Just How Renewable Is It?

The Sustainability of Peat as a Water Remediation Media

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So what is peat, anyway?

Peat is partially decomposed plant matter. In general, peat is found in water-saturated areas where vegetative decay is hindered by climate and lack of oxygen. Over long periods of time, the plant matter accumulates to form a deposit. Although peat can be found world-wide, those deposits cover vast areas of the northern hemisphere and have historically been viewed as valuable natural resources.

There are two major types of peat: *Sphagnum* and reed-sedge. The names reflect the parent plant material that makes up the peat. *Sphagnum* is the most common type of peat and is sold under various names including peat moss and *Sphagnum* moss. It is largely sold into the horticultural market as a soil amendment and can be found in nearly every home improvement outlet. Besides its horticultural value, *Sphagnum* peat is a known sorbent for hydrocarbons such as oil and has been successfully used in various oil clean-up applications.

Reed-sedge peat is less well known. Reed-sedge peat does not attract and hold oil. Rather, its natural, unique chemistry results in an affinity for dissolved heavy metals. Heavy metals include chromium, manganese, cobalt, nickel, copper, zinc, cadmium and lead. Those elements can be beneficial to living organisms, but in large doses, they are toxic. Many waste streams generated as a result of human activity contain harmful concentrations of heavy metals and require cleaning before re-use or discharge into the environment. Many people are familiar with the concept of wetlands as environmental cleaners of toxins, and much of that activity comes from reed-sedge peat and organic matter.

Since 2006, American Peat Technology (APT) has been producing a granular reed-sedge peat media for the removal of dissolved heavy metals from waste streams such as stormwater, acid mine drainage and industrial process water. The media, sold as APTsorb, harnesses the natural ability of wetlands to filter heavy metals, but unlike a wetland which requires an expansive footprint and is not a realistic option for many sites, APTsorb can be installed into conventional vessels such as contactor tanks or underground pre-cast vats.

Is peat a renewable resource?

At the heart of the debate about using peat is the question of whether or not peat is a renewable resource. Much of the industrialized world classifies peat as a non-renewable resource, although the Intergovernmental Panel on Climate Change in 2006 changed its classification of peat from a fossil fuel to a new and separate category between fossil and renewable fuels. The IPCC simply calls this new classification “peat”, which seems to be a recognition of the unique nature of the resource. Certainly peat is not the product of millions of years of formation like petroleum. Yet a deposit of peat requires more time to accumulate to maturity than, say, a hardwood forest.

The research is limited and varied about just how renewable peatlands are. Climate and latitude, plant species, regeneration techniques and hydrology all play critical roles in how quickly bare peatlands can be restored to net producers of peat. To complicate the issue, the role of peatlands –whether pristine, under production or revegetated – in carbon sequestration and greenhouse gas production is also dependent on many factors. This is not a question that is easily and quickly answered.

However, there are several elements in the discussion that require further clarification. First, the current discussions about peatlands generally start with the assumption that peat is an energy source. Once peat is being considered as a combustible fuel, the concerns about regeneration are understandable. Peat has a calorific value of about 15,000 kJ/kg. Compared to the calorific value of natural gas, which approaches 43,000kJ/kg, it requires an inordinately large amount of peat to replace fossil fuels. In that scenario, which requires the deforestation and harvest of enormous tracts of peatlands, we simply must ask the questions about sustainability. Additionally, the horticultural community has raised the issue of sustainability when discussing the use of peat or peat products such as Sphagnum moss. In that application, peat is a luxury commodity that can be replaced with far more renewable products.

Second, the discussions about peatland restoration generally assume that restoration is not complete or valuable until all the characteristics of the original tract are restored. The fact is, peatlands that have been cleared of vegetation but retain a base layer of peat can be valuable in many ways other than the production of peat. Their value for timber production and agriculture is generally not considered, but can have real impact on the surrounding environment and economy. Having said that, it is nonetheless possible to return a harvested peatland into a net producer of peat. What is in question is the length of time it takes to achieve that state. Estimates range from 5 to 100 years.

If the natural resource is taken as a whole, is peat renewable?

The data are varied and contradictory when considering the sustainability of peat harvest on a global scale. In northern Europe, where peat is used as a fuel, peat harvest and use appears to be exceeding accumulation. The picture is more encouraging in North America, where the peat resources are either harvested for horticultural use or used in situ as agricultural land, and accretion rates are almost certainly exceeding losses. It is difficult to accurately quantify accumulation of peat because the rates of deposition are variable from site to site and from year to year.

