

## H R C T E C H N I C A L B U L L E T I N H - 2 . 7 . 5

Hydrogen Release Compound **HRC**<sup>®</sup>**Chromium Remediation in Groundwater****General Background**

Chromium dissolved in groundwater occurs naturally in the environment as the Cr (VI) anion chromate ( $\text{CrO}_4^{2-}$ ) and various Cr (III) hydrolysis species [ $\text{Cr}(\text{OH})_2^+$ ,  $\text{Cr}(\text{OH})_3^0$  and  $\text{Cr}(\text{OH})_4^-$ ]. The predominant species depends on the pH/Eh of the environment. Chromate predominates at higher Ehs (>500mV at pH6 and >300mV at pH9). At lower Eh values, the Cr(III) species are present at higher concentration than chromate with the dominant species being dependent on pH. The dissolved chromium concentration in groundwater is strongly dependent on pH and Eh because Cr(VI) minerals are relatively soluble compared to Cr(III) minerals. Under oxidizing conditions where chromate is stable, total dissolved chromium concentrations can be much greater than 1 mg/L because of the high solubility of chromate minerals. Conversely, under more reducing conditions where Cr(III) species and minerals are stable, the total dissolved chromium concentration is typically much less than 1 mg/L because of the low solubility of Cr(III) minerals such as  $\text{Cr}(\text{OH})_3$  and  $(\text{Fe,Cr})(\text{OH})_3$ .

**Technical Approach**

As a consequence of the variable solubility of the chromium minerals, it is common that chromium contamination in groundwater at levels above 1 mg/L is caused by the presence of chromate. A chromium remediation method that has been shown to be effective is to reduce the chromate to Cr(III) and remove the chromium from groundwater by in situ precipitation of the low solubility Cr(III) minerals. When considering this strategy a question often arises as to the stability of the Cr(III) minerals in the environment and whether or not they will dissolve and release chromium to the groundwater after active remediation has ended. In many cases, the natural pH/Eh conditions of an aquifer favor the predominance of Cr(III) under equilibrium conditions, thus providing for a stable, irreversible reaction.

In natural unamended aquifer settings, the attainment of chromium redox equilibrium is slow. This means that even though Cr(III) should be the dominant redox species of chromium, contamination by Cr (VI) may linger in an aquifer because of the slow reduction to Cr(III). However, once the chromate has been reduced to Cr(III), either by the introduction of a reductant or allowing natural reductants present in the aquifer to have an effect, the precipitated Cr(III) minerals will not dissolve and recontaminate the aquifer.

**HRC Remediation**

Hydrogen Release Compound (HRC), when applied to chromium contaminated aquifers, provides the aforementioned reductant that drives the conversion of chrome (VI) to chrome (III), thus stimulating the rapid precipitation of the chrome complex. This is because, under the mediation of HRC and its breakdown products, the microbial population removes the oxygen, nitrate, sulfate and other competing electron acceptors. This, in turn, depresses the redox potential in the aquifer down to the appropriate negative zone where the conversion and precipitation are achieved.

It should also be noted that the slow release characteristics of HRC allow for the required reducing conditions to be maintained for a long period of time (up to 18 months) with a single application. This makes for a very cost effective aquifer treatment when compared to other remediation alternatives.

When considering the treatment of chromium contaminated aquifers, you should bear in mind that aquifer geochemistry plays a critical role in the success of any treatment. To ensure that the native aquifer conditions will allow for the formation of irreversible precipitates you are encouraged to supply Regensis' technical staff with basic site data on simple inorganic measures (common anions and cations) as well as basic physical parameters such as Eh, pH, temperature and DO. With data in hand, Regensis will be glad to analyze the site specific characteristics. If site characteristics are appropriate, Regensis will aid in the design of an HRC remediation application and will assist in the interpretation of field results at no charge.

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