[PRM] PhosphoReduc Media
FACT SHEET

As new stormwater regulations push MS4's toward more strict TMDL compliance, removal of critical pollutants such as Phosphorus will become a more important component of watershed planning. However, cost-effective means of meeting these TMDL requirements has not been readily available.

PhosphoReduc patented technology based on modified steel slag aggregates [PhosphoReduc Media] has been developed in the USA (Drizo and Picard, 2010). It has been proven to effectively reduce P, pathogens, suspended solids, and metals from a variety of wastewater and runoff sources in over 40 pilot/demonstration projects across 4 continents. Commercial applications include treatment of wastewater effluents, agricultural waste streams (ranging from highly concentrated dairy effluents, silage runoff to agricultural tile drains having P concentrations <1 mg/L), residential septic systems effluents and urban stormwater runoff. In September 2013, PhosphoReduc system became the first interim conservation practice for phosphorus reduction from agricultural subsurface and surface flows (USDA NRCS Conservation Practice Standard 782, 2013). In March 2014, Phosphorus Removal Standard 782 has been included as the USDA/NRCS conservation practice to achieve Phosphorus TMDL in Lake Champlain, Vermont (VT ANR, 2014)

PhosphoReduc Media [PRM] has a long treatment lifespan, handles a large diversity of P concentrations, and efficiently reduces P from various flow rates, with minimal land requirement, and is easily combined with existing drainage and treatment systems. In addition to providing a solution to phosphorus pollution, PRM can be recycled at its end of life as a pollutant removal tool, to be used as a phosphorus rich soil amendment for acid mine reclamation, forestry, horticulture and landscaping.

Over the past few years, PR has received numerous state approvals as well as international permits for technology applications in Canada, Taiwan and Brazil.

Convergent Water Technologies is a Houston, Texas, based company with an exclusive license to use the patented PhosphoReduc filtration media [PRM] to enhance phosphorus reduction in products designed and used to remove pollutants from stormwater runoff, including "green" and "grey" infrastructure systems.

PhosphoReduc Media

PhosphoReduc Media [PRM] is a modified Steel Slag Aggregate, which is an industrial by-product of the steel manufacturing industry. During the manufacturing process, iron-ore and steel scrap is melted in a furnace where the intense heat produced by carbon electrodes melts the scrap and converts it into molten steel. Once the molten material is cooled, it solidifies, the metallic component is removed and fed back into the steel mill and the non-metallic component is crushed to form Steel Slag Aggregates. PRM is sourced from pre-selected producers on a regional basis, providing close proximity to local projects, under strict quality control provided by the technology inventors.

The most effective P removal materials are efficient in both adsorption and precipitation. PRM is rich in Fe and calcium oxides, which plays an important role in P retention by soils and sediments. Fe salts

addition is also the most common method for P removal on conventional wastewater treatment plants. Phosphate ions react with Fe oxides by ligand exchange forming inner-sphere complexes. Ca facilitates P retention via precipitation and formation of Ca-P deposition on the solids surfaces. PRM is proven effective of specific P adsorption onto metal hydroxides (Fe-P precipitation and formation of the Fe(II) mineral vivianite and calcium phosphate precipitations of hydroxyapatite and bacterial uptake at specific hydraulic retention times [HRT]. At higher HRTs PRM may generate effluent with an elevated pH. EPA requirements for discharges of wastewater effluents are < 8.5. Therefore PhosphoReduc has developed a pH media consisting of a mix of organic materials to achieve efficient P removal while maintaining the effluent pH at neutral levels, if needed in specific applications.

The P removal capacity of a material is an important parameter for practical applications as it enables designers to determine the size and longevity of a system. PRM has the highest phosphorus retention capacity compared to other materials used in commercial products. In addition, the physico-chemical properties the media provide the ability to rejuvenate its P retention capacity during dry cycles prolonging life expectancy, and thus further increasing cost efficiency and making it ideal for stormwater applications. PhosphoReduc systems are typically designed to have a lifespan of up to 20 years before the filtration media reaches its P removal capacity. In larger systems a portion of the media may need to be replaced every 7-10 years. High absorption capacity and P retention rejuvenation result in smaller footprint and longer life expectancy.

Leachate

The three types of steel slag materials that were most thoroughly investigated for their potential to remove P from wastewater in the laboratory settings across the world are blast furnace [BF], iron melter slag [IMS], and electric arc furnace [EAF]. Each of these materials has unique physico-chemical and mineralogical properties that are dependent on their production processes. Iron melter slag is uniquely produced in NZ and has significantly lower P retention capacity compared to other steel slag aggregate types (Drizo et al, 2008). While steel slag aggregates have been used as the agricultural fertilizers instead of lime since 1918 (New York Times, 1918; White, 1928), and are regularly used as a base material in roads building, few laboratory research studies have shown that some steel slag aggregates may generate harmful leachate such as Chromium and other heavy metals. However, PhosphoReduc technology co-inventor spent over 10 years researching and screening steel slag aggregates across 4 continents; during this long-term research PhosphoReduc performed strict quality control of the aggregates in the variety of field applications, has selected producers across the USA and abroad and obtained beneficial use determination for material use for P filtration from several states. Therefore PRM does not desorb phosphorus nor leach any metals and is not detrimental to the environment or human health. Moreover, PhosphoReduc has also demonstrated that spent filtration media from their products can be re-used as P rich soil amendment instead of chemical fertilizers, creating a new generation of sustainable, green P fertilizers.

