TREATMENT OF PHARMACEUTICAL WASTE WATER (HERBAL EXTRACT UNIT) BY ZLD PROCESS USING MEMBRANE TECHNOLOGY

[1]Mr. Sushil N. Nikam, [2] Dr. R. W. Gaikwad,

[1]PG Student, PREC, Loni, [2]HOD, Chemical Engineering Department, PREC, Loni,
[1]Department of Chemical Engineering,
[1]Pravara Rural Engineering College, Loni, Dist. Ahmednagar, Maharashtra, India

Abstract: ZLD treatment system utilizes advanced technological water treatment processes are environmentally friendly and highly reliable. For difficult to-treat wastewaters or for situations where scarcity of water demands water recovery (recycle/ reuse) Zero Liquid Discharge (ZLD) technologies help you achieve environmental compliance, reduce your carbon which eliminates liquid waste by converting it into disposable dry solids and Recover around 95% of your liquid waste for reuse. ZLD treatment process can adopted as advanced waste water treatment constituents to by-products that are more readily biodegradable and reducing overall toxicity , pH , COD , TDS , SS , BOD parameters. Zero Liquid Discharge (ZLD) system is to minimize the volume of liquid waste that requires treatment, while also producing a clean stream suitable for use elsewhere in the plant processes. ZLD capable to reduce the all types of waste water and make it reusable and recyclable further for different applications. As per 10 days analysis of different treatment units concluded as up to 82 % of SS and 28 % COD removal in Primary treatment process , 49 % COD and 86 % BOD in UASB process unit, 96 % of both COD and BOD reduction UF process unit and 99 % of TDS reduction in the RO system . As the final results shows the 99 % TDS, 100 % of both COD and BOD, 98 % of SS and TSS reduced (Removed) make it Zero liquid discharge. The plant was generated high quality water which was suitable to recycle in plant premises and which resulted in reduction of water consumption.
This study has been undertaken to investigate the determinants of stock returns in Karachi Stock Exchange (KSE) using two assets pricing models the classical Capital Asset Pricing Model and Arbitrage Pricing Theory model. To test the CAPM market return is used and macroeconomic variables are used to test the APT. The macroeconomic variables include inflation, oil prices, interest rate and exchange rate. For the very purpose monthly time series data has been arranged from Jan 2010 to Dec 2014. The analytical framework contains.

Keywords: ZLD, UF, RO, UASB, MEE Pharmaceutical Waste Water Treatment.

I. INTRODUCTION

A ZLD wastewater treatment system investment can help your facility conserve water that is important to your process while protecting the resources that are valuable to your local community. A Zero Liquid Discharge treatment system utilizes advanced technological water treatment processes to limit liquid waste at the end of your industrial process to as the name suggests zero which environmentally friendly and highly reliable. For getting the strict environmental discharge guidelines and provide effective treatment with the lowest possible life-cycle cost ZLD is the solution. ZLD system based on standalone thermal/evaporative processes, membrane processes or a combination of the two namely hybrid systems resulting in added value, ease of operation and reduced operating costs. More and more, industries are prohibited from discharging any liquid waste originating from their facilities Zero Liquid Discharge treatment system can be help you. ZLD treatment system should capable to

1. Various 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. Used in cooling towers specially 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. Used in water scrubber as scrubbing media.
5. for preparing lime slurry for ETP.
5. Different industrial washing operations.

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. 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].

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) outlet was around 0.2 mg/L.

By the treatment of coagulation-flocculation turbidity removal was around 60 % and which was increased to 80 % after the pH adjustment taking place at the outlet of the clarifier. Studied by the Laine et al. 2000 using multimedia filter was reducing the turbidity to values below 1 NTU and further reduction was taking place at the ultrafiltration stage the water had values below 0.1 NTU. [6].

ZLD is a process that is beneficial to industrial, municipal organizations and the environment because no effluent, or discharge, is left over. 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].

