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Life Cycle Assessment of Waste Water Treatment by Zero Liquid Discharge System

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Abstract: *Freshwater scarcity has become a significant obstacle to economic progress, human health, and environmental conservation due to increased water demands around the world. Use of industrial water is a crucial issue. Driving force behind freshwater usage, which makes a significant contribution of disposing of waste water .In recent years, solutions for reducing industrial wastewater disposal have been proposed, with a new technology known as Zero Liquid Discharge (ZLD) attracting worldwide interest. ZLD's ambitious wastewater treatment goal is to eliminate any liquid waste leaving the plant, primarily power plants, in order to produce clean product water for industrial reuse. Wastewater reuse could effectively save freshwater, relieve freshwater withdrawal pressure, and reduce the environmental risk of industrial wastewater discharge. However, environmental concerns such as chemical use and energy consumption cast doubt on the environmental performance of ZLD technologies. ZLD could achieve water recovery and reuse within industrial systems, lowering environmental risks and repurposing a large amount of wastewater. However, it is also associated with intensive energy and material use to achieve the ambitious goal of zero discharge, which has been deemed in most cases not feasible or cost-effective. In recent years, technological research on various ZLD systems, such as low-salt-rejection reverse osmosis, Osmotically Assisted Reverse Osmosis, and forward osmosis, has been conducted due to increased water scarcity and stricter regulations around the world. Other ZLD technologies, such as Bipolar Membrane Electrodialysis and Membrane Distillation, are mostly bench scale right now. Despite increased research in technical fields, the debate over ZLD technology continues. A ZLD treatment system employs cutting-edge technological water treatment processes that are both environmentally friendly and highly dependable. For difficult-to-treat wastewaters or situations where water scarcity necessitates water recovery (recycle/reuse), Zero Liquid Discharge (ZLD) technologies can assist you in meeting environmental compliance, Reduce your carbon footprint by converting liquid waste into disposable dry solids and recovering approximately 95% of your liquid waste for reuse. The ZLD treatment process can be used as advanced waste water treatment constituents to produce by-products that are more easily biodegradable while lowering overall toxicity, pH, COD, TDS, SS, and BOD parameters. The goal of a Zero Liquid Discharge (ZLD) system is to reduce the volume of liquid waste that must be treated while also producing a clean stream that can be used elsewhere in the plant's processes. ZLD is capable of reducing all types of waste water and making it reusable and recyclable for additional applications. According to the study results, the 99% TDS, 100% COD and BOD, and 98% SS and TSS reduced (removed) make it Zero liquid discharge. The ZLD plant produced high-quality water that was suitable for recycling on site, resulting in reduced water consumption.*

Keywords: Waste Water Treatment

I. INTRODUCTION

As water scarcity worsens, efforts to recover and reuse water in industrial systems are gaining traction around the world. Zero Liquid Discharge (ZLD), a visionary industrial wastewater treatment technology, aims to eliminate all liquid waste from treatment systems. Nowadays, technology is rapidly evolving, progressing from thermal systems to various membrane systems such as reverse osmosis, forward osmosis, electrodialysis, bipolar electrodialysis, and

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membrane distillation. We used Life Cycle Assessment (LCA) to compare the environmental performance of ZLD systems by taking into account the energy consumption, chemical inputs, and membrane uses for each system. We will set the functional unit at 10,000 m3 treated feedwater, which corresponds to 4.3-91.0 hours of treatment plant operation for current capacity in large urban centres. As a result, BMED is the most environmentally friendly ZLD technology, consuming approximately 34,438 kWh of electricity per functional unit, versus 260,640 kWh for traditional thermal systems. BMED ZLD systems could reduce CO2 emissions by up to 82.1% when using coal-fired electricity as the energy source, compared to conventional thermal systems. Electricity power sources also have an impact on environmental impacts. Using electricity generated by cleaner energy power plants aids in the reduction of CO2 emissions and other environmental impacts. In a BMED system, the environmental impact of nuclear-powered electricity would be only 1.9% that of coal-powered energy. A ZLD wastewater treatment system investment can help your facility conserve water that is critical to your process while protecting local community resources. A Zero Liquid Discharge treatment system employs advanced technological water treatment processes to reduce liquid waste at the end of your industrial process to zero, as the name implies, making it environmentally friendly and highly reliable. ZLD is the solution for meeting strict environmental discharge guidelines while also providing effective treatment at the lowest possible life-cycle cost.ZLD systems based on standalone thermal/evaporative processes, membrane processes, or combination of the two, referred to as hybrid systems, provide added value, ease of operation, and lower operating costs. Industries are increasingly being prohibited from discharging any liquid waste generated by their operations. A Zero Liquid Discharge treatment system can assist you. The ZLD treatment system should be able to handle

