Mech-Chem Associates, Inc.

•Design •Engineering •Construction
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# Description of Diffusion Dialysis

Diffusion dialysis is a membrane separation process. It has been successfully used for many years for the separation and recovery of acids from dissolved metal-bearing solutions. Diffusion is the spontaneous movement of a material from an area of high concentration to an area of lower concentration. Driven by the concentration difference, the movement of material will continue on its own until the concentration difference no longer exists. Dialysis is the separation of molecules due to the differences in the rate of movement of the molecules through a semi-permeable barrier. In the recovery of acids with diffusion dialysis an anion exchange membrane acts as a semi-permeable barrier placed between a flowing water stream and a flowing acid with dissolved metal solution. The anion exchange membrane has fixed positive charges located on its surface. These positive charge locations attract the negatively charged anions in solution that come in close contact with the anion exchange membrane surface.

Anions in the acid solution are attracted to the membrane and they are also driven by the concentration difference to diffuse across the membrane to the water side. Simultaneously, the thermodynamic Law of Electroneutrality (in solution total charge must balance to zero) requires that the transference of every anion be accompanied by the transference of a positive charge. Positively charged ions are strongly inhibited from crossing the positively charged membrane because of the repulsion between like charges. The hydrogen ion, present in the acid solution as H3O+1 ions, or protonated water, is also positively charged, but is able to cross the membrane with very little hindrance. This is due, in part, to the high concentration of hydrogen ion in the acid solution and also, in part, because of the highly associated nature of water, which allows the hydrogen ion to effectively delocalize its charge. The net effect is that the rate of diffusion of acid across the membrane is an order of magnitude greater than that of the dissolved cations. Finally, by causing the flow of the acid solution to be in the opposite direction to the flow of water (counter-current flow), optimal advantage of the necessary concentration gradients can be realized. The results are that the water entering the diffusion dialysis system exists as a metal-depleted recovered acid solution and that the acid solution entering the diffusion dialysis system exists as an acid-depleted dissolved metal-bearing solution.

The Diffusion Dialysis system has two feed tanks, one tank is for water and one is for the acid solution to be processed. After the initial unit start-up and engaging of the automatic control switches on the control panel and level controls in each of the holding tanks, the unit will automatically supply process acid solution and water to the feed tanks. Once the chambers are filled with the acid solution and water, the solutions flow independently by gravity into the membrane stack unit. The acid solution and water flow counter-currently through the membrane stack thus maximizing the concentration gradient. Using the principal of diffusion dialysis, anion exchange membranes segregate acid molecules into a purified zone. In a typical system, 80% to 90% of the sulfuric acid is recovered and 80% to 90% of the dissolved aluminum is removed. The exit ports of the membrane stacks are plumbed to a set of metering pumps, which are used to control the flow of acid solution and water through the System. The exit ports of these metering pumps are plumbed to ½" NPT ball valves to enable hard plumbing of the two streams to their final destination.

The System is a fully modularized design on a single skid. Field installation, by Owner, includes providing acid solution feed and discharge piping, waste discharge piping, compressed air, RO or DI water, and 115v/60Hz/1phase electrical power.

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