ORC TECHNICAL BULLETIN #2.1.2

Oxygen Release Compound, ORC®

Source Treatment Applications - Tank Excavation

BACKGROUND

As the U.S./E.P.A. December 31, 1998 deadline approaches for UST upgrades we can expect an increasing number of tank pulls. Following a "tank pull", ORC applications become an economical soil clean-up option which work well with excavation operations. There are two main applications for ORC in this context:

1. The treatment of residual contaminated soils in tank excavation floor
2. Protection of clean fill from recontamination

In addition ORC can also be used in emergency response protocols and these will also be addressed in this Technical Bulletin.

ORC APPLICATIONS

1. The Treatment of Residual Contaminated Soils in Tank Excavation Floor

Application of ORC in the floor of an UST excavation can avoid spot contamination that desorbs enough material to continually contaminate the aquifer. ORC is cost effective in treating residual contamination in situ as an alternative to excavation, removal and treatment. In these applications ORC powder is physically mixed with contaminated soil in the excavation floor.

A specific case involving the treatment of residual contamination with ORC follows:

In this example, the elevated contamination levels have been excavated and hauled off. Soil samples are at or near required levels; however, small amounts of sorbed material may be present below the floor of the excavation. This is a problem with regard to uncontaminated groundwater that may rise into the contaminated soil zone, particularly during seasonal fluctuations.

EXAMPLE:

A tank pit excavation with dimensions of 40 feet X 40 feet where an additional 100 ppm of BTEX over the allowable levels is present. Using a backhoe, ORC is mixed into the upper 2 feet of the excavation floor. Background soil moisture of 3% will catalyze the release of oxygen.

Since residual contamination exists in concentrated areas, one can assume that during the physical mixing process a level of homogeneity is achieved. The ORC calculations, based on the amount of hydrocarbon that can be remediated using a 3:1 stoichiometry, are as follows:

1. Determine the cubic volume of soil and weight of soil being treated:

- 40 feet L x 40 feet W x 2 feet Depth = 3200 cubic feet
- 3200 cubic feet x 100 lbs/cubic foot = 320,000 lbs.

2. Calculate the ORC requirement based on an objective to reduce the soil contamination by 100 ppm. This might arise if the

levels are at 200 ppm and must be at 100 ppm for closure—the differential being 100 ppm.

- Soil weight = 320,000 lbs.
- 100 ppm = 32 lbs. of contamination in 320,000 lbs. of soil

3. Calculate the oxygen and ORC requirements knowing that ORC is 10% oxygen by weight and that there are 3 lbs. of oxygen required to remediate 1 lb. of hydrocarbon.

- 32 lbs. of contamination requires 96 lbs. of oxygen
- 960 lbs. of ORC are required to provide 96 lbs. of oxygen

Therefore to remediate the floor of the excavation by reducing the contamination 100 ppm the application requirement is 960 pounds of ORC, or .3% on a wt/wt. basis. The cost of 960 lbs. of ORC is $9,600 at $10.00 per pound. This is $81/cubic yard and may be comparable to excavation, treatment and removal charges - the cost of which can range from $75 to $120 per yard.

In addition, if the floor of the excavation is in the groundwater then excavation is more difficult and expensive. Furthermore, since benzene is recalcitrant under anaerobic conditions, acceptable rates of remediation where oxygen is not limiting via the use of ORC are an attractive proposition. Without adequate oxygen in the subsurface small desorbing residues can be an on-going source at actionable benzene levels.

2. <u>Preventing Clean Backfill from Recontamination</u>

Recontamination of clean backfill material is another problem for which ORC treatment is ideally suited. A typical example is contaminated groundwater rising into clean backfill generating a new smear zone that can recontaminate groundwater or raise marginal groundwater to actionable levels. This may be prevented by applying ORC as an amendment in the backfill.

EXAMPLE:

Mixing 0.15% ORC into clean backfill material as a preventative treatment, at half the cost of the previous example ($4,800), contaminated groundwater with elevated dissolved phase hydrocarbons can rise into the ORC amended backfill and be managed. In this example we will assume an ORC release profile of 180 days and assume that this is a period of time that groundwater can rise into the clean fill due to natural water table fluctuation cycles. We will also assume groundwater is moving at 1 foot per day. The ORC calculations are as follows.

1. 40 feet (plume width) x 1 foot (velocity) x 2 feet (depth) = 80 cubic feet
2. 80 cubic feet x 0.3 porosity x 28.3 liters/cubic foot = 679 liters/day
3. 48 pounds of 21.8 Kg of oxygen (from .15% wt./wt/ORC) is in the system; this is enough to remediate 7.3 Kg of hydrocarbons.
4. If this remediation occurs over 180 days then 40grams/day (7.3 kg/180 days) can be managed.
5. 40 grams = 40,000 mg/679 liters = 59 ppm per day for 180 days.
6. This is at the upper limit of what can be expected in the dissolved phase for BTEX; so if 59 ppm is treated by 0.15% ORC then 0.1% can handle 39 ppm and so on.

Therefore, each 0.1% of ORC on a 100 lb/cu. ft. soil weight basis costs about $26.00 per cubic yard and can remediate about 40 ppm of dissolved phase hydrocarbon moving through and rising into a filled excavation for 6 months.

<u>OTHER CONSIDERATIONS</u>

<u>Emergency Response to New Leaks</u>

Given that tanks are set on/in pea gravel, some of the ORC injection techniques can be brought to bear to fill the interstices with suspensions or slurries in the event of a spill. In the event of a spill, an agitated spray tank rig and "root feeder" device can be brought in and used to deliver dilute suspensions. This equipment is ubiquitous as it is an integral part of applying a wide variety of insoluble powders used in agriculture. Alternatively, the same solutions or thicker slurries can be applied with Geoprobe equipment when the above scenario proves inadequate due to soil type and depth.

Alternative to Direct Mixing of ORC Powder

For less instantaneous results that rely on advection, dispersion and diffusion of oxygen form a more concentrated ORC source, slurries can be injected using long-barreled "root feeder" devices. Also, the standard oxygen barrier sock product can be laid out in the excavation floor in the appropriate geometry.

Special Methods

Some companies are considering and employing pre-emptive measures that involve the advanced installation of an air sparging gallery. It is less costly to install an ORC system. The system involves installation of a series of 2 to 4 inch wells along the downgradient or upgradient edge of the tank area ready to receive ORC socks. The cost of gallery installation is minimized and slotted casing can be set into place at a fraction of the potential drilling cost. Finally, in the event of an emergency, ORC slurry can be injected to form a barrier at any point in the system.

Monitoring Results

Due to the heterogeneity of contaminated soil, it becomes problematic to judge efficacy of treatments with soil samples. The most effective way of approaching the problem is to monitor the downgradient dissolved phase hydrocarbon levels. One or more small-bore monitoring points, or a single standard monitoring well would be ideal for this task. Low cost BTEX immunoassay and Winkler oxygen titration kits are readily available for easy, low-cost and effective monitoring protocols.

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