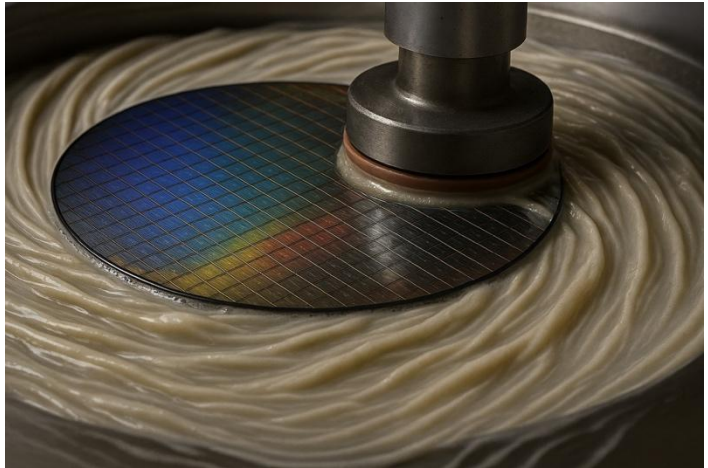


Semiconductor CMP Wastewater

VSEP membrane treatment for water reuse

Wafer Fabrication Process

Semiconductor wafer manufacturing involves many steps. High purity silicon is first extracted from sand. Then following the Czochralski process, the silicon crystals are grown into ingots. Then these are sliced into thin wafers. After cutting the wafer needs to be polished so it is very smooth with no imperfections. Once polished this acts as the substrate for the placement of integrated circuits in a clean room.



To perform the polishing a chemical abrasive slurry is used with oscillating pads.

This process is known as chemical mechanical polishing, or CMP. Typically, the abrasive used is an aluminum, silicon, or cerium based oxide. The chemicals added to the liquid slurry can include surfactants, organic compound additives, and ammonium hydroxide. During polishing metals can be introduced by the wear of the pad and equipment. Also, very fine particulates are removed from the wafer as the abrasion occurs. The abrasive slurry can only be used some long and then needs to be replaced. This generates wastewater that needs treatment prior to discharge.

VSEP System installed for CMP Wastewater in Silicon Valley

In 2014, New Logic began working with semiconductor company in Silicon Valley to treat this wastewater slurry. The client had been hauling this material at a cost of \$1000 per day. Because of the particulates, they were not allowed to sewer discharge. The objective was to remove the suspended solids and then use deionization tanks to make clean water that could be discharged or used as cooling tower make-up. After pilot testing, a full-scale system was installed in early 2015. The wastewater only contained about 0.2% suspended solids, but because of the very fine colloids present that do not settle, the turbidity was very high. The VSEP installed used a 0.05 μm microfiltration membrane that produced filtrate with near zero turbidity and a final concentrate that was only about 5% of the total starting volume. The suspended solids of the concentrate measured about 4%. This resulted in a 95% reduction in hauling costs. The client is considering a filter press to make a cake material from the VEP concentrate that can just be landfilled eliminating all the hauling costs.

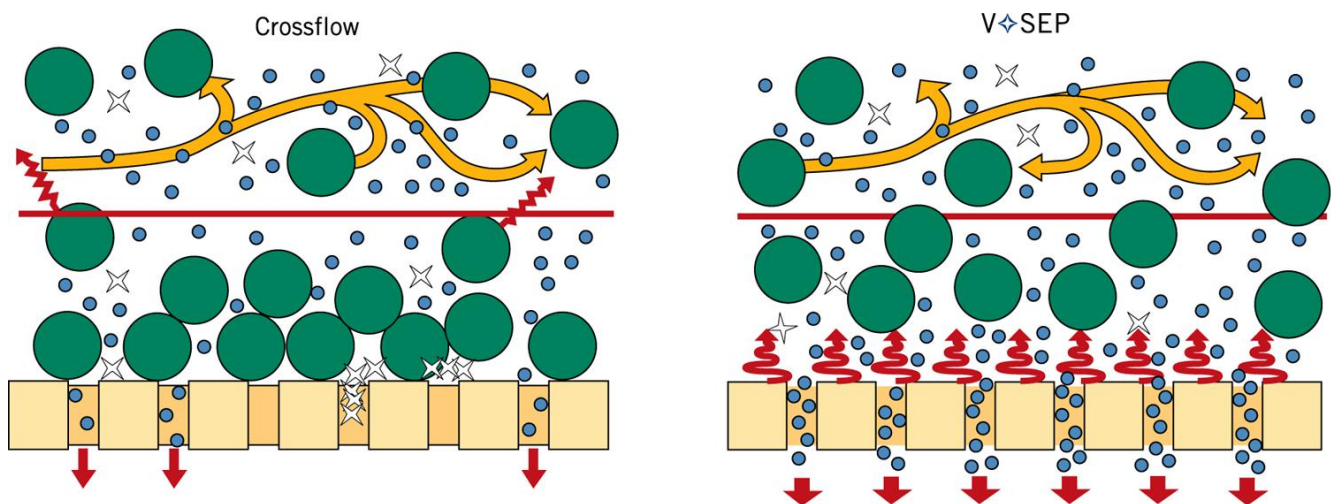
Because ultrapure water is used to begin with, the dissolved solids concentration is very low, and the conductivity measured 70 μS . So, the filtered water has many potential uses in the facility. The VSEP system achieved a very high flux rate of 173 GFD (294 LMH).