1. Different types of waste contamination and flow.
2. Can be helps to chemical volumes adjustments.
3. This treatment process recover around 95% of your liquid waste for reuse.
4. System can be treat and retrieve valuable by products from your waste.
5. System can be produce a dry solid cake for disposal.

Application Of Treated Waste Water

1. In cooling towers for large scale industry
2. Can be used in the gardening purpose for watering plants and lawns.
3. Boiler feed water. (particularly for generating steam for MEE)
4. In water scrubber as scrubbing media .
5. For preparing lime slurry for ETP.
6. Different industrial washing operations

ZERO LIQUID DISCHARGE PLANT

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1. Primary Treatment

In ZLD process Primary Treatment Section the process effluent will be collected in existing aeration tank. After aeration system is pumped to the new ETP site to the oil/ Solvent Separator to remove any floating oil/solvent separation. Finally it is collected in the collection tanks wherein it will be mixed to ensure uniformity in the quality and to even out any flow variations. Neutralization of the Process effluent will be with either lime or HCL in neutralization tank, depending on the pH. Then effluent will be further coagulated with Ferrous Sulphate and then flash mixed with polyelectrolyte to ensure proper flocculation with a Polyelectrolyte. Finally the effluent will be clarified in a Primary Clarifier and will be collected in UASB feed sump for further anaerobic treatment.

2. Secondary Treatment

Primarily treated effluent from the UASB Feed sump will be pumped to the UASB reactor wherein an anaerobic culture of microorganisms will degrade the effluent in the absence of free oxygen and reduce a major part of the organic load (COD/BOD). Biodegradation of effluent in Anaerobic process and biodegraded effluent will be then taken to a pre-aeration tank to remove the septicity and gas entrapped which will also render the suspended solids to settle for which a solids settling clarifier is provided.

