stable manganese dioxide occurs. In most instances, this is a major benefit of utilizing this technology.

There are however certain situations where the formation of manganese dioxide can be problematic and hinder the remedial efforts. In tight soil formations with limited permeability, this mineralization may hamper the transmission of the remediation amendment through the treatment zone. A particular circumstance where this may occur is when working in fractured bedrock. These fractures are pathways that the remediation amendments travel in the subsurface. The formation of manganese dioxide can close off these pathways and reduce the efficacy of the remediation design.

One approach for controlling manganese precipitation is sequestering using a polyphosphate. Polyphosphate reactions work best under alkaline, higher pH, conditions. Less hydrolysis, or breakdown of polyphosphates, will occur under alkaline conditions. Polyphosphate chains are very stable by nature, but stability greatly depends upon the aquatic environment. Hydrolytic stability determines the length of a polyphosphate chain. All polyphosphate chains will reduce to a single phosphate molecule, termed poly-ortho reversion. Typically, under ideal conditions, hydrolysis is slow for polyphosphates. However, as pH decreases or temperature increases, a polyphosphate chain will begin to degrade faster.

The stability of manganese-polyphosphate bonds is superior to those of inorganic ligands. Therefore, the ability for other constituents to reverse the bonding of manganese and a polyphosphate would require a great deal of energy. In the case of a manganese-polyphosphate bond, the longer the phosphate chain the greater the sequestering capability of the polyphosphate due to coordination. The following figures show the relationship of manganese (II) to the three types of linear chain polyphosphates. As shown, triphosphate sequesters the most Mn+2 even though hexametaphosphate has six locations where bonds may form. Pyrophosphate, a two-chain phosphate, sequesters the least Mn+2.

As can be seen from the ideal reactions below, triphosphate requires 2 moles, but removes 5 moles of manganese. Pyro and hexametaphosphate require only one mole for sequestration, but remove less manganese.

$$2Mn^{+2} + 1P_2O_7^{-4} \rightarrow Mn_2(P_2O_7)$$
$$5Mn^{+2} + 2P_3O_{10}^{-5} \rightarrow Mn_5(P_3O_{10})_2$$
$$3Mn_{+2} + 1P_6O_{18}^{-6} \rightarrow Mn_3(P_6O_{18})$$

With detailed understanding of the treatment area and the subsurface characteristics, the design engineer can determine if the use of a polyphosphate would assist in the remedial efforts by chemically binding the Mn+2 and preventing the formation of manganese dioxide. The design of the project that included specific soil chemistry, contaminant concentration, remediation amendment concentration and feed rates will all be factors that need to be considered when determining how best to proceed with the project design. It would be sound procedure to perform bench scale testing to determine proper phosphate selection and ratio to which it is added to the treatment solution. A general ratio of 1 part polyphosphate to 5 parts of permanganate has been used in field work when using sodium hexametaphosphate.

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