

Zero Liquid Discharge Technology

Introduction:

Zero Liquid discharge (ZLD) refers to installation of facilities and system which will enable industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and in-organic compounds/salts) into residue in the solid form by adopting method of concentration and thermal evaporation. ZLD will be recognized and certified based on two broad parameters that is, water consumption versus waste water re-used or recycled (permeate) and corresponding solids recovered (percent total dissolved / suspended solids in effluents)

Objective to treat wastewater in ZLD System:

- To recover water, which can be recycled.
- To separate constituents such as salt, solvents from the wastewater which are difficult to treat in conventional Effluent Treatment Plant.
- To separate valuable by-products from wastewater (case specific, such as Brines, Salts)
- To eliminate wastewater disposal in liquid form to Environment

Components/ Processes involved in ZLD System:

- pH Neutralization unit (Primary Treatment)
- Solvent Stripper unit (Required only for solvents bearing wastewater)
- Biological Effluent Treatment
- Reverse Osmosis
- Evaporation System
- Dryer / Crystallizer

Zero Liquid Discharge Technology

Brief Description of each component /process:

- **pH Neutralization unit (Primary Treatment)**
 - o Most of the ZLD plants have this unit to neutralize the pH.
 - o Required when wastewater is acidic or alkaline in nature
 - o In some plant (such as textile, chemical industries), the treatment is also involve flocculation and sedimentation.
- **Solvent Stripper unit (Required only for solvents bearing wastewater)**
 - o Widely used in solvent bearing wastewater, such as pharma and chemical industries.
 - o In this unit, Wastewater is subjected to distillation at lower temperature to distill out solvents from the wastewater.
- **Biological Effluent Treatment**
 - o Considering the cost-effectiveness of the treatment, biological treatment is used in most of the ZLD system.
 - o Primary treated wastewater (or wastewater after stripping out solvent) is subjected to biological treatment unit, where activated biomass (floccks of various kind of microbes) degrades organic load present in wastewater.
 - o This treatment is effective when dissolved solids are on lower side and wastewater having good biodegradable organic load.
 - o When wastewater is having high amount of inorganic dissolved solids (in-case of wastewater from metal processing, processes involves high amount of acids and alkalis etc.) biological process in not effective, in that case wastewater is directly fed to evaporation section, after neutralizing it with alkali or acid as per nature of wastewater.
- **Reverse Osmosis**
 - o Evaporation system requires high amount of energy and very costly treatment. Therefore, to reduce load to evaporation system, reverse osmoses is employed.
 - o In this treatment unit, wastewater is fed to membrane with the help of high pressure pumps, so due to the pressure dissolved solids are separated from wastewater and water is recovered.
 - o Reverse osmosis process generates two streams of wastewater, one is called "Permeate", which is filtered water having very low dissolved solids (TDS) and another is called "Reject", which is having high amount of TDS.
 - o Permeate stream is reused and reject stream is fed to Evaporation system.

Zero Liquid Discharge Technology

- Evaporation System

- In Evaporation unit wastewater is heated to its boiling point and converted to water vapor.
- Vapors are converted to water using condensers, called "Condensate"
- Condensate water is reused,
- The remaining portion of the wastewater is having high amount of salt, with high temperature,
- This brine solution is then fed to dryer / crystallizer section.

- Dryer / Crystallizer

- Dryer or Crystallizer is used to dry the brine solution, resulting in salt cake.
- The salt cake is generally disposed off in TSDF site, in some cases it is reused and further process to recover salts, heavy metals.

Pros and Cons of ZLD treatment:

- Pros:

- Water can be recovered and reuse, thereby saving natural resources.
- In some cases, salts generated during treatment, are also reused.
- Ability to treat non-biodegradable wastewater or wastewater having solvents in high amount.
- Effective in the areas water scarcity is prevailing.

- Cons:

- Considering multiple kind treatment units employed, skilled manpower with vigilant monitoring is required.
- Break-down of any one treatment unit can affect operation of entire ZLD system.
- Very high capital cost.
- Very high operation cost.

Reference:

1. Guidelines on techno – economic feasibility of implementation of zero liquid discharge (ZLD) for water polluting industries, Central Pollution Control Board, New Delhi.
2. https://gpcb.gov.in/images/pdf/ZLD_PRESENTATION_3.PDF
3. <https://www.ceeindia.org/file/ZLD-Concept-note.pdf>