SELECTIVE CONTAMINANT REMOVAL FROM INDUSTRIAL WASTEWATERS

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Agenda

• Evoqua Water Technologies Background
• Selective Contaminant Removal – Why and How
• Treatment Technology Ranges
• Ion Exchange Resins
• Selective Adsorbents
• Pironox™ Reactive Media
• Case Studies
• Questions
Evoqua/Roseville, MN Facility

Facility Summary

- CERCLA-approved, RCRA-permitted Part B Centralized Treatment & Recovery Facility (CTRF)
- Provides the following services:
  - Bulk hazardous and non-hazardous waste treatment
  - Media-based wastewater treatment system testing, design and supply
  - Ion exchange resin regeneration
  - Adsorptive media handling
  - Recovery of heavy metals
- Customers represent all major industrial and sectors

Evoqua Service Locations

• Carbon Branch Service Locations
• Carbon Reactivation Plants
• Regeneration and Waste Plants
Selective Contaminant Removal

Why selective contaminant removal?
- Goal to only remove target metals
- Remove target metals to very low levels
- Minimize cost and complexity

How are contaminants selectively removed?
- Variety of methods
- Focus on inorganic contaminants removed via media

Examples
- Media Types
- Applications

Technology Treatment Ranges

Conventional Treatment → Ion Exchange → Selective Adsorbents → Pironox™

Chrome → Cadmium and Lead → Zinc → Copper → Mercury → Selenium

1,000 ppm 100 ppm 10 ppm 1 ppm 10 ppb 1 ppb 100 ppt 10 ppt 1 ppt
Non-selective Ion Exchange Resins
- Removal mechanism through exchange
- Strong- and Weak-Acid Cation
- Strong- and Weak-base Anion
- “Commodity” resins

Application Considerations
- Removal to single-double digit ppb levels
- Typical TDS limitations <2000ppm
- Take advantage of selectivity differences
- Applications for removal of Cr\(^{6+}\), Pb, U
- Resins can be regenerated but not always practical

Selective Ion Exchange Resins
- Removal mechanism through exchange
- Chelating Resins
  - Iminodiacetic (IDA) – heavy metals
  - Aminophosphonic – brine softening
- Specialty Resins
  - Thiol/Thiouronium – precious metals and Hg
  - Picolyamine – heavy metals in low pH environments
  - Nitrate-selective
  - Boron-selective
  - Perchlorate-selective

Application Considerations
- Removal to single-to-double digit ppb levels
- TDS limitations low (<2000) to high (>>2000ppm)
- Some regenerable; most not practical
Selective Adsorbents

Specialty Adsorbents
- Removal mechanism through surface interaction
- Carbonaceous – Cd, Cr^{3+}, Cu, Hg, Ni, Pb, Zn
- Iron-based – As, PO_4, Sb
- Titanium-based – As, PO_4, Sb, heavy metals
- Zeolite – NH_3, Cs, K
- Alumina – F

Application Considerations
- Removal to single-digit ppt–ppb levels
  - Single-digit ppt for Hg
  - Single-digit or fractional ppb for As, Cr^{3+}, Cu, Pb, Zn
- TDS limitations low (<2000) to high (>>2000ppm)
- Typically non-regenerable

Potential Pitfalls to Successful Application

Complexed/chelated Metals
- Retard chemi- or physical adsorption
- Chemical destruction pretreatment (oxidation)
- ID media with greater formation constant

Oxidizers (free chlorine, hydrogen peroxide)
- Irreversible damage to functional group, crosslink or binder
- Chemical destruction
- Catalytic media decomposition

Oil Contamination
- Coats and fouls media
- Not easy to impossible to reverse
- Remove in pretreatment steps

Solids
- Media removes dissolved contaminants
- Particle size testing to determine appropriate prefiltration steps
Pironox™ Reactive Media Process

Iron-containing media
- Chemically reduces soluble contaminants
- Removes contaminants via surface interaction
- Applied in CSTR

Targeted toward challenging applications/contaminants
- Power Plant FGD (Hg, Se)
- Acid-mine drainage (As, Cr, Cu, Hg, Mo, Ni, Se, V, Zn)
- Coal ash pond (Hg, Se)
- Refinery wastewater (As, Hg, Se)
- Groundwater/Stormwater

Early commercial stage of development

Contaminant-removal from Refinery Stormwater

Challenge
- Stormwater at refinery was above discharge limits for Free Oil, O&G, BTEX, arsenic, copper and lead
- 2-5ppb limits on metals
- Peak flow rates up to 800gpm during storm events

Solution
- Temporary system required for emergency response
- Combination of treatment technologies including organoclay, activated carbon, selective adsorbent for metals removal
Metals-removal from CPI Plant Cooling Water

Challenge
- Copper and Zinc in local water cycled to higher concentrations in evaporative cooling system
- Blowdown was above new discharge requirements of 10ppb
- Chemical additives unable to achieve low discharge standards

Solution
- Selective adsorbent media used to achieve standards
- Evoqua worked with local lab to improve sampling and testing procedures
- Regulatory compliance reported at detection limit of 2ppb

Cr-removal from Cooling Tower Water

Challenge
- Soil samples showed Cr⁶⁺ contamination from cooling water system
- Next facility shut down in 7 years

Solution
- Project treated chromium in three-stage process
- Drained and treated low level chromium from overflow basin with non-selective IX resin and liner repaired
- Isolated, drained and cleaned water tower then fill
- Substituted molybdate for chromate in cooling loop during operation
Zn-removal at Brownfield Remediation Site

Challenge
- Natural treatment system overwhelmed by multiple tropical storms on natural treatment basin
- Overflow into surrounding river violated zinc limit of 1 ppm
- Plant was fined daily until problem corrected

Solution
- Evoqua installed pumps system to drain area
- Temporary installation of selective IX resin system brought zinc levels below regulatory limit
- 6 month operation while basin was restored to design conditions

V-removal from Power Plant Ash Pile Runoff

Challenge
- Vanadium from ash pile runoff contaminated 400,000-gallon holding pond
- 30 ppm V required reduction to <4 ppm

Solution
- Non-selective IX resin removed V from pond
- Temporary system to clean up holding pond
- Took advantage of high selectivity of resin for V over sulfate
- Pond levels reduced to meet regulatory limit
As-removal from Potable Well Water

**Challenge**
- Elementary school annual water test identified arsenic in only well supplying school
- Water usage during the day had high variations in flow
- School budget was constrained for capital investment

**Solution**
- Iron based selective adsorption media applied in fiberglass vessels
- Design of vessels allowed for high flow variations without channeling through media beds
- System was rented to school district until capital funds were found

TCE and Perchlorate-removal from Well Water

**Challenge**
- A small city’s routine water testing identified perchlorate and TCE in the primary well supply
- Contamination was from nearby military research facility
- Well also had high entrained air levels

**Solution**
- Worked with local engineering firm to remove air from water flow before media treatment
- Evoqua provided activated carbon to remove TCE and non-selective IX resin to remove perchlorate.
Whole Effluent Toxicity Reduction

Challenge
• Municipality had recurring WET testing failures without identification of any specific contaminant violation
• Municipality receives waste from one large automotive facility with pretreated wastewater but process has trace remaining cutting oils, metals within permit guidelines

Solution
• Evoqua implemented activated carbon and selective IX resin resulting in consistent passing WET tests
• Customized resin conditioning protocol eliminated changes in hardness and minimized scaling

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THANK YOU FOR YOUR ATTENTION

QUESTIONS?

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