SHORE PAC®

DISPOSAL OF SHORE PAC SLURRY - AN INTRODUCTION

INTRODUCTION

The use of synthetic polymer slurries as replacements for bentonite and other minerals has become widespread. Key attractions of polymer slurries have been their ease of use and low solids content, which has translated into reduced disposal difficulty for contractors.

CETCO SHORE PAC foundation drilling polymer can be used for cast-in, drilled-hole pilings and functions well in this role. The polymer is considered non-hazardous and non-toxic. It can often be disposed of on-site or with a minimum of post-use treatment. If SHORE PAC polymer slurry is to be disposed of on the jobsite, permission should be obtained from the owner and approval by any local regulatory authority first. CETCO will assist in providing toxicity characteristics and other environmental testing that has been conducted to help with SHORE PAC disposal approval

IS SHORE PAC TOXIC?

SHORE PAC is not toxic. SHORE PAC polymer slurry is classified as a PHPA or partially hydrolyzed polyacrylamide. This molecule is a co-polymer of non-ionic acrylamide with sections that have been chemically converted to become anionic-charged acrylates. There is essentially zero residual acrylamide monomer left after polymerization and the resulting long-chain polymer is quite safe. Similar co-polymers are used in landfill sealing, agriculture, and even cosmetics. SHORE PAC's chemical classification, or CAS number is listed in the U.S.A. EPA TSCA manual under code 25085-02-3. The SHORE PAC polymer type is identified as a non-toxic substance as defined by the U.S.A. Environmental Protection Agency. SHORE PAC is approved for use by The Federal Highway Administration, (FHWA), and has been approved for use throughout the U.S. and globally for decades.

IS SHORE PAC BIODEGRADABLE?

Synthetic polymers, like SHORE PAC are not readily biodegradable. Biodegradable materials are easily broken down by bacterial action in the environment and can be subject to spoilage quickly after mixing. Synthetic polymers like SHORE PAC are not subject to spoilage, which extends their useful life once mixed. Additionally, SHORE PAC slurries do not require use of toxic biocides like polysaccharides.

IS SHORE PAC ABLE TO BE BROKEN DOWN?

While not biodegradable, SHORE PAC slurries are chemically degradable. This means that the addition of a secondary chemical, typically an oxidizer, is necessary to break down the polymer chain. CETCO offers SLURRY BUSTER DRY for this purpose. At the end of the project there is usually a need to dispose of remaining polymer slurry. Shore Pac can be degraded by oxidation, reducing its viscosity to nearly that of water. The oxidation process literally chops the long polymer chains into small units that are too tiny to effectively viscosity water.

Upon completion of the project, any remaining polymer slurry is broken down with the chemical oxidizer SLURRY BUSTER DRY the most common oxidizer for this purpose. SLURRY BUSTER DRY is added to the waste polymer slurry then is pumped and circulated until the slurry is completely degraded. Higher temperatures and more aggressive shearing lead to faster breakdown. It can also be beneficial to decrease the pH down to a range between 5 and 7, thus significantly speeding up the reaction. Extreme care should be taken to guarantee that the pH does not drop below 4 as this can release significant quantities of deadly chlorine gas. For safer pH adjustment, CETCO DPA can be used as the acid source.

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If there is sufficient time, say perhaps overnight, then lower dosages of SLURRY BUSTER DRY can be used. For the purposes of environmental safety, this is often the ideal solution.

The SLURRY BUSTER DRY destroys the polymer chains, dramatically decreases viscosity, and reverts it back to a water-like consistency. The result of SHORE PAC polymer slurry decomposition via SLURRY BUSTER DRY, is water filled with a collection of very short, non-harmful polymer fragments and salts. These fragments are readily adsorbed onto soil surfaces or broken down to the point where bacteria can degrade them further. There will be no residual acrylamide monomer and any remaining free chlorine can be neutralized with addition of CETCO DE-CHLOR.

Oxidation is not the only pathway to removing the PHPA polymer chains. During use, some of the polymer will be lost via other means. The mechanisms leading to this can include adsorption (bonding) onto earth soils and chemical reactions with large organics, iron and divalent cations like calcium and magnesium. Additionally, the sun's rays can actually act as an oxidizer to degrade synthetic polymers in uncovered tanks. It is therefore recommended that polymer in open-top tanks be recharged periodically to maintain desired viscosity.

Finally, as with all ultra-high-molecular weight polymers, there will normally be a measured viscosity loss with hydration time. This will be most apparent in gravity cones like the Marsh funnel where tangled polymer chains can inhibit ideal flow through an orifice. While this overnight viscosity drop may be perceived to be polymer degradation, in truth, this viscosity loss is due to untangling of the long polymer chains as they pull in water and are pulled apart. This is not really breaking of polymer chains, but many users will see it as such. The shear produced by typical mixing is incapable of tearing apart long-chain, PHPA polymers like SHORE PAC and much of the viscosity loss we see is actually due to this untangling behavior.

Over long periods of time in the environment, chain degradation does occur, however. Testing done by the USDA has shown that Polyacrylamide (PAM) polymers will break down once released into the environment at a rate of roughly 10% per year. Much of this degradation is due to oxidative processes and the action of bacteria. The action of sunlight will photo-degrade PAM materials even more quickly than this rate, leading to free-radical-induced cleaving within as little as a day or two dependent on light intensity, temperature and the presence of other chemicals. Once cleaved into individual monomer units, the break-down proceeds quite quickly.

