VSEP Vibes Newsletter

Welcome to the New Logic Research Newsletter.

Acid Purification for Nolans Rare Earths Project

New Logic has recently completed simulated pilot testing and modeling for a Rare Earth Metals mine in central Australia for the company developing this project, Arafura Rare Earths. The pilot testing involved purification of Phosphoric Acid and Sulfuric Acid using New Logic's VSEP Nanofiltration (NF) technology. The vibration of the membrane that occurs with the VSEP limits fouling and scaling and allows for filtration of strong acid slurries that contain suspended solids including those that may be saturated in solubility where crystallization may occur. VSEP does not require pretreatment and unlike ion exchange will capture impurities without regard to selectivity.

The completion of the test work has shown that the VSEP NF filtration system is able to purify the Phosphoric Acid to meet merchant grade quality so that this acid can be sold as a value added product. The VSEP was also able to purify the Sulfuric Acid stream to a level where it can be recycled in the process. To highlight this success, New Logic and Arafura Rare Earths will be working together to present a technical paper on the results of testing.

ALTA 2023 27 YEARS
1 - 5 May | Perth, Australia

The paper is co-authored by Dr. Alex Elliot and Lourdes Valle of Arafura Rare Earths and by Landon Graham and Greg Johnson of New Logic Research. The paper will be presented at the ALTA 2023 conference in Perth Australia. The annual ALTA conference is a world-class metallurgical conference now in its 27th year and will be held at the Pan Pacific Hotel, Perth Australia, on May 1-5. The themes running through the conference reflect key current and developing technology trends.

The title of the paper is: *NOLANS RARE EARTHS PROJECT: INNOVATIVE RECOVERY AND PURIFICATION OF PHOSPHORIC ACID BY VSEP NANOFILTRATION*

Portions of the Abstract:

"The Nolans Rare Earths Project is the only undeveloped advanced ore to oxide rare earths project of scale in the western world. It is designed to produce 4,400 tpa Neodymium-Praseodymium (NdPr) oxide, 470 tpa mixed middle-heavy rare earths (SEG/HRE) and 144,400 tpa of 54% w/w P2O5 Merchant Grade Phosphoric Acid as a by-product.

The leaching of these minerals with phosphoric and sulfuric acids produces excess phosphoric acid along with some thorium, uranium, iron, calcium, magnesium, and other cations, co-extracted during the process. The management of this process stream posed a challenge due to requirements for neutralization, disposal, and containment.

Arafura has since capitalized this challenge into an opportunity, using New Logic Research's innovative VSEP (Vibratory Shear Enhanced Processing) nanofiltration technology. The VSEP nanofiltration membrane effectively recovers more than 70% of the phosphoric acid and rejects majority of the cations including thorium and uranium to meet the merchant

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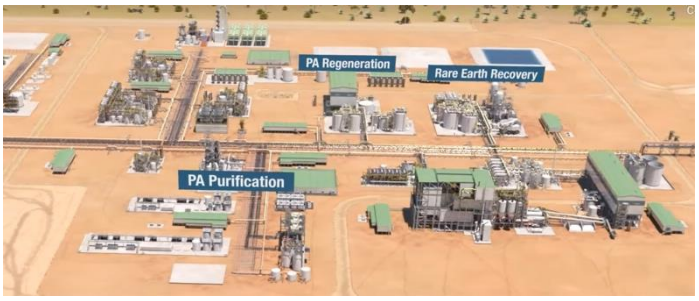
grade specifications using an acid-proof membrane. The technology is also used to control the recirculating load of impurities from recovered mixed phosphoric and sulfuric acids to the process plant. Unlike traditional spiral wound nanofiltration, VSEP can tolerate high suspended solids and calcium saturated feed.

The recovery of phosphoric acid contributes to the economics of the project. Also, the purification of the recycled mixed acid enables major operational flexibility, since it liberates the upstream pre-leach circuit from operating at a very tight range of major impurities. This renders the purification circuit an integral part of the overall Nolans project flowsheet.



This paper aims to share some of the VSEP nanofiltration test work results and its translation to the engineering design of the Phosphoric Acid Recovery and Purification. It also highlights the strategic importance of the circuit to the overall flowsheet, and therefore the technical and economic performance of the Nolans Rare Earths Project."

A full copy of this Abstract can be found here. Arafura-New Logic Abstract

Customer Service

The sale of a VSEP system to a client is only the beginning of a project. New Logic provides lifetime customer support to each of its customers and assigns a project manager to each project. We offer remote access to each system so that our engineers can help troubleshoot problems as quickly as possible. We take this commitment very seriously. We know how frustrating it can be to try to connect with tech support and talk to a real human being. You can reach our engineers 24/7 for any problem that you might encounter.

