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EPA Reviewing Flue Gas Scrubber Effluent Rules

Coal fired power plants face strict air emissions standards. One of the most damaging pollutants in the flue exhaust from a coal-fired power plant is sulfur dioxide. When mixed with moisture, it forms an acid (sulfuric acid). The acid can eat up the exhaust duct, heat exchanger, chimney, and when vented out of the exhaust stack into the atmosphere it causes acid rain. Today most environment agencies require a power plant to use a wet scrubber to contain this sulfur dioxide. This process is called flue gas desulfurization or FGD. As this is a wet process, all the pollutants are trapped in the FGD wastewater. This wastewater cannot be discharged into any water bodies without treatment since it contained a wide variety of pollutants from heavy metals to salts and of course sulfurous compounds.

So, air pollutants have now become potential water pollutants. In the United States, the main pollutants of concern are Selenium, Mercury, Arsenic, and Nitrates. In 2015, the EPA finalized a rule revising the regulations for the Steam Electric Power industry. This primarily affected the coal-fired power plants and came at a time when some politicians were making the reduction of coal a campaign theme. The rule called the Effluent Limitation Guidelines (ELG), put very low limits on toxic metals in wastewater that could be discharged from power plants.

At the time of the new rule, the EPA estimated the total compliance cost to the industry to be $480 million USD. They projected that there would be associated benefits from cleaner water discharge in the amount of $451 million USD. Critics disputed these estimates and put the cost to the industry vastly higher. As a result of the new rule, some power plants decided to close down their coal-fired plants and build new plants based on natural gas. Duke Energy is an example of this. Other companies decided to appeal the new rules. A new power plant or major renovation to an existing power plant can take a decade or more to design and build. Environmental lawsuits and hurdles against any construction work in this industry can be daunting.

The new rule put the industry in turmoil and decision makers were not sure how to manage their operation given the changing rules and whether it would be upheld. During this time, they did evaluate all options for compliance, and this included many pilot tests using VSEP RO membranes to treat the effluent to meet the new rules. New Logic conducted seven long-term pilot tests and quoted dozens of VSEP systems to many power plant companies. These companies would likely ask for time to comply and to evaluate treatment options. So the VSEP performance and cost information was useful to them in the event an action plan would be needed.

VSEP FGD Pilot Trial in Southern Spain

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In addition, the industry organization Electrical Power and Research Institute (EPRI) funded many of the research projects including some of those involving VSEP. EPRI also published a paper at the end of the research showing how the VSEP can be used to meet the new limits. FGD wastewater is typically very high is dissolved solids concentration. This meant that many of the conventional treatment methods such as biological and chemical/physical would not be suitable. The only two methods determined feasible by EPRI were evaporation and VSEP.

Feed, Permeate, and Concentrate Samples

The new ELG limits were extremely low. They were so low in fact that many of the receiving bodies of surface water could have higher concentrations of the metals involved. These limits included <10 ppb (parts per billion) for Selenium, <0.1 ppb for Mercury, <6 ppb for Arsenic, and <113 ppb for Nitrates. The limit for Nitrates is unique to this industry. Nitrate limits for other industry effluents are higher than the 113 ppb limit for power plants. Even though the EPA guidelines for drinking water are that Selenium can be as high as 50 ppb, the limit for this effluent was set at 10. So the coal-fired power plant must produce treated effluent with Selenium levels lower than drinking water.

In 2016, the revised ELGs were challenged in the U.S. Court of Appeals for the Fifth Circuit. On April 12, 2019, the Fifth Circuit issued a decision vacating the limitations for legacy wastewater and combustion residual (Fly Ash) leachate, finding that they were arbitrary and capricious under the Administrative Procedure Act and unlawful under the Clean Water Act, respectively.

For the purpose of the ELGs, "legacy wastewater" is FGD wastewater, fly ash transport water, bottom ash transport water, flue gas mercury control wastewater, or gasification wastewater that is created prior to the date that the revised effluent limitations for these wastewaters take effect at a plant. It is not clear what rules would apply to any new coal-fired power plants.

EPA is collecting additional information on treatment technologies that may be available for these two waste streams. Specifically, the EPA has been seeking information regarding the availability, performance, and cost for systems to treat fly ash leachate and FGD wastewater.
Prior to the ruling by the Fifth Circuit, The EPA was aware of the work done by New Logic in this area and requested a meeting in Washington DC where the performance of VSEP as a treatment method could be discussed. New Logic attended this meeting and described the results achieved during several pilot tests and a full-scale installation in Atlanta, Georgia.

