



Arsenic Applications

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The new Maximum Contaminant Level (MCL) of 10 ppb for arsenic for drinking water has stimulated the development of a slew of new and innovative solutions. Granular iron oxide based adsorption media (GIMs) and strong base anion exchange resins are two of the established technologies that really stand out with proven successes in the field. But with both technologies there are inherent inefficiencies with respect to operation and proper disposal of waste generated.

New Hybrid Media

An exciting Hybrid Media comprised of resin and iron oxide is now available¹. The new media combines the best advantages of both technologies while offering really innovative treatment possibilities for simultaneous removal of arsenic and other contaminants (more on this later). Nanoparticles of iron impregnated into the matrix of a special strong base anion resin give the Hybrid Media both adsorptive and ion exchange properties. The strong spherical ion exchange beads provide ideal hydraulic properties for operation compared to the typical granular iron oxide media.

Painless Backwash

The clean spherical surfaces of the Hybrid Media is a big advantage to installers during startup. The usual procedure of backwashing is painless with the new hybrid media, taking just a few minutes to produce clean water compared to GIMs which requires the flushing of lots of loose iron fines down the drain. With GIMs, getting acceptably clean water can take much longer, sometimes even several hours of backwashing. The new Hybrid Media rarely needs backwashing, and backwashing is needed only when poor control is maintained over suspended solids in the water being treated. GIMs, in stark contrast, are quite friable and easily break up during service, creating arsenic-coated fines that need to be removed through regular backwashing every two to three weeks. Failure to do so can lead to plugging of the media bed and reduction in water flowrate. With the new Hybrid Media, several months of operation can go by without the need for backwashing, making it ideal for installations where discharge of backwash water is not desired.



Economics of Regenerability

Another major advantage of the Hybrid Media over granular iron is its ability to be regenerated with a proprietary caustic/brine procedure, assuring that all arsenic and other adsorbed contaminants are stripped off the media. The Hybrid Media can be reused by the same customer a multiple number of times before disposal. This provides major economic advantages to municipalities and small communities compared to granular iron media which cannot be regenerated, generate a lot of backwash water with arsenic-laden iron fines that must be disposed of, and can only be used once before disposal.

Freedom from Long Term Disposal Liability

Even more, when the Hybrid Media is fully exhausted and must be disposed of, it can be stripped of arsenic before sending the arsenic-free media to the landfill as non-hazardous waste. This solves a real long term potential liability issue faced with granular iron which is currently disposed of in public landfills rated for non-hazardous materials.

This potential liability issue with granular iron media is only now coming to the attention of regulators based on studies done by postgraduates at the University of Arizona². Their research shows conclusively that granular iron loaded with arsenic will leach arsenic under landfill conditions back into the surrounding landfill at very high and hazardous (ppm) concentrations.

This means that several years from now exhausted granular media that was considered safe to dispose of as non-hazardous can become a hazardous nightmare for everyone concerned. Such liability can potentially extend all the way back from the operator of the facility, the generator of the waste, and even to the manufacturer of the media.

Bonus of Removing Other Contaminants with the Hybrid Media

The ability to regenerate (or rejuvenate) the media means that both the adsorptive and ion exchange sites can be regenerated and can thus be used for removing arsenic as well as other contaminants in the water. Such contaminants can include uranium, phosphate and perchlorate, to name a few.

A two-step regeneration procedure is now possible, the first comprising the use of a brine solution to regenerate off uranium while leaving the arsenic bound to the media since the uranium is held by ion exchange while the arsenic is held by adsorption. The second step will use a proprietary procedure using a mixture of caustic and brine to strip off arsenic and other oxyanions (e.g. phosphate and vanadium) that may be picked up during the service cycle.



