VSEP Vibes Newsletter

Welcome to the New Logic Research Newsletter.

VSEP Coal Power Plant Wastewater

Coal fired power plants face very strict air and wastewater emission limits. One of the most damaging pollutant in the air emission is sulfur dioxide which forms an acid in the presence of moisture. This can cause acid rain if allowed to vent to the atmosphere. Today most environmental agencies require a power plant to fit a wet flue gas scrubber to capture the sulfur dioxide. These scrubbers can remove 80-90% of the SOx. This process is called flue gas desulfurization or FGD. As this is a wet process the pollutants are trapped in FGD purge wastewater. This wastewater contains mostly Gypsum with some market value, but also a wide variety of pollutants from heavy metals including Arsenic, Mercury, and Selenium.

VSEP FGD Samples Showing Precipitate in the Reject

Air pollutants now become water pollutants. The effluent must be treated to a very high standard before the water can be discharged. In most cases of high standards for discharge means the water could also be reused by the power plant. The

effluent is saturated with Gypsum and much of this can easily be removed by gravity with a clarifier. After that the water must be purified to remove the heavy metals. Because this water is saturated and will scale very easily, filtration with membranes is a problem, except with the VSEP vibratory RO membranes. VSEP does not have limits for solubility and actually can work like a crystallizer where solids are precipitated during filtration. The other option is forced mechanical evaporation. But even the condensate from this may contain pollutants.

The New Logic Research VSEP RO membrane system can treat this effluent and reduce both capital and operation costs when used before evaporation. The VSEP can also be used to polish the condensate from the evaporator so that all treated water meets discharge requirement. The cost savings both in capital cost and operating costs are enormous. It takes 627 kWh of equivalent heat to evaporate 1 m3 of water. But, it takes only 7 kWh to remove 1 m3 of water using the VSEP RO as pretreatment. It makes sense to use VSEP to remove water as far as possible with the remaining concentrate going into an evaporator.

Since 2009, New Logic has been working on the FGD solution. The EPA has included VSEP as a best

available technology for treating this wastewater. With the new rules on discharge taking place, New Logic has been very busy with power plant customers. New Logic has now pilot tested 14 different power plants to treat FGD effluent. In addition, we have provided 17 other system quotations. All of these projects are in various stage of development. Orders for some of these systems have already been received and are in fabrication at New Logic's factory.

Pilot Test Results

Location	Flux Rate	Recovery	Feed TDS	Conc TDS
	GFD		mg/L	mg/L
Georgia	25.5	83.2%	17,448	63,544
Pennsylvania	30.0	67.0%	41,234	92,984
West Virginia	21.6	75.0%	16,000	59,000
Indiana	27.9	93.0%	7,700	57,000
West Virginia	24.3	78.8%	4,000	14,222
North Carolina	24.8	73.0%	24,600	105,200
Spain	29.5	55.0%	46,800	75,500
Georgia	29.8	93.5%	9,900	80,000
Carolina	14.0	69.0%	30,400	88,600
Tennessee	52.0	75.0%	9,900	37,000
Tennessee	54.6	85.0%	8,300	41,800
	30.4	**77.0%**	**19,662**	**64,986**

Based on several of these pilot tests, we typically see about 2% Total Dissolved solids in the effluent and can remove an average of 77% of the volume as clean water. This results in a small volume of concentrate with average TDS around 6.5% and in some cases as high at 10%.

VSEP's Bench Testing Lab

With our lab facility in Minden Nevada, we have set up an excellent bench testing lab with lots of space and capabilities. Our requests for bench testing increased rapidly last Spring and have continued to be brisk. We currently are running five LP VSEP pilot machines full time in our lab and these have been operated by three fulltime VSEP engineers.

