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DETAILED PROJECT REPORT FOR COMMON EFFLUENT TREATMENT PLANT AT INDUSTRIAL FOCAL POINT, CHANALON, MOHALI, PUNJAB

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1. INTRODUCTION

1.1 GENERAL INTRODUCTION OF ELECTRO PLATING INDUSTRIES

Electroplating is a type of metal finishing operation that changes the surface properties of a metal part to make it stronger, shinier, and corrosion-resistant. Activities at electroplating shops include surface preparation, surface treatment, and post-plating treatment. Electroplating industry is India is spread throughout the country. They are mainly in small scale sectors with over 3, 00,000 small scale units. Metals used for plating are costly metals having superior qualities like nickel, cadmium, platinum, gold, silver, chromium etc. it has been noted that out of the total amount of these metals used in electroplating, 4% goes as waste in sludge spent wash, electroplating solutions etc. The pollutants from the electroplating industries are invariably hazardous, as the effluents contaminate air, water and soil. Some of the polluting agents have deleterious effect on human health, examples being cadmium, lead, and nickel etc. The environmental load in electroplating industry mainly consists of process waste water, hydroxide sludge and sulphuric acid. The untreated rinsing water has a lot of waste.

The electroplating industry is one such type of industry whose effluent if directly released into the fresh water bodies can disturb the aquatic ecosystem in an extremely harmful way. The electroplating industry is a large industry operated throughout the year. A large amount of effluent is generated which contains high pollution load of heavy metals. This industry uses electrolytic processes for plating heavy metals on the metal sheet at a low pH. During this process large quantities of heavy metals remain in the effluent along with acidic pH. No protocols and preventive measures are maintained in the effluent discharge. Thus a large amount of waste water is generated. These effluents are let out openly to get mixed into the rivers and ponds. The channels of the effluent may have many cracks through which the water gets percolated deep inside to contaminate the ground water. The foul smelling of effluents with displeasing color makes the environment unhealthy. The peculiar characteristic of the electroplating industry is that it contains high loads of heavy metals like Chromium, Copper, Nickel, Zinc, etc. These heavy metals are required in small amounts in the animal body. But almost all of them are toxic at higher concentrations. When these effluents containing heavy metals get mixed with rivers, the water quality gets affected as there is no availability of ready and reliable information of the physico-chemical parameters of this effluent. Electroplating is usually carried out with Ni, Zn and Cu. The most common type of

electroplating is by using Ni (Nickel plating). The cell specifications for nickel plating are as follows:

Electrolyte:$NiSO_4$ or $NiCl_2$ dissolved in demineralized water (DMW).

Anode (+ve) :Ni

Cathode (-ve) :Cu

The Ni anode is stored in titanium bags to prevent the falling of anodic sludge. In the electrolyte solution, Boric acid (H_3BO_3) is added in the electrolyte to ensure smooth electroplating .

Thus the physico - chemical analysis is the prime factor to access the quality of water for drinking, bathing, agriculture, fishing, industrial processes and so on. The analysis of waste water, either domestic or industrial, is important to know the pollution strength and its effects on the ecosystem. Domestic and industrial waste waters are analyzed for various parameters to decide, what physical, chemical or biological treatment should be given to make them suitable for discharge either on land for irrigation or in other water bodies.

1.2 APPLICATIONS OF ELECTROPLATING

(a) Electroplating is used for Decoration or Better Appearance. In order to increase commercial as well as decorative value, base metals such as iron, brass, copper, aluminum alloys etc are electroplated with gold, silver, nickel chromium, palladium, platinum, rhodium and copper etc. For special decorative effects tin, cadmium, lead, platinum etc. are also used. One metal may be electroplated over the base metal or an alloy may be electroplated over the base metal or several metals may be plated one over other on the base metal.

(b) Plating for protection

Electroplating has widely been used for depositing protective coatings on iron and steel articles to protect them from corrosion, rusting and chemical attack. Protecting metals applied on iron and steel articles are zinc, cadmium, nickel, chromium, tin and copper etc. Copper and chromium provide protection against rusting and chemical attack, while chromium plating gives shine and clean metal appearance and corrosion protection too. The three coating electroplating has widely been used in automobile industry, followed by lock. For the sake of protection, the galvanic effect of the metal couple formed by electroplating should

also be considered. A galvanic couple, formed by the plated metal with the base metal should not be such that it may increase the corrosion of the base metal instead of preventing it.

(c) Plating for Special Surfaces

There are plants, one part of which can be easily fabricated with an alloy and has got the required mechanical strength too, but is readily corroded when subjected to atmosphere of working or working conditions. In such cases, the part requiring corrosion resistance is exclusively electroplated with a corrosion resistant metal and it serves the purpose in an excellent manner. For example, in internal combustion engines, an electroplated chromium coating not only avoids the wear, but also improves the running performance.

(d) Electroplating for Engineering Effect

In engineering, electroplating is employed for temporary use in metal treatment. Thus before carburizing, the steel parts are copper plated, in order to avoid carburizing at undesired portions. Similarly, portions of steel are protected from nitriding in hardening process by electroplating tin or copper-tin alloys on steel portions.

(e) Electroplating on Non-metallics

Non-metallics such as glass, cloth, porcelain, leather, wood, dried leaves etc. are also electroplated for decoration, for preservation, for obtaining a conductive surface, for increasing their strength and for obtaining light weight parts with the properties of metal surfaces. For example, radar antenna masts made of hard wood or of synthetic resins are electroplated with copper, Electroforming as well as electrotyping both are examples of electroplating of the non-metallics.

(f) Electroforming

Formation of articles by electro-deposition of metals is called electroforming, in which the layer of plated metal is quite thick. For example, many parts used in air craft, radio, radar, automobile industries are electroforming products.

1.3 CONSUMPTION OF WATER DURING INDUSTRIAL OPERATION

The most significant uses of water, in the project facility in focus (as reflected from the secondary data available) are associated with following operations

1. Surface Preparation and Cleaning

   Alkaline Cleaning

Electro polishing

Oxide Removal

2. Metal Plating

Electro Plating

Electroless Plating

Rack Plating

Barrel Plating

3. Protection and Finishing Treatments

Anodizing

Chromate conversion

Phosphating etc.

Also washing operations including interior pre flush, hot water washes and rinses, exterior washing, and formulation of cleaning solutions etc. consume water in significant amount.

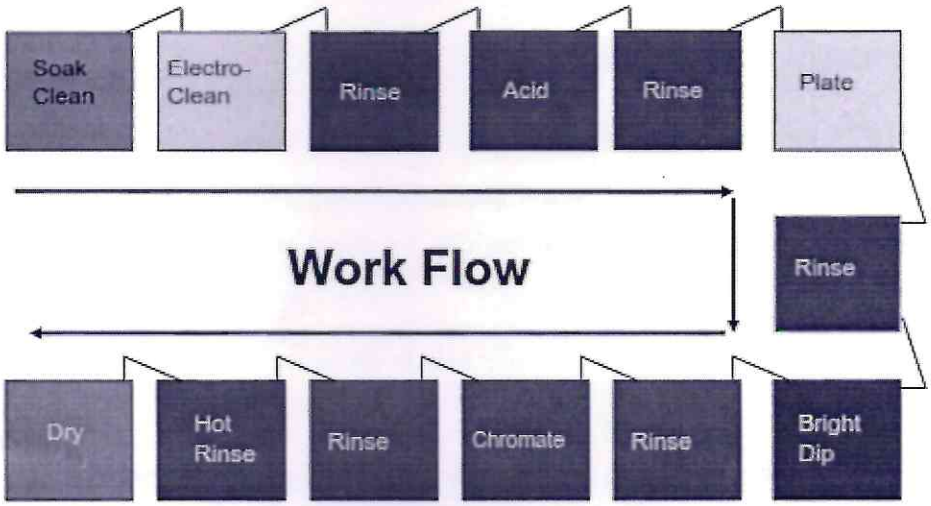


Figure 1 Typical Electro Plating Process

1.4 EFFLUENT GENERATION

Electroplating wastewater comes from surface plating operations where the metal is dipped in an electroplating solution of various types of metals and then rinsed. Electroplating wastewater is typically from washing, rinsing and batch dumps and is at a low pH of ~3-5 and contains soluble forms of the various metals.

Wastewater is generated primarily through manufacturing unit. In the manufacturing unit, the production occurs in a batch, continuous process and is carried out in many steps. As significant amount of chemicals, reagents etc. are involved in production process;

consequently resulting in substantial amount of wastewater, constituting considerable number of pollutants both organic and inorganic.

1.5 WASTEWATER CONSTITUENTS FROM ELECTROPLATING INDUSTRIES

All the constituents of the plating baths contribute to the wastewater stream either through part drag-out, batch dump or floor spill. Electroplating baths may contain Cu, Ni, Ag, Zn, Cd, Cr, Sn, Pb, Fe, ammonia, etc. The anionic components likely to be present include borate, cyanide, fluoride, tartrate, phosphate, chloride, sulfide, sulfate, sulfamate, nitrate, etc. Further, many other additives to induce grain refining, deposit brightening, surface leveling, etc. are also added to the plating baths. These include Mo, Se, As, Co, saccharin, aldehydes, etc., all of which contribute to the waste streams. Apart from these, contaminants like oil, grease, biodegradable mass, suspended solids, etc. may also be present in the wastewaters.

1.6 EFFECTS OF THE WASTEWATER

- Plating effluents are highly toxic and corrosive.
- Cyanide, chromic acid, chromates, salts of heavy metals, e.g., Cd, Pb, Ni, Zn and Cu present are toxic to aquatic life. Their toxicity to micro-organisms inhibits self-purification property of the streams.
- Phosphates and nitrates present in the effluent help in excessive algal growth which is undesirable.
- Colloidal and suspended impurities impart unaesthetic appearance to the stream.
- Owing to the toxic nature of the effluents, they are not disposed into the rivers or water courses. They are generally discharged into sewers. If cyanide is not completely removed, the HCN gas formed may affect the workers in the sewage treatment plant and sewer system. The organic solvents may cause explosion in the sewer system. Oils and greases present may interfere with the biological treatment of the sewage. Acidic or alkaline plating effluents may corrode the concrete structures. Suspended impurities present may clog the municipal sewer system.
- As is highly toxic, it is a chronic, cumulative poison and may cause eruptions on the skin and is said to be a causative agent of some forms of cancer.

- Cadmium (Cd) affects metabolism and may substitute for Ca^{2+} in the bone structure. In fact Cd result in the "Itai-Itai" disease, a seriously crippling effect, observed in Japan, is a result of Cd replacing Ca in the bone structure.
- High concentrations of Fe may stain laundry and fixtures, etc.

The harmful effects of water borne diseases are associated with hexavalent chromium. Most commonly electroplated metals are Zinc, Nickel, Chromium, Aluminium, Copper, Cadmium etc. Out of these, chromium plating is one of the most widely used forms of electroplating and constitutes an important source of toxic heavy metal discharges.

1.7 POLLUTION CONTROL MEASURMENT

With the growth of industry, environmental pollution is rapidly increasing in our country. The awareness of environmental pollution control has come much later than the development of chemical industry in India. The legislation has also come much later than the industrial growth. The pollution control and abatement is therefore going to take time.

There is no doubt that pollution control measures will lead to long term gains, employment increase, increase in productivity, social justice and cleaner environment. It is necessary that the government should give more attractive incentives to encourage industry to adopt pollution control measures. These measures add to the cost of the product which ultimately goes as an additional burden to the customer. Government has to play vital role in controlling the pollution at the licensing stage itself. No license should be issue until the project is found to be environmentally safe. At the present pace of industrial development, it is important that the environment control technologies should be given the highest priority, before the situation worsen and becomes difficult to tackle technically and financially

1.8 CONCEPT OF COMMON TREATMENT

The concept of effluent treatment, by means, of a collective effort, has assumed reasonable gravity by being especially purposeful for cluster of small scale industrial units. Common effluent treatment plants (CETP) not only help the industries in easier control of pollution, but also act as a step towards cleaner environment and service to the society at large. Small scale industries, by their very nature of job cannot benefit much from economies of scale and therefore the burden of installing pollution- control equipment, falls heavy on them. Realizing this practical problem, under the policy statement for abatement of pollution the Govt. felt to extend the scheme for promoting combined facilities for treatment

of effluent and management of solid waste for clusters of small scale industrial units and also to provide technical support to them. Accordingly,

Ministry of Environment & Forests, Govt. of India, had instructed various State Pollution Control Boards, to examine the possibilities of establishing CETPs in various Industrial estates in the respective states. The concerted approach of joint or common effluent treatment provisions has many advantages. Wastewater of individual industries often contains significant concentration of pollutants; and to reduce them by individual treatment up to the desired concentration, become techno-economically difficult. The combined treatment provides a better and economical option because of the equalization and neutralization taking place in the CETP. Other important issues for the merit of common treatment include scarcity of land at the industry's level and a comparatively easier availability of professional and trained staff for the operation of CETP, which can otherwise be difficult, at the individual industry level. For the regulatory authorities also, common treatment facility offers a comparatively easier means of ensuring compliance of stipulated norms. The handling and disposal of solid- waste also becomes increasingly easier as the infrastructure is created in the project itself. The concept of common treatment, based on feasibility, should be part of the new industrial estates as essential component of infrastructure, In fact, the location of industries should always be such that units with compatible nature of activity are located in a cluster which in-turn can facilitate in providing common treatment.

1.9 ADVANTAGES OF COMMON TREATMENT

- Saving in Capital and operating cost of treatment plant. Combined treatment is always cheaper than small scattered treatment units.
- Availability of land which is difficult to be ensured by all individual units in the event they go for individual treatment plants. This is particularly important in case of existing old industries which simply do not have any space.
- Contribution of nutrient and diluting potential, making the complex industrial waste more amenable to degradation.
- The neutralization and equalization of heterogeneous waste makes its treatment techno-economically viable.
- Professional and trained staff can be made available for operation of CETP which is not possible in case of individual plants.
- Disposal of treated wastewater & sludge becomes more organized.

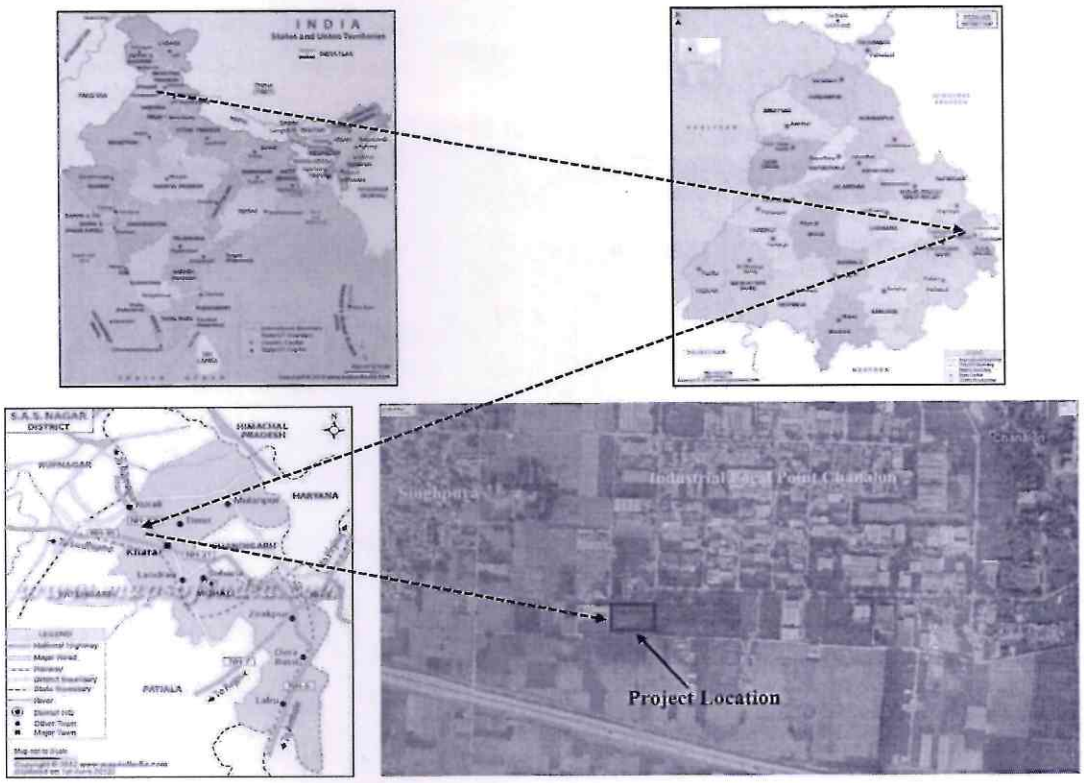
- Reduced burden of various regulatory authorities in ensuring pollution control requirement.

Thus, all the above effluent streams, need to be treated prior to discharge, or any other alternative usage. Being an 'Environment Conscious & Responsible' company, the management intends to recycle and reuse maximum amount of treated water in the process itself by installing the State-of-art ETP followed by UF/RO & Double Effect evaporator. The main objective is to attain the Zero Liquid Discharge (ZLD).

2. INTRODUCTION OF PROJECT/ BACKGROUND INFORMATION

Brief about the Project Location and Project Proponent

M/s Bansal Envirotech Private Limited proposes to erect and operate a Common Effluent Treatment Plant of 600 KLD at PSIEC Industrial Focal Point, Chanalon (Kurali), Mohali, Punjab, (Location explained through Index Map in Fig. 1) at the land adjoining Sewage treatment plant of PSIEC. Layout plan of the project is given in Fig. 2 and Layout plan of the PSIEC Focal Point, Chanalon (Kurali) is given in Fig. 3, along with latitude, longitude of the corner points of the project site in Table 1 and Fig. 4.