RO has a tight pore structure (Membrane used less than 0.001 micron) that effectively removes up to 99% of the dissolved salts (ions), particles, colloids, organics, bacteria and pathogens from the feed water. With the treatment by ZLD-system can produce a clean stream from industrial wastewater and suitable for reuse in the plant and a concentrate stream that can be disposed or further reduced to a solid. [7].

Designed for overall recovery of > 87.5% as condensate the MVR Evaporator to be used. In the ZLD system main use of MVR-Evaporators was designed to handle 15% of the R.O reject and the auxiliary Evaporator is designed to handle 2% of the regenerate liquor from Softener and De colorizes Resin filters. The part of liquid remains which can be evaporated in an MEE along with crystallization of salt. [8].

In ZLD system 40-50% water rejected during the RO process but this ration can be reduced up to 20-25% by means of recycling the rejected water again and again to achieve its goal of 70-75% efficiency. [7].

In zero liquid discharge system the overall loads reduction was 99.2 percent in TDS, 99.9 percent in COD and 100 percent in both the TSS and BOD. By the various experimental analysis relieving that the designed ZLD unit can be used effectively to treat and recycle API manufacturing unit effluents, which helps to meet statutory requirements and reduce concerns on ground water depletion.

By the experimental studied MEE (Multiple Effective Evaporator), ATFD (Agitated Thin Film Drier) and LCS effluent treatment unit made of a SBR (Sequential Batch Reactor) and MBR (Membrane Bio-Reactor) with other unit which is called as water recycling unit consisting RO (Reverse Osmosis) plant the pilot plant of ZLD shown a huge reduction in TDS (Total Dissolved Solids), TSS (Total Suspended Solids), BOD (Biological Oxygen Demand) and TSS (Total Suspended Solid) to 99.2, 100, 100 and 99.9 percent respectively .[9]

II. MATERIAL AND METHODOLOGY

1. ZLD Treatment Options (Sector wise)

1. 1. Distillery

1. Bio-methanation followed by R.O/MEE followed by incineration (slop fired).
2. Bio-methanation followed by R.O/MEE followed by drying (spray/rotary).
3. Concentration through MEE followed by coprocessing in cement/thermal power plant.
4. Bio-methanation and RO followed by MEE followed by bio-composting. (As per new protocol)

1.2 Tannery

Primary treatment + secondary treatment+ pre- treatment for RO + Reverse Osmosis +, MEE (recovery of permeate, crystallized salt, reuse of the recovered condensate).

1.3 Pulp & Paper

Primary treatment + Degasification + RO (2 stage) + NF and UF + Evaporator Concentrator/Crystallizer.

1.4 Sugar - Treatment options

For the sugar industry restricting effluent generation to 100 Liters/ton cane crushed and consumption of water to be restricted to 100 liters / ton initially and further to 50 Liters/ton cane crushed. Recycle of excess condensate to process or ancillary units. Water management/audit to reduce spray pond/cooling tower blow downs and excess condensate and the irrigation protocol for disposal into land applications

1.5 Pharmaceuticals

Primary treatment for Low TDS Effluent treatment system + Secondary treatment + Tertiary chemical treatment to reduce TDS (Pressure sand filter, Activated Carbon filter and filter press for dewatering of sludge) + RO system (permeate is utilized as cooling tower makeup water) + Multi effect evaporator/incinerators. Primary treatment for High TDS Effluent treatment system + stripper to remove VOC + 3 stages Multi Effect Evaporator (forced circulation) Agitator Thin Film Drier (ATFD)+(MEE) condensate is being taken along with Low TDS effluent for further treatment)+ MEE/incineration.

1.6 Textiles

1. Ozonation + bio-oxidation + sand filtration + activated carbon adsorption + micro filtration + reverse osmosis (3 stage) + multiple effect evaporator
2. Chemical precipitation + bio-oxidation + chemical precipitation + sand filtration + Activated carbon adsorption + micron filtration + reverse osmosis (3 stages) + multiple effect evaporator

3. Chemical precipitation + bio-oxidation + sand filtration + dual media filtration + micron filtration + reverse osmosis (3 stages) + multiple effect evaporators.