EQUIPMENT USED

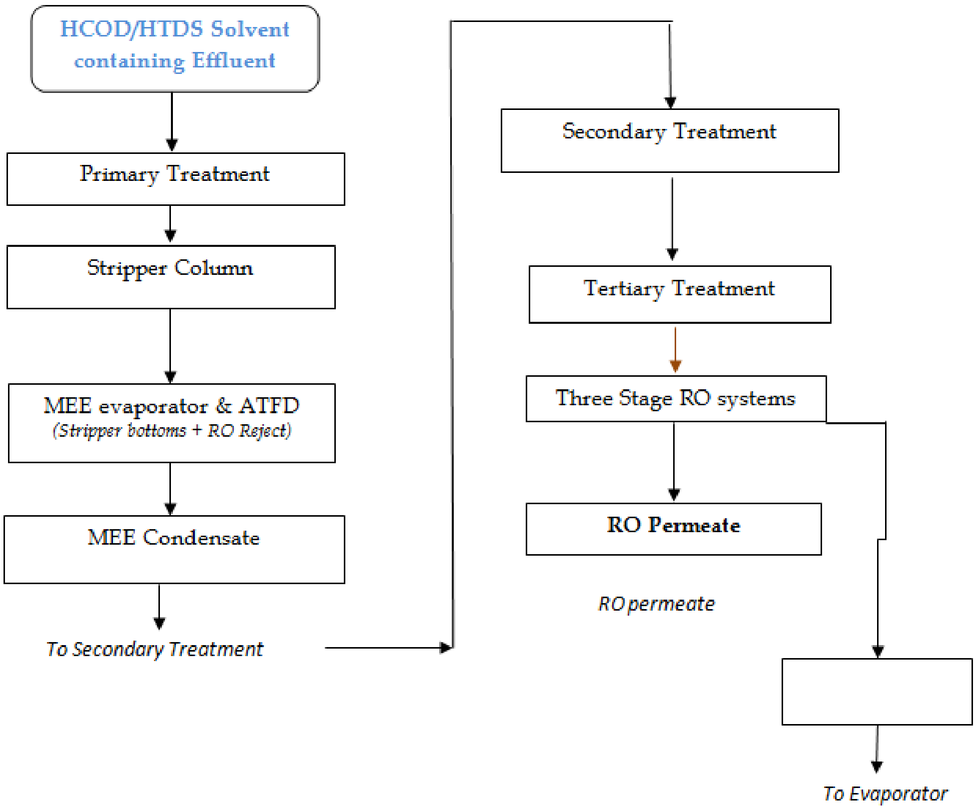
Part A: Effulent Treatment Plant

(1)Chemical dosing tanks (2)Agitators for flash mixer & flocclulator(3)Air blowers(4)Pressure sand fliter(5)Activated carbon filter

Part B: Multiple Effect evaporator

Part C: Reverse osmosis system

DESIGN PHILOSOPHY



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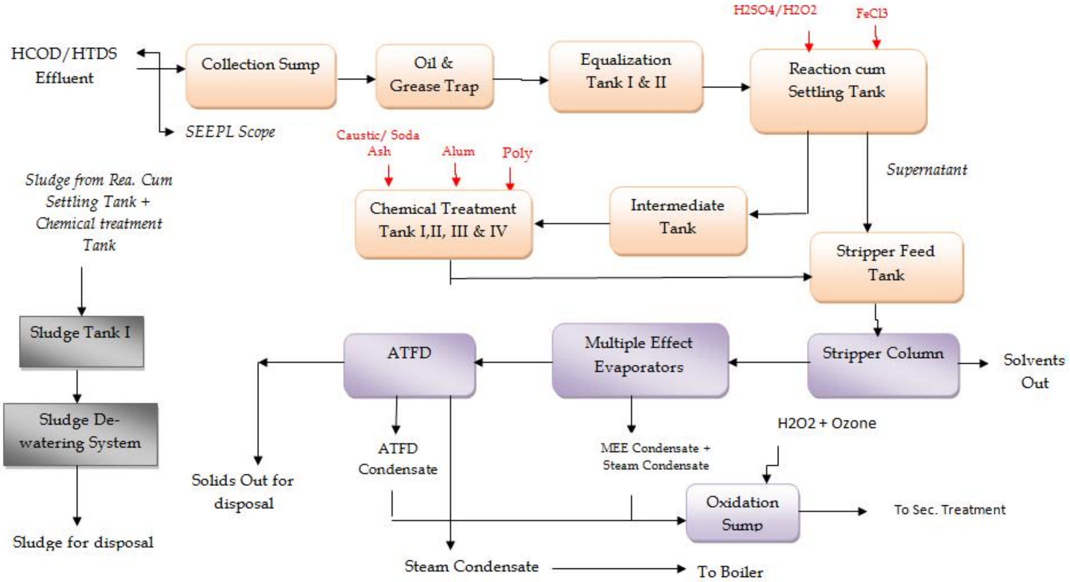
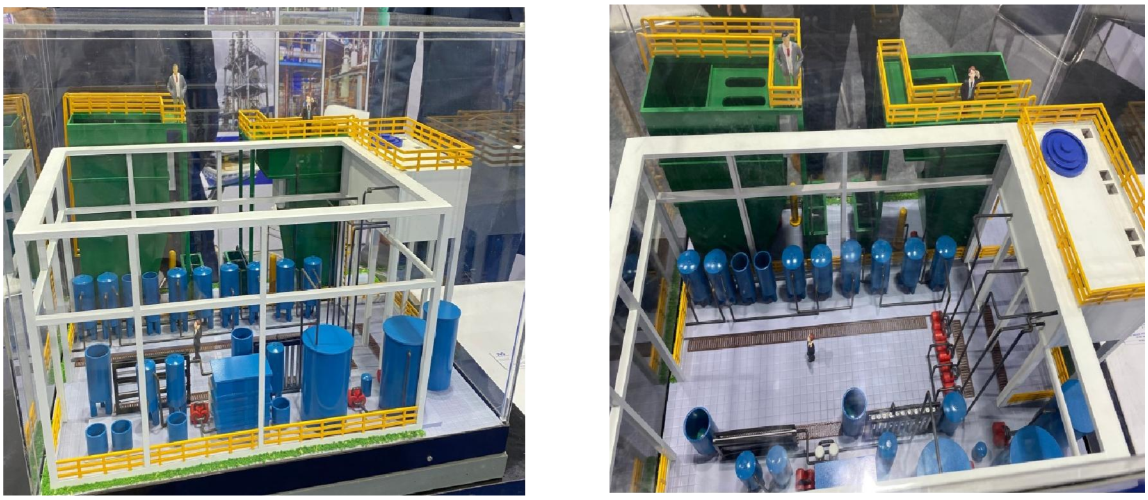
PROCESS FLOW DIAGRAM