Index Map of Project Location

Figure 2 Location Map of the Project Site for the Setting up of the Proposed CETP

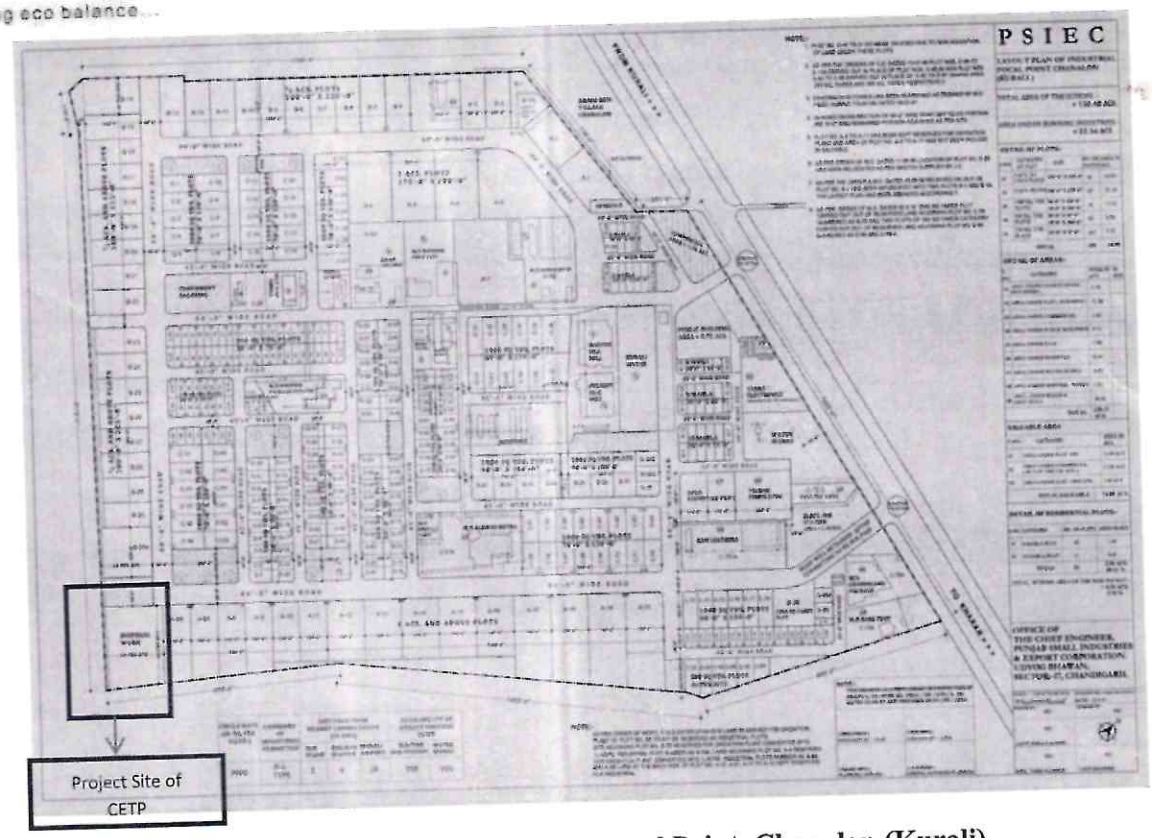


Figure 3 Layout Plan of the Industrial Focal Point, Chanalon (Kurali)

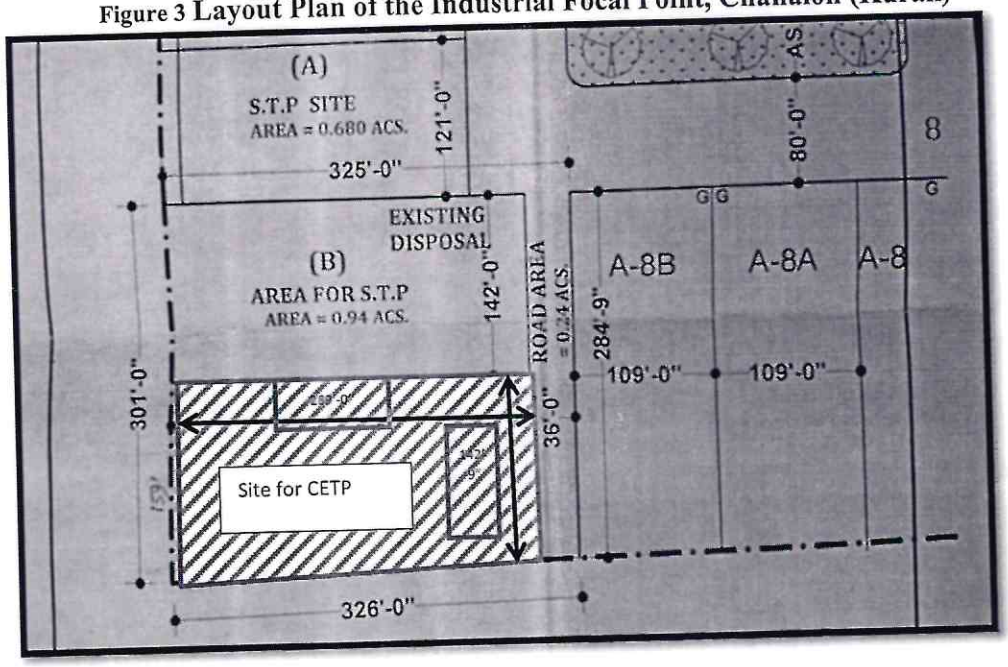


Figure 4 Site Plan of the CETP

Details of the Project Site

The land for the project site has been allotted by PSIEC to Punjab Pollution Control Board (PPCB) on lease hold basis for a period of 20 years on annual lease rent of Rs. 100 for setting up CETP in public interest as per letter no. PSIEC/ Estate/ 25691-92; dated 18/ 9/2019, attached as Annexure 2. Consequently, the possession of the land has been obtained by Punjab Pollution Control Board (PPCB) as per "Possession Certificate" Ref. No. PSIEC/ SDE (M)/ 793 dated 03/10/2019 issued by PSIEC to PPCB for the land admeasuring 4853.15 sq.yards (1.00 Acre) (Annexure 3) Thereafter, a tripartite agreement has been signed between Punjab Pollution Control Board (PPCB), Mohali Industrial Association (MIA) and M/s Bansal Envirotech Private Limited (BEPL) on 20th Dec. 2019 (attached as Annexure 4), whereby M/s Bansal Envirotech Private Limited has been selected by a Special Purpose Vehicle (SPV) of Mohali Industrial Association i.e. Mohali Effluent Treatment Society, for establishment and execution of the CETP project at the allotted project site to Punjab Pollution Control Board (PPCB).

As the project is located in the already designated Industrial Focal Point adjacent to STP thus the project site is located as per the designated land use in the Industrial Focal Point of PSIEC and will be exempted from Public Hearing requirements as per EIA Notification 1986, Clause 7: Stages in the Prior Environmental Clearance (EC) Process for New Projects; III. Stage (3) - Public Consultation: of Industrial Focal Points. [Whereby it is mentioned that all Category 'A' and Category B1 projects or activities shall undertake Public Consultation, except "all projects or activities located within industrial estates or parks (item 7(c) of the Schedule) approved by the concerned authorities, and which are not disallowed in such approvals."

Table 1 Corner coordinates of the project site

S. No.	Corner	Coordinates
1.	A.	30.812952^{O}N & 76.579903^{O}E
2.	B.	30.813358^{O}N & 76.579896^{O}E
3.	C.	30.813309^{O}N & 76.580901^{O}E
4.	D.	30.812952^{O}N & 76.580904^{O}E

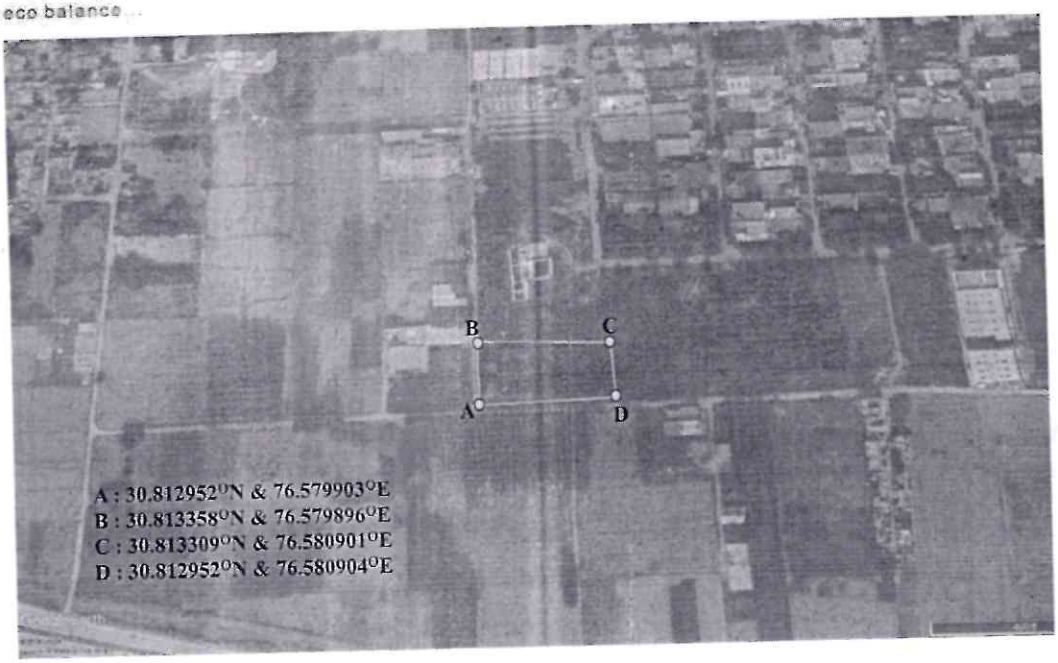


Figure 5 Corner Coordinates Of the Project Site

4. BACKGROUND OF THE PROJECT

M/s Bansal Envirotech Private Limited was incorporated as a private company and recognized start – up (Certificate of recognition is attached as Annexure 5) with young entrepreneurs as directors of the company, within the meaning of section 2 (68) under the Companies Act 2013 as per articles of association, for establishing latest technologies for environment management in the state of Punjab.

The company will cater to the needs of the treatment of effluents from Metal Surface Finishing, Polishing Industries of MSME and large scale, which are in need to treat their effluent, but have no in house facility or insufficient infrastructure and also industries having characteristics of high pollution load, requiring effluent treatment. Being not able to set up an effective ETP and the Multi-level evaporators being exorbitantly beyond the reach of such industries, the need to set up a CETP is totally justified, to cater for the treatment of effluent generated from the industries in the IFPs in the adjoining districts.

The Technology for Effluent Treatment Plant (ETP) being adopted to treat the effluents is the Preliminary Treatment followed by Physico-chemical, biological system, aeration/ polishing tanks for any presence of COD/ BOD and then Tertiary Treatment. The treated effluent from ETP will then be polished by Ultra- Filtration followed by Reverse Osmosis Plant (UF-RO Plant). The final RO treated water i.e. RO Permeate will then be collected into treated water

storage tank for further use and RO Reject with high TDS value, will be sent to Evaporator unit where the high TDS effluent will be evaporated and the condensate will be collected as the treated water and concentrate will be sent to hazardous waste disposal site. This Technology is highly popular and trusted as it is environmental friendly. The modus operandi is to employ tankers of different capacity to collect and transport wastewater from different industries and based on their composition.

5. DESIGN BASIS

The Environmental Protection Rules, 1986 provide standards for Common Effluent Treatment Plants. These standards apply to discharges from industries to an inlet of a CETP as well as to the CETP itself for treating and discharging the effluents.

Based on the secondary data available and requirement of PCB for treated effluent, the characteristics for the raw effluent and treated effluent for the design purpose are given below in the table:

S. No.	Parameter	Unit	Design Parameter
1.	pH	-	1 -2.5
2.	BOD	mg/l	150- 200
3.	COD	mg/l	500
4.	Oil & Grease	mg/l	50
5.	TSS	mg/l	350- 450
6.	TDS	mg/l	12,000- 15,000
7.	Iron as Fe	mg/l	10
8.	Zn	mg/l	30- 40
9.	Total Cr	mg/l	110- 120
10.	Hexavalent Cr	mg/l	80- 90
11.	Ni	mg/l	50- 60

Table 2 Raw Effluent Characteristics

Note: The above parameters are for designed purpose only. If there is any change in the above parameters, the design will be changed accordingly.

The treated effluents standards as specified for the CETP are represented in the following Table:

S. No.	Parameter	Unit	Treated effluent after ETP	Treated effluent After UF/RO	Treated water norms after ETP as per PCB
1.	pH	-	7-8	7-8	6-9
2.	BOD	mg/l	<30	Nil	<30
3.	COD	mg/l	<150	Nil	250
4.	Oil & Grease	mg/l	<5	Nil	10
5.	TSS	mg/l	<30	Nil	100
6.	TDS	mg/l	<20,000	<500	2,100
7.	Iron as Fe	mg/l	BPL	BDL	3
8.	Zn as An	mg/l	BPL	BDL	5
9.	Total Cr	mg/l	<5	BDL	2.0
10.	Hexavalent Cr	mg/l	<2	BDL	0.1
11.	Ni	mg/l	<10	BDL	3.0

Table- 3: Characteristics of Treated effluent for Design Purpose

6. TREATMENT SCHEME FOR CETP

STAGE 1: PRELIMINARY TREATMENT

- Receiving Chamber/Sump
- Fine Screen Chamber
- Oil & Grease Chamber
- Effluent Equalization Tanks- 4 Nos.
- Acid, Alkali and SMBS Dosing Ssytem
- Automatic pH Controller Systems

STAGE 2: PHYSIOLOGICAL TREATMENT

- Lime Preparation Tank
- Flash Mixer Tank
- Primary Tube Settler Tank-1
- Flocculation tank
- Automatic pH Controller Systems at Primary treatment
- Chemical Dosing System
- Primary Tube Settler Tank-2

STAGE 3: POLISHING UNIT TREATMENT

- Polishing Tank
- Tube Settler

STAGE 4: TERTIARY TREATMENT

- Filter Feed Tank
- Pressure Sand Filter
- Activated Carbon Filter

STAGE 5: METAL REMOVAL SYSTEM

- Resin Filter

STAGE 6: SLUDGE TREATMENT

- Sludge holding Tank
- Volute

STAGE 7: ZERO LIQUID DISCHARGE PLANT

- Ultra Filtration (UF) System
- Multistage Reverse Osmosis (RO) System

STAGE 8: MULTI EFFECT EVAPORATOR

- Evaporator
- ATFD (Agitated Thin Film Drier)
- High Speed Diesel (HSD) Based Boiler
- Cooling tower

7. BRIEF PROCESS DESCRIPTION

ETP has been designed to ensure that various parameters of treated wastewater are well below the permissible limits, even under the varying flow conditions which are typical for such systems.

The major process steps along with salient technological aspects are described below

7.1 COLLECTION AND CONVEYANCE SYSTEM OF EFFLUENT

The effluent from various member industries will be collected in the tankers or fleet of vehicles of capacities 6.0 Kl to 20.0 Kl with epoxy coated bullets and tanks and equipped with chemical resistant pumping gears to enable collection of effluents and will be sent to the CETP site for effluent treatment. All the effluents will be collected mixed together from various industries in the common collection unit.

7.2 PRIMARY TREATMENT

Main Chanel for Effluent

The main collection chanel will be lined by PP lining in the underground RCC Tank. Polypropylene tanks are highly valued for being corrosion-resistant and abrasion-resistant. As a safety precautions PP lining is considered at the RCC tank in order to avoid the seepage of effluent into the ground in case of spillage.

Screening and OGT

From the collection tank, the effluent will be pumped up to the ETP site where the effluent will be first passed through a bar screen chamber provided with a perforated bar screens (Coarse and fine) at the inlet point in the bar screen chamber for removal of floating materials. Removal of floating/ coarse matter is essential otherwise it can choke piping/pumps/ etc. and hinder the normal operation of the treatment plant. Bar screen shall be so designed that it can be cleaned manually from outside the Tank.

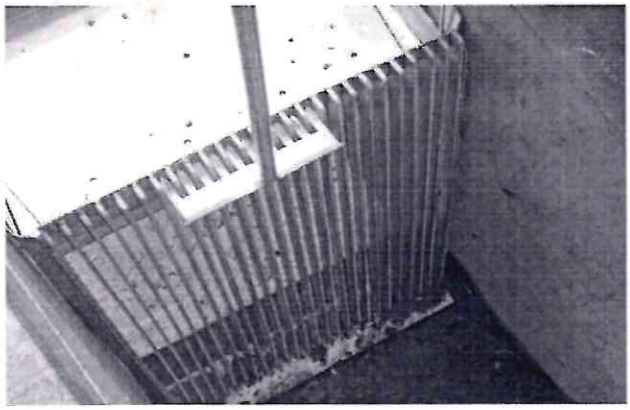


Figure 6 Screening at ETP Inlet

From screen chamber, the effluent will be transferred to the Oil & Grease trap (OGT) by gravity. Oil and Grease is designed to remove free floating oil & grease by the process of floatation and for the removal of Bio-degradation of oil or to be periodically manually removed.

Batch Type Equalization Treatment

Batch type effluent equalization treatment will be done wherein; four equalization tanks will be constructed. The overflow of (O&G) trap is collected into the effluent Equalization tanks. Firstly the effluent will be collected into one tank then it will be aerated, neutralized and then will be sent further for physiochemical treatment.

Once the treatment is occurring in the preceding tank, the succeeding equalization tank will be filled up with the effluent for treatment. In this way the effluent will be equalized in bath wise.

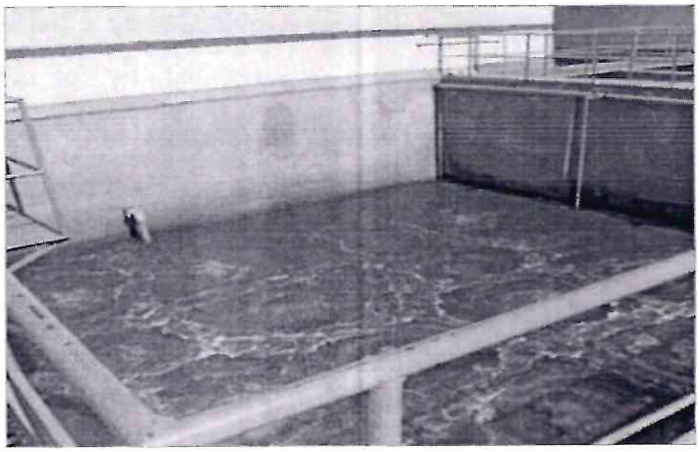


Figure 7 Equalization Tank

Aeration in Equalization Tank

Effluent from the collection tank comes to the equalization tank in wastewater treatment. The main function is to act as buffer. To collect the incoming raw effluent that comes at widely fluctuating rates and position to the rest of the ETP at steady flow rate. Providing consistent flow and loading to a biological process is important to maintain optimal treatment.

Aeration and mixing is provided both to keep the fluid from becoming anaerobic and smelly and to biodegrade some of the organic compounds present. Benefits of aeration in the Equalization Basin:

- Efficient aeration and mixing
- Simply balance flows during fluctuations
- Mix and aerate or just mix

Homogeneous mixture in Equalization Tank is done via the actions of coarse bubble diffusers , oxygen transfer efficiency of a coarse bubble diffuser is 10%-20% and are capable of delivering 6 - 12 m^3 / hour air , typical diameter of coarse bubble diffuser is 150 mm , coarse bubble diffuser is shown below

Figure 8 Course Air Bubble Diffusers

pH Neutralization in Equalization Tank

Neutralization of process water is a critical step in most industrial wastewater treatment processes. A basic pH adjustment / neutralization is being done in this step.

Since the effluent has varying pH, chemical dosing i.e. acid and alkali will be done for neutralizing the incoming effluent.

In this system, effluent will flow into the equalization tank where a pH sensor (also known as pH electrode or pH probe) senses the pH of the solution. The sensor provides input to the pH controller device which operates chemical pump(s) to inject acid or caustic as required to

neutralize the effluent. The aeration serves to evenly distribute the neutralizing chemicals throughout the holding tank to ensure complete neutralization. From Equalization tank, the effluent will further undergo chemical treatment in flash mixer.

