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Comparison between Conventional ETP and ETP using Nanofiltration by Analyzing the Results of Chemical Industry as Per CPCB Norms

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Abstract: ***Our mother nature has its own capacity of purifying the water but due to billions of population her capacity is reducing as the quality of waste water is becoming worst. Without the treatment of waste water it becomes troublesome for whole ecosystems as well as for the environment. Globally around 80% of waste water is being discharged in the natural streams without any proper treatment. If it continues likewise then the day is no longer when we starve for pure water at least for drinking purpose. Waste water treatment helps to keep the water in its purest form for reuse for various domestic as well as industrial purposes. Waste water treatment also helps to protect the ecosystem. There are various ways to treat the waste water such as rainwater harvesting, desalination, water location transfer, zero liquid discharge, water treatment plants etc. for the treatment of high amount of waste water from industries and municipal areas suitable water treatment plants are necessary. Generally the conventional treatment of water consists of 4 stages like preliminary, primary, secondary and tertiary treatment. But in some cases (like chemical, pharmaceutical, petroleum industries) advanced treatment is required which is known as quaternary water treatment. This process involves advanced oxidation and fine filtration. Each of these units has different capacity of removing different solids as the water passes through it successively and as an end result we get the clearer form of water than it's before. This research also deals with the advanced membrane filtration technology like Nano-filtration where it can partially replaces RO and the comparison between the results obtained from conventional ETP and ETP by using Nano filtrations as advanced filtration technique which replaces sand and carbon filters.***

Keywords: Nano Filtration, membrane filtration, sand and carbon filters ETP (Effluent treatment plant), RO (Reverse Osmosis), waste water treatment.

1. Introduction

Industrial waste water is the biggest source of waste water among all the sources. And the quality of discharged water depends on process being used for the production. It contains mainly organic and inorganic substances out of which organic substances are biodegradable and inorganic substances are non bio degradable. The main concern of industrial waste water is the amount of synthetic compounds which it carry and discharged into the environment. Due to the presence of some unidentified toxic compounds we have to use complex treatment processes to remove them from the water.

Generally chemical industries prefer conventional ETPs like preliminary treatment (screening and oil and gas removal chamber), primary (neutralization, flocculation and primary settling), secondary (aerobic and an anaerobic treatments, secondary settling), tertiary treatment (sand and carbon filters, Ultra filtration, RO, EDR etc.).

As the time passes some new technologies has been introduced for the waste water treatment out of these Nano-filtration is the pressure driven membrane liquid separation technology. This treatment is generally used as tertiary treatment which replaces sand filters and ultra filtration. Pore size of Nano-filtration is slightly greater than RO so in some cases it partially replaces RO. It provides high rejection of inorganic substances like heavy metals and non metals etc. which in turn reduces the TDS amount of the treated water. It is also used to remove odor and soften the water. Most of the nanofiltration membranes are composite materials of polymer and mainly manufactured in spiral design. No of tubes depends on the quantity and quality of the water to be treated. It is the future technology of the waste water treatment which needs to be discovered thoroughly

2. Problem Statement

Approximately 75% of population in the developing countries like India has no hygienic means of disposing facilities. The problem with the current waste water treatment processes is that they are not sustainable. The effect of inadequate treatment can lead to poor health results on social, economic, environmental and political levels.

Objectives

1) To find out better solution for waste water treatment by comparing conventional treatment with new technology.
2) To obtain unique solution for troubled water.

3. Methodology

A. Conventional treatment of waste water

1) Grit Chamber:

Effluent water collected from different streams is primarily passed through the grit chamber to remove the floating solid material. The size of grit chamber depends upon the size of particles passed through it. In case of chemical industry very small volume of floating materials are coming from

the streams so only the mesh is required to remove the floating material.

2) Oil and Grease Trap:
Oil and grease trap is used to remove scummy material like oil and grease where the settle able solids from the waste water are removed through the series of oil and grease trap. It can be removed by two methods, manually and mechanically here in this chemical industry it has been done manually. Chamber cleaning is done after every 6 months.

