Managing Phosphorus Export from Golf Courses Using Industrial Byproducts as Filter Materials

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Objectives:

This project will investigate the ability of industrial byproducts, namely steel slag, activated carbon, and biochar, to remove excess P in golf course effluent. Various blends of the byproducts and filter casing designs will be investigated to determine optimal conditions for P removal.

Start Date: 2011
Project Duration: 2 years
Total Funding: $20,000

Golf courses, and in particular the tees, fairways, and putting greens, are vulnerable to loss of phosphorus (P) as dissolved reactive P (DRP) through sandy, porous grass rooting media and subsurface tile drainage. Excess levels of phosphorus in surface waters promotes eutrophication, which, in turn, can have significant ecological, commercial, and public health ramifications for affected waterbodies .

In the past 25 years, sorption and precipitation of dissolved P using industrial byproducts and natural materials has received considerable attention. In the current study, we used steel slag as the primary P filter after trials runs with different blends of industrial byproducts proved it to be the most effect at capturing dissolved P.

A 30.5-cm (12-inch) subsurface pipe with flow control structure was installed to route irrigation reservoir water at the western edge of the course through two, 200-cm (78.7 in) long, 10.2-cm diameter corrugated black tiles. Each tile was filled with 28.5 kg of steel slag that was previously removed of fines with a U.S. Standard Mesh #16, 18 mm sieve. The pore volume of the material was 6.5 L. Flow into the tiles from the 30.5 cm pipe was regulated using in-line, adjustable, gated valves.

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Flow through the tiles was recorded at the outlet of each tile using Thel-mar compound v-notch weirs in conjunction with Isco flow meters. Water samples to be analyzed for DRP were collected prior to filter interaction and 1 – 30 seconds post filter depending upon flow rate. Both continuous flow and storm-simulated samples were collected. Continuous flow samples were 1-2 times a week for a 7 week period. Two 4 hr storm simulations each were conducted within the 7 week period.

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Summary Points

- Of all the samples processed, approximately 93% of samples had DRP concentrations greater than or equal the 0.03 mg/L DRP threshold known to promote eutrophication.
- Average DRP reduction across all continuous and storm-simulated conditions was 56.4% ± 5.1%. For continuous flow samples, which averaged a flow-rate of 0.012 L/second mean reduction in incoming DRP was 79.6% ± 21.6%. The large variation in the mean value is a consequence of the slag's decreasing ability to remove DRP over time because of the occupation of DRP sorption/precipitation sites.
- The two storm simulations averaged a flow of 0.74 L/s and a mean reduction in DRP by 51.5% ± 3.3%. While DRP reduction for the storm simulation appears to have remained constant, it is also expected to decrease with time.
- For both continuous flow and storm events, pH and electrical conductivity of the slag filtered effluent did not differ significantly from the pre-filter samples. In contrast, it appears that the slag reduced the total suspended solids (TSS).