Neutralization of pH in the effluent will be fully automatic. The pH Control System will automatically monitor and control the pH range.

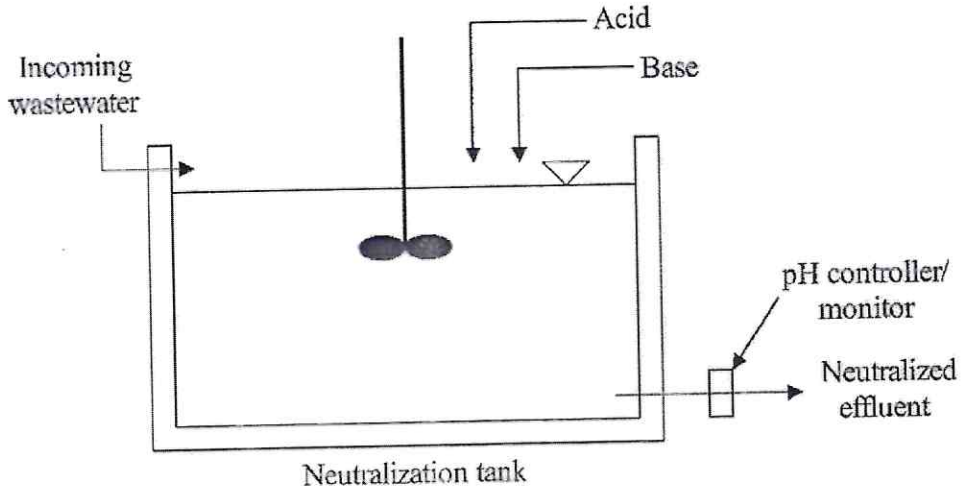


Figure 9 Neutralization Process

Chromium Reduction in Equalization Tank

Various metal finishing processes such as chromium plating, chromating, bright dipping, chromic acid anodizing and chromium stripping contribute to chromium in the wastewater. Although chromium is present in both the trivalent (Cr+3) and hexavalent (Cr+6) state, the dominant species is Cr+6. Unlike most heavy metals which are precipitated readily as insoluble hydroxides by pH adjustment, Cr+6 must first be reduced to the trivalent state because it forms the chromate complex which behaves as an anion and cannot form an insoluble hydroxide.

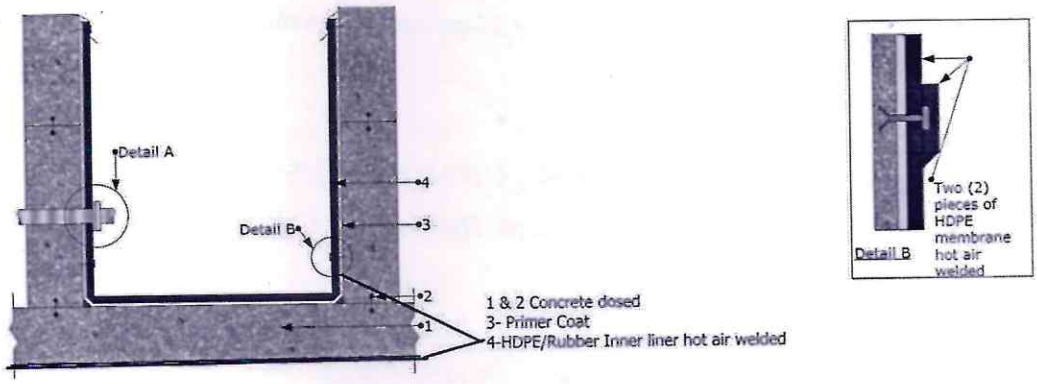
Conventional chromium reduction is achieved by reaction of Cr+6 with a reducing agent. The most commonly used reducing agents are sulfur dioxide gas, Sodium Bisulfate and sodium metabisulfite (dry granular power) i.e. SMBS. In the Equalization tank, sodium meta-bisulfate will be added at pH 2- 2.5 and the whole of hexavalent chrome is converted into trivalent chrome. In this way, Chrome in the incoming effluent will be treated here by following reaction.

$$3NaHSO_3 + 2H_2CrO_4 >>> Cr_2(SO_4)_3 + 3NaHSO_4 + 5H_2O$$

The pH Control System will automatically monitor and control the pH range. The equalization tank will be equipped with online displayed TDS and pH meter.

Safety of Equalization tank from seepage

The equalization RCC tank are also designed with protective layer of PP lining at bottom & Rubber lining/ PP inside the tank to avoid the seepage into the ground if any as a safety measure. The sectional drawing of the same is also shown as follows:



A prototype of RCC Tank lined up with HDPE/Rubber internally and externally

Figure 10 Lining of Tanks

7.3 PHYSIOCHEMICAL TREAMENT

Brief Introduction about the process

Physico-chemical treatment of wastewater focuses primarily on the separation of colloidal particles. This is achieved through the addition of chemicals (called coagulants and flocculants). These change the physical state of the colloids allowing them to remain in an indefinitely stable form and therefore form into particles or flocs with settling properties. Physicochemical treatment involves a set of processes which may be consecutively performed in a single unit or in separate units. These processes are coagulation, flocculation and sedimentation.

Coagulation

Coagulation process is integral to neutralizing the charges (usually negative) on the colloid surfaces by addition of coagulant while rapidly mixing of waste water. Ferric chloride, aluminium polychloride,ferric sulphate, aluminium sulphate, iron polychloride and sodium aluminate are some of the commonly used coagulants which are applied in varying doses depending on quality of waste water. Coagulation and rapid mixing with short contact times

helps in destabilizing the colloid surfaces so they can clump together and thus conditioning them for next step of flocculation.

Alum

$Al_2(SO_4)_3 + 3\ Ca(HCO_3)_2$ ----------> $2\ Al(OH)_3 + 3CaSO_4 + 6\ CO_2$

Aluminum Sulfate + Calcium Bicarbonate gives Aluminum Hydroxide + Calcium Sulfate + Carbon Dioxide

Ferric Sulfate

$Fe_2(SO_4)_3 + 3\ Ca(HCO_3)^2$ ----------> $2\ Fe(OH)_3 + 3CaSO_4 + 6\ CO_2$

Ferric Sulfate + Calcium Bicarbonate gives Ferric Hydroxide + Calcium Sulfate + Carbon Dioxide

Ferric Chloride

$2\ Fe\ Cl_3 + 3\ Ca(HCO_3)_2$ ----------> $2\ Fe(OH)_3 + 3CaCl_2 + 6CO_2$

Ferric Chloride + Calcium Bicarbonate gives Ferric Hydroxide + Calcium Chloride + Carbon Dioxide

Mechanism of Coagulation

In wastewater, colloidal particles, TSS will settle very slowly or not at all because the colloidal particles carry surface electrical charges that mutually repel each other. This surface charge is most commonly evaluated in terms of zeta potential, the electrical potential at the slipping plane. To induce coagulation, a coagulant (typically a metallic salt) with the opposite charge is added to the water to overcome the repulsive charge and "destabilize" the suspension. For example, the colloidal particles are negatively charged and alum is added as a coagulant to create positively charged ions. Once the repulsive charges have been neutralized (since opposite charges attract), van der Waals force will cause the particles to cling together (agglomerate) and form micro flocs.

Flocculation

Process, wherein, the colloids come out of suspension in the form of flocs, either spontaneously or due to the addition of a clarifying agent. Flocculation, a gentle mixing stage, increases the particle size from submicroscopic microfloc to visible suspended particles. Floc size continues to build with additional collisions and interaction with added inorganic polymers (coagulant) or organic polymers. Macrofloc s are formed and high molecular weight polymers, called coagulant aids, may be added to help bridge, bind, and strengthen the floc, add weight, and increase settling rate. Once floc has reached it optimum size and strength, water is ready for sedimentation. Design contact times for flocculation

range from 15 or 20 minutes to an hour or more, and flocculation requires careful attention to the mixing velocity and amount of mix energy. To prevent floc from tearing apart or shearing, the mixing velocity and energy are usually tapered off as the size of floc increases. Once flocs are torn apart, it is difficult to get them to reform to their optimum size and strength. The amount of operator control available in flocculation is highly dependent upon the type and design of the equipment.

Polymers Addition for flocculation

Polymers (long-chained, high-molecular-weight, organic chemicals) are becoming more widely used. These can be used as coagulant aids along with the regular inorganic coagulants. Anionic (negatively charged) polymers are often used with metal coagulants. Low-to-medium weight cationic (positively charged) polymers may be used alone, or in combination with alum or ferric coagulants to attract suspended solids and neutralize their surface charge. Polymers are effective over a wider pH range than inorganic coagulants. They can be applied at lower doses, and do not consume alkalinity. They produce smaller volumes of more concentrated, rapidly settling floc. Floc formed from use of a properly selected polymer will be more resistant to shear, resulting in less carryover and a cleaner effluent.

Primary Settling System

The Primary Settlement or sedimentation tanks are designed to reduce the velocity of the wastewater flow, allowing heavier organic solids (called raw sludge) to settle. It may be rectangular, circular or square shape. Sedimentation tank, also called settling tank or clarifier, component of a modern system of water supply or wastewater treatment. A sedimentation tank allows suspended particles to settle out of water or wastewater as it flows slowly through the tank, thereby providing some degree of purification.

Types of Primary Sedimentation Tanks

1. Typical primary sedimentation tank
2. Circular Radial Flow Tank
3. Up Flow Tanks

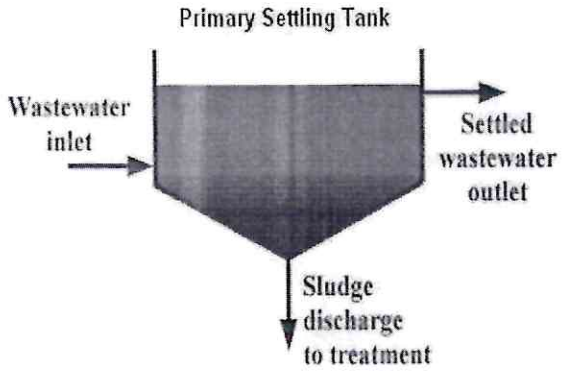


Figure 11 Typical working of Tube Settler Tank

Tube Settler Systems for Clarification

Tube settler is a system consists of inclined plate type clarifier used for clarification. Tube settlers and parallel plates increase the settling capacity of circular clarifiers and/or rectangular sedimentation basins by reducing the vertical distance a floc particle must settle before agglomerating to form larger particles. Tube settlers use multiple tubular channels sloped at an angle of 60° and adjacent to each other, which combine to form an increased effective settling area. Tube settlers capture the settleable fine floc that escapes the clarification zone beneath the tube settlers and allows the larger floc to travel to the tank bottom in a more settleable form. Hoppers are manufactured at bottom of the clarifier to collect the solid into compact mass particles which are settling down and the clarified liquid exits. From the bottom of hoppers, sludge is withdrawn and the liquid exits the unit at the top of the clear water launders.

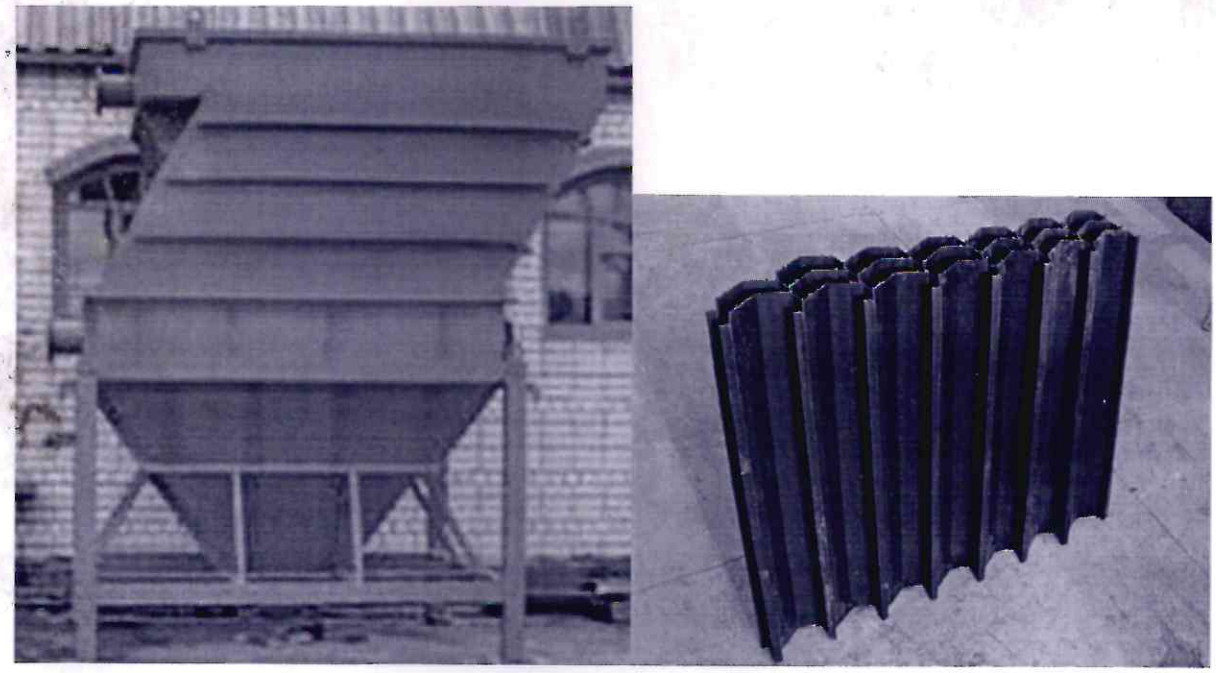


Figure 12 Tube Settler Tank and Tube Deck Media for Tube Settler Tank

7.4 PHYSIO- CHEMICAL TREATMENT FOR CETP

Physico-chemical treatment of wastewater focuses primarily on the separation of colloidal particles. This is achieved through the addition of chemicals (called coagulants and flocculants). These change the physical state of the colloids allowing them to remain in an indefinitely stable form and therefore form into particles or flocs with settling properties.

Chemical coagulation of raw waste-water before sedimentation promotes the flocculation of finely divided solids into more readily settleable flocs, thereby enhancing the efficiency of suspended solid, BOD5 and phosphorus removal as compared to plain sedimentation without coagulation.

From Equalization Tank, the effluent will be pumped to flash mixer tank for further treatment.

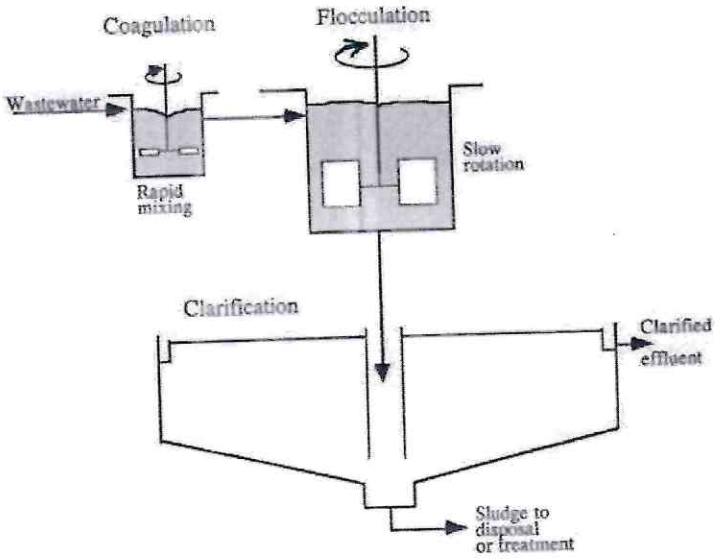


Figure 13 Physiological Treatment

Milk of Lime Preparation

Firstly, in Lime Preparation Tank, milk of lime i.e. hydrated lime is formed. Lime is the most widely used reagent in water treatment applications. It is supplied in two forms:

- quick lime: CaO;
- Slaked (or hydrated) lime: $Ca(OH)_2$.

In both cases, these reagents will contain between 4 and 20% of solid impurities (CaCO3, SiO2…). These impurities must be removed before the product is used.

Lime powder (CaO) will be added to Lime preparation tank gradually and mixing will be done by agitator. From this tank, the milk of lime will be transferred to lime dosing tank by gravity. The impurities remain settled at the bottom of the lime preparation tank from where these solids will be drained off for disposal.

Flash Mixer Tank followed by Settling Tank

From lime dosing tank, the solution will be pumped to the flash mixer tank through dosing pumps automatically to obtain a pH within a range of 9-10.

The metering pumps are positive displacement reciprocating pumps provided with stroke adjustment mechanism to vary flow of liquid as per requirement. Accuracy of flow is controllable within + 1%.

Effluent coming from Equalization tank is neutral in nature and in flash mixer tank, this effluent is dosed with the milk of lime from lime dosing tank. This dosing increases the pH level of the effluent upto 10 or 11 which results in chemical reaction with heavy metals ions.

As the pH reaches 11, then the dosing of lime will be automatically cut-off and poly dosing will be started. When poly is added in the tank, the formed flocs get thickened. These flocs and the chemicals are continuously getting mixed by variable speed (50-60 rpm) Agitator in Flash mixer tank.

Effluent from the flash mixer is then passed to Primary Tube Settler Tank-1 which consists of tube deck settling media of uPVC constructed material. With the virtue of gravity effluent flows in the inlet area of settling tank and comes to media zone where the sludge will be restricted at the bottom by uPVC media and effluent will flow upward from where it will go to clear water launder zone. From launder, effluent will be transferred to flocculation tank for further treatment.

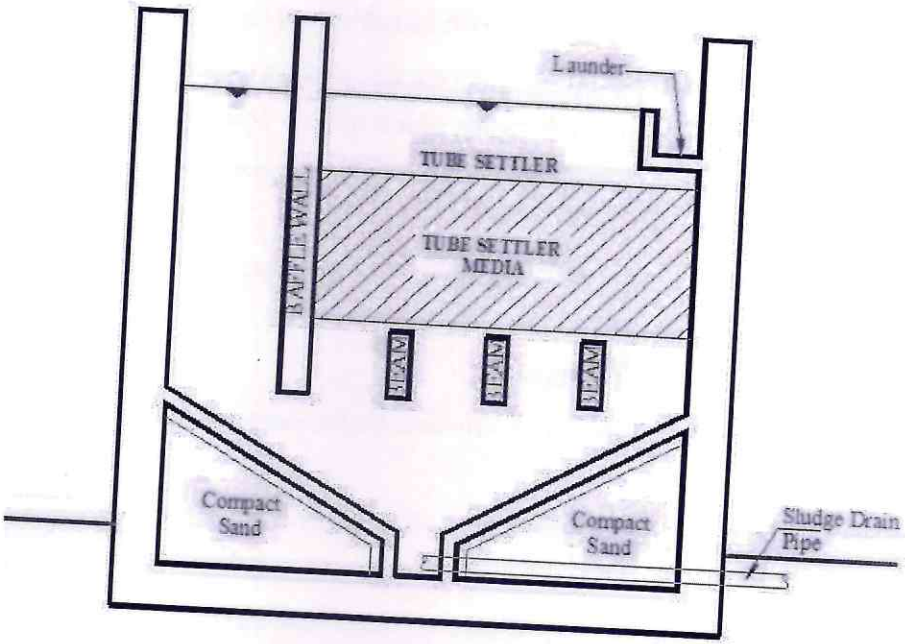


Figure 14 Cross- Section view of Tube Settler Tank

Treatment in Flocculation Tank

Once the effluent is transferred into flocculation tank, Alum dosing is done to obtain the pH in the range of 7-7.5. Poly is also dosed to thicken the sludge formed. By coagulation & flocculation process the mass of flocs will increase. For proper mixing of chemicals Slow moving Agitator (20-30 rpm) is provided in Flocculation tank. Mixed effluent having flocs which were developed in Flocculator shall be transferred to Primary Tube Settler Tank- 2 for settling of flocs. From primary tube settler the effluent will be transferred to polishing tank and settled sludge from primary tube settler tank 1 & 2 will be transferred to sludge dewatering system.