The applications that have recently been tested include:

Urea Nitrogen Clarification
Biogas Effluent
Chemical Polymer Dewatering
Flue Gas Desulfurization (FGD)
Acetic Acid Purification
Bean Soak Water
Zirconium Purification
Dye Wastewater
PVC Latex
Sugar Beet Effluent

We currently have 13 bench tests upcoming and on deck. These applications include:

Boric Acid Purification
Biogas from Ethanol Effluent
Truck Manufacturing Wastewater
Catalytic Converter Coating
Wheat Pulp
Potato Wastewater
Condensate
Phosphoric Acid Purification

After conducting bench tests like this now for years, there aren't too many applications that New Logic has not seen before. This wealth of application knowledge is a benefit to our clients. For more information about bench testing or field pilot testing, contact Landon Graham at: lgraham@vsep.com

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Next EPA Target – Meat Processing Facilities

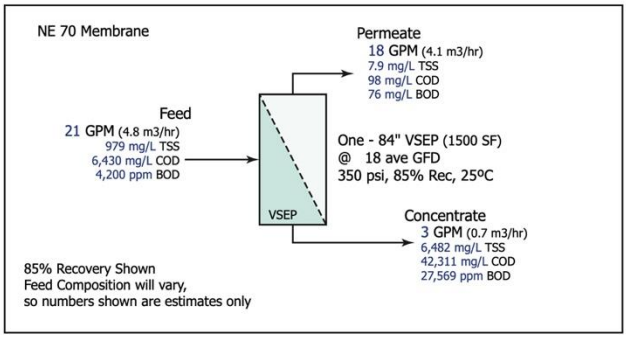
Now that food inflation has taken hold, people hope for stabilization and slowing of inflation. A new challenge has arisen that will have to affect the cost of meat and poultry. The EPA is initiating a new rule that regulates slaughterhouse and meat processing facilities. This new rule will take effect in August 2025. This is not much time for these companies to become wastewater treatment experts and to select the best technology

There are some of these facilities that discharge to surface waters and these 171 facilities in the US are already regulated by the EPA with discharge permit requirements. There are about 5000 facilities in total and most of them discharge wastewater to the municipal sewer where the effluent is treated along with the rest of the sewage. But as has become common, these municipal treatment plants are at capacity and have no plans for upgrades or expansion. So the burden shift upstream and industries are now required to pretreat effluent before sewering.

The new rule is a result of lawsuits filed by 13 environmental organizations. The new rule will apply limits on Nitrogen, Phosphorous, Oil & Grease, Suspended Solids, and Biological Oxygen Demand (BOD). The EPA estimates the total monetized benefits of tightening the wastewater standards would be $100M. It is not clear what the cost to industry will be to implement treatment systems to comply with this rule. The EPA estimates that between 16 and 53 facilities will close resulting in at least 17,000 job losses.

VSEP Pilot Test at a Belgian Slaughterhouse

New Logic has been approached by some of these facilities in the past, but this has mostly been to see if the economics would improve by installing our system instead of paying surcharges to discharge high BOD water. VSEP has been pilot tested several times. By using Nanofiltration (NF) the BOD can be reduced very significantly so that no surcharges would apply. A VSEP system could recover about 85% of the volume as NF filtrate that can be sewered. The remaining reject would be concentrated in organics and could make a nice feedstock to a biogas facility. Or, the reject could be evaporated to make a landfillable material.



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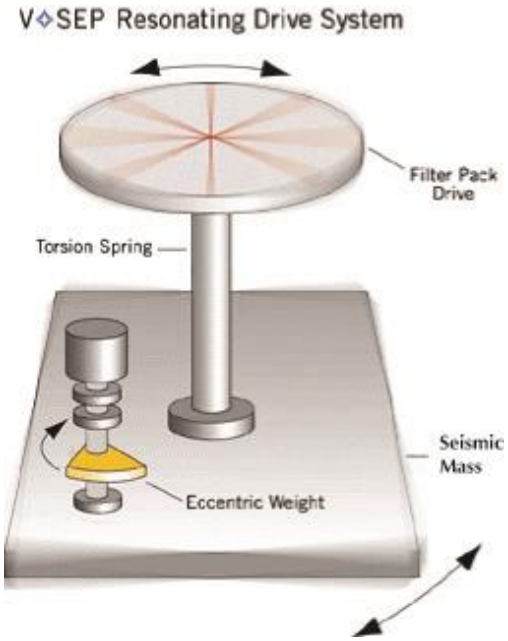
Word of the Day - Resonance

In physics, resonance refers to phenomena that arise as a result of matching periods of oscillating objects. For an oscillating system driven by a time varying external force, resonance occurs when the frequency of the external force coincides with the natural frequency of the object. Resonance can occur in various systems, such as mechanical, electrical, or acoustic systems, and it is desirable in certain applications, such as musical instruments or radio receivers. Resonance can also be undesirable, leading to excessive vibrations or even structural failure in some cases. A column of soldiers marching in regular step on a narrow and structurally flexible bridge can set it into dangerously large amplitude oscillation. On April 12, 1831, this happened when the Broughton Suspension Bridge near Salford England collapsed while a group of British soldiers were marching across.

