Cleaning Up Coal

Meeting Coal Ash Effluent Regulations with HydroFlex™

Coal continues to be an important part of the U.S. energy mix, with coal-fired power plants producing 39% of the nation's energy in 2014. However, power companies are facing increasing regulatory and community pressure to reduce the amounts of heavy metals and other potentially problematic elements in their waste streams. New processes are needed to help power companies meet the latest regulations and guidelines.

HydroFlex™, an innovative water processing technology from Winner Water Services, is an effective and cost-efficient option to supplement current treatment methods and help power companies meet new, more stringent effluent regulations.

The Mounting Regulatory Pressure on Coal-Fired Power Plants

Burning coal leaves behind coal combustion residuals (CCR), also called coal ash, which can contain high levels of sulfates, arsenic, lead, selenium and other elements that may be toxic in large quantities. In order to keep these elements out of fresh water, most power plants contain the waste in large holding or containment ponds on site. In 2014, in response to some high-profile holding pond failures and pressure from environmental activists, the EPA issued new regulations requiring regular inspection of surface impoundments and ordered closure of impoundments and landfills that failed to meet the new engineering and structural standards. In September 2015, the EPA revised its effluent limitation guidelines and standards. The new regulations include stringent new requirements on the discharge of arsenic, mercury, selenium and nitrogen in wastewater streams from flue gas desulfurization and require zero-discharge of pollutants in ash transport water.

The EPA estimates that annual compliance costs for the new effluent regulations could be as high as $480 million for the industry. The industry is also facing hundreds of millions of dollars in expenses for removing or reinforcing existing containment ponds. Because of the liabilities imposed by the new regulations and the costs associated with compliance, some companies are choosing to eliminate containment ponds at their coal-fired power plants. However, this will require dewatering of the coal ash slurry and treatment prior to release to reduce the contaminants of concern to acceptable levels.

Limitations of Existing Treatment Technologies

Coal ash slurries have proven to be difficult to treat with existing technologies. Standard lime treatments are low cost, but do not reduce concentrations of all elements to acceptable levels. While liming may significantly reduce the levels of many heavy metals, these treatments struggle to reduce sulfates to acceptable effluent limits and leave some elements, such as selenium, almost untouched. At the same time, they vastly increase the levels of calcium and the overall hardness of the treated water. This causes significant problems for most operations due to scaling in membranes and evaporators. Other technologies, such as membrane-based technologies, are costly, subject to fouling and result in large streams of rejected waste.

The HydroFlex Solution

HydroFlex provides power companies with a new option for treatment of coal ash slurries and effluents from CCR containment ponds. It has been shown to significantly reduce sulfates and other contaminants left behind by lime pretreatment while also reducing the calcium concentrations and overall hardness of lime-treated water.

HydroFlex is a platform technology based on well-understood solvent extraction principles. Solvent extraction has been practiced in the mining industry for decades to recover copper, uranium and other metals from leach solutions. Winner Water has developed a proprietary process that deploys solvent extraction principles to enable safe and effective wastewater treatment.

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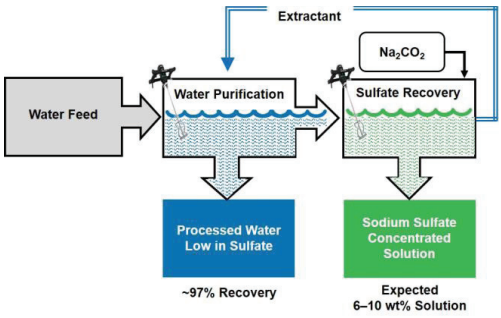
The HydroFlex process provides distinct advantages over current technologies in the areas of water purification, treatment efficiency, selective contaminant removal and reduced waste.

- Water Purification: Sulfate and selenate are reduced 70–90% in the process, and calcium is reduced by more than 99%.
- Treatment Efficiency: HydroFlex produces >99% clean discharge, with no reject stream.
- Selective contaminant removal: HydroFlex focuses treatment efforts to control costs.
- Reduced waste: The selective extraction process yields concentrates that may have the potential for reuse.