7.5 POLISHING TREATMENT OF EFFLUENT

Brief Introduction about the process

For the removal of additional suspended solids and pollutant from partially treated primary effluent, effluent polishing is an effective treatment. In this process, the effluent is fed into an aeration tank wherein air is being provided for further oxidation of mental ions and other suspended solids.

Oxidation of Effluent by Aeration

In the Polishing tank, all the effluent from primary tube settler will be oxidized to CO_2 & H_2O by the aeration principle in aeration tank. Air is a very fast oxidizer--considerably faster than chlorine. Air is a powerful oxidizer of both metals which quickly converts unfilterable metal ions to filterable metal ions. Twin-Lobe Blowers for oxidation provides the aeration.

Air blowers

An air blower is a machine used for generating flow of air at substantial pressure. Primarily air blower performs following functions:

a. Generating the specific quantity of air flow.

b. Build Pressure of generated air flow to accommodate for the pressure drop.

Working Principle of air blower

Blowers increase the pressure of the absorbed gas by a series of vortex motions formed by the centrifugal movement of the impeller. When the impeller is rotating, the channels in the impeller push the air forward by the centrifugal movement and a helical movement occurs. During this movement, the gas is continuously compressed along the channel and the pressure increases linearly. The pressurized air is transferred from the outlet duct of the blower to the installation to be used.

Fine air Diffusers System

It comprises piping to diffusers and the diffusers. The diffuser elements will be membrane type and resistant to ingredients such as hydrocarbons, oil and grease. This will provide a high oxygen transfer rate coupled with a minimal pressure drop besides permitting simple erection onto the horizontal air manifold.

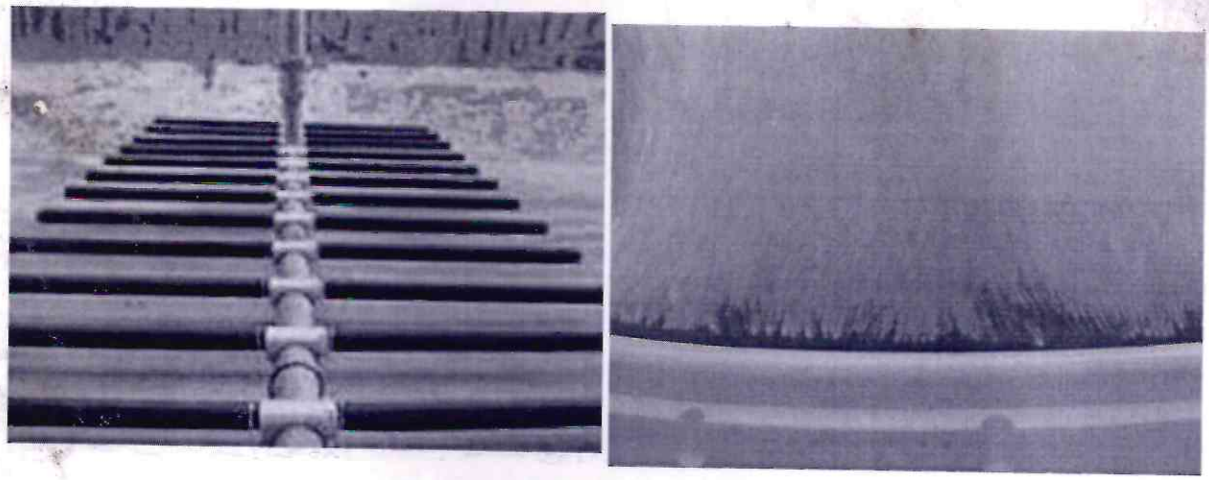


Figure 15 Fine Air Bubble Diffusers

They will have minimal coupling / attachments to the air manifold and will have self-cleaning properties while in action. The diffuser unit is made up of corrosion resistant material. The membrane diffusers permit connection to the air manifolds of circular or square cross section and the entire lot of diffusers shall be capable of

7.6 POLISHING TREATMENT FOR CETP

In the polishing tank, the effluent coming from primary tube settler Tank is further treated by oxidation with the help of pressurized air provided by air blower. Due to presence of some organic and suspended solids present in the partially treated effluent, aerobic bacteria start growing in the polishing tank in presence of aeration. This generation of bacteria further degrades any type of organic and biodegradable matter.

This mixed liquor consisting of treated effluent and bacteria is then transferred to the settling tank consisting of settling media wherein the sludge is settled down at the bottom and clear treated effluent is left over the top of tube settler tank. The secondary clarifier/tube settler, specifically designed on low overflow rate, is provided after the polishing tank to enable separation of solids. A steep slope is provided in the secondary settling tank to eliminate the need of scrapper mechanism. The generated sludge is removed from the bottom hopper by sludge removal pumps and diverted to the sludge holding tank for further treatment.

The clear water from the top of tube settler is sent to filter feed tank for further tertiary treatment.

7.7 TERTIARY TREATMENT

Brief Introduction about the process

Wastewater leaving the Secondary Clarifiers looks as clean as drinking water! Depending on conditions, this water can go directly to the Disinfection process to produce recycled water, or it can go the Filtration Building i.e. Pressure Sand Filter (PSF) and Activated Carbon Filter (ACF). The purpose of tertiary treatment is to provide a final treatment stage to further improve the effluent quality before it is discharged to the receiving environment (sea, river, lake, wet lands, ground, etc.).

As the wastewater reaches the tertiary treatment stage, it still has residual suspended matter and fine particulates. Further, it has a relatively high level of nutrients such as nitrogen and phosphorus and has microbes and odor in it. During tertiary treatment process, different methods are used to remove all these contaminants and properties from wastewater.

The first stage of tertiary treatment is filtration which helps primarily to remove residual suspended matter in wastewater. Sand filtration is the usual method that is used for this purpose. In some cases, residual toxins may be present in wastewater and to filter them out, activated carbon is used to adsorb the toxins and remove them from wastewater.

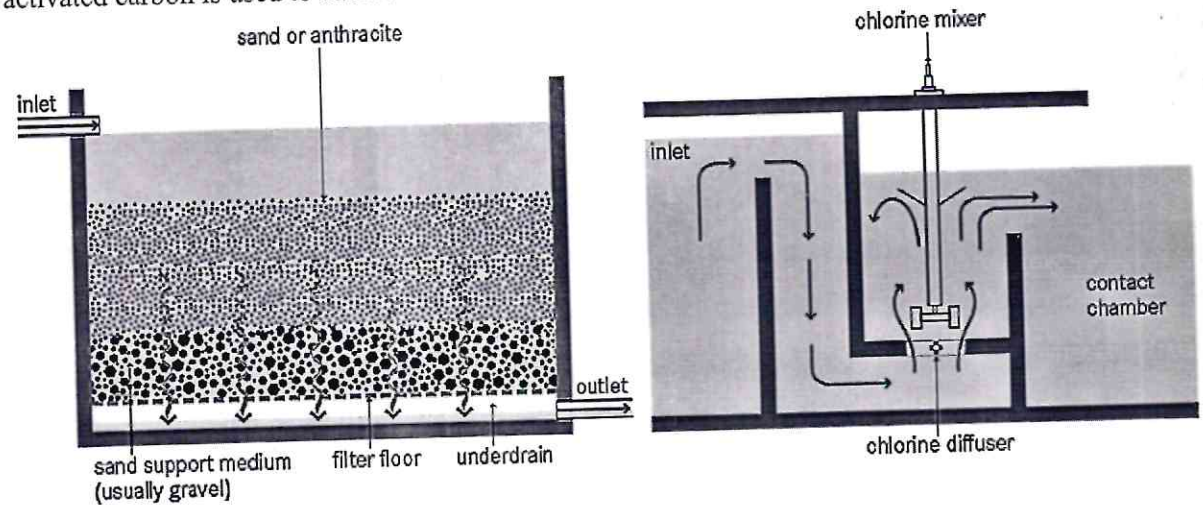


Figure 16 Tertiary Treatment

The final steps in tertiary wastewater treatment, before release into the environment, are removing any undesirable microbes through the process of disinfection and also removal of odors from wastewater. The clear and less cloudy nature of wastewater at this stage is critical for efficiency and effectiveness of the disinfection process. Several disinfection agents can be used depending on wastewater condition (pH, clarity etc.) And among them chlorine, ozone, ultraviolet (UV) light are most common.

FILTRATION SYSTEM

Filtration process removes the particulate matter by passing water through the porous media. The filtration process consists of different types of media which are usually made up of sand, gravel, and charcoal. There are two types of sand filtration, slow sand filtration, and rapid sand filtration.

Pressure Sand Filter

The pressure sand filter (PSF) is used as a tertiary treatment unit to trap the trace amounts of solids which escape the clarifier, and can typically handle up to 50 mg/l of solids in an economical manner. This unit is essentially a pressure vessel that is filled with graded media (sand and gravel).

Working of PSF

The upper layers of the sand perform the actual filtration function. The gravel layers merely provide physical support to the upper sand layers. The sand used in the PSF is not ordinary construction sand: It has particle size in a specific range, and is specially sieved for this purpose. Here, the filtration occurs along the entire depth of the sand layer.

Figure 17 Pressure Sand Filter

The solid particles in the water get entrapped and enmeshed in the spaces between the sand particles. Gradually, the space between sand particles gets filled with incoming solids. This blocks the passage of water through the sand layer. As a result, the pressure at the outlet drops, and wastes the pumping power, and reduces the throughput of the filter. When the pressure drops beyond a limit, the sand is cleaned by backwashing of the filter (back flushing) with water, in which water is passed in the reverse direction (from outlet to inlet).

This process agitates, fluidizes and expands the sand bed. The backwash water carries away the lighter pollutant solid particles as backwash waste.

Activated Carbon Filter

An activated carbon filter, like the Pressure Sand Filter, is a tertiary treatment unit. It receives the water that is already filtered by the Pressure Sand Filter and improves multiple quality parameters of the water: BOD, COD, clarity (turbidity), color and odor.

Working of ACF

This filter uses the adsorption action of activated carbon. Activated carbon is typically manufactured from coconut shell or charcoal, the "activation" process creating a highly porous material with a very large surface area. Organic pollutant molecules are physically adsorbed and held fast within the catacomb-like porous structure of the activated carbon. Granular activated carbon is typically used for this purpose. The water filtered by the Pressure Sand Filter enters the Activated Carbon Filter.

Figure 18 Activated Carbon Filter

Unlike in the case of the sand filter, trapped molecules in the carbon cannot be back washed and got rid of. Hence, activated carbon in the filter has a finite capacity to adsorb and hold the pollutants, after which the carbon is said to be exhausted. The exhausted material is removed from the filter and disposed off: Fresh activated carbon is charged in the filter.

Backwash Process of Filters

With the continuous operation, these filters get clogged gradually. So, they require Backwash treatment after every 7-8 hours to clean various clogged layers of fine sand, gravel, activated carbon etc. which are present inside the PSF and ACF. Backwash is also necessary and required whenever the required range of pressure difference increases in the filters.

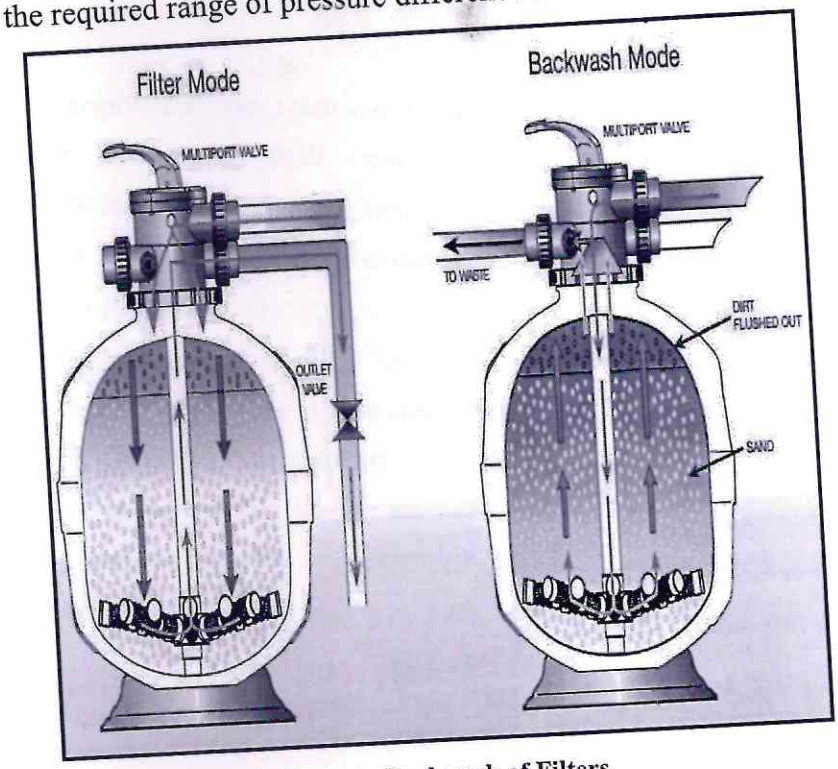


Figure 19: Auto-Backwash of Filters

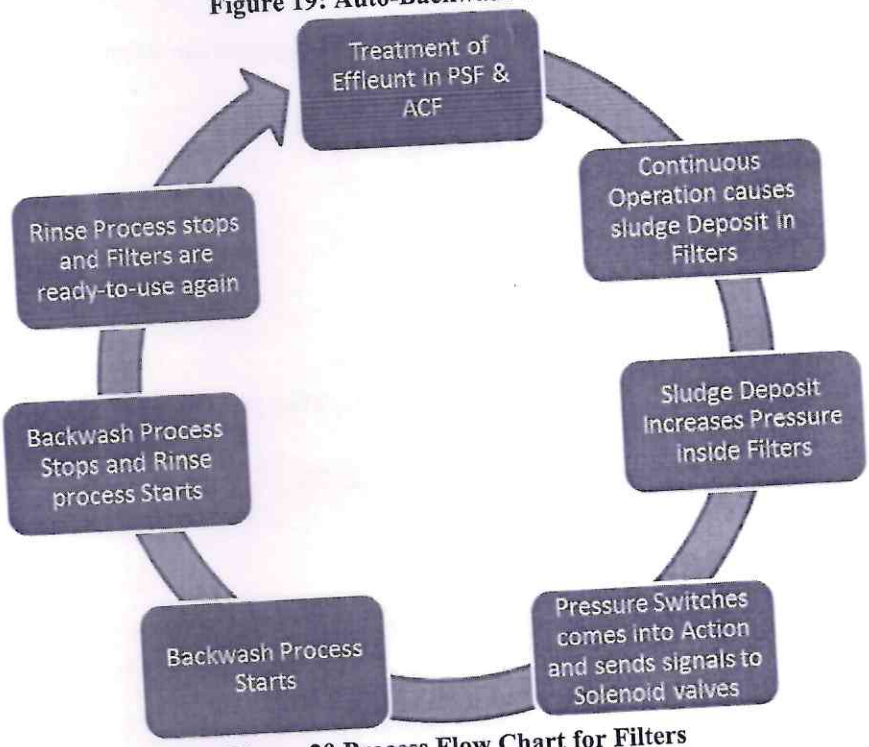


Figure 20 Process Flow Chart for Filters

DISINFECTION

Brief Process Description

Disinfection is the process designed to kill or inactivate most microorganisms in wastewater, including essentially all pathogenic organisms. Water disinfection means the removal, deactivation or killing of pathogenic microorganisms. Microorganisms are destroyed or deactivated, resulting in termination of growth and reproduction. There are a number of chemicals and processes that will disinfect wastewater. Wastewater disinfection is applied to provide protection to humans against exposure to waterborne pathogenic microorganisms. Microbial inactivation is achieved in these processes by induced biochemical changes within the pathogenic microbial population. Disinfectants should not only kill microorganisms. Disinfectants must also have a residual effect, which means that they remain active in the water after disinfection. A disinfectant should prevent pathogenic microorganisms from growing in the plumbing after disinfection, causing the water to be re contaminated.

Modes of disinfection

Disinfection can be attained by means of physical or chemical disinfectants. For chemical disinfection of water the following disinfectants can be used:

- Chlorine (Cl_2)
- Chlorine dioxide (ClO_2)
- Hypo chlorite (OCl-)
- Ozone (O_3)
- Halogens: bromine (Br_2), iodine (I)
- Bromine chloride (BrCl)

For physical disinfection of water the following disinfectants can be used:

- Ultraviolet light (UV)
- Electronic radiation
- Gamma rays
- Sounds
- Heat

7.8 TERTIARY TREATMENT FOR CETP

The Clarified water collected from the collection launder of the tube settler tank is then passed to the Filter Feed tank. The partial treated effluent is then collected and kept hold for at least one hour after which the effluent will be pumped to the tertiary filters for filtration of suspended solids.

Firstly, the effluent from filter feed tank will be fed to PSF wherein media of variable sized sands and gravel is placed to remove the suspended solids.

After the PSF, the effluent is fed to ACF, wherein activated carbon with Iodine value more that 900 is filled along with the sand and gravel to remove fine suspended solids, colour and odor.

After the filtration, the effluent will be disinfected by application of UV system.

Ultra Violet System

UV Disinfection System is an extremely effective way to combat microbial contamination in water. UV treatment for water is recognized as a safer and more cost-effective way to disinfect water for industrial applications. In UV water disinfection technology, Ultraviolet light of wavelength 253.7 nanometers is used for disinfection of bacteria, viruses, molds, algae, and other microorganisms, which multiply and grow. UV disinfection technology destroys the DNA of microorganisms which leaves them dead and unable to grow further. UV disinfection technology can be used for drinking water disinfection, process water disinfection, wastewater disinfection, and surface disinfection. Other than disinfection applications, this technology can also be used for TOC removal and Ozone destruction.

