ZLD

ZERO LIQUID DISCHARGE

SYSTEM DESIGN SUMMARY

ZLD TECHNOLOGY
S.M.A.R.T. ZONES™

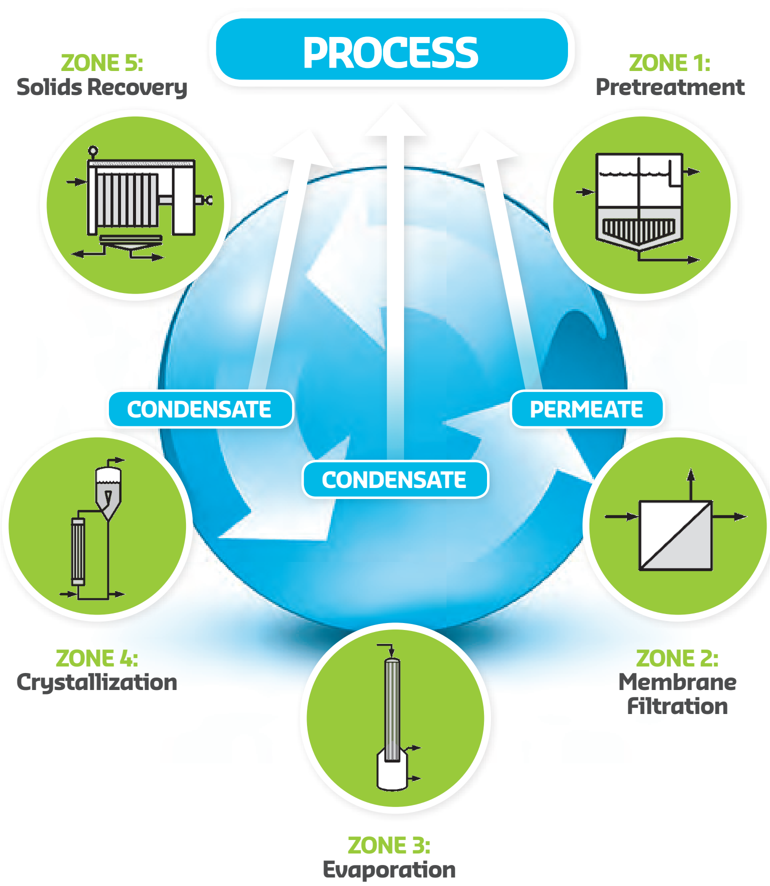
ZERO LIQUID DISCHARGE (ZLD) REPRESENTS THE ULTIMATE CUTTING-EDGE TREATMENT SYSTEM FOR THE TOTAL ELIMINATION OF WASTEWATER EFFLUENT INTO NEIGHBORING WATERWAYS.

The ZLD System removes dissolved solids from the wastewater and returns distilled water to the process (source). Reverse osmosis (membrane filtration) may be used to concentrate a portion of the waste stream and return the clean permeate to the process. In this case, a much smaller volume (the reject) will require evaporation, thus enhancing performance and reducing power consumption. In many cases, falling film evaporation is used to further concentrate the brine prior to crystallization.

Falling film evaporation is an energy efficient method of evaporation, typically to concentrate the water up to the initial crystallization point. The resultant brine then enters a forced-circulation crystallizer where the water concentrates beyond the solubility of the contaminants and crystals are formed. The crystal laden brine is dewatered in a filter press or centrifuge and the filtrate or centrate (also called "mother liquor") is returned to the crystallizer. The collected condensate from the membranes, falling film evaporator and forced-circulation crystallizer is returned to the process eliminating the discharge of liquids. If any organics are present, condensate polishing may be required for final clean-up prior to reuse.

ZLD TECHNOLOGY S.M.A.R.T. ZONES

ZLD technology includes pre-treatment and evaporation of the industrial effluent until the dissolved solids precipitate as crystals. These crystals are removed and dewatered. The water vapor from evaporation is condensed and returned to the process. This process may utilize all or part of five S.M.A.R.T. ZONE™ engineering modules including pretreatment, membrane filtration, evaporation, crystallization and solids recovery. Each module can be executed in parallel to expedite the design and implementation process.



S.M.A.R.T. Z PROCESS™

S.M.A.R.T. ZONE 1

PRETREATMENT: In the majority of cases, it is more cost-effective to remove contaminants prior to evaporation/crystallization. This pretreatment step often includes lime-soda softening which requires clarifiers to remove calcium and magnesium compounds.

S.M.A.R.T. ZONE 2

MEMBRANE FILTRATION: Where possible, membrane filtration such as reverse osmosis can be used to treat the wastewater. The permeate (clean water) is reused in the process and the reject/concentrate is sent on to evaporation.