Choosing between Adsorption and Ion Exchange

With the new hybrid resin and iron oxide media, the old dilemma of choosing between adsorption and ion exchange is resolved. Instead of choosing one or the other, water treatment practitioners can now combine both functions in a single bed of media. Further it is now quite feasible to supplement the ion exchange capability of the Hybrid Media by mixing or layering with selective ion exchange resins for co-removal of other contaminants. The following examples serve to illustrate the new power given to water treatment practitioners:

Co-occurrence of Arsenic & Uranium

One logical option for co-removal is to use a standard Type II Strong Base Anion Resin (SBA II) that can be brine-regenerated to remove both arsenic and uranium. If the waste brine containing arsenic and uranium can be discharged to a Public Owned Treatment Works (POTW) or the sanitary sewer, then this certainly would be an option to consider. However, SBA II resins generally have limited capacity for arsenic of about 500 bed volumes or about 3700 gallons per cubic foot of resin, depending on sulfate content of the water. They therefore require frequent regeneration (every 1 to 2 days) resulting in the need to dispose of relatively large volumes of waste brine to the sewer amounting to about 1% of the water treated.

The Hybrid Media, on the other hand, will typically have capacities for arsenic and uranium that are greater than 50,000 bed volumes (or 375,000 gallons per cubic foot of resin) and will generate regeneration waste volumes of approximately 0.02% of the water treated or about 50 times less waste than the SBA II resin.

For combined removal of arsenic and uranium, the Hybrid Media provides the unique ability during regeneration to separate the uranium waste from the arsenic. Using a two-step regeneration procedure, operators can first strip off the uranium using a brine solution and then strip off the arsenic with a proprietary caustic/brine solution. Therefore an operator can choose between either on-site disposal of uranium followed by offsite regeneration for arsenic or offsite regeneration for both contaminants.

Co-occurrence of Arsenic & Phosphate

In this case, both arsenic and phosphate are picked up by adsorption and capacities for each contaminant is determined by pH and relative concentrations of competing species present in the water (e.g. vanadium, silica, etc.).



Phosphate usually occurs naturally at higher concentrations than arsenic (e.g. 125 ppb PO₄ versus 10 to 50 ppb for arsenic) and this means that the media will usually exhaust based on phosphate. Regenerating with caustic/brine will strip both contaminants from the media.

Co-occurrence of Arsenic & Perchlorate

In this case, arsenic will be removed by adsorption while perchlorate will be removed largely by ion exchange. Brine and caustic have very limited ability to regenerate perchlorate off the media. Current practice with perchlorate is to use strong base anion resins on a single use basis and then send off the resin to a facility for incineration during which the perchlorate is permanently destroyed. For the Hybrid Media which will also be loaded with arsenic, it is not advisable to incinerate the media until the arsenic is stripped from the media, as it would otherwise generate undesirable arsine gas during incineration. In such a case, the media will be first stripped of arsenic and then sent for incineration.

Since more selective perchlorate resins are available, it is quite possible to design the system with a mixture of the Hybrid Media and a perchlorate selective resin at a ratio that allows simultaneous exhaustion of the mixed media for both arsenic and perchlorate or any other desired endpoint.

These are just a few examples of how the new media can be utilized.

Conclusion

The introduction of a hybrid iron oxide / resin media opens up a range of innovative water treatment possibilities that allows use of a single vessel to remove arsenic and co-contaminants such as uranium, phosphate and perchlorate. This can significantly reduce cost to consumers. Operators can now provide “cradle-to-grave” assurance against potential long-term liability, by choosing a “landfill safe” method of disposal by regenerating and stripping off arsenic before disposing of the media in a non-hazardous landfill.

References:

- 1 POU – POE Removal of Arsenic and Uranium with ArsenX-NP – Francis Boodoo, The Purolite Company, NGWA Feb 2005
- 2 TCLP Underestimates Leaching of Arsenic from Solid Residuals Under Landfill Conditions – Amlan Ghosh, Muhammed Mukiibi, and Wendell Ela – Dept. Of Chem. & Env. Engineering, University of Arizona, Tucson, AZ – Env. Sci. & Tech. 2004, 38, 4677- 4682