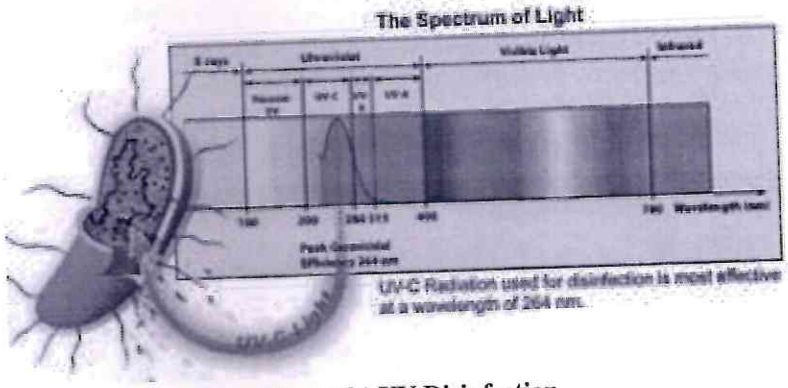


Figure 21 UV Disinfection

Working of UV Technology

In the UV water disinfection technology, the UV light disinfects by penetrating microorganisms and destroying their DNA. DNA plays an important role in organisms' functions and reproduction hence destroying the DNA prevents the organism from being active and multiplying. This UV energy (wavelength of 240-280 nm) is also naturally found

in sunlight in very small quantities. The same energy is produced in stronger intensities with the help of high mercury discharge lamps, commonly known as UV lamps.

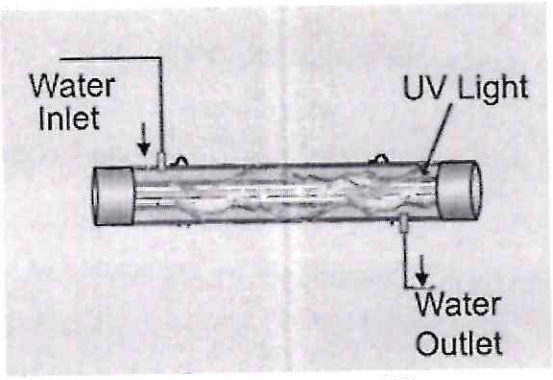


Figure 22 Working of UV

7.9 ULTRA-FILTRATION (UF) SYSTEM

Brief Process Description

Ultrafiltration (UF) is a variety of membrane filtration in which forces like pressure or concentration gradients lead to a separation through a semipermeable membrane. Suspended solids and solutes of high molecular weight are retained in the so-called retentate, while water and low molecular weight solutes pass through the membrane in the permeate (filtrate). The main separation mechanism of UF membrane filtration is size exclusion or sieving and the graphic illustrates that UF effectively removes particles in the size range of less than 0.01 to 0.1 mm. Effective removal of these contaminants in a source water results in a filtrate well suited for further treatment by downstream reverse osmosis (RO). Ultrafiltration is applied in cross-flow or dead-end mode.

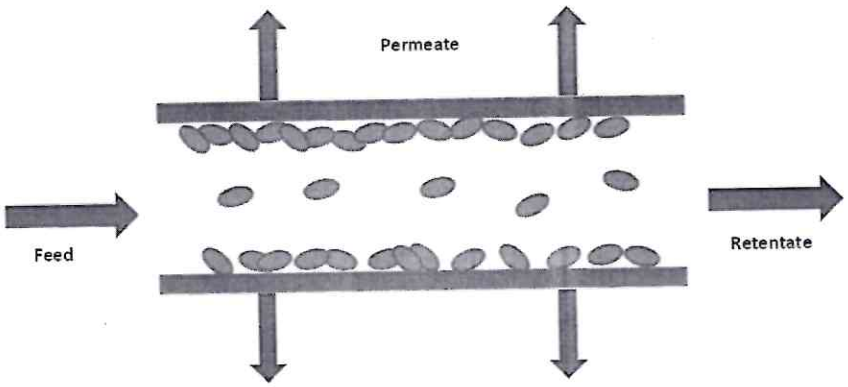


Figure 23 Cross flow UF Treatment

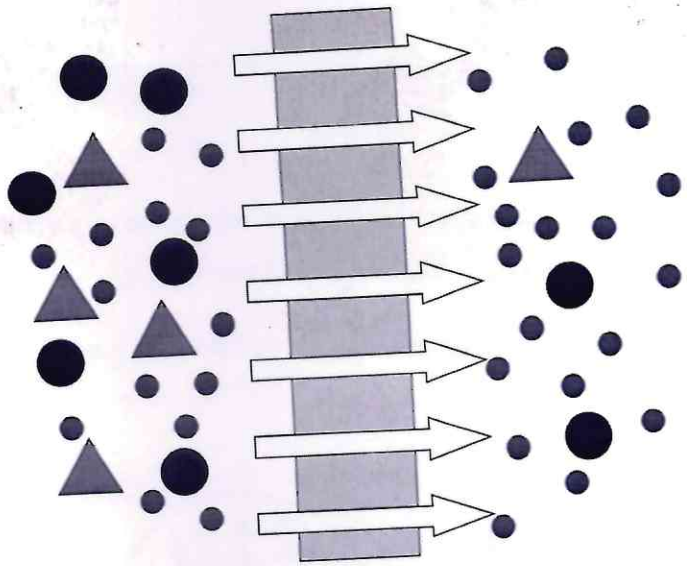


Figure 24 Dead End operation for UF Technology

Ultra Filtration systems are pressure-driven membrane operations that use porous membranes for the removal of dissolved and colloidal material. These systems differ from Reverse Osmosis Systems by relatively low driving pressures, usually under 1034 KN/m^2. Numerous polymers, including Poly (Ether Sulfone) (PES), Polysulfone (PSF), Poly(Vinylidene Difluoride) (PVDF), and polyacrylonitrile (PAN), are commonly used for UF Plant. Ultra Filtration is normally used to separate colloidal material and large molecules with molecular weights in excess of 5000 from salts and low molecular weight materials, with pores of 0.001 to 0.1 micron. Turbidity is sharply reduced by 99 %. UF is an excellent means to remove metal hydroxides, reducing the heavy metal content to 1 ppm or less. UF permeate will be stored in the UF permeate tank.

Working& Principle of UF Plant

- The basic operating principle of ultra-filtration uses a pressure induced separation of solutes from a solvent through a semi permeable membrane.
- Ultrafiltration (UF) is a type of membrane filtration in which hydrostatic pressure forces a liquid against a semi permeable membrane. A semi permeable membrane is a thin layer of material capable of separating substances when a driving force is applied across the membrane. Once considered a viable technology only for desalination, membrane processes are increasingly employed for removal of bacteria and other microorganisms, particulate material, and natural organic material, which can impart color, tastes, and odors to the water and react with disinfectants to form disinfection

byproducts (DBP). As advancements are made in membrane production and module design, capital and operating costs continue to decline.

Ultrafiltration uses hollow fibers of membrane material and the feed water flows either inside the shell, or in the lumen of the fibers.

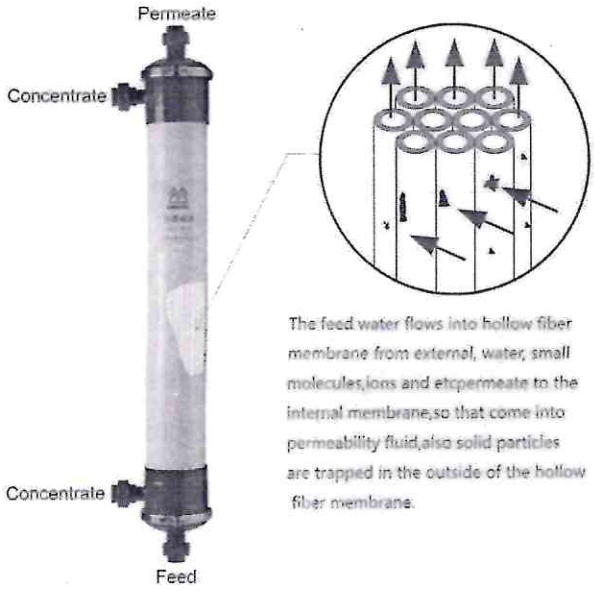


Figure 25 Filtration through hollow fiber UF

Suspended solids and solutes of high molecular weight are retained, while water and low molecular weight solutes pass through the membrane. This separation process is used in industry and research for purifying and concentrating the particles having molecular weight (103 - 106 Dalton), especially protein solutions. When strategically combined with other purification technologies in a complete water system, UF is ideal for the removal of colloids, proteins, bacteria, pyrogens, proteins, and macromolecules larger than the membrane pore size from water. The primary removal mechanism is size exclusion, though surface chemistry of the particles or the membrane may affect the purification efficiency. UF can be used as pretreatment for reverse osmosis systems or as a final filtration stage for deionized water.

Benefits of UF Plant

- Low fouling membrane modules
- Excellent filtration performance with high flux
- High chemical resistance and temperature tolerance for effective membrane cleaning
- Very fine nominal pore diameter (0.02 μm)
- High removal efficiency of bacteria & viruses

- Dead-end or concentrate bleed flow capabilities
- Can be periodically back washed and air scoured to improve performance and extend operating life by removing the fouling layer
- Simple, vertical, modular design allows low cost, compact systems
- UF Outside-In or Inside-Out Configuration allows for less plugging and higher solids loading, higher flow area and easier cleaning.

Membrane Fouling

Despite the enormous applications of MF and UF membranes in various fields, their permeability and selectivity deteriorates over time because of an accumulation of solids, suspended particles, colloids, and bacteria on the membrane surface and within the membrane pores; this is known as *membrane fouling*. Fouling is the deposition of retained particles, colloids, macromolecules, salts, biomolecules, and so on on the membrane surface or inside the pore at the pore wall. Fouling reduces the membrane flux either temporarily or permanently.

The main mechanisms of fouling are:

(1) Adsorption of partially rejected matter within the membrane pores (pore constriction).

(2) Plugging of individual pores by particles similar in size to the pores (pore blocking).

(3) Accumulation of completely rejected particulate matter on top of the membrane surface also (cake formation).

Several pretreatment methods for preventing UF membrane fouling include coagulation, sand treatment, flocculation, chemical treatment, adsorption, and ozone oxidation.

7.10 ULTRA FILTRATION TREATMENT FOR CETP

From tertiary treatment system, the effluent will be collected into UF feed tank from where it will be moved into ultra-filtration system for removal of turbidity and to reduce the SDI level to enhance the recovery rate through the RO Membranes provided at the downstream in RO System. Once the effluent is collected in the UF feed tank, it is pumped to micron filter is paced before UF module to remove any micron solids of size 5 micron to 10 microns. After passing to micron filters, the effluent is fed to UF modules.

Due to very fine suspended solids present in the raw water, UF feed system gets clogged over a period of time and needs cleaning / backwashing periodically. When the Trans Membrane Pressure (TMP) across the UF membrane modules gets increased to a predetermined set point, backwashing through the backwash pumps will take place manually. Cleaning of the membrane in the UF system will be required periodically with the chemicals i.e., Sodium

Hypo Chloride and Hydrochloric Acid, having high and low pH to remove the biological growth retained over the UF membrane. After that, the UF permeate will be stored in the storage tank. Backwash will be done by withdrawing water from the Permeate Storage Tank. Also, this storage tank will be used to feed the Reverse Osmosis (RO) Plant.

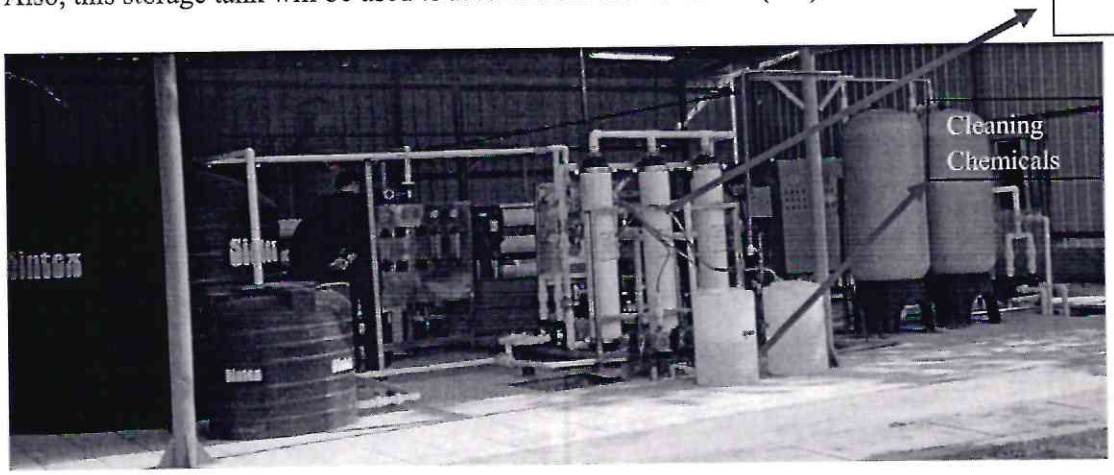


Figure 26: Ultrafiltration Plant

7.11 REVERSE OSMOSIS (RO) SYSTEM

Brief Process Description

Reverse osmosis (RO) is a special type of filtration that uses a semi-permeable, thin membrane with pores small enough to pass pure water through while rejecting larger molecules such as dissolved salts (ions) and other impurities such as bacteria. Reverse osmosis is used to produce highly purified water for drinking water systems, industrial boilers, food and beverage processing, cosmetics, pharmaceutical production, seawater desalination, and many other applications. It has been a recognized technology for more than a century and commercialized since the 1960's.

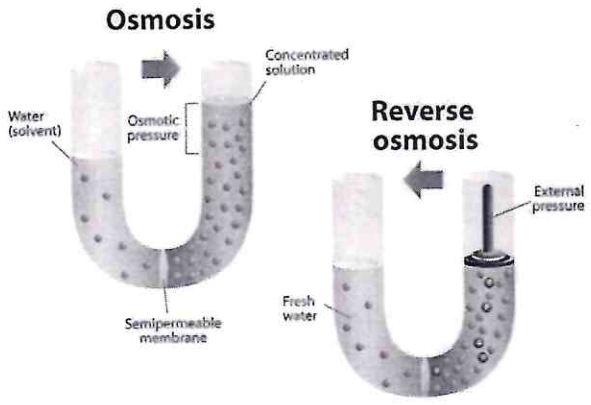
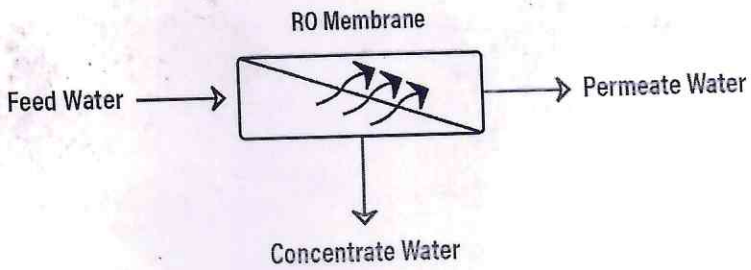


Figure 27 Concept of Reverse Osmosis



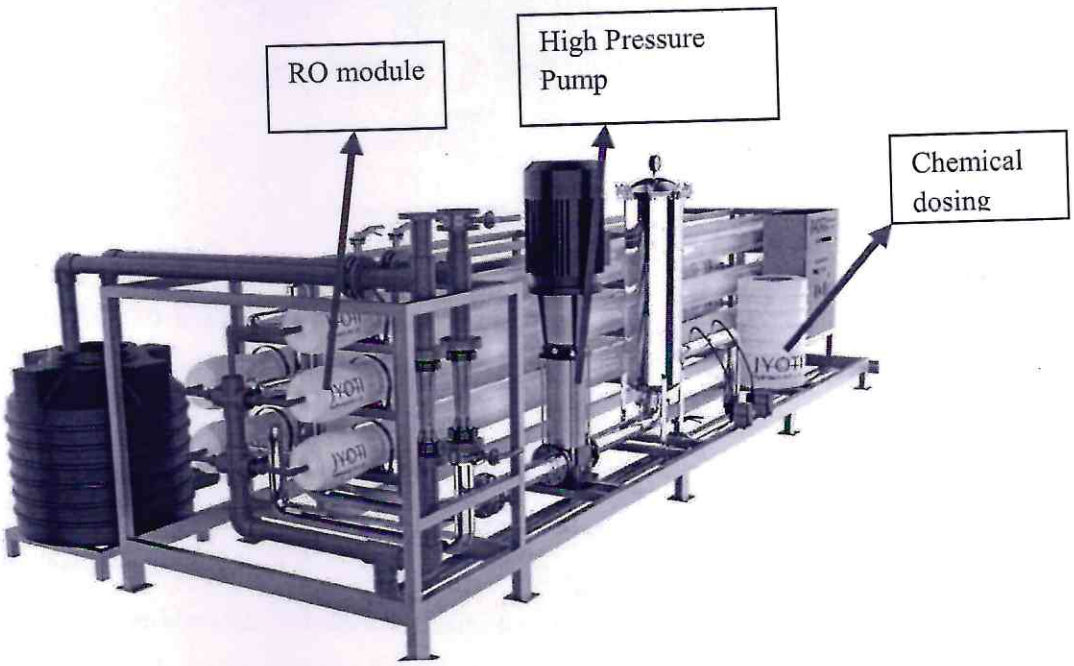


Figure 28 RO Plant

Semi- Permeable Menbrane for RO Plant

The membranes used for reverse osmosis systems have a dense polymer barrier layer in which separation takes place. A reverse osmosis system is built around its individual membranes. Each membrane is a spiral wound sheet of semi-permeable material. Membranes are available in 2-inch, 4-inch, and 8-inch diameter with the 4- and 8-inch diameter sizes most commonly used in industry. The industry has accepted a 40-inch length as a standard size so that membranes from different manufacturers are interchangeable in equipment systems. One of the primary measurements of a membrane is its square footage. Membranes are available in the range of 350-450 square feet of surface area.