Broughton Suspension Bridge failed from Resonance



All systems, including molecular systems and particles, tend to vibrate at a natural frequency depending upon their structure. This frequency is known as a resonant frequency. When an oscillating force, an external vibration, is applied at a resonant frequency of a dynamic system, object, or particle, the outside vibration will cause the system to oscillate at a higher amplitude than when the same force is applied at other, non-resonant frequencies.

The resonant frequencies of a system can be identified when the response to an external vibration creates an amplitude within the system. Small periodic forces that are near a resonant frequency of the system have the ability to produce large amplitude oscillations in the system due to the storage of vibrational energy. Resonance phenomena occur with all types of vibrations. Resonant systems can be used to generate vibrations of a specific frequency like musical instruments. VSEP employs this resonance phenomenon to oscillate or vibrate the parallel discs of membranes in the filter pack. The VSEP vibratory base is composed of a large mass at the bottom with a torsion spring connecting that to a filter pack mass at the top. This structure has a natural resonant frequency of about 50 hz. The external force used is an eccentric bearing. When this bearing speed increases and matches the natural resonant frequency of the structure, the filter begins to oscillate or vibrate with an amplitude of about ½" reversing direction 50 times per second.

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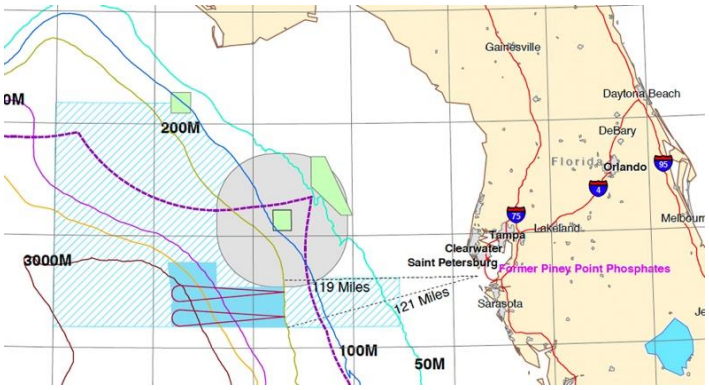
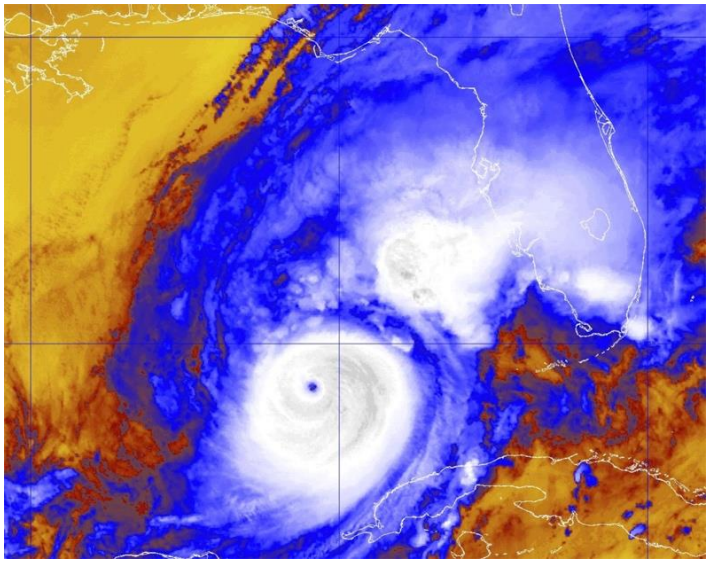
Phosphate Mining Legacy

As I am writing this, I am watching hurricane Milton approach Sarasota Florida with a track that will pass through a heavily populated area in central Florida around Lakeland and Disneyworld. They expect the storm to make landfall as a Cat 3 storm with storm surges of up to 15 feet around the Tampa Bay area. They are calling this a once in century storm.