EFFLUENT TREATMENT PLANT

Tertiary Treatment

In the tertiary treatment process the clarified effluent from the secondary clarifier will be disinfected by sodium hypochlorite and further treated through a Pressure Sand Filter and an Activated Carbon absorber. For additional treatment and a tertiary clarifier may be required to remove the silica content in the effluent before feeding to RO. After disinfection treated effluent and anticipated additional treatment to remove silica will then be fed to Ultrafiltration (UF) system for removing colloidal matter and improving the silt density index (SDI) before feeding to Reverse Osmosis and permeate generated from RO will be recycled and reused in the process plant for suitable activity while the Reject generated from RO will be evaporated in MEE to separate the salt which will be landfilled at the authorized Secured Landfill site.

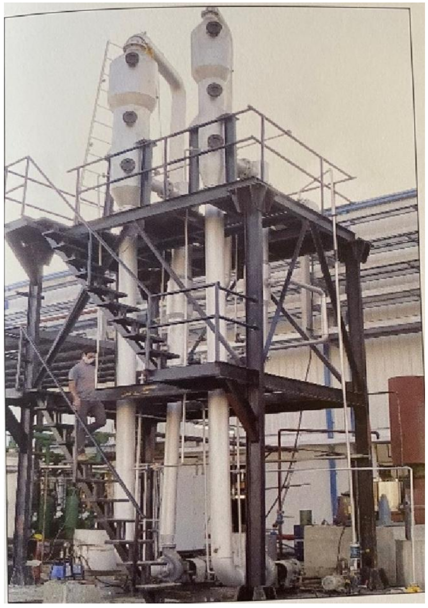
Advantage

1. Minimizes wastewater discharge.
2. Maximizes water recovery.
3. Removes many environmental issues.
4. Reduces dependence on local water sources.
5. Significantly reduces the risk of sanctions within the legislative standards for discharged waste.

6. Lower pretreatment requirements – higher TSS, COD and turbidity limits in the feed water.
7. Possibility to avoid evaporator with direct use of crystallizer.
8. Significant reduction in capital and operating expenses.

Disadvantage

1. High capital investment.
2. Reduced water permeability, greater energy usage, and damaged membranes and equipment.
3. Problematic balance of TDS /TSS.
4. Corrossion.
5. RO membane fouling.