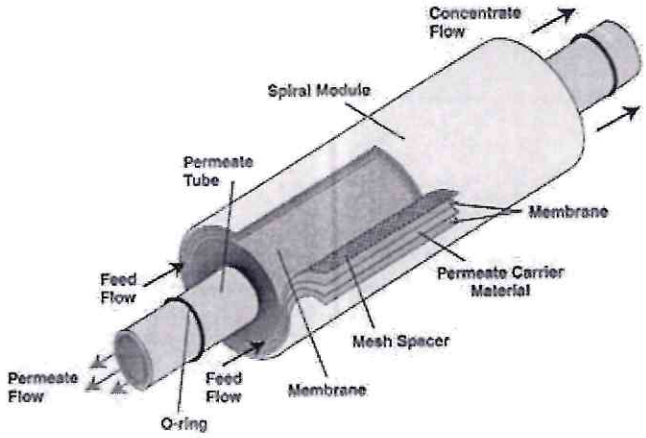


Figure 29 RO Membrane

Working & Principle

It is the process by which water molecules are forced through a 0.0001 micron semi-permeable membrane by water pressure. Reverse Osmosis works by using a high pressure pump to increase the pressure on the salt side of the RO and force the water across the semi-permeable RO membrane, leaving almost all (around 95% to 99%) of dissolved salts behind in the reject stream. The amount of pressure required depends on the salt concentration of the feed water. As the feed water enters the RO membrane under pressure (enough pressure to overcome osmotic pressure) the water molecules pass through the semi-permeable membrane and the salts and other contaminants are not allowed to pass and are discharged through the reject stream (also known as the concentrate or brine stream), which goes to drain or can be fed back into the feed water supply in some circumstances to be recycled through the RO system to save water. The water that makes it through the RO membrane is called permeate or product water and usually has around 95% to 99% of the dissolved salts removed from it

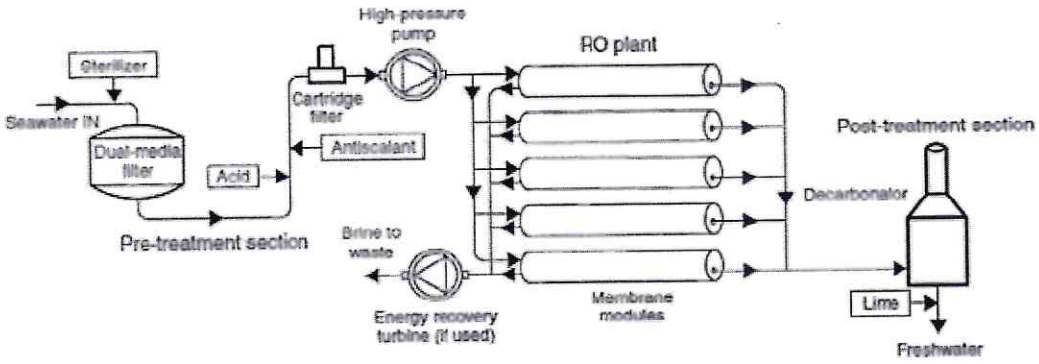


Figure 30 Working Principle of RO Plant

For the membrane to be usable it must be in some type of container (membrane housing) so pressure can be maintained on its surface. It is this pressure that supplies the energy to force the water through the membrane, separating it from unwanted substances.

7.12 RO SYSTEM FOR CETP

The effluent from UF Permeate Tank will be pumped to the Micron Filter (MF) by RO feed pump wherein, the suspended impurities greater than 10 & 5 micron is filtered so as to ensure that membranes are not clogged. The water from MF will be passed to RO System. The scaling tendency of feed water in RO membrane could be removed by dosing of antiscalent (Silica inhibitor) in water.

The water then shall enter the RO membrane Housing at high pressure through a high-pressure pump. Instruments like Rota meter are provided online at the downstream level to measure the quality & quantity of treated water. The RO permeate shall be stored in a RO Permeate Water Storage Tank from where, it will be used in the process again. RO reject will be stored in RO Reject Tank from where it will be sent to evaporator for further processing.

7.13 MULTI EFFECT EVAPORATOR

Brief Introduction about the process

A multiple-effect evaporator is an apparatus for efficiently using the heat from steam to evaporate water. In a multiple-effect evaporator, water is boiled in a sequence of vessels, each held at a lower pressure than the last. A multiple-effect evaporator uses the water vapor from one effect as the heating medium for the next effect, which operates at a lower boiling point. The latent heat in water vapor can also be reused by thermally or mechanically compressing the vapor to a higher pressure and temperature. It combines two or more evaporator bodies to conserve steam, which is condensed in the first-effect heat exchanger only. Water evaporated in the first-effect vapor body is condensed in the second-effect heat exchanger, which provides energy for evaporation in the second-effect vapor body (and so on for additional effects). Vapor from the last effect flows to a condenser. Evaporator bodies are typically operated under vacuum to reduce the temperature of boiling.

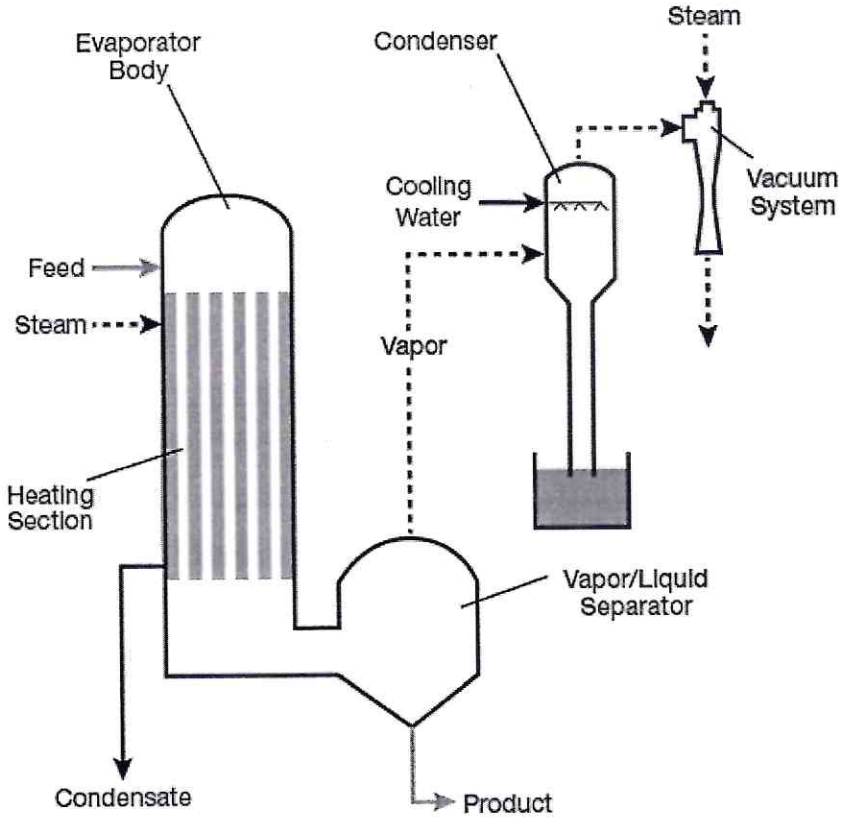


Figure 31Single Effect Evaporator

Falling Film Evaporator

In a falling film evaporator, the liquid is fed at the top of the tubes in a vertical tube bundle. The liquid is allowed to flow down through the inner wall of the tubes as a film. As the liquid travels down the tubes the solvent vaporizes and the concentration gradually increases. Vapor and liquid are usually separated at the bottom of the tubes and the thick liquor is taken out. Evaporator liquid is recirculated through the tubes by a pump below the vapor-liquid separator. The distribution of liquid in the inner wall of the tubes greatly affects the performance of this type of evaporator. The falling film evaporator is largely used for concentration of fruit juices and heat sensitive materials because of the low holdup time. The device is suitable for scale forming solutions as boiling occur on the surface of the film.

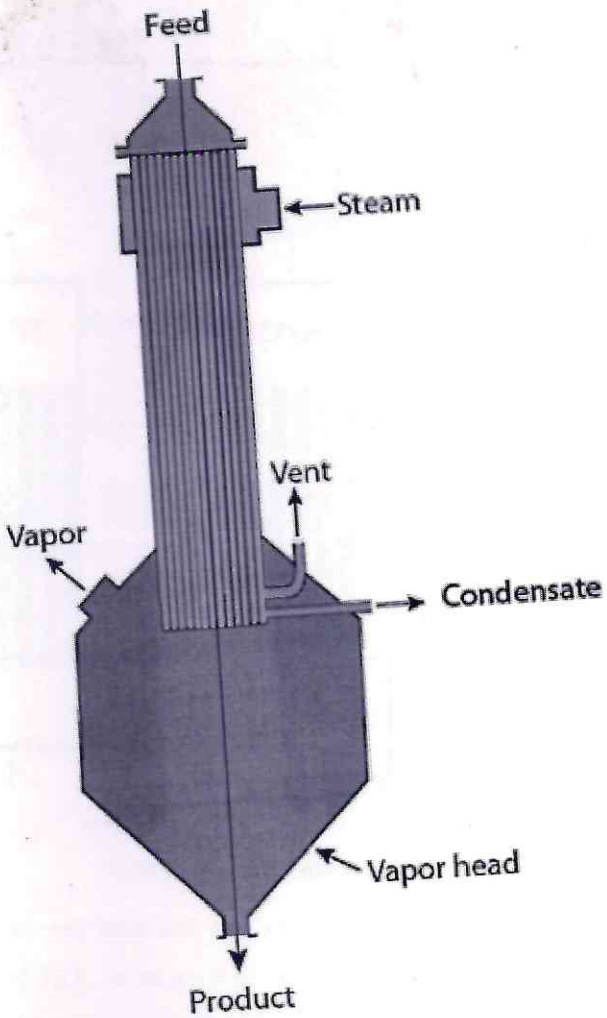


Figure 32 Falling Film Evaporator

Working Principle

A multiple effect is an evaporation unit which consists of several evaporators thermally linked and thus reducing considerably energy consumption. The first effect is heated directly and next effects are heated by vapors from the previous effects. The last effect process vapors are condensed on a heat sink. Heating is archived commonly with live steam, but can also be done with a heat transfer fluid such as thermal oil or a molten salt etc.

Steam is supplied into the steam compartment. Feed enters the top of the tube. The temperature of the boiling liquid is same as that of the vapor head. The feed flows down the walls of the tubes. The liquid gets heated rapidly. The liquid boils and becomes vapor which forms smaller bubbles. These tend to fuse to form layers of bubbles, which travels down the tubes. Concentration takes place during this down wards journey. Vapor and liquids are separated in the cyclone separator.

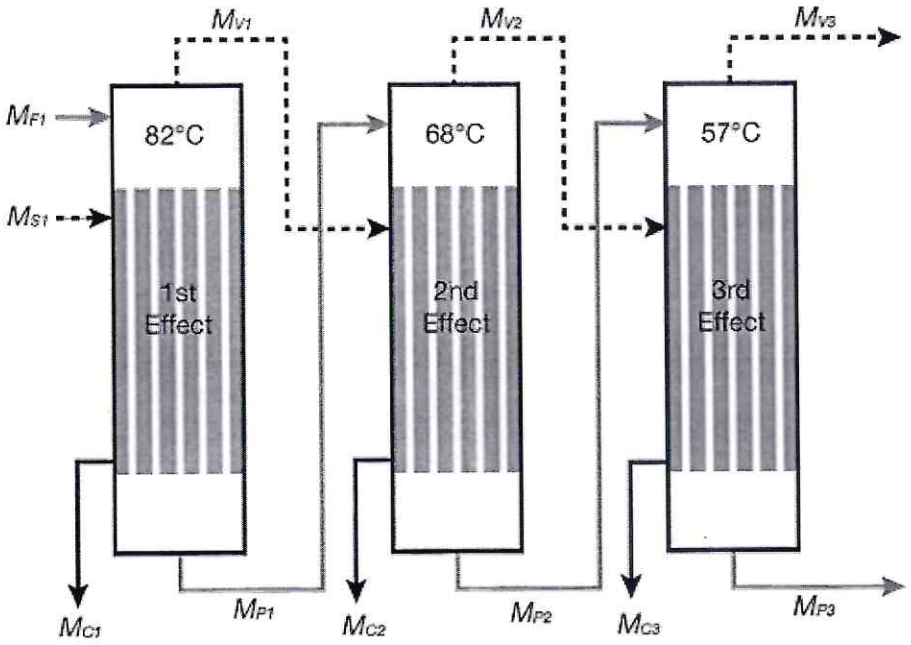


Figure 33: Multi Effect Evaporator

In a falling film evaporator feed enters from the top and flow the walls of the tubes. In the head, the product is evenly distributed into the heating tubes. The liquid enters the heating tube and forms a thin film on the tube wall where it flows downwards at boiling temperature and is partially evaporated by getting heated rapidly due to heat transfer steam. The liquid boils and becomes vapor which forms the small bubbles. The product and the vapor both flow downwards in a parallel flow. This gravity-induced downward movement is increasingly augmented by the co-current vapor flow. Concentration takes places during this down wards journey. Vapor and liquids are separated at the bottom. The device is suitable for scale-forming solutions as boiling occur on the surface of the film.

Key Benefits of Falling Film Tubular Evaporators

- Short product contact time minimizes thermal degradation effects
- Low tube wall temperature and heat flux minimizes fouling
- Performance provides high efficiency for multiple effect designs
- Suitable for heat sensitive products
- High vapor shear reduces foaming products
- Turndown on recirculation designs is close to infinite

7.14 MEE FOR CETP

RO reject contains a lot amount of salt that's the reason it has been called as hyper saline wastewater since the chemical added in the process are removed at treatment steps except the salts in form of dissolved solids. The feed parameters of RO reject affect the efficiency of evaporator.

Reject from reverse osmosis system is stored in balance tank and pumped to the falling film evaporators (first and second effects) through the tubes of the first calendrias, where heat is added. The vapor from first falling film effect is separated and sends to the second falling film effect and so on in order boil the effluent. The vapor leaving from the last effect is condensed in the condenser and the supersaturated liquid flows down the down flow tube. The leaving vapors are condensed and then can be stored in separate collection tank from where; it will be reused for various purposes.

The concentrates remained after each calendrias is then collected into a separate tank called concentrate collection tank. From this tank, the concentrate is sent to Agitated thin film dryer for drying purposes.

7.15 AGITATED THIN FILM DRYER (ATFD)

ATFD is a suitable solution for all types of drying applications. For evaporators, ATFD is a stand to convert concentrated liquid to dry powder or flakes.

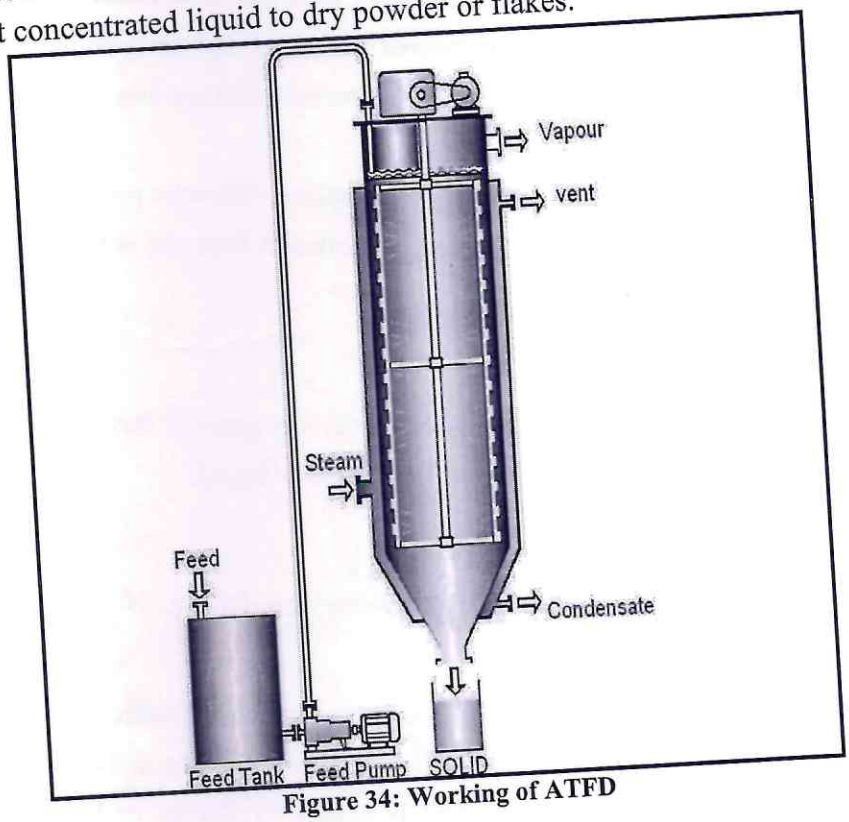


Figure 34: Working of ATFD

Working Principle of ATFD

ATFD consist of cylindrical body with heating jacket around it and a bladed rotor inside the shell having conical shape at bottom. These blades are all over the length of dryer and spread the wet concentrate in a thin film over the surface of heated wall inside the shell. As the heat is transferred to the shell by steam, all the concentrate gets dried leaving the solids at bottom. An outlet vent is also provided to pass out the condensed steam.

Key benefits/advantages of Agitated Thin Film Dryer

- Reduced time for Evaporation when compared to solar evaporation pans
- Solar pans can be gradually eliminated after installation of ATFD.
- Condensate with reusable quality can be recovered from the ATFD system and the same can be reused in the process.
- Manual handling of waste salt can be totally eliminated and minimum manpower is sufficient to bag the salt, instead of engaging huge manpower for cleaning of waste salt from the solar pans.
- During rainy seasons overflowing of solar pans can be avoided by operating ATFD system and waste salt can be recovered as dry salt and shall be bagged & stored in yard. Hence, units and CETPs shall be operated continuously without any stoppage during rainy seasons.
- Lower foot print area for installation as compared with solar pans.
- Ground water contamination by seepage/leakages from the solar can be avoided by elimination the solar pans.

7.16 ATFD FOR CETP

An Agitated Thin Film Dryer (ATFD) is used for dry salt recovery through evaporation of highly concentrated mother liquor (from chillers & centrifuges).

7.17 BOILER

HSD Based non IBR boiler is considered of capacity App. 650 kg / Hr @ 7 kg Pressure.

- **WORKING PRINCIPLE**

  Steam boiler is a cylindrical shape closed vessel which has sufficient capacity to contain water and steam. Generally, water or alternative fluid is stored in steam boiler to generate steam. That water or fluid is heated by flames or hot gasses which are produced by combustion of fuels and consequently steam is generated in the boiler at

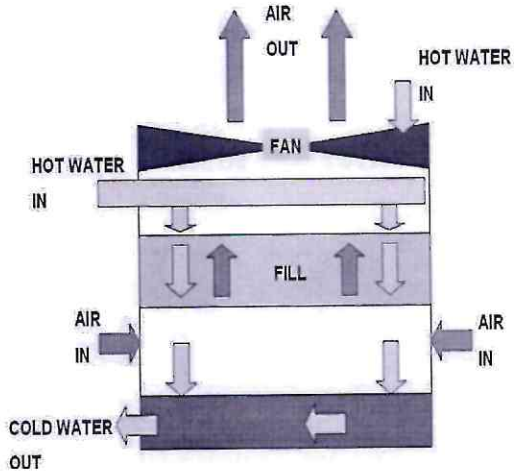
different pressure according to Steam boiler's size and it's specification. That steam is now passed through a pipe and supplied into different production unit, power plant etc.

Advantages of Boiler:

- Fluctuation of steam demand can be met easily.
- Larger heating surface can be achieved by using more numbers of water tubes
- Very high pressure in order of 140 kg/cm2 can be obtained smoothly
- Due to convectional flow, movement of water is much faster.
- And rate of heat transfer is high & its efficiency is high.

7.18 COOLING TOWER

Cooling Tower of Capacity 75 TR is considered with pump & basin is also considered.