1.7 Refineries

Primary treatment, secondary treatment and tertiary treatment. Reverse Osmosis mainly used for the tertiary treatment and permeate is utilized and rejects are discharged into cooling tower.

1.8 Fertilizer

Chemical treatment+ Reverse Osmosis (Rejects as filler material and permeate in the process)

1.9 Dye & Dye intermediates

Chemical Treatment + MEE

2 EFFLUENT TREATMENT PLANT

2.1 DESIGN BASIS

Nature of Effluent : Waste Water

Quantity of Effluent : 90 KLD

Mode of Disposal of Treated Water : Recycle for Process, Horticulture

Table No. 2.1 General Site Data

Parameter	Value/Information
Location	Hosur Tamil Nadu
Altitude	871 m above MSL
Nearest Airport	Bangalore (80km)
Temperature (MIN)	18-20 0C
Temperature (MAX)	28-30 0C
Compressed air Specification	Instrument air for valves operation
Oil content	Nil
Pressure	Suitable
Piping standard	ANSI/other suitable

The Effluent Treatment Plant shall be designed on basis of following inlet conditions

Table No. 2.2 Inlet Conditions for Treatment Plant

Parameters	Value
pH	5 - 10
BOD	8200 mg/L
COD	16500 - 12000 mg/L
TSS	750 mg/L
TDS	≤17000 mg/L

The Proposed Effluent Treatment system upon reaching steady state would produce the following results when operated under optimum design conditions and subjected to a regular monitoring & testing.

Table No. 2.3 Outlet Design Conditions

Parameters	Value
pH	6.5 – 8.5
BOD	< 50 mg/L
COD	< 400 mg/L
TSS	< 80 mg/L
TDS	< 17000 mg/L

Note –

Unit of all above Parameters is ppm (mg/liters) except pH.

Raw Effluent Characteristics are considered based on data provided in ETP Inquiry, However based on Input Characteristics Output Characteristics will also change.

TDS shall not remove by Biological Treatment System. For TDS Removal we have to implement RO system after proposed biological and filtration system.

Preamble

At present we have an ETP with the capacity to treat 30 KLD of Effluent with ZLD system.

As per of CCA the permissible effluent generation 30 KLD which is to be treated and to be reused.

The actual effluent generation is 70 to 90 KLD vary from time depending upon the production.

Since the existing ETP is under designed in comparison to actual effluent generation the performance of ETP & ZLD systems are not achieved.

As per of CCA the production capacity is 40 MT/Month.

A New ETP project is being proposed to overcome the difficulties in existing plant operation and to reuse 100% of water recovered from waste water to comply pollution control board's norms.

2.2 Effluent Treatment

A. PRETREATMENT

1. Screen Chamber – Bar Screening
2. Oil & Grist Trap Tank
3. Equalization Tank
4. Effluent Transfer Pumps
5. Neutralization / pH Correction
6. Coagulation & Flocculation
7. Primary Clarification

B. ANAEROBIC TREATMENT – UASB

8. UASB Feed Tank
9. UASB Feed Pumps
10. UASB Reactor (Up-Flow Anaerobic Sludge Blanket)
11. Tube Settler Tank
12. Pre-Aeration Tank

C. SECONDARY AERTAION SYSTEM AND FILTRATION

13. Aeration Tank – Activated Sludge Process
14. Secondary Clarifier

D. FILTRATION SYSTEM

15. Filter Feed Tank
16. Filter Feed Pumps
17. Pressure Sand Filter (PSF)
18. Activated Carbon Filter (ACF)
19. Hypochlorite Dosing
20. Treated Water Storage Tank