How much peat is APT using?

American Peat Technology is currently harvesting reed-sedge peat from a 160-acre site located about a mile from our processing plant in central Minnesota. The harvest site is part of an expansive bog that was tiled and drained in the 1920's and converted to

agricultural fields. The harvest of the deposit starts during the summer months when the top layer of peat is skimmed off and pushed into windrows. In winter, once the site has frozen and can support truck traffic, the windrows are loaded and transported to the processing plant.

At current production levels, the deposit contains enough peat for 300 years of production. As the demand for APTsorb grows, however, we obviously anticipate a reduction in that projection. As with all peat harvesting operators, we hold a permit from the U.S. Army Corps of Engineers. Our permit allows the harvest of peat to a depth of 84 inches and requires remediation of the site once our harvest operation is completed.

Until recently, the research regarding peat focused largely on the exploitation of the resource. Not surprisingly, there is not a wealth of information about how to restore a peatland to its original state. When the time to stop harvest on our existing site arrives, APT will use the best available technology to remediate the site. We have a reputation for cooperating with researchers and regulators, and we expect to maintain those connections through the restoration process.

How should the peat resource be used?

One of the factors to contemplate in the discussion about sustainability is the concept of best use. As mentioned above, peat is not ideal as an energy source. Fossil fuels and renewable sources are more favorable options when evaluating energy production compared to environmental cost. The worldwide concern about diminishing peat reserves is heating up, largely as a result of the climate change discussion, and the move to discourage peat as a fuel is gaining momentum in policy changes and public opinion. Simply stated, peat is too valuable to be used as a marginal source of energy.

Peatlands and the role they play in carbon sequestration and climate change is another subject to consider in the discussion about best use. The balance between carbon dioxide and methane, peatlands and increasing global temperature is complex, but the general consensus is that undisturbed peatlands act as carbon sinks. Certainly, peatlands that have their original hydrology intact are efficient filters of toxins, temper water fluctuations and provide wildlife habitat.

All these factors need to come into play as we continue the discussion about harvesting peat. Given that human impact on the planet is inevitable, conversations that debate the question of how to best use the natural resources around us in a sustainable, thoughtful way ultimately serve to benefit both us and the environment.

What are the options for water treatment?

When considering the technologies for remediation of water contaminated with heavy metals, the list is short. Obviously, the best solution is to avoid the problem altogether through management techniques that minimize contamination. Once metals escape the best management practices and make their way into water sources, however, the overlying concept is to transfer the contaminants from the aqueous stage to the solid stage. That can be achieved through chemical and non-chemical processes such as precipitation, flocculation, coagulation, flotation, ion exchange, adsorption and membrane filtration. These processes are often incomplete, expensive and replete with their own environmental liabilities. As with all technology, the balance sheet of advantages and drawbacks is unique for every situation.

Ion exchange and adsorption fall under a category of treatment called sorption. In sorption, individual ions of the metal of concern are transferred onto the solid surface of a media, thereby removing the metal from the water. There are many mechanisms of sorption, but one of the characteristics of sorption is the propensity to "polish", or remove even trace amounts of metal from water. Sorption is often used as a final step in treatment schemes to remove the last, minute fractions of contaminants. Especially in water where the contamination levels are initially very low, such as stormwater, sorption medias are the often the treatment of choice.

The sorption mechanism called ion exchange is the gold standard of sorption for a number of different reasons. Ion exchange resins are remarkably efficient at removing metals from water. They are relatively safe to use and handle. They can be regenerated once they are exhausted. Unfortunately, they are very expensive. Also, they are manufactured from petroleum products.

Ion exchange resin (L) and APTsorb (R)

The APTsorb media harnesses the many natural chemical mechanisms of reed-sedge peat, but all of those mechanisms are considered sorption. And like most sorption medias, APTsorb is efficient at polishing contaminated waste water of the last parts per billion of heavy metals. In that respect, APTsorb is a direct replacement for traditional resins.

Are there "greener" alternatives for water remediation?

There are other sustainable materials besides peat that use sorption for contamination remediation. Almost all organic material has some sort of capacity to sorb heavy metals, be it wood biomass, compost, soil or plants. Compost is of particular interest because of its decomposed nature. The processes of decomposition effect chemical changes on the surfaces of the organic substrate, creating additional sorption sites.

