# Market Profile: Zero liquid discharge systems

# From zero to hero – the rise of ZLD

**Regulatory drivers are ensuring that zero liquid discharge is gaining in popularity. Capital and operating costs can still prove prohibitive, as Gord Cope discovers.**

If there was ever a Holy Grail of water recovery and reuse in an industrial plant, then it is undoubtedly zero liquid discharge, or ZLD. While it may be difficult and expensive to achieve, zero liquid discharge is easy to define.

"A ZLD system means that no liquid waste leaves the boundary of the facility," says Keith Minnich, Veolia's vice president of water solutions and technologies. "Technically, that could mean you have a big pond inside the fence, but the term usually refers to a mechanical system of an evaporator and a crystallizer."

There are thousands of evaporator/crystallizer thermal systems in use around the world, serving a wide variety of sectors. Chemical plants use them to make chloride for feedstock in the plastics industry. The food and beverage industry produces powdered coffee and milk. But relatively few of these systems (a total of just over 100 worldwide), are designed purely as ZLD systems, in which the purpose is to recover and reuse as much water as possible.

Although dozens of regional companies supply various components for evaporation and crystallization, the ZLD niche is dominated by three major players: Aquatech, GE Power and Water, and HPD, a subsidiary of Veolia. "HPD is the largest evaporation and crystallization company in the world," says Minnich. "We have close to 700 systems in many different sectors: pulp and paper, salt, chemical processing, oil and gas, biofuels, and power generation. Many of these installations are not ZLD systems; they are part of a system used to produce an industrial product." In all, total capital investment in ZLD systems around the world is estimated to be between $100-200 million per year.

Most industrial processes create a wastewater stream. This can be bleed from boilers, blowdown from cooling towers, or saline water from crude oil extraction. Reverse osmosis and other membrane technologies can cut the stream by 80% or more, but a facility inevitably still ends up with a significant flow of concentrated liquid waste.

Generally speaking, the smaller the volume, the easier it is to dispose of. "In conventional processes, you typically get sludge with 30 to 40% solids, whereas in a ZLD system the solids content ranges between 85 and 95%, thus providing a much lower volume and dryer sludge," says Anant Upadhyaya, senior vice president of corporate growth at Aquatech, which entered the ZLD space in 2000 through its acquisition of Aqua-Chem. "Why not minimize the wastewater by recovering and reusing water, which is essentially what the ZLD process does?"

The ZLD process creates solid waste using two devices – evaporators and crystallizers. Evaporators, which can concentrate brines up to 250,000 ppm TDS, are designed to be extremely energy-efficient by using mechanical vapour recompression, or VPR. "If you were to simply boil water on a stove, it would take 1,000 Btus to boil one pound of water," says Minnich. "But if you use VPR, it only takes 30 Btus." In the VPR evaporator process, water is heated until it boils at 100°C. The vapour goes into a centrifugal compressor which compresses it slightly, making the temperature rise. The boiling takes place on a thin-film heat transfer surface, where steam condenses on one side and water boils on the other side.

When the brine concentration exceeds 250,000 ppm TDS, it is pumped under high pressure from the evaporator to a forced circulation crystallizer. The brine is released into a vessel where the pressure falls, the remaining water boils off and the salts crystallize. This salt is still slightly damp, but conforms to EPA solid disposal standards. The salt cake, which is a fraction of the original waste stream, is then disposed of in landfill.

There are several drivers for the adoption of ZLD. "Water is a resource that is getting scarce in many geographic locations," says Upadhyaya. "In many locations in the US, the Middle East, Africa, India and China, less than 5% of wastewater is presently recovered. With water becoming so scarce, the very first thing that comes to mind is: why are we wasting so much? The first inclination is to recover and recycle."

A second motivator is the growing social responsibility of recycling and reuse.

"The EU has many countries with limited resources," says Upadhyaya. "Those circumstances have led to a compulsion toward minimum wastage, maximum reuse. Twenty years ago, there was little of that in North America, but now we recycle bottles, newspapers and plastics. Society deems it worthwhile to do so, and technologies have evolved to make economic recycling possible."

A third driver is economics. As potable water becomes scarcer in many jurisdictions, its price rises. In addition, as regulations on the discharge of waste fluids into open waterways become more stringent, treatment costs rise. Customers look at the potential for savings, comparing the cost of ZLD to the cost of fresh water and the savings on sludge disposal. Regulation represents the biggest incentive by far. "Nobody puts in a ZLD unless they have to, because it's very expensive," says Tim Cornish, marketing manager for HPD. "It's driven by discharge regulations."

### Don't pass the salt

It was US federal regulatory pressure that gave birth to the ZLD sector. "Back in the 1970s, they were having a salinity problem in the Colorado River," says Minnich.

"As a result, regulations were created prohibiting discharge of cooling tower blowdown into the river. Evaporation-based technology was developed to recover the water and concentrate the salt. The distillate evaporated and was returned to the power plant, and the highly concentrated brine went to a crystallizer where it was processed into salt cake. The systems would handle 500-2,000 GPM. There were dozens built."