VSEP Vibes Newsletter

Welcome to the New Logic Research Newsletter.

Rare Earth Mine Attracts New Funding

Did you ever wonder what a magnet is made of and how it became magnetic? There is one naturally occurring metal that is magnetic. It is called Lodestone which comes from the ore Magnetite. There is a group of other metals known as ferromagnetic materials. This group includes iron, cobalt, nickel, and some alloys of rare earth elements, mainly neodymium and samarium. These ferromagnetic materials can be made magnetic by exposing them to a magnetic field using electricity. Using a magnetizing fixture that directs current through the non-magnetized part, electrons in these metals are lined up making the material magnetic. Ordinarily, the enormous number of electrons in a material are arranged such that their magnetic moments cancel out. So magnetism has to do with the configuration of electrons and their relative orbits.

Neodymium is the strongest magnet that there is. The actual alloy is $Nd_2Fe_{14}B$. Neodymium is one of many of the Rare Earth Metals. They are called Rare Earth Metals, but that doesn't necessarily mean that they are hard to find. These are actually pretty plentiful. However, there are only a few places where these metals are mined and even fewer places where the ores are refined. The main mining areas are in China, United States, Brazil, India, Sri Lanka, and Australia. World reserves of Neodymium are estimated at eight million tons. The world's production of Neodymium was only about 7,000 tons in 2004. The bulk of current production is from China. The Chinese government imposed strategic material controls on the element, causing large fluctuations in prices. The uncertainty of pricing and availability have caused many companies to look to secure reliable supply of these materials outside of China. Many

80-Module VSEP System to be Installed in Australia

governments also realize that the supply chain issues are a national security risk and have sought to encourage development of domestic mining and refining capabilities.

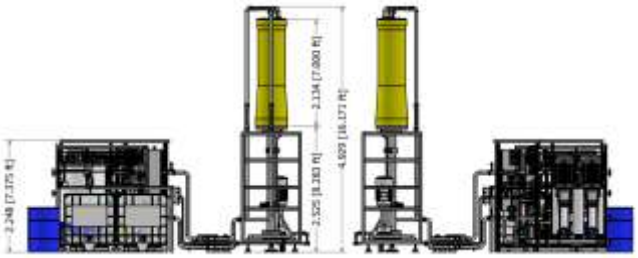
The supply of permanent magnet materials will need to increase substantially to meet the demand of a growing electric vehicle (EV) industry. EV and wind demand for Neodymium magnets may more than double between now and 2030. Some sources even suggest a quadrupling. China currently refines 90% of the world's Rare Earth Metals. Countries with EV expansion plans are looking to reduce dependence on Chinese exports. Today only 11 major mines and 7 major processing plants are found worldwide. 6 of the 7 refining plants are in China and 1 in Malaysia, as well as a smaller plant

in Estonia. New mines and processing facilities are under development in Australia and the United States. But these projects involve long time frames for their development. Strategic investments are necessary to build capacity outside China. Offtake agreements from equipment manufacturers and end users must be secured before investments become viable. Governments have a role in de-risking the necessary investments as well.

One of these new projects in development is the Nolans project being developed by Arafura Rare Earths Ltd. Arafura's Nolans project is a rare earth mine and processing facility in the Northern Territory of Australia near Alice Springs. The project is Australia's first vertically integrated rare earth mine where a single site mining and refining operation will provide a secure and traceable supply chain to meet domestic and international needs for these critical metals. The project will produce 4,400 tons per year of Neodymium-Praseodymium (NdPr) Oxide and 470 tons per year of mixed middle-heavy rare earth metals. Additionally a byproduct of the process is about 144,400 tons per year of Merchant Grade Phosphoric Acid.

Early development of the project is underway and Arafura has secured very significant offtake agreements with governments and automobile manufacturers. Arafura has also recently announced it has secured an additional $533 million dollar package of debt securities from the Commonwealth government. This added to the previous commitments amounts to $840 million Dollars in government funding. This along with private investments made puts the company well on its way to full project funding.

The leaching of these minerals with phosphoric and sulfuric acids produces excess phosphoric acid because of the high concentration of Phosphorous in the ore. The acid leach solution will contain thorium, uranium, iron, calcium, magnesium, and other cations, that must be removed to make the merchant grade acid that will be sold. The management of this process stream posed a challenge due to requirements for neutralization, disposal, and containment.