S.M.A.R.T. ZONE 3

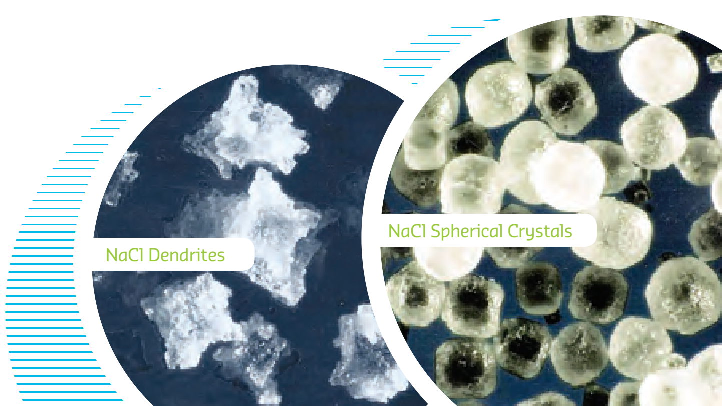
EVAPORATION: When a significant amount of water needs to be evaporated prior to the crystallization step, pre-concentration in a falling film evaporator is the most efficient solution. These evaporators require less heat/power per unit of water evaporated.

S.M.A.R.T. ZONE 4

CRYSTALLIZATION: The crystallizer is the heart of the ZLD process. Typically, forced-circulation crystallizers are used, which evaporate the water past the crystallization point. Crystals are mechanically dewatered and the resulting filtrate/centrate is returned to the crystallizer. The crystallizer usually requires corrosion resistant materials due to the extremely high salt concentrations present. In some cases, part of the crystallization can be achieved by spray driers to overcome high solubility of certain salts. The clean condensate is returned to the process for reuse and the dewatered crystals are transported off-site for reuse or disposal. This crystallization process is extremely sensitive to the wastewater chemistry as the ions present will determine the boiling point elevation which has a major impact on the power consumption, impacting both capital and operating costs.

S.M.A.R.T. ZONE 5

SOLIDS RECOVERY: Sludge generated by **S.M.A.R.T. ZONE™ 1**, is generally mechanically dewatered in a plate-and-frame filter press. A solids concentration of 20-50% dry solids can usually be achieved and the filtrate is simply recycled back to the beginning of the pretreatment system. The crystals from **S.M.A.R.T. ZONE™ 4** can also be mechanically dewatered, but corrosion resistant materials are usually necessary due to the high salt concentrations present. The crystals can be dewatered in a filter press (belt or recessed chamber) or centrifuge and as a result, much higher solids concentrations can be achieved. The filtrate (or centrate) is then returned to the crystallizer.



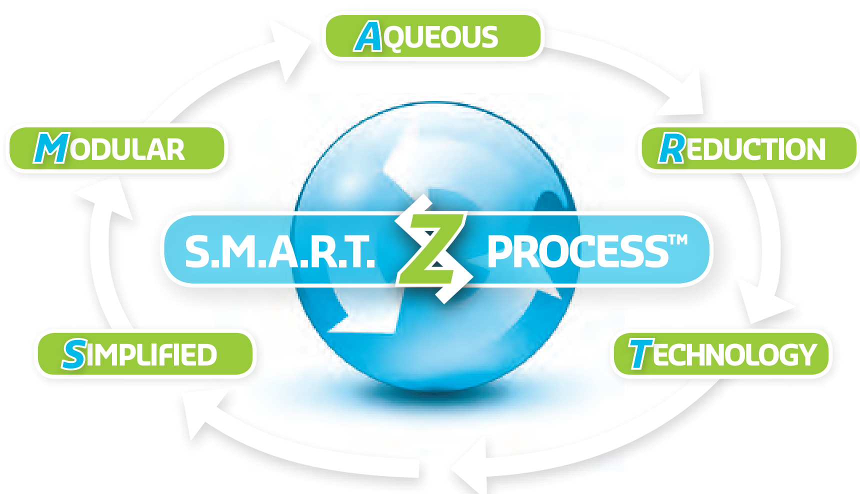
SYSTEM ENHANCEMENTS

MULTIPLE EFFECTS: Evaporation processes such as falling film evaporators can be installed in series such that the water vapor from one is reused in the next. In this way, the efficiency of the evaporation process can be increased and almost doubled, tripled, etc. based on the number of evaporator effects installed. This increases the capital cost of the system, but it is more economical for larger flow operations based on the energy saved.

WASTE HEAT USAGE: Economics are enhanced when waste heat found in most industrial applications can be productively reused in the ZLD design. This can take the form of dryer exhaust gas or low pressure return steam. The evaporator designs can make use of these 'waste' heat sources, significantly saving on energy requirements.

INTEGRATION EFFECTS: The chemistry of ZLD systems is very complex. The waste streams from the different zones are very interdependent. Having a single point of contact for the entire system is therefore crucial. We can design, supply and install ALL of the equipment that makes up the ZLD System (Physical-Chemical Pre-Treatment Systems, Membranes, Evaporators, Crystallizers and Solids Recovery Systems).

MECHANICAL VAPOR RECOMPRESSION: For some applications, turbofans or high speed compressors can be more economical by reducing the steam usage with electricity. Water vapor produced in the evaporator or crystallizer can be compressed and reused as the heating source. Depending on the boiling point elevation of the wastewater, single- or multi-stage vapor compression systems can be used. MVR systems are typically implemented where high evaporation rates are necessary.



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