The VSEP Process

Membrane system designers have struggled to reduce fouling by using tangential flow or "cross flow" filtration. In this method, membrane leaf elements are placed in a plate and frame, tubular, or spiral-wound cartridge assembly, through which the substance to be filtered (the feed stream), is pumped at a high velocity to create shear forces. The shear forces produced on the face of the membrane tends to keep the membrane clean. Unfortunately, in these cross flow systems it is not economical to create shear rates measuring more than 10-15 thousand inverse seconds. This limits the use of cross flow to low-viscosity (watery) fluids, further restricting the use of conventional membrane separations systems.

NEW LOGIC has developed an alternative method for producing intense shear waves on the face of the membrane leaf element. The technique is called Vibratory Shear Enhanced Processing (VSEP)

In VSEP systems, the feed slurry remains nearly stationary, moving in a leisurely meandering flow between parallel membrane leaf elements. The leaf elements move in a vigorous vibratory motion tangent to the face of the membranes. The shear waves produced by the membrane vibrations cause solids and foulants to be repelled and liquid to flow through the membrane pores unhindered.



Fluid Dynamics Comparison between VSEP and Conventional Crossflow Filtration

In an industrial VSEP machine, the leaf elements are arrayed as parallel discs separated by spacers. The disc stack is moved in a torsional oscillation, like the agitator of a washing machine, faster than can be seen without a strobe light. This produces a shear rate at the membranes of about 150,000 inverse seconds, literally ten times greater than that obtainable in cross flow systems. In contrast to cross flow systems where as little as 10% of the energy required to run the system is converted to shear, VSEP enables nearly 99% of the total energy to be converted to shear at the membrane surface where it can do the most good.

Semiconductor manufacturing requires a lot of ultrapure water and there is a movement to recycle as much of this water as possible. Deployment of VSEP would allow for complete reuse and zero-liquid discharge. Many new fabrication plants are being built in areas that are water starved such as Arizona. Access to clean water is critical for the multi-billion dollar facilities. In addition to all the water needed to manufacture the semiconductor chips that will be needed to fuel the AI boom, data centers are consuming vast amounts of water for cooling of the equipment. These also could benefit from a VSEP ZLD process.

For more information about a VSEP system, contact your New Logic sales engineer

New Logic Research

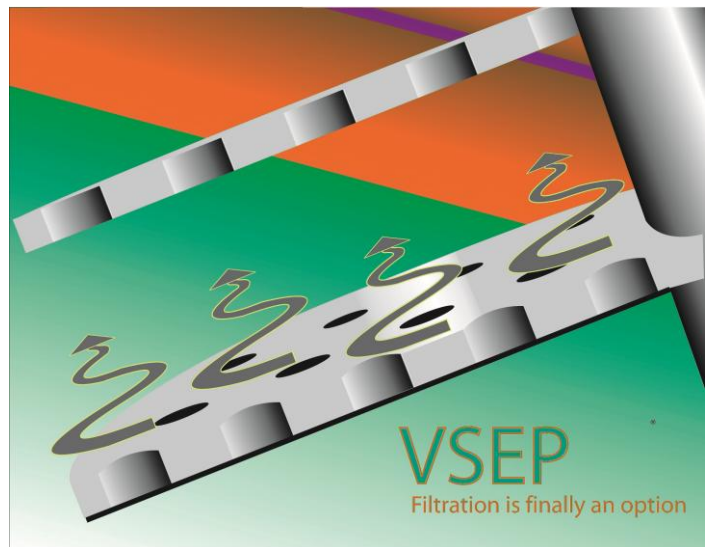
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