Arafura has solved this challenge and will be 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 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. Arafura is anticipating procurement of this large VSEP system soon and will be the largest VSEP project installed to date.

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Ningbo Plastic Recycling Exhibition

The plastic recycling industry is another area where a VSEP system can provide waste minimization and cost savings. After the plastic to be recycled is shredded, it is cleaned. This is done using a strong caustic solution plus a final rinse. The effectiveness of the cleaning is considered in the value of the final recycled plastic bits. Cleaning with caustic means large consumptions of town water and also handling and purchase of large amounts of sodium hydroxide. Because plastic is often recycled and made into food or water containers, simple caustic is used. The recycled materials cannot have residue of other types of surfactant cleaners. The caustic is effective and removing labels and glues from the previous use. Typically. The spent caustic and the rinse water must be discharged. pH adjusting for sewer discharge will be required. So, in addition to storing caustic, acids must be kept onsite as well.

The caustic cleaner can only be used for so long before it becomes spent. New Logic can provide special Nanofilter (NF) membranes that can tolerate high pH and can purify the hot caustic solution so that it can be reused. The hot caustic water can be recycled and reused in the process. The rinse water can also be recycled with a VSEP RO system. New Logic has installed VSEP systems for this purpose.

Recently, Edwin Wong, Zhang Bing, and Jason Choy hosted our New Logic booth at the plastic Recycling Exhibition held in Ningbo China. A LP VSEP pilot unit was set up in the booth with a simulated spent caustic solution so that exhibit participants could see this separation in action.

Many potential clients expressed interest in what they saw.

Ningbo is one of China's oldest cities with a history that dates back to 6300 BC. It has a population of nearly 10 million and ranks 12th in terms of GDP amount the cities of China

WWW.VSEP.COM Website Traffic

While most of our website visitors are domestic, we do get very strong international attention. We are still looking for that good VSEP Representative in Greenland.

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VSEP + WesTech Engineering = Solution

Pioneers tamed and built the West only 150 years ago. This was a unique period in human history. Brave souls left their rocky soil in Pennsylvania in search of a better way in the far frontier. In the 1800s, there were no roads, bridges, or cities in the Western half of the United States. This was not that long ago. It was the pioneer spirit that inspired these people to create what we have today. This pioneer spirit still exists today.

Infrastructure was non-existent at the time. It was the pioneers and the engineers of those days who built the roads, towns, dams, communication lines and other things that are required for settlement of this vast barren land. This involved many incredible engineering feats that are remarkable even today. A railroad system was laid and operational with unbelievable speed given the technology of the day. Railroad engineers had to figure out how to deal with the 3000 foot elevation change from the valley floor in Western Nevada to the top of the mighty Sierra Nevada mountains. Water resources had to be captured and stored to facilitate farming in this dry land to feed the ever growing populations. It was the early pioneering engineers who designed and built the Hoover Dam which is the largest reservoir in the United states. It has a capacity to hold 28 million acre-feet of water and today provides water to 20 million people.

New Logic Research and WesTech Engineering both hold to that pioneering spirit. New Logic is located in the Carson Valley south of Reno Nevada and WesTech Engineering is based in Salt Lake City Utah. Both have been in business for decades and are engineers who look for a better way. These two companies have been working together to provide solutions for customers that reflect the pioneer spirit and the best available technology.

WesTech and VSEP engineers Pilot Testing FGD

There are many engineering companies out there who do provide solutions. But many of them simply go to the engineering book and copy and paste the conventional treatment process for a client in need. It won't be the best solution, but is the one that is written down and has been used for 100 years. There is no risk in this and not much thought is required. Many times, these engineers recommend Roman technology to solve modern day problems. WesTech Engineering is different than most and through its experience and intelligent thought will do the leg work to provide the best and most suitable technology solution to its clients.

New Logic's VSEP technology is one of the tools that WesTech has utilized to solve difficult treatment problems for its clients, especially in the Power Plant industry. New Logic has been working with WesTech now for several years to design turnkey treatment plants where the VSEP is the heart of the technology solution. The two companies recently completed a full-scale long

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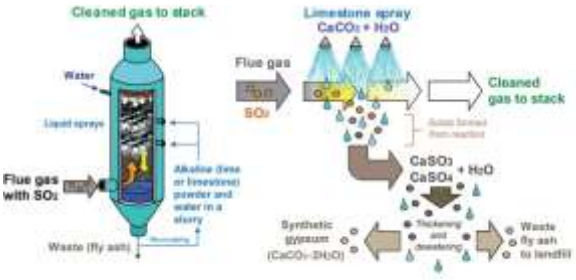
term pilot at a power plant to provide a treatment solution for the flue gas scrubber wastewater known as FGD or Flue-Gas Desulfurization.