E. SLUDGE DEATERING SYSTEM

21. Sludge Holding Tank
22. Sludge Thickener
23. Sludge Dewatering System

III. EXPERIMENTAL ANALYSIS

3.1 Observations

3.1.1 Characteristics of Raw Effluent

Table No 3.1 Raw Effluent Characteristics

Day	pH	COD	BOD	SS	TDS
Day 1st	9.54	10810	4060	400	4080
Day 2nd	11.27	8880	3560	390	2830
Day 3rd	11.34	8413	3960	380	3230
Day 4th	9.89	8010	3990	330	4120
Day 5th	9.10	7840	3110	300	2980
Day 6th	9.43	7200	3020	340	3890
Day 7th	9.80	7200	3080	340	2850
Day 8th	9.04	6899	2810	660	3780
Day 9th	8.64	6800	2830	760	2970
Day10th	9.06	6240	2730	610	3510

Table 3.1 shows the characteristics of Raw Effluents like pH, BOD, COD, SS and TDS for 10 days analysis of Effluent taken from the lab where parameters to be analyzed.

3.1.2 Characteristics of Effluent after Primary Treatment

Table No 3.2 Effluent Characteristics after Primary Treatment

Day	% pH Reduction	% COD Reduction	% SS Reduction
Day 1st	27.68	19.34	50
Day 2nd	29.11	22.13	59
Day 3rd	34.40	21.16	52.64
Day 4th	32	6.25	60.61
Day 5th	26.27	11.23	26.67
Day 6th	21.10	13.23	35.3
Day 7th	24.08	10	47.10
Day 8th	21.03	28.6	81.85
Day 9th	20.49	25.89	73.79
Day 10th	19.54	10.3	80.24

Table 3.2 shows t3e characteristics of Effluents like pH, COD and SS for 10 days analysis of Primary Effluent Treatment Plant after treatment taken from the lab where parameters to be analyzed .

3.1.3 Characteristics of Effluent after UASB Treatment

Table No 3.3 Effluent Characteristics after UASB Treatment

Day	% pH Reduction	% COD Reduction	% BOD Reduction
Day 1st	12.61	44.96	86.67
Day 2nd	35.37	39.03	86.18
Day 3rd	21.64	36.3	81.82
Day 4th	4.61	34.90	84.72
Day 5th	4.33	46	83.61
Day 6th	8.2	43.1	84.44
Day 7th	14.12	47.36	84.42
Day 8th	10.38	39.6	84.7
Day 9th	3.64	48.42	87.90
Day 10th	9.61	42.15	84.99

Table 3.3 shows the characteristics of Effluents like pH, BOD and COD for 10 days analysis of UASB treated Effluent after UASB treatment process taken from the lab where parameters to be analyzed .

3.1.4 Characteristics of Effluent after UF Treatment

Table No 3.4 Effluent Characteristics after UF Treatment

Day	% COD Reduction	% BOD Reduction
Day 1st	95	96.3
Day 2nd	93	95.7
Day 3rd	94.85	96.6
Day 4th	94.3	95.1
Day 5th	95.4	96.1
Day 6th	95.6	95.8
Day 7th	94.9	96.25
Day 8th	90	95.4
Day 9th	96.3	94.2
Day 10th	93.6	95.2

Table 3.4 shows the characteristics of Effluents like pH, BOD, COD and TDS for 10 days analysis of UF treated Effluent after UF treatment process taken from the lab where parameters to be analyzed .

3.1.5 Characteristics of Effluent after RO Treatment

Table 3.5 shows the characteristics of Effluents like pH and TDS for 10 days analysis of RO treated Effluent after RO treatment process taken from the lab where parameters to be analyzed .

Table No 3.5 Effluent Characteristics after RO

Day	% TDS Reduction
Day 1st	98.5
Day 2nd	98.4
Day 3rd	99
Day 4th	99.7
Day 5th	99.11
Day 6th	98.6
Day 7th	98.7
Day 8th	98.3
Day 9th	97.6
Day 10th	98.6