➢ WORKING PRINCIPLE

The evaporation process only takes place on the surface of a liquid and needs latent heat of vaporization to happen. Sensible heat is drawn from the body of the water to the surface to supply the energy needed for the latent heat. It can be seen that for a little evaporation a lot of sensible heat will be needed therefore the main body of the circulating water is cooled for very little loss of water. Warm to hot water from the cooling process is pumped to the top of the cooling tower and into the sprays where the water is broken up into droplets and distributed over the Fill. The water droplet spreads out as it slides down the Fill creating the surface area necessary for evaporation. The evaporation rate of the water is restricted by the amount of moisture already in the air around it. To maintain evaporation the moistened air must be replaced with dry air, usually by fans blowing air through the tower.

7.19 SLUDGE HANDLING SYSTEM

Brief Process Description

Sludge dewatering is the separation of a liquid and solid phase whereby, generally, the least possible residual moisture is required in the solid phase and the lowest possible solid particle residues are required in the separated liquid phase ("the filtrate").

During the course of the water treatment, products coming from the pollution are extracted while the treated water is released in the environment. Amongst these products coming from the pollution one can distinguish:

Particles that decant naturally or that come from the physico-chemical treatment. Excess micro-organisms coming from the dissolved organic matter treatment Mineral matter that is non biodegradable All these products are suspended in more or less concentrated forms and the resulting liquid is called **sludge**. The quantity of sludge generated depends upon the degree of treatment or quality of treated effluent required i.e., higher the degree of wastewater treatment, the larger the quantity of sludge to be treated and handled.

Type of sludge:

Primary sludge: Comes from the primary or physio-chemical Process.

Biological Sludge: Comes from the biological treatment of wastewater.

Mixed Sludge: Comes from blend of primary and biological sludge.

Digested Sludge: Comes from biological stabilizing step i.e. digestion process.

Mineral Sludge: Produce during mineral process such as quarries or mining beneficiation process.

The water content of the sludge is very high, and solids constitute very small part of it. Therefore before final disposal further treatment is required for this sludge to reduce water content and oxygen demand.. Most wastewater treatment processes produce a watery sludge byproduct. Disposing of this sludge can often prove very expensive and for that reason, a sludge dewatering system is a great option for reducing costs. By dehydrating the solid byproduct, the weight and volume of product is reduced, delivering major cost savings. The reduction in volume of the sludge can be achieved by thickening, dewatering and drying; and stabilization of organic matter can be obtained by employing digestion (aerobic or anaerobic), incineration, composting, heat treatment, chlorine oxidation or lime stabilization. The flow sheet for biological sludge treatment is presented.

Residuals Treatment Process Flow Diagram

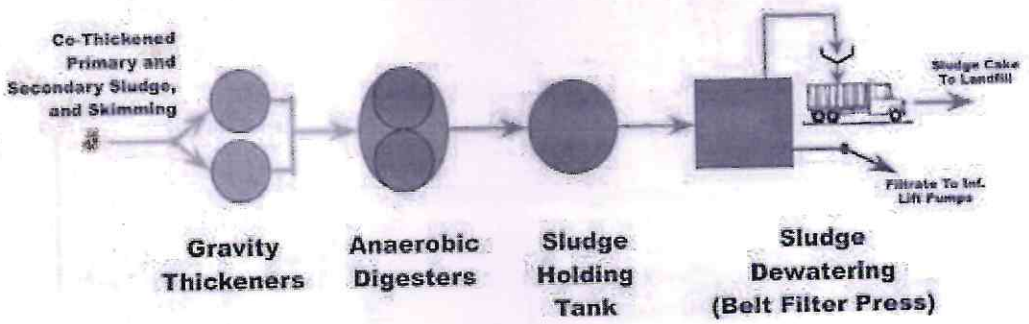


Figure 35 General Sludge Handling Units

Sludge Dewatering

The purpose of sludge dewatering is for waste minimization and to achieve overall cost efficiency for disposal. ... Sludge dewatering is typically focused on reducing the weight and volume of the sludge so that disposal costs - including transportation - are kept to a minimum. The choice of a sludge treatment method is dependent on several factors including the characteristics, volume, timing and the available disposal options. Various machines are being used for sludge dewatering purpose. Widely used machines are listed below:

- Filter Press
- Centrifuge
- Screw Press
- Sludge Drying Beds

Working of Sludge Dewatering Units

This is a five-step process: sludge removal, storage, conditioning, dewatering and disposal.

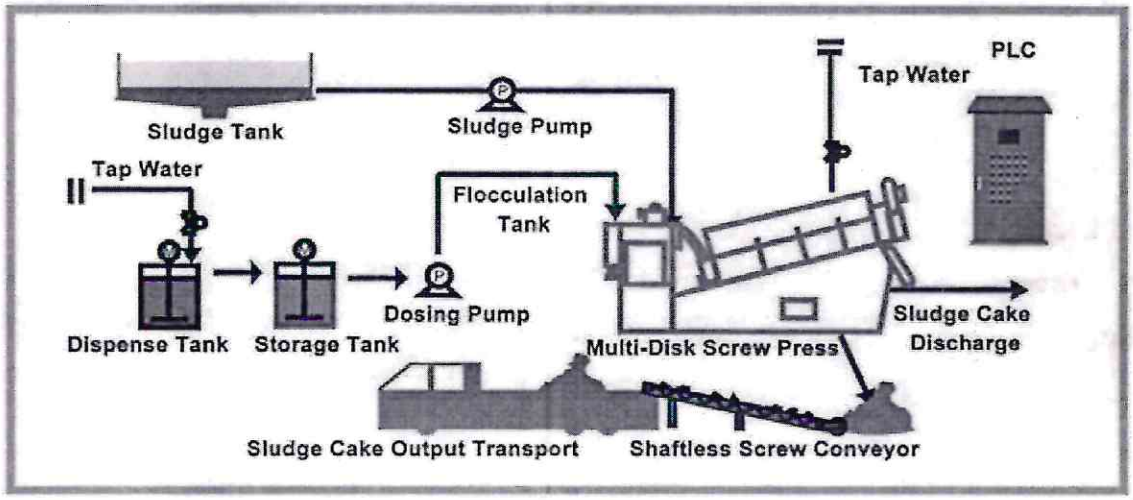


Figure 36 Sludge Dewatering Process

1. **Sludge Removal**: Organic sludge originates from various sources such as Primary Settling Tank (PST), Secondary Settling Tanks (SST), etc. PST and SST sludge usually have 65% -75% volatile solids. This sludge is removed by Sludge removal pumps installed near the settling tanks.
2. **Sludge Storage**: The removed sludge will be stored in holding tank. Sludge Holding Tanks provide storage and blending for the thickened waste activated sludge, primary sludge, imported sludge, and scum before further processing.
3. **Sludge Conditioning/ Thickening**: Sludge thickening is a process in which the solids concentration is increased and the total sludge volume is correspondingly decreased, but the sludge still behaves like a liquid instead of a solid.
4. **Sludge Dewatering**: Equipments mentioned as above are used to dewater or squeeze the thickened sludge. The purpose of sludge dewatering is to reliably and efficiently concentrate the wastes into high solids filter cakes for easy and cost-effective disposal.
5. **Final Sludge Disposal**: Final disposal of the sludge from the treatment plant generally involves some form of land disposal. The most common methods of land disposal include spreading on land, lagooning, dumping, and landfilling.

7.20 SLUDGE DEWATERING SYSTEM FOR CETP

From the tube settler tanks, settled Chemical sludge, which will be inorganic in nature, will be transferred to the sludge holding tank. Here, Poly will be dosed to thicken the sludge and this thickened sludge will be sent to the Volute. The dewatered water from the Volute will be again sent to the Equalization Tank & Dried sludge will be stored & disposed to TSDF Site.

Volute

The Volute dewatering press offers both sludge thickening and dewatering in one machine. Suitable for industrial sludge, primary and secondary treatment sludge, aerobic and anaerobic bio solids, digestate dewatering and oily sludge thanks to its self-cleaning moving ring mechanism that prevents clogging.

The Volute is a horizontal continuous operation screw that is designed for dewatering/ solid-liquid separation for a wide range of influent, effluent, other products. Volute is structured with a filter element that consists of two types of Rings: Fixed Ring and a Moving Ring along with a screw that thrusts the filter element & transfer and pressurizes the sludge. The gaps between the Rings and the screw pitch are designed to gradually get narrower towards the direction of sludge cake outlet and the inner pressure of the filter element increases due to the volume compression effect which thickens and dewaters the sludge.

Working of Volute

Sludge is fed into a mixing tank or screw head where polymer is thoroughly mixed in. The sludge then passes through a flocculation tank where gentle mixing and flocculation occurs. From there, the sludge overflows into the dewatering drum and is pressed. The Volute is equipped with separate main drive and cone motors for independent control of speed and retention time within the press. The entire operation is controlled by the Volute Dewatering Press control panel. The final solids are later dried to produce briquettes/sludge. Liquid is extracted from three areas of the Volute to maximize output and recovery. Free liquid is drained immediately to reduce the imposed hydraulic load.

Benefits of Volute

- Clog free & good for oily sludge.
- Reduces sludge volume which cuts down the transport and disposal costs.
- Continuous & easy operation
- Compact, modular design saves space
- Minimal maintenance (only 2 – 3%) & Easy automation
- Minimal alignment and wear issues

- Low power consumption (5% of a Centrifuge)
- OH & S benefits
  - ✓ Low noise & Low odor – may be contained (along with harmful vapors)
  - ✓ Minimal exposed moving parts,
  - ✓ Easy to install

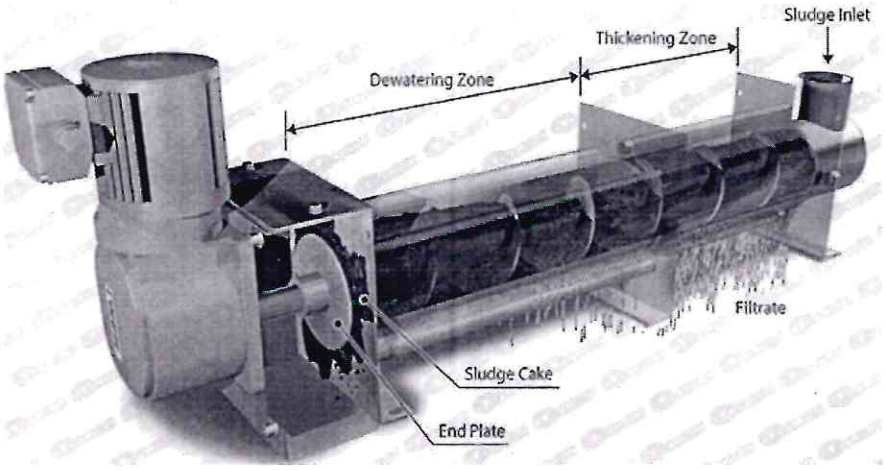


Figure 37: Volute Working Principle

Operation and Maintenance of Volute

The Volute Dewatering Press requires very little operator attention, other than periodic inspection and chemical replenishment. As a fully automated process, it controls the operation of wasting sludge directly from the biological process or clarifier, chemical make-up and dosing, flocculation, and then dewatering. Depending on operating conditions, a partial overhaul of the dewatering drums may be required every three years. This two-hour operation is undertaken in the field, with minimal disruption to plant operation.

ONLINE CONTINUOUS MONITORING SYSTEM

OCMS which is fully compatible with the Guidelines of CPCB & SPCB will be installed at outlet of final treatment.

➢ WORKING PRINCIPLE

This analyzer is operated on **Dual Beam UV Vis-absorption spectrometry** as measuring principle. COD, BOD & TOC is independent program for calibration, analysis and validation, as compared to parameters calculation for one to another parameter such as COD to BOD to TOC of other system. pH & temperature measuring principal is unique, non-porus/non-leaking combined reference electrode for technically consisting pH performance. Long term stable and maintenance free in operation.

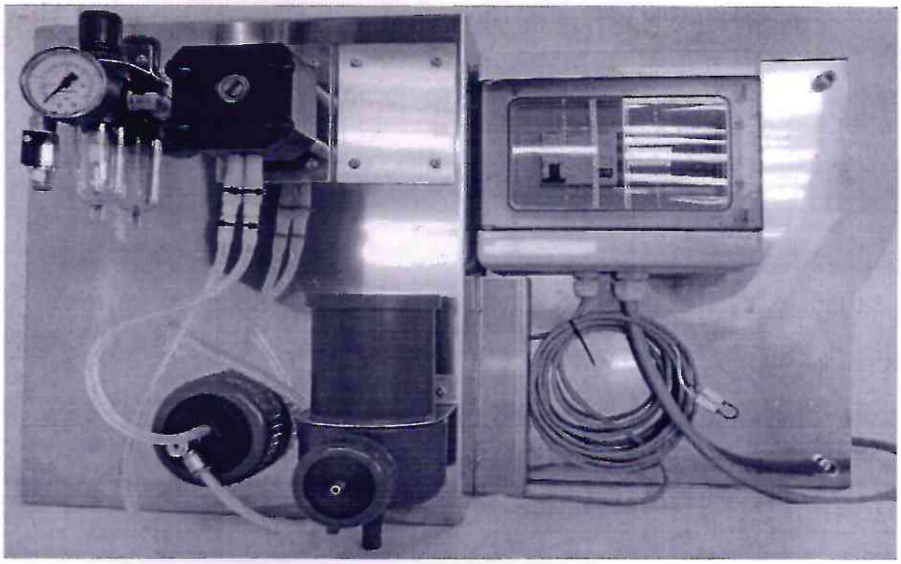
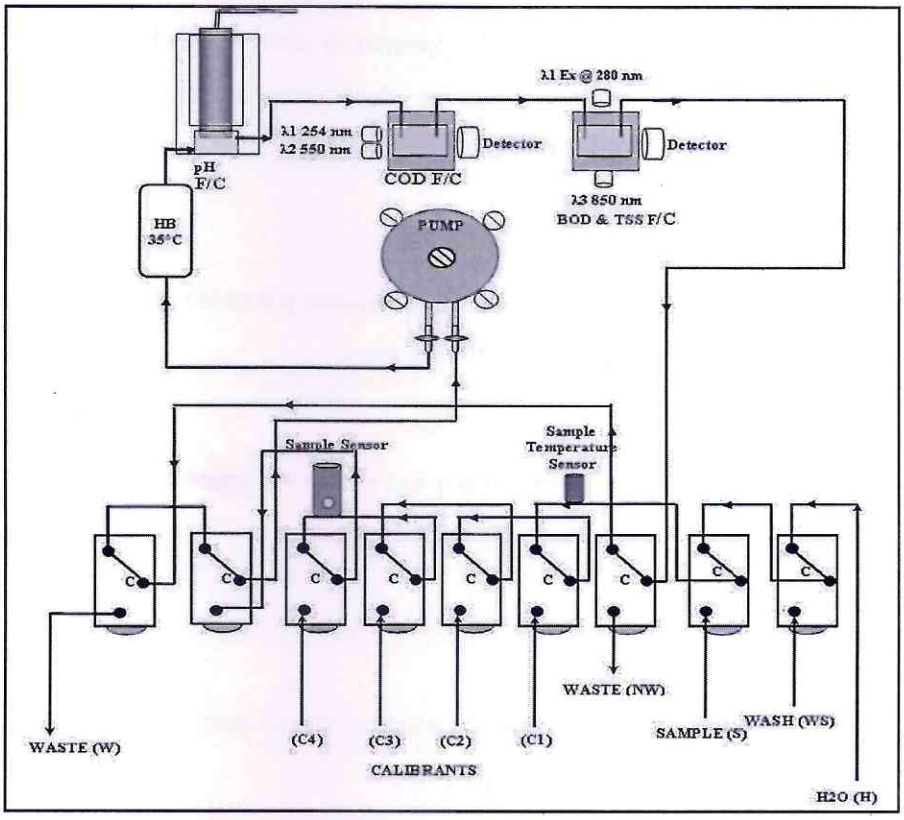


Figure 39: Online monitoring system



8. PROJECT DESIGN

Electroplating effluent treatment system typically consists of a primary physico-chemical treatment followed by Oxidation treatment. With this the salinity is not removed and this further requires application of membrane processes (like Reverse Osmosis (RO)) to the treatment train to achieve the desired parameters. While membrane processes recover high quality water, they also generate highly concentrated rejects or brine. The Zero Liquid Discharge (ZLD) plants also include systems for management of RO rejects. These are in addition to the membrane filtration and Multiple Effect Evaporator (MEE) systems that have been adopted for water recovery, reuse and to achieve ZLD.

The complete project is designed based on the parameters mentioned above in the design basis. The treatment scheme includes various electro-mechanical Equipments, civil structures, pipelines, chemicals, consumables etc.

Scope of the Project

Scope of the project makes the detailed design on wastewater treatment plant with a capacity of 600 m3 /day. The following main facilities are designed;

Mechanical design

All required mechanical equipment for wastewater and sludge treatment facilities.

Sludge treatment facility

Sludge thickening and Dewatering

Electrical design

All required power supply and control system for wastewater and sludge treatment facilities

Other facility piping system

Production of water using for treatment plant, Pile foundation, Access road and bridge, Site preparation and Supplementary soil improvement

Wastewater treatment facility/ Civil Structure Design

Collection station, Equalization tank, Primary sedimentation tank, Aeration tank, Final sedimentation tank, and Disinfection tank.

9. DESIGN OF CETP

ETP has been designed to ensure that all the outlet treated waste water is well below the desired parameters.