Recently, our Alex Goodman was assisting a customer in Florida who has been running his system for about a year with some programming bugs. Alex was able to edit the program and fix the problem and got a very nice reply from the operations guy:

Alex, Thanks for this detailed write-up. I will save it for our records and await a quote for the spare parts. We will plan for a 2-3 day visit like this every year during our annual outage.

Thanks again for yall's help. We have been very satisfied with the performance of this system over the last year but above all we have been impressed with the quality of your service!

Have a great weekend,

Ben, Fiber Line Manager

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How VSEP Got Started in 1987

Ric Johnson and Brad Culkin met at a party one time and realized that they could join forces and create a new company. At the time, Dr. Brad Culkin had started up a speaker company with his brother-in-law called Velodyne that made sub-woofers. A speaker is a resonating membrane and when electrical current is applied the speaker makes a sound. Brad possessed a Ph.D. in Chemical Engineering and Ric was just out of business school, so it seemed like a good match. They rented a small warehouse in Emeryville California and set about to make a vibrating or resonating membrane device to filter liquids.

Ric Johnson, using his business proficiency and his best suit encountered a pharmaceutical company that wished to develop a desktop blood separating device that a doctor could use in the office for immediate test results. They set up a meeting and Brad described the device technology that they could produce. The two guys got the order and proceeded to develop the first vibrating membrane instrument using resonance.

The company was started with no seed money and by two guys just out of college with a lot of hopes and dreams but very little cash. This order and the money from it got the ball rolling. Several other subsequent R&D development projects were also negotiated by Ric and implemented by Brad and it soon became clear that they was a lot of opportunity and a big market for this kind of device. So the VSEP grew in size from a desktop device weighing about 6 pounds to a huge 16 foot tall 5000 pound machine capable of processing just about any kind of liquid.

Converting Manure to Drinking Water

The efficacy of separating clean water from liquid swine manure as a source of drinking water for pigs was evaluated in a trial at Ridgetown College, University of Guelph using New Logic's VSEP vibratory RO membrane system. The VSEP employs the use of oscillating vibration, which controls the effects of "concentration polarization" that limits permeation of conventional crossflow membrane systems. Studies have shown that the VSEP is capable of 5-15 times the permeate flux per unit of area when compared to conventional membrane crossflow systems. The use of vibration to control

membrane fouling by suspended solids has increased the number of applications where membrane filtration can be used now. This includes liquid/solid separation of liquid swine manure. New Logic has installed about 20 raw manure or digested manure projects.

During the Ridgetown College study, water was recovered from liquid pig manure using the VSEP LP Pilot unit. The VSEP was fitted with an reverse osmosis (RO) filter pack. The quality of the recovered water or permeate was assessed and provided for drinking water to young pigs.

The controlled study used different drinking water for three groups of pigs. The water provided to the three groups included regular barn water, half barn water and VSEP permeate, and VSEP permeate only. A total of 54 pigs were allocated to 9 pens of 6 pigs each. All pens were balanced for sex with 3 barrows and 3 gilts being allocated to each pen. The data collected included initial and weekly body weights, daily feed consumption and feed consumption on a pen basis. Mortalities and their causes were recorded. Morbidity of the pigs was assessed in several ways including their growth performance, frequency of treatment, and the levels of feed and water consumption.

Results showed that the VSEP produced water from liquid manure at a quality level acceptable to pigs. The data revealed that no performance or health effects resulted from providing the recovered water from liquid manure to young weaner pigs (12 - 26 kg liveweight). The pigs drank as much of the permeate from the VSEP as the normal barn water supplied to the pigs. It can be assumed that if young pigs will accept this water with no seemingly ill effects, then the water should be quite acceptable to older pigs.

Parameter	Barn water	50%/50%	Permeate
Initial Wt. (Kg)	12.4	12.4	12.6
Week 1 Wt.	15.0	14.9	15.3
Week 2 Wt.	17.8	17.8	18.3
Week 3 Wt.	21.8	22.1	22.7
Final Wt. (Kg)	26.6	26.9	26.9
ADFI (Kg)	1.20	1.18	1.23
ADG (Kg)	0.50	0.52	0.51
F/G	2.38	2.28	2.40

ADFI - average daily feed intake
ADG - average daily gain
F/G - Kg feed per Kg gain.

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EPA Regulations in the Pipeline

In 2020, the EPA had 13,758 employees distributed over 10 regional offices. The annual budget for the EPA was 9 Trillion Dollars. When the agency was formed in 1970, it had 5,800 employees and an annual budget of $1.4 Billion. While the number of employees has not quite tripled, the annual budget has increased by 6,000%.

From the period between 1995 and 2006, there were 88,899 federal regulations that took effect. Staying current on new rules and regulations can be daunting for industry especially when the rules change over time. Some significant new rules are under consideration.