REVERSE OSMOSIS & MULTIPLE EFFECT EVAPORATOR

II. LITERATURE REVIEWS

After ZLD treatment process total effluent generation from the industry is segregated into high COD/TDS and low COD/TDS concentration streams. Stripper followed by Multiple Effect Evaporator is treated high concentrated wastewater stream from manufacturing process[1]. WTP reject is sent to MEE and condensate water from MEE is sent to ETP along with other low COD/TDS waste streams i.e. cooling, washing and boiler and ETP followed by RO, permeate from RO is reused for cooling and reject is sent to MEE. So there is no discharge of treated effluent from the industry and unit maintains Zero Liquid Discharge.[2].Water which is evaporated in MEE recovered and recycled while the brine is continually concentrated to a higher solids concentration and the levels of COD and total suspended solids are to be reduced to acceptable values given by the Pollution Control Board and pH to neutral. [3].ZLD is a process that is beneficial to industrial, municipal organizations and the environment because no effluent, or discharge, is left over [4].In 2013 Veolia water treatment ZLD systems employ the most advanced wastewater treatment technologies to purify and recycle all the wastewater produced within the plant. Effluent Segregation, Effective Treatment, Complete Reuse, Transformation of COD into Incinerable Organics and TDS Into Dry Salts for Disposal in Secured Landfill by the Zero Liquid Discharge Based Treatment System. [5] By the application of powdered activated carbon and by reverse osmosis almost 50 % TOC removal was taking place during the coagulation-lime softening step including the use of powdered activated carbon. Remaining value of TOC was removed by the reverse osmosis (RO).0.2 mg/L or less was the (RO) outflow level. Turbidity elimination was around 60% by the coagulation-flocculation therapy, and it climbed to 80% after the pH correction. occurring at the clarifier's exit. Multimedia filters were used in the Laine et al. 2000 study to reduce turbidity to levels below 1 NTU, and after additional turbidity reduction occurred during the ultrafiltration stage, the water had levels below 0.1 NTU. [6]The RO process efficiently eliminates up to 99% of the dissolved salts (ions), particles, colloids, organics, bacteria, and pathogens from the feed water because to its tight pore structure (membrane employed is less than 0.001 micron).With the help of the ZLD-system, it is possible to separate the industrial wastewater into clean streams that may be reused in the plant and concentrate streams that can be disposed of or further processed into solids. In ZLD systems, 40–50% of the water is rejected throughout the RO process, however this ratio can be decreased to 20–25% by repeatedly recycling the rejected water in order to reach the system's target efficiency of 70–75%. [7].The MVR Evaporator will be employed if the overall recovery is greater than 87.5% as condensate. The primary MVR-Evaporators in the ZLD system are made to handle 15% of the R.O. reject, and the auxiliary MVR-Evaporators are made to handle 2% of the regenerate liquor from the softener and decolorize resin filters.[8] The overall loads reduction in the zero liquid discharge system was 100% for TSS and BOD, 99.2% for TDS, and 99.9% for COD. By demonstrating through numerous experimental analyses that the planned ZLD unit can be utilised to treat and recycle API manufacturing unit effluents, it is possible to comply with legal requirements and lessen worries about ground water depletion. The pilot plant of ZLD demonstrated a significant reduction in TDS (Total Dissolved Solids) and TSS (Total Suspended Solids) through the experimentally studied MEE (Multiple Effective Evaporator), ATFD (Agitated Thin Film Drier), and LCS effluent treatment unit made of an SBR (Sequential Batch Reactor) and MBR (Membrane Bio-Reactor) .

III. FUTURE SCOPE AND BENEFITS

ZLD can be used in waste water treatment.
ZLD can be used as a secondary treatment for waste water.
The ZLD process can reuse waste water.
Because this treatment process can treat any type of industrial waste water, it has a wide range of applications. •ZLD's ability to recycle any type of waste water can help to avoid a waste water shortage and recover up to 95% of your liquid waste for reuse. BENEFITS 1.Conservation of Water 2.ZLD systems use cutting-edge wastewater treatment technologies to purify and recycle nearly all of the wastewater generated. 3.Decreases wastewater discharge, i.e.reduces water pollution 44.Preferred option for industries where effluent disposal is a major bottleneck 5.Prevents exploitation of disposal system hydraulic capacity 6.Separation of salts / residual solvents improves ETP and CETP efficiency 7.Valuable by-product of separated solids that aids in reducing the payback period 8.Mixed solvent separated in the stripper can be reused or used as a co-processing solvent. 9.Ease of obtaining environmental permits 10.More emphasis on production/business rather than following regulatory authorities 11.Reducing industrial water demand frees up water for agriculture and domestic use.

V. CONCLUSION

When compared to conventional processes, ZLD treatment processes can be used as advanced waste water treatment constituents to produce by-products that are more readily biodegradable while effectively reducing overall toxicity, pH, COD, TDS, SS, and BOD parameters. Many hazardous organic pollutants can be effectively removed from wastewater using ZLD. Pretreatment, Anaerobic treatment (UASB), Secondary Aeration System, Filtration System, and Sludge Dewatering System are included in ZLD for pharmaceutical industrial waste water treatment, as well as various process units such as Screening, Coagulation, Filtration, UASB, UF, RO, MEE, and so on.To reduce their impact on environmental contamination, industries are subject to a number of environmental restrictions. Zero liquid discharge (ZLD) technologies, which attempt to concentrate waste ideally to the complete dryness have evolved to comply with the new standards. During ZLD treatment, water is recovered whenever possible so that it can be recycled.

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