The area inland from there has the largest activity of Phosphate mining in the world. The acidic radioactive wastewater produced during mining Phosphate is stored in enormous ponds called Gyp Stacks because they contain a lot of acidic Gypsum. These ponds are above ground lakes that are surrounded by earthen berms. A failure of these levies would be an environmental catastrophe. There is no plan to treat this water and make it go away. The current plan is to someday cap these and hold the water there indefinitely. But there are questions about the safety of this and how long the earthen structures will last. An assault by a strong hurricane presents an imminent danger. The danger includes wind and rain damage to the earthen walls and also an overtopping of the pond due to heavy rains that will accompany the storm.



Proposed Ocean Dumping Site for Gyp Stack Water



A few years ago, the earthen structure at a mining operation owned by Piney Point was in danger of failure and seepage was discovered at the base of the berm. An emergency plan was developed to empty the Gyp Stack by hauling the effluent on barges and then dumping it untreated 120 miles off the coast of Florida. This would cause environmental damage but would not be as bad as a berm failure in a highly populated area

Phosphate mining is concentrated in areas where deposits of phosphorous exist. These places include Florida, North Carolina, Wyoming, Idaho, Ontario, Saskatchewan, Queensland Australia, Morocco, and Jordan. The process of mining Phosphorous ore involves first removing about 25' of overburden. The phosphate rock is removed using a dragline and sent to a washer where large clay balls are pulverized and removed. The remainder passes through a shaker screen where sand and phosphate pebbles are recovered. This slurry is sent to a floatation basin where the sand and phosphate are separated. The sand is saved for reclamation and the phosphate is dewatered and stored in stockpiles. The stored phosphate rock is

shipped by rail to the processing plant where it is finely ground to a uniform size and mixed with Sulfuric Acid. The result is Calcium Sulfate and Phosphoric Acid. The Calcium Sulfate (gypsum) is removed by filtration to clarify the Phosphoric Acid. 3 H2SO4(l) + Ca3(PO4)2(s) + 6 H2O(l) = 2 H3PO4(s) + 3 CaSO4-2H2O(s)

Above Ground Earthen Gypsum Stack

After the Phosphoric Acid is removed a large volume of acidic effluent containing Gypsum is generated. The problem of this stored effluent has been known for a long time. In 2004, New Logic was contacted by several Phosphate mining companies in Florida and conducted pilot trials in cooperation with the industry organization Florida Institute of Phosphate Research (FIPR). The work was done for the Piney Point facility that later developed the berm problem. The results of the testing were excellent and showed that the VSEP RO system could recovery 85% of the volume as treated water at a very high flux rate of 30 gallons per square foot per day (GFD). The discharge limits were given at 0.5 mg/L Phosphorous (P) and 40 mg/L total dissolved solids (TDS). Even though the starting effluent had P as high at 1000 mg/L and TDS at 8000 mg/L, New Logic demonstrated that with three RO passes, we could achieve the discharge limits. Capital cost and operating cost estimates were provided at the time, but nothing was ever done. We could have volume reduced the effluent pond by 85%. A few years later, the berm failed and emergency measures were taken to prevent a catastrophe.

Satellite Image of Mosaic Gypsum Stacks

Similar environmental disasters have occurred in North Carolina during hurricanes where storage ponds are also use for liquid manure from the many pig farms there. There are more pigs in North Carolina than there are people. Several of these failed completely during a large hurricane event and let loose huge volumes of untreated manure into surrounding surface waters. It is just a matter of time until the problem repeats in Florida unless something is done about these Gyp Stacks.

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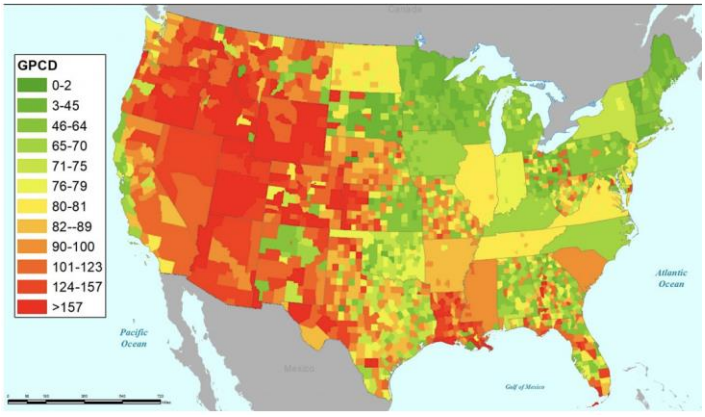
Water Recycling