1] The EPA is considering a new rule on Chromium in drinking water that would lead to a limit 3000 times lower than the current value. The draft assessment would lead to a drinking water limit of 35 parts per trillion versus the current federal drinking water standard of 100 parts per billion of total chromium. The assessment is not consistent with the decisions of other prominent science and regulatory bodies around the world. For example, in 2020 the World Health Organization issued a final background document that recommends retaining the current WHO guideline value for total chromium (50 ppb) based on newer, high-quality data from chronic drinking water carcinogenicity studies noting that the overall weight of evidence supports this level as safe.

2] EPA will collect a wide array of data early next year to develop its wastewater discharge rule to control PFAS from surface finishing operations. Specifically, EPA has prepared a mandatory questionnaire to be completed by surface finishing facilities that have conducted chromium plating processes and have used PFAS.

3] EPA has issued guidance to states and POTWs on how it can use existing permit authorities to reduce PFAS in water discharges. While EPA's Office of Water works to develop industry-specific Effluent Limitation Guidelines (ELGs) and water quality criteria for PFAS discharges, this guidance identifies steps that states, publicly owned treatment works (POTWs), and industrial dischargers can implement under existing authorities to reduce the discharge of PFAS. This guidance includes monitoring of industrial users that are suspected of being potential sources of PFAS.

4] California state air authorities plan to finalize a rule to phase out all chrome electroplating and anodizing. The rule is expected to be finalized by the summer of 2023. By January 2024, the rule would prohibit any new permits for new facilities. By 2026, existing Chrome plating facilities would need to implement control requirements which are yet to be determined. By 2039, all Chrome plating operations in California would be banned.

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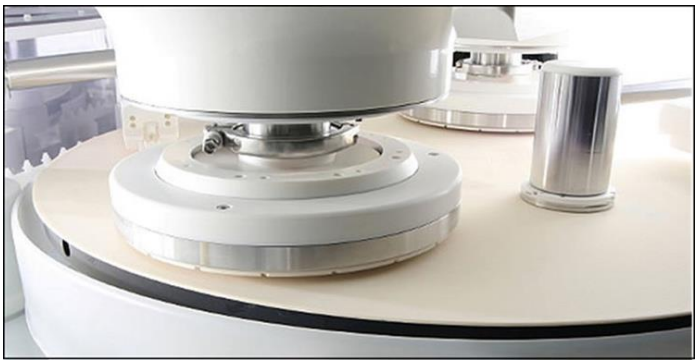
VSEP Treats Wafer Fabrication Effluent



IBM developed the first polishing technique for semiconductor wafer fabrication in the 1980s. The process is known as chemical mechanical planarization (CMP). The process involves chemical and mechanical (abrasive slurry) polishing of wafer surfaces. The abrasive materials can be fumed silica, alumina, or ceria. Many other organic and inorganic additives are used as part of the chemical polishing part.

With polishing and cleaning, a wastewater stream of about 10 Liters (2.6 gallons) is generated for each wafer produced. The wastewater can contain as much as 3-12% total solids and needs to be treated by removing nano-particles and chemical contaminants prior to discharge. A typical fab plant will use about 1000 m3/day of electronics grade water where 30-40% of this is used for the CMP process.

Traditional chemical coagulation/flocculation treatment processes involve high dosage of chemical electrolytes such as Alum and Ferric Sulfate to help solids agglomerate and settle down for removal through subsequent filtration. This leads to high operational costs due to high chemical demand and sludge disposal costs. Also, this method is unable to ensure a high separation efficiency for the typical contaminant concentrations.

In 2015, New Logic installed a VSEP with a 0.05 µm microfiltration membrane to filter CMP slurry effluent for a wafer fabrication plant in California. This was a relatively small operation and the client was previously paying to haul the effluent generated. They were hauling about 300 gallons per day at a cost of $1000/day. They wanted to install a wastewater treatment plant to reduce operating costs. They installed a P-50 VSEP with MF to remove the nano-sized particles. The filtrate is passed through a cation exchange resin to make water clean enough to discharge to sewer. The VSEP is able to volume reduce the effluent by about 90-95% with a flux rate of about 70 GFD (122 LMH)

Their production rate has grown and the P-50 VSEP is now handling about 1000 gpd. Only periodic hot water flushing is used for cleaning. The customer has drastically cut their operating costs and the purchase of the P-50 VSEP paid for itself in only a few months of operation. The VSEP reject is a very thick slurry and this is put into 55 gallon drums for disposal by truck. It is only a very small percentage of what they used to haul.