EPA anticipates citing this information in the current Steam Electric rulemaking and this information could become part of any future rule-making efforts. The industry realizes that the decision by the appeals court says the current rule is too arbitrary and that a

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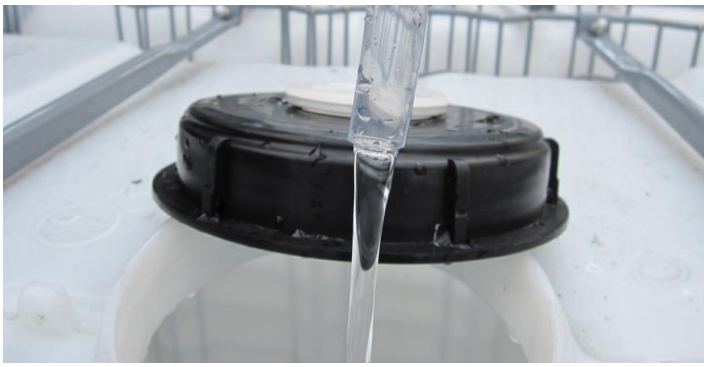
new more documented and defined rule may take place in the future. This could also happen as a result of an administration change in the US government.

Since coal is abundant in the Appalachian Mountains, many of the power plants in the East Coast of the United States use coal as an energy source to make steam. Coal would have to be transported long distances to be used in the West, so these power plants primarily run on natural gas. Coal is also used for power plants in many countries around the world. These countries may not have the strict guidelines on wastewater discharge, but even without the 2015 strict regulations, the FGD effluent must be treated prior to discharge in almost all places.

Starting in 2009, New Logic has demonstrated the ability of VSEP to treat this very difficult effluent to meet almost any discharge rule. New Logic has just recently completed pilot testing for a power plant in Spain where the issue was not Mercury or Arsenic, but Boron.

Pilot testing with VSEP has shown that an average flux rate of 26 GFD (44 LMH) can be achieved with an average recovery rate of 75%. The remaining concentrate would go to an evaporator. Since the cost of operating a VSEP is far less than the cost of evaporation, this makes a very economical ZLD solution for the client. During pilot testing, the VSEP performed with effluent TDS as high as 46 g/L and made concentrate with TDS over 100 g/L.



Mobile VSEP Systems

Many of our clients have expressed an interest in using the VSEP system on a mobile platform. We have completed many of these kind of projects that have taken many creative forms. Some of these are for pilot test equipment where the filtration work is only done for a short period of time. The mobile full-scale plants are mostly used for special projects that are intended to be competed in a few weeks or months. Shown below are several examples.

Open Pickup Trailer used for pilot equipment

Closed Pickup Trailer for mobile pilot testing

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Container used to conduct pilot testing outside

Open Trailer for a full-scale 36” Pilot system

Customized VSEP Trailer for Frac Water treatment

Full Scale 84” VSEP Trailer

Two Story Containers for a 2-Module 84” VSEP System

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New Rep Spotlight: Esmil Process Systems

Esmil Process Systems is located in High Wycombe, England. Wycombe, as it is called, has a population of about 125,000 souls and is located about half-way between London and Oxford. As with many towns in Europe, it can trace its roots back to medieval times and before. A Roman Villa was recently excavated dating back to the 2nd century AD. The towns motto is "Industry Enriches" and that has been true for Esmil as well.

ESMIL
WASTE WATER TREATMENT SYSTEMS

Esmil offers a very wide range of treatment solutions including the VSEP technology. What defines Esmil is its ability to provide a complete solution for a customer with a specific need. They can provide services from design to implementation in the UK and elsewhere. Esmil has had particular success in the pulp and paper industry treating Medium Density Fiberboard (MDF) Effluent.

Engineer, Parag Kachare of Esmil

The company is directed by Mr. Devinder Nath Chabba, or Dev Chabba as he is commonly known. Dev is a chemical engineer with a rich history and wealth of experience. The senior technical expert, Parag Kachare manages the company's projects and technical department. Esmil and New Logic first connected almost 13 years ago and Esmil is one of New Logic's longest serving distributors. Together, these companies have worked on a wide range of potential projects including landfills, power plants, a beer factory, and many more. New Logic would like to acknowledge Esmil for its fine work in representing the VSEP technology.

Bench Test Update: Andalusian Leachate

The port city of Huelva is located in the autonomous region of Andalusia along the Gulf of Cadiz in Southern Spain. It is located at the confluence of the Rio Odiel and Rio Tinto. In 1492, Christopher Columbus started his historic first expedition from the town of Palos de la Frontera, a small community about 13 km from Huelva.

In about 1873, a British mining company started operations in the mountains above Huelva, mining copper and other metals. The company was named after the local Rio Tinto. Since then the company has become a mining super-power around the world. Environmental protests have occurred in the region for more than a hundred years. One notable protest in 1888 involved the Spanish army opening fire on a group of protesters in the village plaza of Rio Tinto which lead to the deaths of between 100 and 200 local people.

A waste disposal site was established in the small town of Nerva near the mining sites to contain some of the industrial wastes from the local activities. As with any collection of industrial waste, leachate is produced. This leachate is stored and treated. New Logic was recently contacted after there was interest in using VSEP to treat this hazardous leachate material.