We recycle plastic bottles, batteries, aluminum, and many other products. Recycled PET plastic bottles are used to make carpeting. Recycling as a way of preserving resources can make a lot of sense. It is not always sensible or economical and sometimes costs more to recycle than it does to start with the basic raw materials. We focus on finding sources of renewable energy to meet the energy needs of a constantly changing way of life. Electric cars and data centers will consume more and more power. Infrastructure needs to be planned for this. Microsoft is investigating using micro-nuclear power plants for their data centers. As world populations continue to grow, electrical and power needs will increase.

Water is a resource that is limited. Even though 70% of the Earth's surface is covered by seawater, the amount of fresh water available is limited and precious. There has been focus on water conservation especially during drought periods, but very little has been done with water recycling. Instead of using water once and then throwing it away, it often makes more sense to recycle the water at the point of use.



You don't think about energy when you think of water. But, it requires a huge amount of work energy to extract, store, and deliver safe water to the point of use. It takes even more energy to make the used wastewater go away. The industry organization, EPRI, estimates it takes an average of 2.6 kWh of electrical energy for every 1000 gallons that runs through the system. In the Western United States where the per capita use is the highest, each person might use 50,000 gallons per year requiring 130 kw of energy. Multiply that by the total population and it is a significant amount of energy just to move water in and out of the point of use.

A typical VSEP wastewater RO system uses about 0.5 kW/1000 gallons of energy to treat wastewater and recycle the clean permeate for reuse. Recycling the water in this way consumes only 20% of the energy it takes to deliver the fresh water and handle the wastewater. If this was done on a large scale, the energy savings would be very large. Just as producing Aluminum from

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Bauxite ore requires a huge amount of energy and recycling aluminum requires only a fraction of that, recycling water also can reduce the overall power needs and infrastructure requirements.

In addition to the benefit to society by reducing the overall power requirement for water, there can be considerable cost savings for the water user who pays for town water and for sewer discharge. The American Water Works estimates that the average cost for commercially used town water is $5,56/1000 gal. The cost of wastewater discharge is an average of $6.86/1000 gal. The total is more than $12/1000 gal. A typical VSEP RO wastewater treatment system costs about half that to operate.

So industrial water recycling from effluent can result is a 80% reduction in power consumed and a 50% reduction in cost savings for water used and effluent discharged. Water and wastewater are not always top of mind for commercial users and more focus is given to efficiency in producing the product that they make. But water is used for everything that is made. Wastewater is also generated. Improved efficiency in these areas can improve the overall operations of any company.

New Logic is Expanding

New Logic started out in a small warehouse in 1987 and has been growing ever since. Even though we recently moved our operation to a 30% larger building in Minden Nevada, we have quickly outgrown this facility. During the last year, we received 17 different system orders and at one time had filter pack orders for 82 filters. New Logic has been hiring new workers to keep up with demand. But, it has become clear that even our new facility will not be large enough.

To account for future growth, New Logic has purchased a 2 acre empty lot next door to its existing facility where we will build a new 26,000 square foot manufacturing building. The new building will be a clean room type facility where the filter pack manufacturing will be moved to. This new facility will allow for a larger assembly area for filter production and will then free up space in the existing facility for more system skid fabrication.

New Logic has hired a local design company to begin final plans and to complete the permitting process. Completion of the new building is expected by the end of 2025 or early 2026.

Site of New Logic's Planned Expansion

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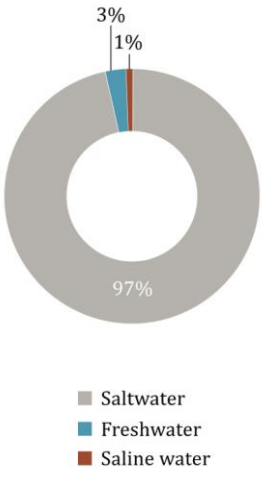
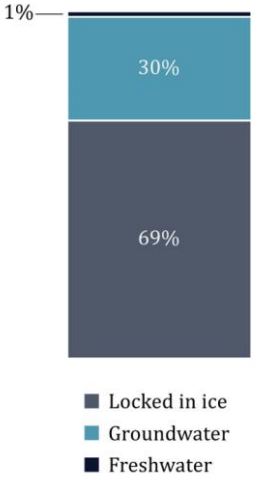
Water is a Fixed Amount