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Get to Know New Logic – Sarah Anderson

We like to spotlight the people at New Logic. No matter how good your technology is, unless you have quality people behind the product, you will not last the test of time. Of course we have many skilled engineers with fancy titles and lots of education, but we really rely on the craftsman to make a design into reality and be of superior quality. During College, I worked as a carpenter to help me pay for college. While doing that, I always envied the carpentry of days gone by. Before power tools and modularization, trades like carpentry and masonry were like art forms. Building fine architectural structures was like a piece of art just like a fine painting or a life-like sculpture. It is this craftsmanship that is rare and really fine. Engineers use their brain to build things; craftsmen use their brain and their hands to create something of purpose and beauty.

Sarah recently joined New Logic and is one of these exceptional craftsmen. Sarah lives in Genoa Nevada which was founded in 1851 and was the first settlement in what became the Nevada territory. It is not far from Minden and New Logic and is also home to the oldest bar in the state opening in 1853.

Sarah has quickly mastered the assembly of our LP pilot units. In addition, she is building our Series B and P-50 VSEP units and more of New Logic's line of filtration equipment. Before coming to New Logic, she was working for a company installing lift kits on pickup trucks. She is a very skilled mechanic and can visualize what the machine should look like before starting. She knows when something is not fitting right and how to remedy that. Just like you hope for a skilled mechanic when you take your car for repairs, New Logic now has a top notch craftsman building our machines. If you purchase a LP or P-50 VSEP from New Logic, Sarah made it.

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Lithium Extraction from Brines

Demand for Lithium that is used for electric vehicle batteries is growing and will soon out-pace the production levels currently in place. Lithium is abundant in various deposits and salty lakes, but is very difficult to isolate and purify since it is found in a soup with other alkali metals. The extraction and purification of Lithium has been very widely studied for many decades. A simple and economical direct extraction method has yet to be found. For Lithium in brine solutions, the treatment methods are multi-stage processes involving very complex flow sheets. One method includes pre-treatment to remove some impurities followed by organic or inorganic absorbents such as an ion exchange resin. The difficulty with this process is the selectivity for Lithium when many other alkali and alkaline metals are present. Another process involves various precipitation steps to remove things like Magnesium and Calcium followed by a solvent recovery process. Solvents can include supercritical CO2, methanol, or ethanol. The most common process for treatment of brines is to use large solar evaporation ponds in series. Due to the varying solubilities, metals, sodium, and potassium can be precipitated in the early stage ponds finally purifying the Lithium Chloride and then concentrating it in the later stage ponds.

For many years people have explored the idea of harvesting metals or nutrients from brine waters. In 2005, New Logic conducted bench scale studies to look at the idea of extracting Potassium from a sample of Dead Sea brine. In this case, Nanofiltration membranes were used to selectively allow Potassium Chloride to pass through the membrane and to reject as much Magnesium Chloride as possible. A good separation was possible when using a 150 Dalton NF membrane, however, because the Dead Sea brine tested was about 30% total solids, the flux rates were low and the pressure needed was very high. Subsequently, we tested more open NF membranes with sizes between 200 and 300 Daltons. The selectivity was not as good, but the flux rates and pressure used were much better. We then proceeded to use three passes using these more open NF membranes and by doing multiple passes were able to achieve a final separation between Potassium and Magnesium that was acceptable.

VSEP Dead Sea Brine Samples

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New Logic has done work using membranes to compliment the process of Lithium extraction. The same issues with selectivity exist for Lithium. But, New Logic believes that a VSEP NF system could be used as a pretreatment step to remove a significant portion of the multivalent metals and other contaminants making downstream processing more efficient.

There are several current and planned lithium brine projects where the total dissolved solids concentration is far less than the Dead Sea project making the use of tighter more selective NF membranes possible. For example, the Silver Peak mine in Nevada operated by Albemarle is simply brackish water with low TDS levels. NF could be used here to remove nearly all of the Magnesium, Calcium, and Iron prior to evaporation.

Another brine type Lithium recovery prospect is the Geothermal brine generated at several power plants near the Salton Sea in Southern California. The lower TDS level would allow 150 Dalton NF membranes to be used for multivalent ion removal leaving only monovalent ions in solution. One of the complexities of this particular brine is the presence of high levels of Silica in the geothermal water. Silica concentrations can be as much as 340 mg/L. This would preclude the use of conventional membranes due to the fouling nature of Silica at these levels. The VSEP system, however, is not limited by Silica scaling or by other solubility limits.

In addition to the possible use of Nanofiltration to remove multivalent ions and other impurities, VSEP with an RO membrane can be used to remove only water to volume reduce the brine prior to evaporation ponds or other treatment methods. This may be able to reduce the volume by 75% or more making the size of evaporation ponds much smaller and the size and cost of other treatment processes smaller as well.

A third possible use for VSEP would be filtration after the chemical treatment step where Lithium Hydroxide is added to a brine to precipitate Magnesium, Copper, Nickle, and Calcium. In this case a VSEP with an Ultrafiltration (UF) membrane can be used without fouling to remove 100% of the precipitated metals.

About the newsletter author:

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