IV. RESULTS AND DISCUSSION

4.1 % Reduction of pH, COD and SS

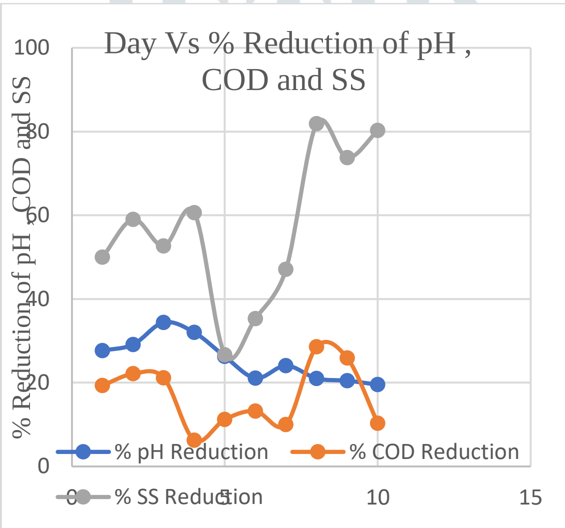

Fig. 4.1 % Reduction of pH, COD and SS

Fig. 4.1 shows the % Reduction of pH, COD and SS for 10 days analysis of Primary Effluent Treatment Plant after treatment taken from the lab where parameters to be analyzed.

4.2 % Reduction of pH, COD and BOD

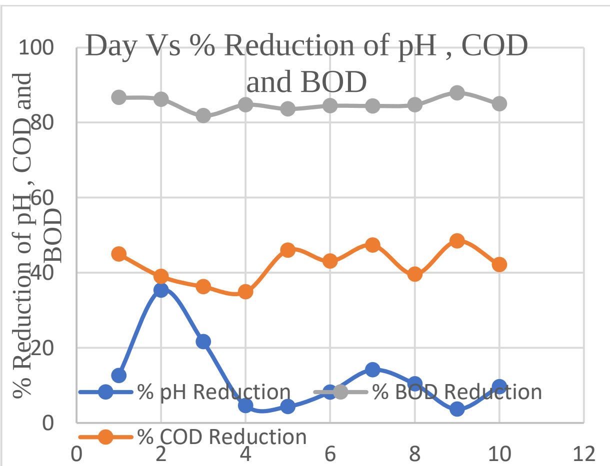

Fig No. 4.2 % Reduction of pH, COD and BOD

Fig. 4.2 shows the % Reduction of pH, BOD and COD for 10 days analysis of UASB treated Effluent after UASB treatment process taken from the lab where parameters to be analyzed.

4.3 % Reduction of pH, COD and BOD

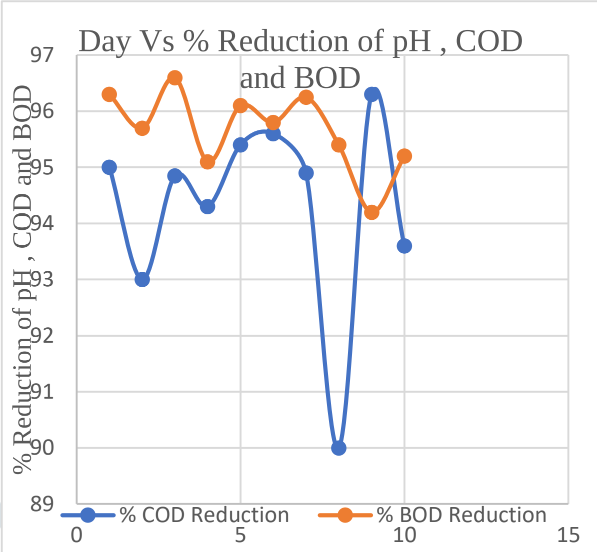

Fig. 4.3 % Reduction of pH, COD and BOD

Fig. 4.3 shows the % Reduction of COD and BOD for 10 days analysis of UF treated Effluent after UF treatment process taken from the lab where parameters to be analyzed.