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The River (Rio) Tinto near mining town of Nerva

A bench test was conducted on a sample of the water sent to New Logic's facility for testing. The operating company currently evaporates the leachate and is looking for a less expense method of dewatering. The sample provided for testing had a total solids concentration of about 1.7% with a conductivity of 18,520 µS. Being primarily from mining waste, the leachate is very high in Iron and Chlorides. Manganese and Sulfur are also high at 313 and 50 mg/L respectively. Since there is no household waste, the organic content is fairly low. Iron fouling can be particularly problematic for most conventional membrane systems.

Samples from Leachate Testing

For maximum volume reduction prior to evaporation, the VSEP was operated at high pressure (900 psi or 62 Bar). During the batch concentration study, the VSEP produced a flux rate of about 18 GFD (30 LMH) and an overall recovery of 84% leaving just 16% of the volume as concentrate that would be evaporated.

The final concentrate from the VSEP test had 13.6% total solids, 75,100 µS conductivity, and 112, 500 mg/L COD. New Logic has proposed a 2-module high pressure VSEP system constructed of 904L stainless steel components due to the high Chloride levels. In addition, the proposal includes three stages of conventional spiral RO to polish the VSEP filtrate to meet the very low levels required for surface water discharge.

VSEP Pilot Testing

Pilot testing can be a very effective way to demonstrate the VSEP technology to the client and to confirm the actual performance that can be achieved. Many of our customers have read the literature about the vibration of the membrane, but seeing is believing. The LP VSEP is a small scale VSEP that has about 1.5 m2 of membrane area and can be used for collecting data that will scale up to much larger systems.

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The LP VSEP is about the size of a small refrigerator and has wheels on the frame. The equipment can be set up in about an hour. New Logic ships these pilot machines all over the world and our engineers travel to each project to get the equipment running and to train the people using it. In addition, many of our international distributors have pilot machines and conduct pilot trials.

The equipment comes with an appropriate membrane installed, a feed pump, a CIP tank, and all the supplies needed to run a successful test. New Logic has conducted thousands of these pilot tests. Many times, New Logic does not need to pilot test when it has done an application multiple times already. But some customers request the pilot test for their own confirmation purposes. Normally, New Logic has about 5 field pilot tests running in several different countries. Here are some of the pilots currently running or about to start:

Bay County Landfill

Heavy precipitation means more water runs through a landfill, eventually draining out as a clear, stinky liquid called leachate. Bay County landfill must haul the leachate to a treatment facility at Panama City Beach. Big rains mean the county needs a back-up hauler to help with excess liquid. The low bidder offered $23.50 per 1,000 gallons hauled. The amount of leachate hauled per year varies by rainfall. In 2012, the county hauled 5.8 million gallons, but in 1999, it carried 14.7 million gallons due to major storms. This represents a cost of about $350,000 for one year. This landfill is currently pilot testing a VSEP system with the idea to use VSEP to volume reduce the leachate to save on hauling costs. Ironically, the VSEP pilot was delayed due to a destructive hurricane last fall.

Local Biotech Company

New Logic is conducting a pilot test for a client who manufactures methanotroph bacteria. These bacteria metabolize methane as their only source of Carbon and energy. There are many possible uses of this type of bacteria including bioremediation and possible use as a fuel where methanol can be produced. The bacteria culture is grown in a fermentation broth and the biomass can be sold as an animal feed product. The fermentation broth also contains salts and other soluble materials that the client would like to remove. VSEP is begin tested to see how it compares to centrifugation and crossflow membranes.

Coffee Manufacturer

A multinational beverage company making coffee, cola, tea, and hot chocolate will pilot test VSEP. The company was founded in the Netherlands in 1753. There are several applications for VSEP in the production of dried coffee including dewatering the coffee prior to spray drying or freeze drying. In this case, the customer uses a large amount of caustic cleaning water to clean the equipment. This cleaning solution will accumulate suspended

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solids, chemical oxygen demand (COD), oil, and other contaminants and eventually must be disposed of. Because of the very high pH and the high levels of COD, disposal is expensive and problematic. In addition, the customer spends a lot on caustic to prepare new cleaning solutions. VSEP is begin tested in Europe to filter the used cleaning solution using a high pH tolerant nanofiltration membrane so that the life of the cleaning solution can be extended. This will save the client money on caustic purchases and on disposal costs.

Gezhouba Landfill

This customer has already purchased a full-scale VSEP system and New Logic is conducting pilot testing to confirm the performance projections given to the client earlier. During the storage of the solid waste used to burn to make energy, leachate is collected. Incinerating the leachate in the cement kiln consumes extra fuel and so, the client wants to volume reduce the leachate prior to incineration. The client wants to reduce the leachate volume by 75% and would discharge the treated water into the Yangtze river. Pollution controls have become quite strict for surface water discharge compared to what they used to be. New Logic will be pilot testing a VSEP LP with an RO membrane and a spiral pilot unit that will polish the permeate from the VSEP

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