The ERM Sustainability Institute recently issued a report highlighting the need for action on water infrastructure. Just as changes to the way we produce energy are being advanced, our use and storage of water needs an upgrade. Water wars are common in California, but water scarcity could soon be coming to a neighborhood near you. The report makes several points:

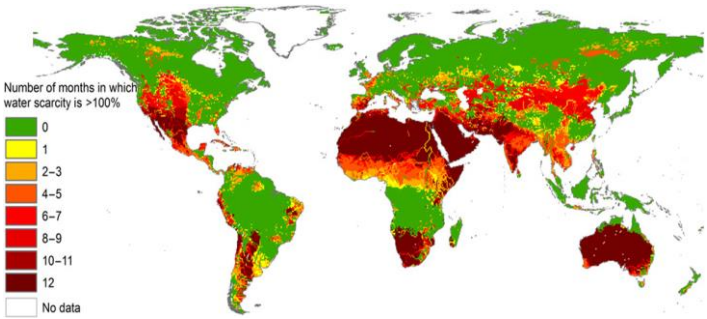
- Digitalization has increased the mismatch between supply and demand
- Existing water infrastructure is at the end of its useful life
- Emerging regulations (PFAS) have the potential to increase the cost of water
- Capital is being deployed but there is a $91 B gap compared to the need
- Water prices charged do not reflect the actual cost of water
- Access to water will become a critical strategic decision for corporations
- There is a market opportunity for circular water systems (VSEP)





Just as the production of Bitcoin is now using vast amounts of energy, new data centers are using huge amounts of water for cooling the servers that store the data. Data Centers have been located near sources of clean plentiful water. This water is used in cooling towers where the water is recirculated as a coolant. During the process, the water heats up and a large percentage of the water evaporates. As this happens, the dissolved solids present in the source water are concentrated. Because this closed loop cannot go on indefinitely, a purge or "blow-down" must be used to remove salt from the loop. This brine is wasted and put back into the environment.

A mid-sized data center can use 300,000 gallons per day. Larger data centers can use as much as 1 to 5 million gallons per day. Out of this about 75% evaporates and 25% is wasted as brine blowdown. New Logic has installed several systems to treat the brine blowdown to minimize the reject volume of salt brine. Our typical cooling tower blowdown project can recover 85% of the volume of blowdown that can be recycled to the cooling tower to reduce the load on raw water sources.



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In addition to public investments in water infrastructure, the public can participate by investing in these kind of water recycling projects. Many of the companies that operate data centers like Microsoft make big marketing claims about sustainability, but lack much effort when it comes to the resource of water. Power plant companies who have difficulty in discharging cooling tower brine have already made significant investments in water recycling. It will take a multi-pronged approach to solve the coming water scarcity problem. The digital universe needs to start to address this issue as well.

Age has its Benefits

1987 was a long time ago. Back then, cell phones did not fit in your pocket. Computers were more like word processer that were better than a typewriter. Back then, there used to be phone booths. In 1987 New Logic started like Hewlett and Packard by two guys in a garage. The two founders were Ric Johnson and Brad Culkin. It took almost a decade to develop the design and have fully commercialized product. The first couple of system sales were hard because we did not have any references. So we mostly engaged with risk takers who believed in us. 37 year later, we are still here and have hundreds of customers worldwide. The name recognition of VSEP has grown exponentially. Almost all the projects we install now are applications that we have done many times. We don't do any marketing and all of our business comes from word of mouth. The hardest thing in the early days was that we needed to sell systems to generate revenue. Selling systems was very difficult with no references and a first generation design. One of the tricky questions we got was: "What is the expected life of the equipment?" Of course all we could do was guess. But now 37 years later, we have the data to back it up. Our longest running system is for an electrochemical machining company who manufactures turbines and aircraft parts. They took the risk and installed a system in 1997 that Is still running strong today. So we can say with authority that the equipment should last at least 27 years. The filters are consumable and they have replaced them every 4 or 5 years since the beginning. Amazingly, the project manager for that company is still in charge of the VSEP system. We have many other examples of long running systems out there now.

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