



Remove Soluble Phosphorus Drain Tile & Field Runoff

Blue-Green Algae blooms represent a nuisance that forms in water when excess nutrients exist. It is accelerated by warmer temperatures and has become prevalent in lakes and water bodies throughout the world as phosphorus has accumulated. A common control treatment approach is to lower a key nutrient, such as phosphorus and nitrogen coming into the water body, allowing reducing excess nutrients. Phosphorus is a nutrient required for humans, animals and plants but it also accumulates and leads to harmful algae blooms that degrade water quality. It is becoming highly regulated in the U.S. and Europe. Phosphorus is a key component in modern fertilizers, is used in most food & beverages and is added to water for corrosion control.

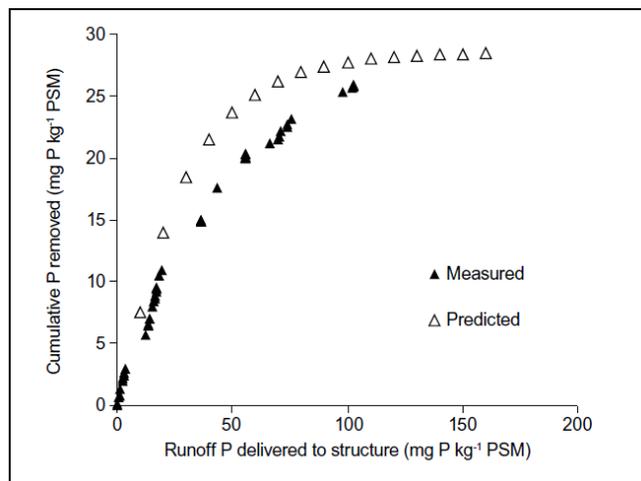
MetaMateria offers a unique product **for absorption of phosphorus (PO4 Sponge)** that uses nanotechnology to provide more absorption of phosphorus than other materials. Capacity to absorb P is overwhelmingly higher than other natural and manufactured products. Phosphorus can be removed and PO4 sponge reused multiple times. Phosphate ions can be recovered. Shapes can be made for many applications that can remove significantly more P than slag.

Sorption Media	mg-P/Kg
PO4 Sponge - Meta	
High > 5mg/L	80,000
Low < 2 mg/L	25,000
Iron Ore (Hematite)	1,430
Iron Slag	420
Crushed Red Bricks	510
LECA (expanded clay)	800
Activated Fe Alumina	17,100
Filtra-D	2,500
Phostec	7,000

PO4 sponge removes soluble phosphorus at both high and low concentrations, so it can be effective for treating waste water or lower levels found in lakes, streams and agriculture water runoff. P can be lowered below 0.09 mg/L (ppm), making it ideal for many applications.

Significant attention is being given to lowering SRP (soluble reactive phosphorus) in agricultural drainage ditches. Both laboratory and field trials have shown that beds of iron/steel slags can be used to reduce P from runoff water. Calcium based materials are also considered for this application. While these materials are relatively inexpensive, considerable quantities are needed to remove 50% or more of the soluble P in the water. Also, some concern exists as to long term contamination due to leaching of metals and other hazardous compounds (e.g. chrome); consequently alternatives are desired where water enters environmentally sensitive areas.

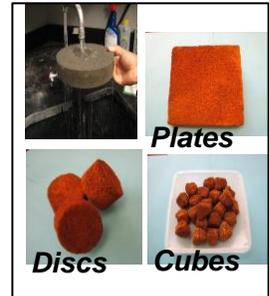
Slag contains iron and sometimes calcium which are P-sorbing materials. A bed of some 3 tons of sieved slag (below) was placed in a structure at a depth of 8-9 inches. Water containing SRP was run through the bed of slag for 5 months with an average retention time of 19 min. The slag bed removed about 25% of incoming P. The graph at the right shows both the measured and predicted curves for the cumulative removal of SRP.



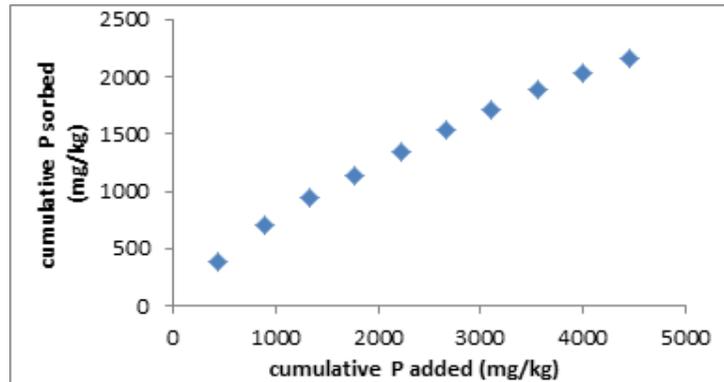
Phosphorus Remediation; USGA Green Section Record, Vol 50 (10), 5/11/2012; C Penn, G Bell, J Warren, J McGrath

PO4 Sponge is a manufactured absorbent in different shapes that can absorb more SRP and do it more quickly; thereby significantly reducing the size of the P-removal system and quantity of adsorbent needed. It has been shown to adsorb much more SRP than other manufactured sorbent products. Further, if installation is designed properly, PO4 Sponge can be regenerated and reused multiple times.

Dr. Chad Penn, who conducted the slag sorption study reported above, has established a laboratory test to predict P sorption, similar to the graph shown above.



Dr. Penn tested our PO4 Sponge and found results to be impressive, as can be seen in the curve shown here. Compared with the slag curve shown above, the cumulative P sorbed is significantly higher and the product was still absorbing after 4500 mg/Kg of P was added. In the graph shown previously, sorption peaked out after 125 mg/Kg. This indicates PO4 Sponge should sorb over 40 times the amount of P removed by the steel slag, thus much less material will be required.



While PO4 sponge is more expensive, it can be regenerated and reused multiple times and likely will remove a higher percentage of incoming P than slag for a longer time.

MetaMateria believes that properly designed structures using PO4 Sponge will be a very effective sorbent for removing SRP from farm runoff water and for other applications and it will economically compare with lower capacity products. Testing is needed to properly demonstrate the potential offered by the PO4 Sponge in field runoff applications.

In summary, PO4 Sponge media offers the following Unique Capabilities

- **Holds much more phosphorus** than other products
- **Effective at both high and low concentrations**
- **Can be reused multiple times** to remove many more grams of Phosphorus
- **Long Life & Cost Effective exists** for most removal applications
- **P can be Recovered from Regenerated Liquids** in usable forms
- **Flexible Shapes & Sizes** for most applications
- **Water Passes thru Product** at low pressures
- **pH Remains Stable** for good process control

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