



New Options for Treating Selenium in the Coal Industry

An Envirogen Technologies White Paper
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Cutting-edge selenium treatment options

A portfolio of technology to address a broad range of applications



Today, selenium in its many forms is becoming an issue of concern to

environmental groups and regulatory agencies. Envirogen Technologies offers a technology portfolio designed to respond to the selenium treatment requirements of mining, power generation, refining, agricultural and groundwater applications.

Envirogen's patented fluidized bed reactor (FBR) biological treatment technology has been proven as a 'best in class' approach for handling large flow rates of selenium-containing wastewater, with low capital and operating costs, and over a wide range of influent and discharge limit conditions. On the low-flow end of the spectrum, Envirogen's patented High Efficiency Ion Exchange technology offers treatment solutions that can be highly tailored to variable waste stream compositions and overall treatment system configurations. These ion exchange systems offer a small footprint and minimal operational requirements – allowing them to be used in tight spaces or remote locations.

Envirogen's team works with consulting firms and directly with facility engineering teams to adapt these technologies to meet the needs of a specific treatment application – and can provide design, build, permitting and operating expertise as required, providing guaranteed performance and

guaranteed costs over the life of an installation.

The selenium dilemma

In the United States and Canada, the issue of selenium discharge into the environment is becoming a matter of increasing concern. The U.S. Environmental Protection Agency has added selenium to its list of National Resource Water Quality criteria with a recommendation of 5 µg/L. Several states have followed with enforcement actions at this same low level. In Canada, interim criteria are being established at similarly low levels.



Currently available selenium treatment technology includes biological treatment and a number of physical-chemical processes – such as ion exchange, membrane filtration and adsorption – that vary widely in efficacy and cost. Most treatment options remain both costly and/or unproven for selenium-containing waste streams for reasons, which include removal efficacy, variability in volume and composition of influents, system sizing and logistics considerations, as well as operating requirements.

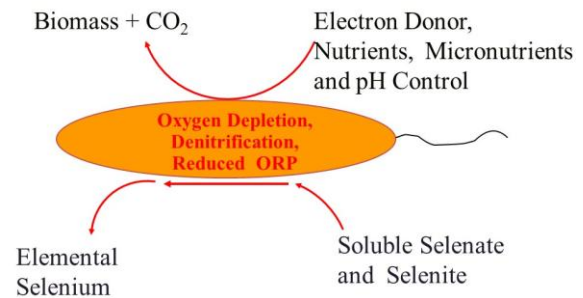
Fluidized Bed Reactors

Best-in-class performance for high volume, high concentration clean-up

Biological treatment of contaminated wastewater streams has a long track record of high removal rates and low operating costs for a broad range of influent flows and contaminant concentrations. In the area of selenium treatment, most biological treatment studies in mining, power generation and refinery operations show a need for large systems to maintain adequate residence times and the need for supplemental equipment to handle issues such as suspended solids. These issues significantly increase the cost for successful biological treatment of all species of selenium.

Envirogen Technologies is a leading environmental firm in the area of biological treatment with hundreds of systems installed across the United States. Our patented Fluidized Bed Reactor (FBR) technology has a long track record of providing high removal rates with the low cost of operation and “green” benefits typical of biological treatment systems. The advantages of employing an FBR in a selenium treatment application include an ‘order of magnitude’ cost advantage in system design and installation compared with other commercially available technologies, due to smaller system footprints as well as the ability to manage issues such as suspended solids and waste disposal in a much more effective fashion over a broad range of influent flow rates.

Envirogen’s FBR is a biologically active reactor utilizing project-specific media and



electron donors, operated upflow in an anoxic state. Selenite and selenate are reduced to insoluble selenium that is removed along with biomass and feed suspended solids by downstream liquid/solids separation (usually filtration). This fluidized bed allows for plug flow operation, very high biomass concentrations and consistent performance. The removal of excess suspended solids and biomass from the fluidized bed is accomplished with Envirogen’s patented biomass control and in-bed cleaning systems. Combining a high concentration of biomass with plug flow allows Envirogen FBR systems to achieve extremely low effluent selenium levels on a consistent basis.

Proven technology in coal mining applications

Recently, Envirogen FBR technology demonstrated the ability to achieve <5 ppb selenium over a 10-month period in treating mining leachate at a West Virginia mining site. Similar experience at a Canadian mine now confirms these results – in the presence of high nitrate levels. Our FBR has been used in similar reductive applications for more than 10 years for applications such as perchlorate, where low levels (<4 ppb) are consistently achieved at high flows (6,000 gpm) and in high TDS streams. The same anoxic operating regime is used at our nitrate installations, at which nitrate is usually treated to non-detect levels. Envirogen is an industry leader in the use of bioreactor technology, with over 200 systems installed in the United States.

Further reading on FBR in selenium applications: [Review of Available Technologies for the Removal of Selenium from Water \(prepared for the North American Metals Council\)](#)

High-Efficiency Ion Exchange

Ideal for lower concentrations & remote locations

Ion exchange technology has achieved considerable success in treating a wide range of inorganic contaminants from both industrial and municipal water streams in a cost-effective manner. In theory, ion exchange can be used to remove both selenate and selenite anions from wastewater streams. However, pilot studies using conventional ion exchange technologies for selenium removal have pointed to the weakness of this technology and associated high cost because of high levels of competing anions (sulfates) and other conditions of influent streams that lead

High Efficiency Ion Exchange Benefits

- Ideal for lower contaminant concentrations (<150 ppb)
- Can handle multiple contaminants (co-occurring nitrate)
- Engineered for long media life and optimized performance
- Small footprint & low operation requirements
- Ideal for remote locations



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to plugged resin beds, headloss, rapid resin degradation and excessive regeneration.

Envirogen Technologies' High Efficiency Ion Exchange process is based on a patented system design that addresses many of the challenges seen in real world selenium removal applications. These systems are capable of removing selenium to very low levels (< 5 µ/L) – cost effectively. In addition, they have the advantages of a small footprint and automated operation, making them ideal for space restricted treatment facilities and remote locations.

Envirogen's proprietary multi-bed system configurations offer faster kinetics and long media life while meeting a wide range of volume requirements. We employ remote monitoring and communication capability to enable our customers and field service technicians to ensure proper performance and attend the unit as needed.

Envirogen offers high-efficiency ion exchange systems with low capital investment options and pay-for-performance guarantees over the lifetime of the installation, creating the best opportunity for an optimized lifecycle cost.

Fluidized Bed Reactor Benefits

- Selenite and selenate are reduced to insoluble selenium
- "Green" technology means low energy & chemical usage
- Ideal for higher contaminant concentrations
- Can handle multiple contaminants - including nitrate
- Engineered for superior biomass control & process efficiency
- Order of magnitude' cost advantage versus other leading technologies

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