The flexibility inherent to the process allows Winner Water to meet clients' effluent and/or process goals without paying for treatment that isn't needed or required.

Proven Results

In a bench-scale demonstration project for a large power company, HydroFlex was used to process coal ash slurry that was pretreated with a standard lime (calcium carbonate) treatment. Chemists analyzed samples before pretreatment, after the lime pretreatment, and after processing the pretreated water with HydroFlex.

As shown in Table 1, the lime pretreatment was effective in reducing the levels of many metals, such as zinc copper and aluminum, to within treatment goals. However, the resulting water still had high levels of selenium and sulfates, and calcium levels were significantly increased. Processing the pretreated water with HydroFlex reduced selenium by 90%, from 1,960 ug/L after pretreatment to 174 ug/L after processing with HydroFlex. Sulfate levels, which were 37,300 mg/L prior to pretreatment and 2,540 mg/L after treatment, were further reduced to 486 mg/L. In addition, HydroFlex almost completely removed the high levels of calcium left after the lime pretreatment, reducing calcium levels by 99.7%.

The treatment goals for all contaminants were not achieved with the lime and single HydroFlex extraction experiment. Additional extraction stages can be incorporated, or the water reprocessed to further remove other contaminants of concern to within the desired effluent range. The flexibility of the HydroFlex process will allow refinements to the process to better target boron and other elements of concern. By modifying the properties of the solvent used as an extractant, the process can be targeted to different contaminants. In addition, processed water can be easily processed through HydroFlex to further reduce contaminants to acceptable effluent levels.

Table 1: Levels of Key Contaminants Prior to Treatment, After Lime Pretreatment and After HydroFlex

ND = Non Detect

Analyte (units)	As Received	After Lime Pretreatment	After Lime Pretreatment Plus HydroFlex	Treatment Goals (ug/L)	Lime Pretreatment Removal %	After Lime Pretreatment Plus HydroFlex Removal %
Calcium (ug/L)	321,000	974,000	1,120		-203.4%	99.7%
Magnesium (ug/L)	8,120,000	561	373		100.0%	100.0%
Total hardness (ug/L)	34,200.0	2,430.0	4.3	<1,000	92.9%	100.0%
Aluminum (ug/L)	3,410	86.80	ND		97.5%	
Arsenic (ug/L)	ND	10.0	6.4	53 or 6-8	-300.0%	-156.0%
Barium (ug/L)	46.0	162.0	10.7		-252.2%	76.7%
Boron (ug/L)	32,900	28,700	26,600	500	12.8%	19.1%
Cadmium (ug/L)	51	ND	ND	3.40	97.1%	97.1%
Cobalt (ug/L)	612	ND	ND	5	95.9%	95.9%
Copper (ug/L)	301.0	21.0	12.5	23	93.0%	95.8%
Lead (ug/L)	ND	ND	ND	19	ND	ND
Manganese (ug/L)	1,590.0	ND	9.9		100%	99.4%
Nickel (ug/L)	871	ND	ND	509	99.4%	99.4%
Selenium (ug/L)	1,750	1,960	174	10-16	-12.0%	90.1%
Strontium (ug/L)	8,630.0	1,960.0	21.1		77.3%	99.8%
Zinc (ug/L)	1,260	47.80	ND	343	96.2%	
Total alkalinity (mg/L)	10	100	90	250	-900.0%	-800.0%
(mg/L) Total Dissolved Solids	53,000	6,830	3,970	<1,500	87.1%	92.5%
(mg/L) Total Suspended Solids	60	74	20	<10,000	-23.3%	66.7%
Chloride (mg/L)	117.0	115.0	44.8	100	1.7%	61.7%
Sulfate (mg/L)	37,300	2,540	486	<1,000	93.2%	98.7%

Conclusion

An integrated treatment regimen that includes lime pretreatment and HydroFlex offers power companies an effective and cost-efficient way to meet the new EPA effluent regulations. Utilizing low-cost and widely accepted lime pretreatments as a first step keeps overall treatment costs low. HydroFlex further reduces contaminants to meet the more stringent environmental regulations while softening water and reducing the calcium added by the lime pretreatment.

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