Coal Power Wastewater: Selenium Challenge and A New Solution

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More stringent regulations are making treatment of selenium in wastewater a bigger challenge in industries such as power, refining, mining and construction. With increasing focus on water quality, some federal, provincial, and local regulatory agencies are moving towards tighter selenium discharge limits to as low as 3 µg/L (ppb). Although the US EPA has designated biological treatment as the Best Available Technology (BAT) for selenium treatment, a more efficient, simple, reliable and cost-effective treatment technology is still lacking in the market.

In water and wastewater, selenium generally exists as soluble oxyanions, selenite (SeO_3^{2-}) and selenate (SeO_4^{2-}). Organo-selenium compounds are also present in some wastewater, such as coal mining and refining waste streams. Among these, selenate is the more mobile and prevalent species, which is also more difficult to remove.

This abstract provides an insight into an innovative selenium treatment media, which has high selenium removal efficacy and capacity regardless of the presence of interfering cocontaminants in the water, such as sulfate, nitrate, phosphate, molybdenum, mercury, and most other heavy metals. The new media developed for selenium removal is an engineered and surface-modified iron-based media, which has high surface area, reactivity and contaminant capacity. Reduced iron is the functional unit in this media. The media functions by reducing selenate/selenite to elemental selenium, which is then strongly adsorbed on the media surface. A case study of selenium removal from coal combustion residue (CCR) effluent using an innovative media is presented here. In the CCR wastewater, selenium is one of the key contaminants that is naturally occurring in soil, groundwater and coal.

A pilot study was conducted to evaluate the treatment of selenium in CCR effluent. General process arrangement for the flow-through pilot unit involves six (6) up-flow columns connected in series, filled with the media up to 70% of the column height. The influent pH was maintained between 5.0 and 6.5 by dosing acid before the first, third and the fifth column. The pilot unit was fed with the CCR effluent, which contained 374 ± 38.2 µg/L of selenium (all selenate) along with co-contaminants such as molybdenum, arsenic, boron, sulfate, and nitrate. The treatment target for selenium was 12 µg/L. The total operational EBCT was 60 min (10 min in each column). The pilot unit was operated continuously for 30 days with selenium consistently removed below 12 µg/L. Additionally, the pilot also consistently removed molybdenum, a co-contaminant of concern, from 3,000 µg/L to almost non-detect levels.

Contaminant breakthrough was not observed during the study period. Based on the media isotherm studies, the media is estimated to last for 3 to 9 months for such wastewaters. In summary, the pilot study demonstrated successful use of this new selenium removal technology for the treatment of CCR wastewater at relatively short EBCTs, demonstrating its potential to be established as a disruptive selenium treatment technology.

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Dr. Madan Tandukar is a Process Leader with ECT2. Madan possesses a Ph.D. and Post- Doctorate in Civil & Environmental Engineering from Nagaoka University, Tohoku University and Georgia Institute of Technology. Madan has 22 years of experience with water/wastewater treatment and soil remediation. Madan holds 5 patents and has authored more than 45 scientific articles and 3 book chapters.

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Michael Nickelsen has over 30 years of industry specific experience to the ECT2 team where he works as VP, Research and Development. He specializes in treatment technologies with emphasis on the development, engineering, design and application of oxidation and synthetic adsorbent technologies. Michael holds both a Bachelor's and Master's Degree in Chemistry from James Madison University and Old Dominion University, respectively. Michael is a member of the American Chemical Society, the American Water Works Association, and Sigma Xi. Aside from authoring over 41 scientific papers in peer reviewing professional journals, he is also an inventor on several environmental process patents.

Dave Kempisty

Dr. Dave Kempisty is the Director of Emerging Contaminants at Montrose Environmental Group and ECT2 (Emerging Compounds Treatment Technologies). ECT2 is an equipment company focused on developing and commercializing treatment technologies for emerging, difficult-to-treat contaminants. Dave's responsibilities include: leading research and new product development; providing technical leadership on all projects; proposal development; intellectual property; and communication with the engineering/remediation community.

Paul Newman

Paul Newman is the Defence Sector Leader for ECT2. Paul's focus is currently on supporting the DND and DoD (US) in pilot- and full-scale water treatment deployment, and pairing our regenerable ion exchange process with destruction technologies. He received his Bachelor's Degree in Geology from the University of Windsor and his Master's Degree in Mineral Exploration Geology from McGill University.