Implementation Options

PRM can be utilized in a wide variety of implementations, including as an add-on element for high performance modular bioretention systems, as a blanket over traditional bioretention systems, as a replacement for storage aggregate under advanced permeable pavement systems, as a component of

inlet based treatment systems, and as an element of an in-line pipe-based system for retrofit or new construction, among others.

This system can function efficiently (reducing P at about 75-90%) at Total Suspended Solid concentrations as high as 100 mg/L, is easily installed, has minimal land requirements, can flexibly reduce P efficiently from various flow rates, and can achieve high TSS (70-90%) and P removal at both high and low concentration influents.

Example Projects: Agricultural and Urban Runoff Treatment

2007-2008

NPP Agricultural Runoff Treatment, Grand Isles, VT
Filter Volume ~3.64 m^3
TSS removal 65-95%
DPR mass reduction 50%

Industrial Park Runoff, St Albans Bay, VT
Filter Volume ~0.14 m^3
DPR mass reduction 65%
Metals & TP reduction 70%

Agricultural Tile Drainage Runoff Treatment, St Albans Bay, VT
Filter Volume ~ 0.04 m^3
DRP mass reduction ~67%
TP & Metals reduction ~ 73%

Stormwater Outflow , St Albans, VT
Filter Volume ~ 0.22 m^3
DRP mass reduction ~ 71.5%
TP & metals reduction ~ 70%

2008

Stormwater Retention Pond Retrofit, Loudon County, VA
Two PhosphoReduc Filters laid out in series, 2,000 SF area each, were installed in January 2008 as a retrofit to existing retention pond with the aim to reduce Phosphorus from combined agricultural, industrial and urban stormwater runoff.

2010

Agricultural Tile Drainage Runoff Treatment
Nordic Farms, Charlotte VT
Filter Volume ~ 0.40 m^3
DRP mass reduction ~ 81.5%
TP & metals reduction ~ 75%

2011

Silage Runoff Treatment, Adison County, VT
Filter volume ~ 4 m^3
DRP mass reduction ~ 90%
TP & metals reduction ~ 75%
Pathogens reduction ~ 90%
TSS Reduction ~ 75%

Golf Course Runoff Treatment, Columbus, OH
Filter volume ~ 0.002 m^3
DRP reduction ~ 84.7%
TP reduction ~ 80.3%
TSS Reduction ~ 74.4%

2012

Urban Stormwater Runoff Treatment, Hardwick, VT
PhosphoReduc Bioretention System
Results will be available in 3-4 weeks.

2013

Sewage and Urban Runoff Treatment, Vitoria, Brazil
Filter volume ~ 22 m^3
DRP mass reduction ~ 99%
TP mass reduction ~ 99%
Pathogens reduction ~ 98%
TSS mass Reduction ~ 90%

Agricultural Tile Drainage OH
Currently being monitored.

Please view PhosphoReduc website for more information on current project case studies.

Beneficial Re-Use

PhosphoReduc Technology provides phosphorus harvesting from a variety of wastewaters and stormwater runoff. PhosphoReduc Filtration Media captures phosphorus over time and converts it to CA-P and Fe-P forms that are available for vegetation uptake (Bird and Drizo, 2009). Similar to other P retention products, PRM's P retention capacity decreases over time and the media will need to be replaced (once every 5-10 years depending on the site specific characteristics). The spent PRM will be very rich in P, thus providing phosphorus recycling from wastewater and stormwater runoff through creation of phosphorus rich products that can be used as soil amendments instead of chemical fertilizer. Phosphorus harvesting, recycling and re-use is particularly important given increasing concern over world P reserves decline and its potential impacts on food prices and food security. By using recyclable industrial by-product as a phosphorus filtration media PhosphoReduc has created an exceptional sustainable green product that transforms industrial waste product into cutting edge clean water technology and provider of the new generation of green P fertilizers.

Bios

PhosphoReduc, LLC, CEO, and technology co-inventor, Dr. Aleksandra Drizo, is one of 3 world pioneers who established the research field on phosphorus removal by an industrial by-product material and is recognized worldwide as a leader in innovative phosphorus removal technologies. For the past 20 years, Dr. Drizo's research and expertise has been in sustainable water resources management, research, development, implementation and assessment of innovative technologies for water pollution treatment, prevention and control.

She is an author of 40 peer reviewed publications, has given over 80 presentations and lectures at various regional, national and international conferences, and taught classes to undergraduate and graduate students across several continents on phosphorus removal measures to mitigate eutrophication and harmful algae blooms.

A 20 year career building cutting-edge technology companies prepared Convergent President, Robert Adair, to see the stormwater industry, and its myriad of challenges in a non-traditional light. Building on that perspective, his Texas-focused firm, Construction EcoServices, has been a driving force for the implementation of new ideas, new technologies, across the state of Texas since 2002.

Robert also led the formation of the Houston Land/Water Sustainability Forum in 2007. The HLWSF is largely responsible for the rapid adoption, adaptation and implementation of Low Impact Development (LID) in Texas and has achieved national recognition for its unique, market-driven approach to driving change, from the USEPA and Water Environment Foundation among others. It's techniques are being replicated in communities across the country.

Founded in 2010, Convergent Water Technologies, Inc., is a nationally-oriented company focused on breaking down the barriers to innovation and the successful, cost-effective and widespread implementation of LID and Green Infrastructure. Convergent is enabling innovators to get new ideas to market through a national network of Value-Added Resellers operating on a solutions-oriented approach to delivering them, and insuring that the systems and products delivered drive down the costs while raising the bar on performance, maintainability and vendor commitment to the product lifecycle.

References

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