Many years ago, coal fired power plant would emit Sulfur in the exhaust flues from the combustion of coal to make electricity. When the Sulfur comes in contact with the moisture, Sulfuric Acid is created and this then causes acid rain. Then, these companies installed flue gas scrubbers where a water mist is sprayed from the top to clean the exhaust gas and remove Sulfur. This then created an effluent problem. This effluent contains Mercury, Arsenic, Selenium and other toxic substances. Regulations on the discharge of this effluent have evolved over the years and new strict limits of these pollutants are now in place. So, this then requires another transformation in water treatment that the power plants must provide. WesTech and New Logic are providing the cutting edge new method that employs the VSEP vibrating membrane system to eliminate the toxic materials and to make water that is clean enough to discharge or reuse.

For more information, contact:
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Another Biogas Effluent VSEP Project

New Logic has installed 33 Biogas effluent projects worldwide. Anaerobic digestion is one of the oldest processes used for stabilization of sludges. In an anaerobic digester, complex carbohydrates are converted to methane and carbon dioxide. Only the anaerobic process can be used for methane recovery in order to generate electricity. The methane is burned to power a generator. This process occurs in a closed system and requires 30-60 days of retention time. The residual sludge will contain many of the nutrients for fertilizer, by much of the nitrogen escapes in the forms of methane. One benefit is that the remaining sludge is pathogen free and nonputrescible.

As with the human stomach, digestion is very effective at consuming organic matter and converting it to carbon dioxide, water, and energy. Digesters can reduce some inorganic materials, but only those that can be settled. The problem is that manure and feedstock for biomethanization contains much more than

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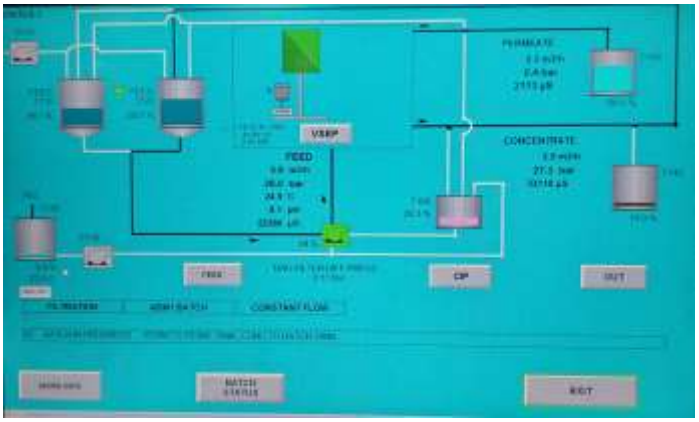
organic material and solids that can settle. The remaining effluent is still potentially harmful if not treated in the proper manner. The digester will have little or no effect on things like chlorides, nitrates, phosphates, potassium, and sulfates. Digesters are also not capable of eliminating metals such as sodium, calcium, magnesium, iron, aluminum, copper, and zinc.

Digesters can produce methane, but is not a complete water treatment solution by itself. In each case, the remaining effluent water would need to be land applied or disposed of safely in some other way. Direct surface water discharge would not be possible. VSEP membrane filtration can be used effectively to treat the effluent from a biogas plant for surface water discharge. In addition, the VSEP system will concentrate many of the nutrients contained in the effluent and can yield a profitable value added stream of concentrated fertilizer that can be shipped as a slurry, or dried to make a dry fertilizer.



Most of the VSEP projects installed are in areas where land application of the effluent is not possible. This can be because of limited space and over-fertilization of the land like in Belgium or Korea. It can also be places like Canada and Lithuania where the ground can be frozen for most of the year and land application is only possible for a few months every year.

New Logic has recently commissioned a VSEP system to treat biogas effluent for a company called Tium in South Korea. The system consists of a single module VSEP RO module plus two stages of Spiral RO polishing. After three passes of RO, the Ammonia level is reduced from about 4,000 mg/L to <15 mg/L. The digester effluent has very high suspended solids level that are screened ahead of the VSEP system to remove particles that are larger than 100 microns. Even with this screening, there is a large concentration of suspended solids that pass through the VSEP system and are concentrated in a batch process. New Logic has been installing 2 or 3 of these kind of projects each year.