3) Equalization Tank :
Transfer effluent through HDPE pipe line from scrubber tank to equalization cum neutralization tank or ML collection tank and transfer the effluent in advanced oxidation tank. Here treat the effluent by fenton reagent (H2O2 + FeSO4). Settle the effluent in the tank and transfer clean effluent to equalization tank I/II and slurry transfer to multiple screw press for sludge dewatering. Agitate effluent by aeration grid and neutralize it manually by lime water or by acid or caustic flakes (if required). Check pH it should be maintained between 6.5 to 8.5

4) Flash Mixer:
Effluent from the equalization tank is passed to flash mixer where coagulation and flocculation is done. Coagulation is done by using both chemical and natural coagulants depending upon the chemical parameters of the effluent to remove the suspended particles present in the water. The density of suspended particles is same as that of water so they float in it so as to settle down that particles, density of the particles is increased by adding poly aluminum chloride (Aln(OH)mCl3nm) and poly electrolyte (C3H5NO) as coagulants so that flocc formation of the particles will be there. The dose of coagulants is based on the laboratory jar test.

5) Primary clarifier:
Coagulated water from flash mixer goes to primary clarifier, (where the sludge settled at the bottom of clarifier which is transferred to multiple screw press where the sludge and water is separated, sludge dried on sludge drying is disposed to TSDF as per SPCB guideline) and clear water through launder goes to aeration tank for further treatment.

6) Aeration Tank:
Effluent from primary clarifier is further treated at the aeration tank where oxidation is done by using air diffusers, Oxygen is required to grow MLSS (mixed liquor suspended solids) and MLVSS (mixed liquor volatile suspended solids) which are very helpful to remove biodegradable substances by the aerobic treatment of waste water.

7) Secondary clarifier:
Effluent overflow from the aeration tank goes to the secondary clarifier where all the biomass settled at the bottom of the secondary clarifier is transferred to aeration tank through circulation pump to maintain the 25 to 50% of MLSS if concentration of MLSS is exceeding 50% in aeration tank then transfer activated sludge to sludge drying bed. Allow gravitational flow of supernatant liquid to a tank i.e holding sump.

8) MGF and ACF:
Water from the holding sump flows down through the filter inlet through the media bed. The media bed consists of multiple layers of sand, pebbles and gravels arranged according to size and density. As the raw water passes through different layers of the media, filtration takes place in each media layer. The media bed retains all the suspended solids, dust and dirt present in the water and the clear filtered water flows through the outlet of the filter for the further treatment through ACF. ACF works on the principle of adsorption, filter medium absorbs or reacts with a pollutant molecules then filtered water is passed for the further treatment.

9) Ultra filtration:
Water from the MGF and ACF is passed through ultrafiltration to remove the turbidity and other suspended pollutants of the water. Permitted water of UF goes to the RO for the further treatment and the rejected water of UF goes to the EDR for the further treatment.

10) RO (Reverse Osmosis):
Permitted water of the ultra filtration is treated through the RO system to reduce the TDS from the water simultaneously COD reduction is achieved. Permitted water of the RO is clear water which is sent back to the utility services for reuse. And the rejected water from the RO is sent to the EDR system for the further treatment.

11) EDR:
Rejected water from UF and RO is treated through EDR and permitted water from EDR is sent again back to UF for treatment.

12) Evaporator:
Waste water evaporation is a time tested method for reducing the water portion of water based wastes. The evaporator converts the water portion of water based wastes to water vapor while leaving the higher boiling contaminants behind. This greatly minimizes the amount of waste that needs to be hauled off site. processed condensate from the evaporator is sent back to the equalization tank and steam condensate from the evaporators is sent to the utility services and sludge collected m aporator is sent to CTSDF (common transportation, storage, disposal facility).

B. Waste water treatment with Nanofiltration technology

1) Mixing Tank:
Organic and inorganic effluents comes from streams are mixed here to maintain the range of pH, TDS, COD etc. Batches of water should be mixed such that its COD value should be in the range of 8000 to 10000 for the efficient working of the further systems.