4.4 % Reduction of TDS

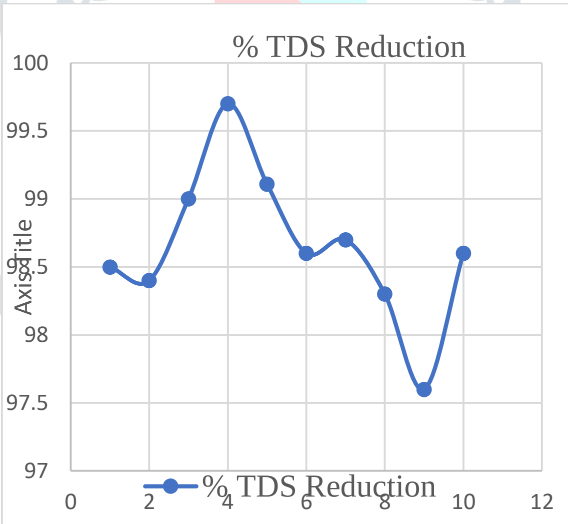

Fig. 4.4 % Reduction of TDS

Fig. 4.4 shows the % Reduction of TDS for 10 days analysis of RO treated Effluent after RO treatment process taken from the lab where parameters to be analyzed .

V. CONCLUSION

ZLD treatment process can adopted as advanced waste water treatment constituents to by-products that are more readily biodegradable and reducing overall toxicity , pH , COD , TDS , SS , BOD parameters effectively than the convectional processes. ZLD is very effective method in the removal of many hazardous organic pollutants from wastewaters. Present work of ZLD for pharmaceutical industrial waste water treatment which consists of Pretreatment , Anaerobic treatment (UASB) , Secondary Aeration System , Filtration System and Sludge Dewatering System has different process units like Screening , Coagulation , Filtration , UASB , UF , RO etc. We study of ZLD for pharmaceutical industrial waste water treatment 10 days analysis of different treatment units concluded as up to 82 % of SS and 28 % COD removal in Primary treatment process, 49 % COD and 86 % BOD in UASB process unit, 96 % of both COD and BOD reduction UF process unit and 99 % of TDS reduction in the RO system.

As the final results shows the 99 % TDS, 100 % of both COD and BOD, 98 % of SS and TSS reduced (Removed) make it Zero liquid discharge. The plant was generated high quality water which was suitable to recycle in plant premises and which resulted in reduction of water consumption.

VI. FUTURE SCOPE AND BENEFITS

Future Scope

• ZLD can be adopted to treatment of variety of industrial waste water.

RO reject with high TDS can further be treated in multiple effect evaporator (MEE) & agitated thin film dryer (ATFD) to recover valuable by-products.

• ZLD can be used as an additional treatment to treat & recycle waste water.

• ZLD process can make waste water reusable.

• This treatment process can treat any type of industrial waste water so have wide scope to treat different types of industrial waste waters.

• ZLD capable to make recyclable any type of waste water can avoid the shortage of fresh water and Recover around 95% of your liquid waste for reuse.

BENEFITS

1. Water Conservation
2. ZLD systems employ the most advanced wastewater treatment technologies to purify and recycle virtually all types of wastewater produced.
3. Reduces the wastewater discharge i.e. reduces water pollution
4. Preferred option for industry where disposal of effluent is major bottleneck
5. Prevents exploitation of hydraulic capacity of disposal system
6. Separation of salts / residual solvents improve efficiency of ETP and CETP
7. Separated solids valuable by-product which helps in reducing the payback period
8. Mixed solvent separated in stripper can be reused or used as Co-processing
9. Ease in getting environmental permissions
10. More focus on production/ business rather than tracking after regulatory authorities
11. Reduction in fresh water demand from the Industry frees up water for Agriculture and Domestic demands.

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VIII. Nomenclature

BOD - Biochemical Oxygen Demand
COD - Chemical Oxygen Demand
TDS - Total Dissolved Solids
TSS - Total Suspended Solid
TOC – Total Organic Carbon
NTU - Nephelometric Turbidity Units
LCS - Low concentrated Sludge
SBR - Sequential Batch Reactor
MBR - Membrane Bio-Reactor
ZLD - Zero liquid discharge
MEE - Multiple Effective Evaporator
ATFD - Agitated Thin Film Drier
UF - Ultra Filtration
RO - Reverse Osmosis
CCA – Chambers & Collection Tanks Analysis