There are a number of substantial differences between peat and compost, however, which affect their performance against heavy metals. First, peat forms in anaerobic, acidic conditions over a long period of time. Composting is generally carried out in aerobic conditions at a more neutral pH and can be achieved in a matter of weeks. The chemistry in those environments is quite different and results in two distinct materials with different carbon-chain backbones, sorption mechanisms, and surface activities. Overall, peat is more effective against heavy metals because it is differently decomposed. While it is true that compost can approach the effectiveness of peat, it is unclear what composting conditions are necessary to consistently meet those performance standards. Research continues into using compost as a water remediation media, but it is a young science with many unresolved questions. Right now, the best use of compost is as a soil amendment, not as a sorption media.

Does peat compare to conventional water remediation?

Compared to the current technologies for water remediation, APTsorb ***is*** the environmentally-friendly alternative. APTsorb approaches the efficiency of petroleum-based resins with almost none of the environmental liabilities so prevalent in petroleum extraction and processing. The source of the parent material is, rightly so, becoming more and more a factor when making a decision about what type of remediation treatment to use. Beyond a doubt, peat is a resource that can be managed in a way to be renewable for those applications where it is the best use, such as water remediation.

Bench scale treatment column of APTsorb

Other water mediation technologies such as chemical precipitation or flocculation generally do not have the ability to clean water to the same degree as a sorption media. They can be very useful as first-stage treatments, but even then, their end products can result in large quantities of hazardous wastes and they often require substantial expenditures of energy. Treatment with APTsorb does not result in increased mass of waste, and can often be used in passive, gravity-fed systems that don't require outside energy sources.

It is possible that composted biomass may someday eliminate the need for peat harvest. In the meantime, though, relying on compost as a remediation media is resulting in the unnecessary release of dissolved metals into the environment. Simply stated, the body of knowledge about peat as a sorption media far exceeds that of compost. To continue to use compost despite its poor performance record is hardly a green solution.

Finally, peat has an advantage over conventional technologies that APT is only now starting to explore. With other technologies, the solid substrate that holds the metal of concern is generally a liability: it needs to be disposed of or regenerated. Peat, however, is a natural material that is beneficial on its own. Most people are familiar with the concept of peat as a soil amendment. Depending on what contaminants have been sorbed onto the surface, the used peat has potential as a slow-release fertilizer. Many heavy metals, in small amounts, are necessary for life and plant growth. Peat that is loaded with, say, copper, could potentially be spread on copper-deficient soils. Over time, as the organic material breaks down in the soil, the copper would become available to the growing plants. This is an idea that is only now being explored, but it is another possible benefit of using peat for pollution abatement.

Like a balance sheet, our accounting of the use of natural resources has pluses and minuses. Undisturbed land is a rare gem, but we need farmland to produce food. We all desire clean air, but we also need electricity to power our homes. No one wants to live by a strip mining operation, but we need steel to build the infrastructure of society.

Similarly, we need clean water, but the processes and technologies of an industrialized society seem to go hand-in-hand with water-borne pollutants. Certainly, the best solution for contamination is to eliminate it before it can happen. When despite our best efforts, we are faced with the need for water remediation, our recourse is to move on to the next balance sheet of comparing efficacy to cost. That cost includes environmental sacrifices as well as dollars and cents.

The plain and simple truth is that we need treatments to clean our waters once they become contaminated with heavy metals. The technologies for water remediation are varied and every single one of them comes with an environmental cost. In the balance sheet of pollution abatement, peat as a sorption media swings toward the sustainable side. Certainly when compared against competing technologies such as petroleum-based ion exchange resins and caustic chemical precipitation, peat is a sustainable, green solution.

Having said that, APT is nonetheless committed to an on-going effort to better understand the processes of plant decomposition and how we can use that knowledge to reduce our dependence on natural peat; we understand that we are stewards of the peat deposit that we are harvesting. We recognize that we have a rare chance to harness and mimic the processes of nature in a truly sustainable way through the study and knowledge of this amazing natural resource. At the same time, we are a young company marketing a new, innovative, green product that has the potential to revolutionize water remediation technologies. Currently, the balance tips toward our using the natural resource in front of us. In the future, the balance will almost certainly swing toward the reuse and recycling of biomass.

That we need clean water is not debatable. The challenge comes in managing and understanding the technologies available. Peat has proven itself as a water remediation media for tens of thousands of years in the wetlands, fens and bogs scattered across the globe. APTsorb is the modern package of that same proven performance. With careful management and judicious use of the resource, we can meet the challenge of sustainability to provide for many, many additional years of clean water.