IS SHORE PAC POLYMER SLURRY DISPOSABLE?

Treated slurry fluids are environmentally safe when handled as directed. When breakdown is complete, all that remains are quantities of short acrylate-acrylamide chain fragments, sodium and chloride salts and water. In some instances, organics from the soil can be converted into low molecular-weight chlorine-containing products, which may be regulated locally. The SHORE PAC molecule itself does not convert this way. It is recommended that additions of DE-CHLOR be added to halt the chemical reactions in such cases where chlorinated compounds are regulated prior to discharge. It is also recommended that the lowest possible dosage of SLURRY BUSTER DRY be used and longer contact times be used (up to 48 hours). Typically, the resulting, oxidized product is sent down sewer drains (as allowed), but can also be solidified for landfill disposal, or simply spread on the ground to evaporate, or used in dust control.

WHERE ELSE ARE PHPAs USED?

Polymers with the same chemical make-up SHORE PAC are used in potable water treatment as secondary flocculants, with federal government clearance. Similar molecules are widely used throughout the world as coagulants for solid/liquid separation. PHPAs are used in paper manufacturing, wastewater treatment, mineral and oil extraction, soil conditioning and as thickeners in cosmetics. As such, they have many regulatory approvals around the world. Uses include such things as drinking water treatment, indirect additives for food-contact paper, and for agricultural soil conditioning. Municipal sewage sludge, which has been polymer-treated for de- watering, is widely applied to agricultural land. When crosslinked, PHPAs are even used in baby diapers.

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TECHNICAL NOTE 3.14.11

HYPOCHLORITE REACTIONS

Upon addition to water, calcium hypochlorite ionizes into calcium bicarbonate and hypochlorous acid:

$$Ca(OCl)_{2(s)} + 2\ H2O_{(l)} + 2CO_{2(g)} \rightarrow Ca(HCO_3)_{2(s)} + 2\ HClO_{(aq)}$$

In water, sodium hypochlorite is ionized into sodium ions and hypochlorite ions:

$$NaOCl_{(aq)} \rightarrow Na + OCl-$$

In acidic media, the hypochlorite ion (OCl-) will be in equilibrium with hydrochlorous acid:

$$H^+ + OCl- << >> HOCl$$

FREE RADICAL GENERATION

HClO (hypochlorous acid) can react with hypochlorite ions to form a peroxide radical (●OH) and a hypochlorite radical (●ClO) is a series of steps shown below:[iii]

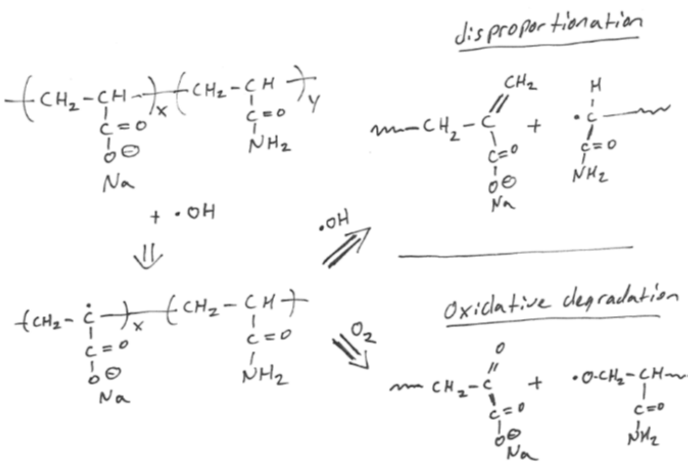
$$HOCl + OCl^- \rightarrow {}^\bullet ClO + Cl^- + {}^\bullet OH$$

$${}^\bullet OH + OCl^- \rightarrow {}^\bullet ClO + OH^-$$

$${}^\bullet ClO + OCl^- + OH^- \rightarrow 2Cl^- + O_2 + {}^\bullet OH$$

POLYMER ATTACK

The peroxide radical is suspected to attack the polymer backbone leading to chain scission, also known as beta scission. The pathway to chain scission is depicted below starting with a hydrogen atom abstraction from the polymer chain. Cleavage of this backbone leads to smaller segments of polymer chain.[i]



HYPOCHLORITE CONSUMPTION

As expected, during this reaction, only a portion of the hypochlorite is consumed. However, testing with anionic polyacrylamide-polyacrylate copolymers (12-16 Mil MW and 30% anionic) suggests that only about 4% to 12% is so consumed. This leaves a significant amount left in solution post treatment. This excess hypochlorite can naturally react with organic soil matter[ii] and/or sunlight[i] leading to decreasing levels over time. It reacts with metals to produce metal oxides and hydroxides. It is recommended that sodium thiosulfate (CETCO DE-CHLOR) be used after treatment in order to neutralize any residual hypochlorite which may negatively affect the surrounding environment.

i Cheng, Peiyao, "Chemical and photolytic degradation of polyacrylamides used in potable water treatment" (2004). Theses and Dissertations, Paper 993. http://scholarcommons.usf.edu/etd/993

ii http://www.water-research.net/watertreatment/chlorination.htm

iii I.Wienk; E. Meuleman; Z. Borneman; Th. van den Boomgaard; C. Smolders; J. Polym Sci.A. 33 (15), 1995, 49-54