2) UASB:
UASB uses an Anaerobic process whilst forming a blanket of granular sludge which suspends in the tank. Waste water flows upward through the blanket and is processed by the anaerobic microorganisms. The upward flow combined with the settling action of gravity suspends the blanket with the aid of flocculants. the sludge bed is made up of dense

microorganisms with naturally granules from .5 to 2 mm in diameter which is the accumulation of influent suspended solids and bacteria biomass settled down in the bottom. These granules form sludge with high sedimentation velocity can avoid sludge wash out from reactor even at high hydraulic loads. The bubbles generated at sludge bed go up with some granule sludge. The motion of the released bubbles with up flow speed cause hydraulic turbulence which provide reactor self mixing without mechanical agitation. Gas solid liquid three phase separator at the top of the reactor. The three phase separator is the key part of the system which is used to separate water phase from sludge solids and gas phase. The treated effluent is discharged at the top of the effluent system and biogas is collected by gas cap at the top while sludge solids are settled back to the sludge in the bottom.

3) Aeration Tank:

Secondary treatment consists of the aerobic bio-reactor is a biological treatment unit in which dissolved organic matter is destroyed by micro organisms in the presence of oxygen. Compressed air is provided by Twin lobe blowers through air diffusers installed in the aeration tank. Air diffusers are tubular membrane diffusers that transfer very fine bubbles of air into the contents of the aeration tank. Oxygen present in the air is easily utilized by micro organisms for their survival and degradation of the organic matter present in the effluent. The activated sludge process is named so because there is a production of an activated mass of microorganisms capable of stabilizing a waste aerobically. Organic waste is introduced into a reactor where an aerobic bacterial culture is maintained in suspension.

4) Membrane bio reactor:

The mixed liquor from the aeration tank will flow to membrane tank by gravity. In membrane tank the filtration process take place. MBR is essentially a high MLSS (10000-20000 mg TSS/l) activated sludge process with an integral solid liquid separation mechanism, the membrane unit. Each standard membrane unit is comprised of two separate sections, a membrane case and a diffuser case. The membrane case contains a number of manifold flat panel membrane catridge with an average porosity of 0.1 microns. The bottom diffuser case supports the membrane case and house a coarse bubble diffuser

The membranes are immersed in the membrane tanks and use suction pumps to create a vacuum on the permeate side of the membrane. This vacuum is the force which pulls permeate through the membrane. As permeate is removed through the membrane, solids will tend to build up and form a cake layer that acts as a barrier to flow. To combat this, a coarse bubble aeration stream is applied which helps to scour solids off the surface of the membrane. In addition to aeration the fibers are periodically back flushed with permeate water. Back flushing forces water from the inside to the outside of the fibers. This reverse flow serves to remove from the membrane surface any accumulated solids that have not been removed by the air scour. The permeate water is collected in permeate water tank for further purpose.

5) Nano Filtration:

Nano filtration is a membrane filtration based method that uses nanometer sized through pores that pass through the membrane. Nano filtration membranes have pore sizes from 1-10 nanometers smaller than that used in micro filtration and ultra filtration but just larger than that in reverse osmosis. Membranes used are predominantly created from polymer thin films. Materials that are commonly used include polyethylene terephthalate or metals such as aluminum. Pore dimensions are controlled by pH, temperature and time during development with pore densities ranging from 1 to 106 pores per cm2

Filtration is the final step in the solid removal process. The removal of suspended and colloidal particles by media filtration is based on their deposition of surface of filter grains while the water flows through a bed of these media. The quality of the filtrate depends on the size, surface charge and geometry of both suspended solids and filter media as well as on the water analysis and operational parameters. Here activated carbon placed as a filter media. Nanofiltration shows 70% water recovery and rejected water goes to RO for further treatment.

NF normal start up:

- Open H.P.P suction valve and partially throttle discharge valve to avoid low suction tripping initially.
- Start high pressure pump
- Brine control valve should in fully open condition
- Open H.P.P. discharge valve gradually
- Throttle brine control valve and control brine flow and product water flow
- Monitor NF system pressure and control it
- Initially drain the product water for 20 min then start closing the brain control valve very slowly
- The flow of brine will start reducing and the N.F reject pressure will start increasing.
- Adjust to the required flow rate and pressure and start collecting product water from product outlet.

6) RO:

Rejected water from Nano filtration is treated here by passing it through series of filters to get clear water. Rejected water from RO goes to evaporator.

