5 Practical Strategies for Removing Heavy Metals and Cyanides from Waste Water

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Industrial Waste Water Treatment for Heavy Metals

Removing heavy metals and cyanides from your facility's industrial waste water is a costly concern. These five strategies can help you identify ways to improve your compliance and your bottom line.

1. Review Current Regulations and Analyze Options

The U.S. Code of Federal Regulations, Title 40, lists requirements according to the EPA's industrial categories. These categories are based on what each facility produces, and likewise, what kind of production waste they create. Your company's effluent limitations are identified based on its industrial category.

Once the correct category is identified, then analyzing your treatment options can begin. For example, if you plan to discharge unchelated heavy metal waste streams and hydroxide precipitation to POTW (publicly-owned treatment works), a pretreatment discharge permit under Title 40 may be adequate. Direct discharge into an open waterway will typically require more aggressive treatment.

There are several technologies that can help you meet your goals, such as chemical precipitation, carbon adsorption, ion exchange, and reverse osmosis. Chemical precipitation (CP) is the most common option for removing heavy metals, and the common precipitants are hydroxide, sulfide, and carbonate.

Electrocoagulation (EC) is a newer technology that removes total suspended solids, heavy metals, emulsified oils, bacteria, and other contaminants. While CP is an additive process which results in increased chemicals in waste water; EC uses no additives. The capital costs for implementing EC are higher, but lasting operational costs are significantly lower when compared with CP, providing a great return on investment.

2. Minimize Flow to Reduce Capital and Operational Costs

Minimizing your waste water is perhaps the most important and easiest way to reduce your capital and operational costs.

A. Design effective spraying and rinsing systems with vigorous agitation to reduce the amount of water needed in the process.
B. Understand the process chemistry and avoid contaminants that are highly regulated or difficult to remove from the waste stream.
C. Minimize chemical carryover through careful design of racking and carriage systems.
D. Maintain process equipment and housekeeping practices to avoid spillage and eliminate any water waste generated through recovery and cleanup.

E. Understand your rinsing and cleaning goals: you only need to clean to the requirements of your process. Anything beyond will lead to unnecessary waste water.

3. Segregate Waste Streams to Improve Efficiencies and Recycling Options

Segregated waste water streams allow for individual contaminants to be treated efficiently, minimizing chemical usage and promoting reuse and recovery. Most reuse and recovery systems have large capital and operating costs which make them impractical except in cases where large amounts of material can be recovered. However, preplanning and using segregated lines can have a significant impact to savings. Treating the reject, regeneration, or diminished water with the general waste can often be more effective with the use of ion exchange or reverse osmosis, for example, on high-strength waste streams.

4. Take Note of Other Chemicals Used in the Facility's Processes

Survey your facility for chemicals that can interfere with heavy metal removal. Many chemicals can act as a complexing agent by holding dissolved metals in solution and preventing them from precipitating during the treatment process. These must be eliminated or controlled by either segregating them and treating them separately or in diluted form by slowly metering them into the waste flow. Common and prevalent complexing agents, also known as chelators, are sodium citrate, citric acid, and ammonia compounds.

It's also good to note that the chemicals you use in your waste water treatment system affect the level of regulatory attention it will receive. Some chemical selections would require the facility to be managed under the OSHA 1910.119 Process Safety Management (PSM) of highly hazardous chemicals. Use of chlorine gas and sulfur dioxide gas are effective in reducing the chemical cost of operating a waste treatment facility. But, use of these chemicals will require the facility to comply with the additional PSM rules. This may still be the best option, especially if the facility is already regulated under PSM due to other hazardous chemicals. Alternatively, choosing other oxidizing and reducing methods to avoid PSM altogether may be the best option, especially in a tight industrial or urban setting. Understanding the consequences of these choices builds the frame work for making informed decisions based on a complete spectrum of requirements.

5. Operational and Cost Optimizations

A. **Pre-work:** Evaluate equipment, chemical, operational, waste disposal costs before finalizing your treatment technology.
B. **Testing:** Perform jar testing, bench testing, and pilot testing instead of relying on theoretical analysis since each waste water stream is different.
C. **Planning:** Account for future changes to waste water volumes, constituents, and updates to regulatory systems by installing systems that be updated and changed to meet new demands.
D. **Concentration Levels:** When waste water streams have been segregated, the individual contaminants become more concentrated because they have not been diluted by other wastes. In their more concentrated forms, they actually require less chemical treatment and smaller tank volumes due to lowered reaction times. For example, excess chlorine in alkaline

chlorination of cyanides and excess sulfuric acid and sulfur dioxide in hexavalent chromium reduction.

E. **Weighing Specific Treatment Options:** Frequently, you'll find that a solution that requires additional equipment and higher upfront cost will result in more efficient operational costs and better results down the road. By the time you reach this step, you'll be able to determine your best path through the kinds of testing and planning mentioned above.

It can be difficult to keep regulatory concerns, new technologies, and best options straight. Consult an expert to help drive down your bottom line and increase your efficiencies.

About ADF Engineering

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About the Authors

Ted Ortiz, P.E., has more than 30 years of experience in process and environmental engineering for the manufacturing and chemical processing industries. Ted's understanding of chemistry coupled with his process design experience makes him uniquely qualified to manage complex waste water treatment projects and engineering design for many of ADF's clients.

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