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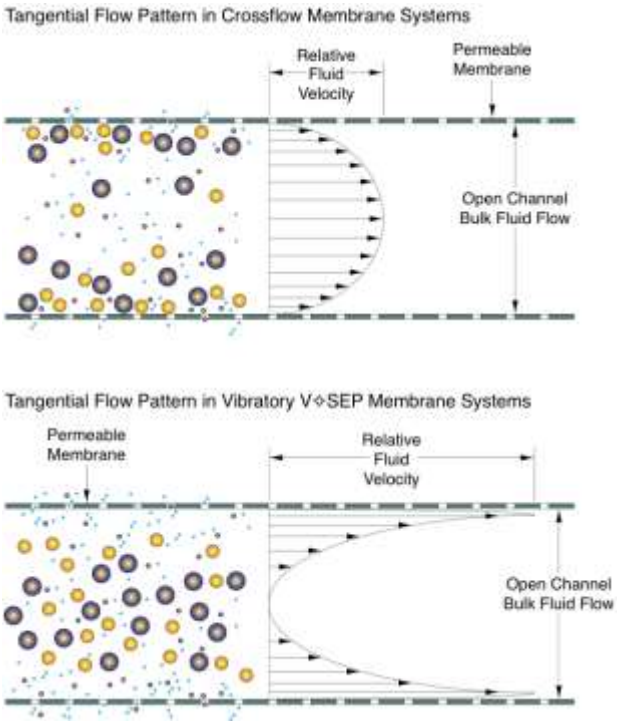
Membrane Terms – Concentration Polarization

As water passes through the membrane and dissolved solids are rejected by the membrane, a more concentrated layer of solids is formed near the membrane surface. This leads to a concentration gradient. The salt concentration near the membrane exceeds the salt concentration in the bulk solution. This concentration gradient is called concentration polarization. The result of concentration polarization is a reduction in the water permeation rate and salt rejection rates versus theoretical estimates.

The effects of concentration polarization are:
1. Greater osmotic pressure at the membrane surface than in the bulk feed solution and reduced Net Driving Pressure differential across the membrane.
2. Reduced water flow across membrane.
3. Increased salt flow across membrane.
4. Increased probability of exceeding solubility of sparingly soluble salts at the membrane surface, and the distinct possibility of precipitation causing membrane scaling due to the close proximity to the membrane.

Spiral membrane systems try to limit the differential in concentration of dissolved solids by creating turbulence at the membrane using crossflow velocity. Due to the drag from the membrane, this can only have limited effect.

Whereas, in the VSEP system, the turbulence and shear generated by the oscillation nearly eliminates the concentration gradient leading to lower osmotic pressure at the membrane surface and less chance of scaling on the membrane. The VSEP has demonstrated its ability to act like a membrane crystallizer and can precipitate solids because this will happen in the bulk flow instead of near or on the membrane.



Rep Spotlight – Wastewater Ability

South Africa has always held incredible opportunity for VSEP. An evolving economy and the mining and industrial effluent markets there are enormous. There are also challenges when it comes to water supply and drought. The challenge is the distance and for the South Africans, access to technology to

solve problems is a big impediment. New Logic has had success there and for many years was able to install full-scale systems. New Logic does rely on local companies who are on the ground and can provide timely service and support. During the early days, New Logic did work with a few local companies that had success but struggled and eventually moved on to other tasks. Fortunately, New Logic was able to partner with Wastewater Ability to see that the market is served.

Wastewater Ability (PTY) Ltd is 51% Black owned company managed by Mohau Lekopa with a level 2 BBBEE status in the business of filtration and fluid separation using Vibratory Shear Enhanced Process (VSEP) membrane filtration technology to eliminate chemical water treatment. Their mission is to build, modernize and manage waste water filtration and fluid separation plants throughout Africa through strategic technology partnerships and product support from partners around the world. They offer the following solutions to address the current wastewater challenges faced by Producers:

- Minimize the wastewater generated from plants.
- Reduce water consumption as well as raw materials consumption
- Concentrate unwanted materials in wastewater leading to volume reduction of waste
- Purify liquid products to achieve higher quality
- Reduce disposal cost.
- Reduce the need for chemical treatment

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