7) Evaporator:

Waste water evaporation is a time tested method for reducing the water portion of water based wastes. The evaporator converts the water portion of water based wastes to water vapor while leaving the higher boiling contaminants behind. This greatly minimizes the amount of waste that needs to be hauled off site. processed condensate from the evaporator is sent back to the equalization tank and steam condensate from the evaporators is sent to the utility services and sludge collected from evaporator is sent to CTSDF (common transportation, storage, disposal facility).

4. Results

	TDS	COD	% reduction
inlet	2484	4322	
primary	2693	4329	-.16
secondary	2981	2340	45.95
tertiary	2834	1991	14.91
U.F	2752	2134	-7.18
R.O	1818	1010	52.67

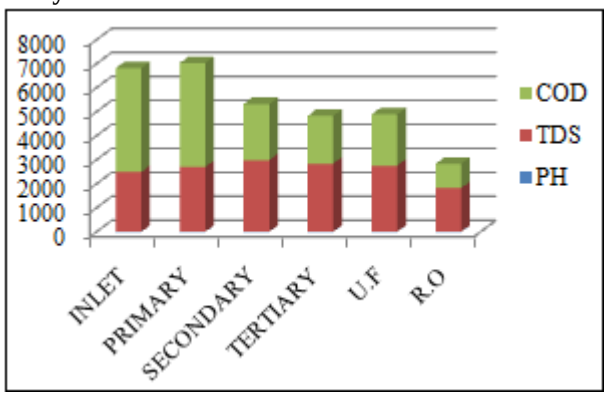
Conventional ETP results

	TDS	COD	% reduction
Mix (60+40)	5544	11675	
U.A.S.B	5544	9515	19
AT-1	5544	3072	55
MBR	5544	1222	16
NF-90 feed	5525	1222	
RO (P)	771	207	53.7
NF-2(R)	13895	3675	16.7
NF-2(P)+ R.O(R)	2203	376	29.6

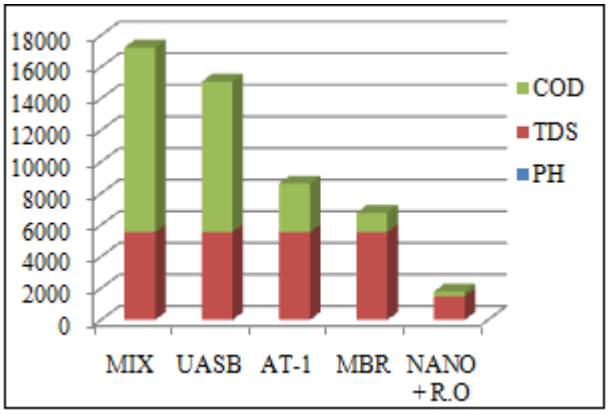
Results using Nanofiltration

5. Analysis of Results

Analysis of results obtained from conventional ETP



Analysis of results obtained from ETP with Nano-Filtration



Comparison

S. No.	Conventional ETP	ETP with Nano-Filtration
1	Costly (because for the treatment of high COD and TDS water through MEE more steam is required so ultimately it increases the cost of treatment with very less % reduction)	Cost effective (as we are getting almost 80% recovery of water through Nano-filtration +RO system, steam is required for the treatment of only 20% of water so it ultimately reduces the cost of treatment.)
2	More energy consumption	Less energy consumption
3	Less reduction in the parameters like COD, TDS, pH	more reduction in the parameters like COD, TDS, pH
4	Less effective for commercial use.	More effective for commercial use.

6. Conclusion

1) Effluent treatment plant using Nano-filtration shows reduction in the parameters like COD, pH, turbidity, TDS etc. as compared to conventional ETPs. It helps to achieve ZLD (zero liquid discharge) of the entire water treatment system as there is no loss of water at any process of effluent treatment plant.
2) Results have been achieved within the limits of CPCB norms by using Nano filtration technology

7. Future Scope

1) The installation of NF facilities is expected to increase for water treatment in future in the world it is due to the increase of population, urbanization of coastal and arid areas, scarcity of fresh water supplies, greater reliance on oceans, and poorer quality supplies such as brackish ground water and treated wastewater.
2) The wastewater engineering companies should study the possibility of utilizing a greater number of NF plants for water treatments, water reuse and in particular, desalination of brackish water and specific contaminants removal.

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