Following points are considered during the design of sewage treatment unit:

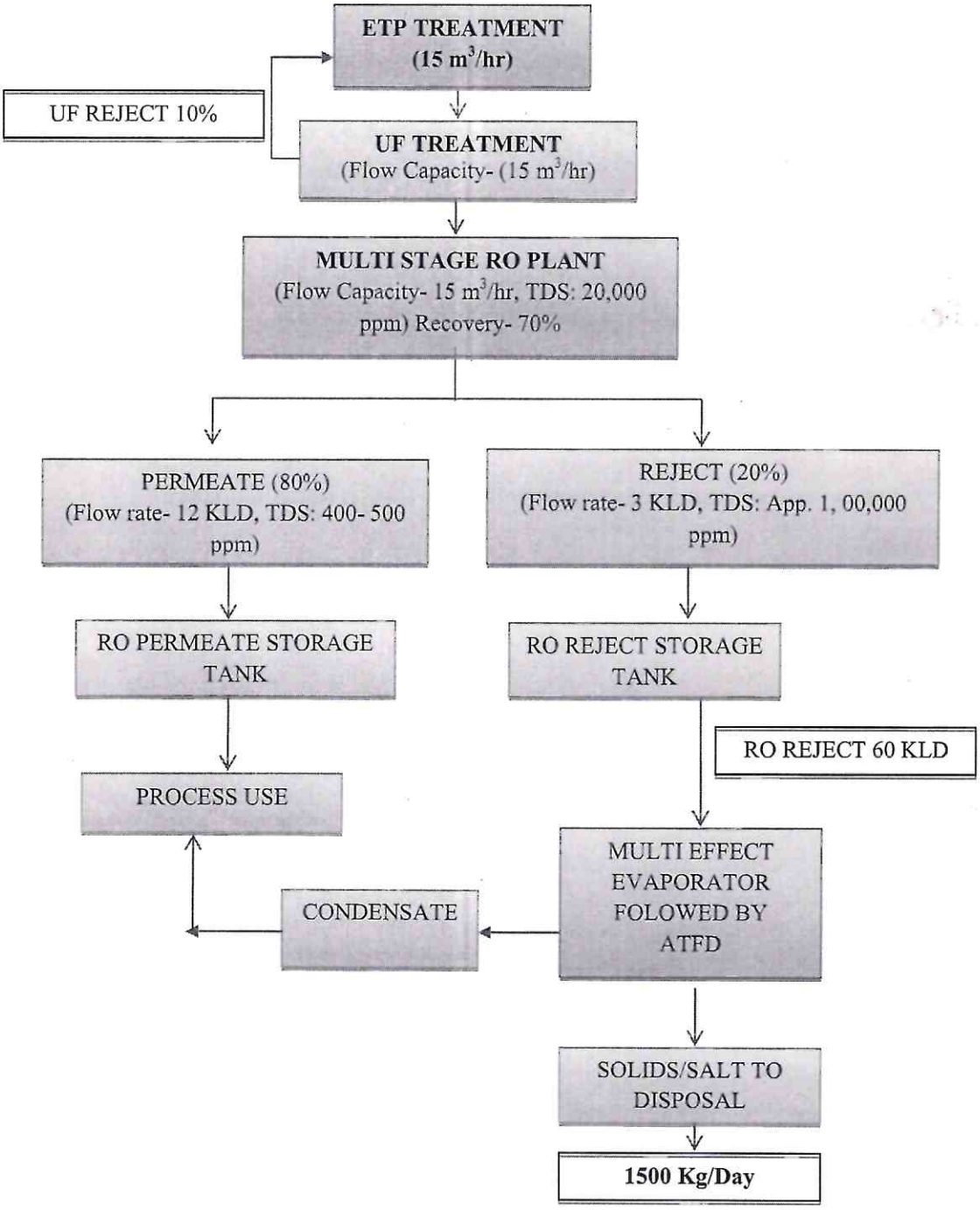
- The design of the treatment units should be economical; easy in maintenance should offer flexibility in operation.
- Instead of providing one big unit for each treatment more than two numbers small units should provided, which will provide in operation as well as no stoppage during maintenance and repair of the plant.
- ETP will be designed in such a way to reuse the maximum quantity of treated effluent back in the process.

The design and size of the ETP depends upon:

- Quantity and quality of the industries discharge effluent.
- Land availability
- Monetary considerations for construction, operation & maintenance

restoring eco balance

PROCESS FLOW CHART



9.1 Design and Electro- Mechanical Equipments required for ETP

The list of the mechanical equipment required for the ETP and their design along with he specifications is given below:

S. No	Description	Qty.
	PRIMARY TREATMENT	
1.	**BAR SCREENS** Application- Screening of floating matter **1.1 COARSE BAR SCREEN** One number Bar Screens (coarse) Manual, made of Poly Propylene (PP) flat of suitable size, with clear opening of 20mm **1.2 FINE BAR SCREEN** One number Bar Screens (fine) Manual, made of Poly Propylene (PP) of suitable size, with clear opening of 10mm MOC- PP	2 Nos.
2.	**EFFLUENT TRANSFER PUMPS** Application- To feed effluent to Flash mixer tank from Equalization Tank Type: submersible raw effluent lifting pumps to pump effluent from Equalization tank to Flash mixer tank Type- Air operated double diaphragm. Capacity: 15 m^3/hr ,Head :10-12 m MOC – PP	6 Nos. (4W +2S)
3.	**COMPRESSOR FOR AIR OPERATED DIAPHRAGM PUMPS** Capacity- Suitable for air operated pumps. Accessories- MS base plate, safety valves, suction filter, Air hoses, Air Pressure Regulators, NRV, PRV, ant vibration pad, belt, Belt guard, Drive and driven pulleys.	1 No.

4.	**AUTOMATIC pH CONTROLLER SYSTEM AT EQUALIZATION TANKS** Range : 0-14	4 Nos.
5.	**CHEMICAL DOSING SYSTEM FOR ACID DOSING TANK** Application - Storage of chemicals Type- Vertical Capacity- 200 Liters MOC – HDPE / PP	1 No.
6.	**CHEMICAL DOSING SYSTEM FOR ALKALI DOSING TANK** Application - Storage of chemicals Type- Vertical Capacity- 200 Liters MOC – HDPE / PP	1 No.
7.	**CHEMICAL DOSING SYSTEM FOR SMBS DOSING TANK** Application - Storage of chemicals Type- Vertical Capacity- 200 Liters MOC – HDPE / PP	1 No.
8.	**AERATION GRID FOR EQUALIZATION TANKS** Application - For providing air in respective tanks Accessories- Complete with piping & valves MOC: UPVC **COARSE AIR DIFFUSERS FOR EQUALIZATION TANKS** Application - For providing air in the Tank MOC –Silicon/EPDM	4 Lots

	Type: Coarse	
9.	**AGITATOR FOR FLASH MIXER TANK** Drive: 2.0 HP Type: Gear Motor MOC of Shaft: SS MOC of Base Frame: MSEP	1 Set.
10.	**AGITATOR FOR FLOCCULATION TANK** Drive: 2.0 HP Type: Gear Motor MOC of Shaft: SS MOC of Base Frame: MSEP	1 Set.
11.	**AUTOMATIC pH CONTROLLER SYSTEM AT FLASH MIXER & FLOCCULATION TANK** Range : 0-14	2 Nos.
12.	**AGITATOR FOR LIME PREPARATION** Drive: 1.0 HP Type: Gear Motor MOC of Shaft: SS/MSFRP, MOC of Base Frame: MSEP	1 No.
	DOSING TANK FOR MILK OF LIME Application - Storage of chemicals Type- Vertical Capacity- 200 Liters MOC – HDPE / PP	1 No.
	DOSING PUMP Application - To dose the chemicals in Tank,	2 No. (1W + 1S)

	Capacity: 0-100 lph, MOC- PP	
13.	**DOSING SYSTEM FOR ALUM** **DOSING TANK FOR ALUM PREPARATION** Application - Storage of chemicals Type- Vertical, Capacity- 200 Liters MOC – HDPE	1 No.
	AGITATOR FOR ALUM PREPARATION Drive: 1 HP Type: Gear Motor MOC of Shaft: SS/MSFRP MOC of Base Frame: MSEP	1 No.
	DOSING PUMP Application - To dose the chemicals in Tank, MOC- PP	2 No. (1W + 1S)
14.	**DOSING SYSTEM FOR POLY** **DOSING TANK FOR POLYELECTROLYTE PREPARATION** Application - Storage of chemicals Type- Vertical MOC – HDPE	2 Nos.
	AGITATOR FOR POLYELECTROLYTE PREPARATION Type: Gear Motor MOC of Shaft: SS/MSFRP MOC of Base Frame: MSEP	2 Nos.

	DOSING PUMP Application - To dose the chemicals in Tank, Capacity: 0-40 lph, MOC- PP	2 No. (1W + 1S)
15.	**PRIMARY TUBE SETTLER TANK MEDIA** Application - For settling of sludge Length – 860 mm MOC- PVC UV Stabilized	2 Lot
16.	**CHEMICAL SLUDGE REMOVAL PUMP** Application- For disposal of sludge Type- Centrifugal, Monobloc, horizontal , Self priming Capacity-10 m3/hr, Head- 10 m, MOC – CI	4 Nos. (2 W +2 S)
	SECONDARY TREATMENT	
17.	**AERATION GRID FOR POLISHING TANK** Application - For providing air to tank Accessories- Complete with piping & valves MOC: uPVC/MSEP	1 Lot.
18.	**AIR DIFFUSERS FOR POLISHING TANK** Application - For providing air in tank Type: Tubular – Fine membrane, MOC –Silicon/EPDM	1Lot.
19.	**AIR BLOWER WITH ACCESSORIES FOR EQ. TANKS, POLISHING TANK & SLUDGE HOLDING TANK** Application - Supply of air for mixing Capacity: 650 m^3/hr, Head: 0.55 Kg/ cm^2	2 Nos. (1W +1S)

	MOC: CI, Accessories- MS base plate, safety valves, suction filter, silencer, NRV, PRV, ant vibration pad, V belt, Belt guard, Drive and driven pulleys	
20.	**SECONDARY TUBE SETTLER TANK MEDIA** Length – 860 mm, MOC- PVC UV Stabilized	1 Lot
21.	**SLUDGE RECIRCULATION / REMOVAL PUMP** Application- For recycle / disposal of sludge Type- Centrifugal, Monobloc, horizontal , Self priming Capacity: 10 m^3/hr, Head: 8- 10m, MOC – CI	2 Nos. (1W +1S)
	TERTIARY TREATMENT	
22.	**FILTER FEED PUMP** Application-To feed the treated effluent to Pressure sand filter/ backwashing Type- Centrifugal, Monobloc, horizontal , Self priming Capacity: 15 m^3/hr, Head: 25- 30 m MOC – CI	2 Nos. (1W +1S)
23.	**SELF SUPPORTING PRESSURE SAND FILTER** Application –Removal of fine suspended solids Capacity: 15 m^3/hr Filtration Rate: 14 m^3 / m^2 / hr Media- under bed with graded silica sand MOC – MSEP **Accessories: Pressure Switches, Solenoid valves**	1 No.
24.	**SELF SUPPORTING ACTIVATED CARBON FILTER**	1 No.

	Application - Removal of fine suspended solids, Color & Odor Capacity: 15 m^3/hr Filtration Rate: 14 m^3 / m^2 / hr Media- under bed with graded silica sand & Activated carbon , MOC – MSEP **Accessories: Pressure Switches, Solenoid valves**	
25.	**UV DOSING SYSTEM** Capacity: 15 m^3/hr MOC:SS	1 No.

9.2 Design and Projection for UF Plant

UF Plant of Capacity 15 m^3/hr is designed by hydranautic's Nitto Software. The complete design is mentioned as Annexure- 1.

9.3 Electro- Mechanical Equipments required for UF Plant

The list of the mechanical equipment required for the UF Module is given below:

UF MODULE		
1.	**UF FEED PUMP** Type- Horizontal, Centrifugal, Head: 15 m Capacity: 15.0 m^3/hr MOC: CI	2 Nos. (1W + 1S)
2.	**UF MEMBRANE MODULE** Capacity: 15.0 m^3/hr Membrane Area: 75.0 m^2 Purpose: For Removal of colloidal matters Type of membrane: Hollow fiber MOC- PVC/ABS	As per OEM design
3.	**MICRON FILTERS BEFORE UF MODULE** Application – Removal of micro suspended solid	1 Lot

	Capacity: 15 m^3/hr MOC- PVC, Size- 5 Micron	
4.	**UF BACKWASH/ CLEANING PUMP** **(As per OEM Design if required)** Type- Horizontal, Centrifugal Capacity: 15 m^3/hr MOC: CI Body with SS Impeller	1 Lot
5.	**HYPO DOSING SYSTEM** Application – For Removal of Pathogen **DOSING TANKS – 1 No.** Type – Vertical, Capacity-500 Liters, MOC – HDPE **DOSING PUMPS: 1No.** Application - To dose the Hypo solution, MOC- PP Type- Electronic, Capacity- 0 - 10 Lph	1 Lot
6.	**ACID DOSING SYSTEM** Application – For pH adjustment , prevent scaling & reduce rate of Fe2 + oxidation **DOSING TANKS – 1 No.** Type – VerticalCapacity-500 Liters, MOC – HDPE **DOSING PUMPS: 1 No.** Application - To dose the acids solution, MOC- PP Type- Electronic, Capacity- 0 - 10 Lph	1 Lot

9.4 Design and Projection for RO Plant

Design Basis for Ro Plant

Flow Rate: 300 KLD (15 m^3/hr)

Inlet TDS: 20,000 ppm

RO Plant Recovery: 80 %

RO Permeate: 12 m^3/hr (TDS: 450- 500)

RO Reject: 3 m^3/hr (TDS: 1, 00,000 ppm)

RO Plant of Capacity 15 m^3/hr is designed by hydranautic's Nitto Software. The complete design is mentioned as Annexure- 2.

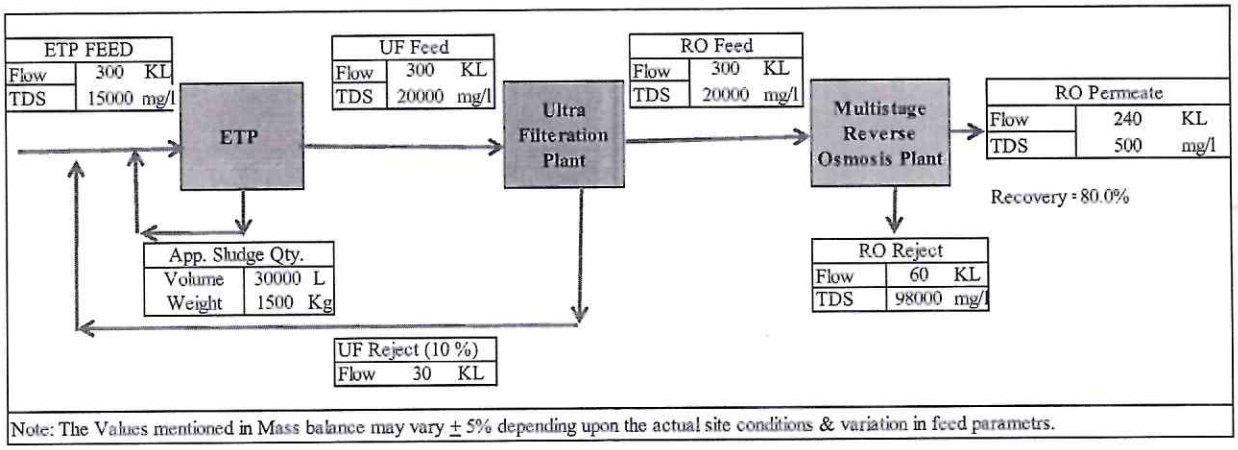
9.5 Electro- Mechanical Equipments for RO Plant

The list of the mechanical equipment required for the Sludge dewatering system is given below:

RO PLANT– MULTI STAGE MODULE		
1.	**RO FEED PUMP** Type- Horizontal, Centrifugal, Head: 15 m Capacity: 15 m^3/hr, MOC: CI	2 Nos. (1W +1S)
2.	**SMBS DOSING SYSTEM** Application – For Removal of Chlorine **DOSING TANK** Type – Vertical, Capacity-100 Liters, MOC – HDPE **DOSING PUMP** Application - To dose the acids solution, MOC- PP Type- Electronic, Capacity- 0 – 10 Lph	1 No.
3.	**ANTI SCALING DOSING SYSTEM** Application – For Removal of scaling in water **DOSING TANK** Type – Vertical, Capacity-500 Liters, MOC – HDPE Make-Sintex **DOSING PUMP** Application - To dose the acids solution, MOC- PP Type- Electronic, Capacity- 0 – 10 Lph	1 No.
4.	**MICRON FILTERS BEFORE RO MEMBRANES** Application – Removal of micro suspended solid, Capacity: 15.0 m^3/hr, MOC: PVC Size: 5 microns	1 Lot
5.	**HIGH PRESSURE PUMP FOR MULTISTAGE RO PLANT** Application- To feed RO Membrane Type- Vertical, Capacity-15 m^3/hr MOC – SS wetted parts, Head: as Per OEM Design	6 Nos. (3W + 3S)
6.	**RO MEMBRANE HOUSING (PRESSURE VESSEL)** Application: For Fixing of RO membrane MOC: PVC	2 No.
7.	**RO MEMBRANE**	4 Nos.

	Application: For Removal of TDS MOC: Composite Polyamide Type: BW Membrane	
8.	**RO FLUSHING / CLEANING SYSTEM** Application- For cleaning of RO membrane **DOSING TANK** Type – vertical, Capacity-100 Liters, MOC – HDPE	1 No.

9.6 Material Balance for CETP Effluent



Note: The Values mentioned in Mass balance may vary ± 5% depending upon the actual site conditions & variation in feed parametrs.

9.7 Design and Electro- mechanical equipment required for Sludge Handling

The list of the mechanical equipment required for the Chemical Sludge dewatering system is given below:

CHEMICAL SLUDGE DEWATERING SYSTEM (VOLUTE)		
1.	**Chemical Sludge Feed Pump** Application- To feed the Sludge from Holding tank to Volute. Capacity-5 m^3/hr Type- Screw Type MOC – CI	2 Nos. (1W +1S)
	AERATION GRID FOR SLUDGE HOLDING TANK MOC- UPVC Make- ECO **Air Diffusers- For Sludge Holding Tank** Type- Coarse MOC –EPDM/ Silicon Dia: 150 mm	1 Lot

	Volute Along with Flocculation Tank, Sludge Flow control Tank Type: Screw mechanism MOC: SS-304 Capacity: 1 m^3/hr Power Requirement: 0.2 KW Make-Eco	1 No.
	POLY DOSING PUMP MOC- PP, Make- E-Dose Capacity- 0-6 Lph	1 No
	POLY DOSING TANK Capacity-100 Litres MOC-HDPE Make- Sintex	1 No.

10.DESIGN FOR EVAPORATOR & ATFD

10.1 Design basis for Evaporator

S. No	Particulars	Unit	Evaporator	ATFD
1.	Product		RO Reject Water	Concentrate from Evaporator
2.	Capacity	KLD	60	
3.	Feed Rate	Kg/hr	3360	1152
4.	Initial solid	%	12	35
5.	Concentrate final solids	%	35	90
6.	Concentrate output	Kg/hr	1152	448
7.	Concentrate Outlet temperature	°C	46	45
8.	Water Evaporation Rate	Kg/hr	2208	704
9.	Solids recovery rate	Kg/hr	-	448

Table 4 Design basis for Evaporator and ATFD

10.2 Utility for Evaporator and ATFD

S. No	Particulars	Unit	Value
1.	Cooling Water Inlet Temperature	°C	32
2.	Cooling Water Inlet Temperature	°C	38
3.	Cooling water for Evaporator	m^3/hr	55
4.	Cooling water for ATFD	m^3/hr	70
5.	Cooling Tower Capacity	TR	250

Table 5 Cooling Water for Evaporator and ATFD

S. No	Particulars	Unit	Value
1.	Steam Pressure	Kg/cm^2	6
2.	Steam Temperature	°C	164
3.	Steam for Evaporator	Kg/hr	765
4.	Steam for ATFD	Kg/hr	890
5.	Total Steam Capacity	Kg/hr	1655

Table 6 Steam requirement for Evaporator and ATFD

10.3 Material Balance for Evaporator

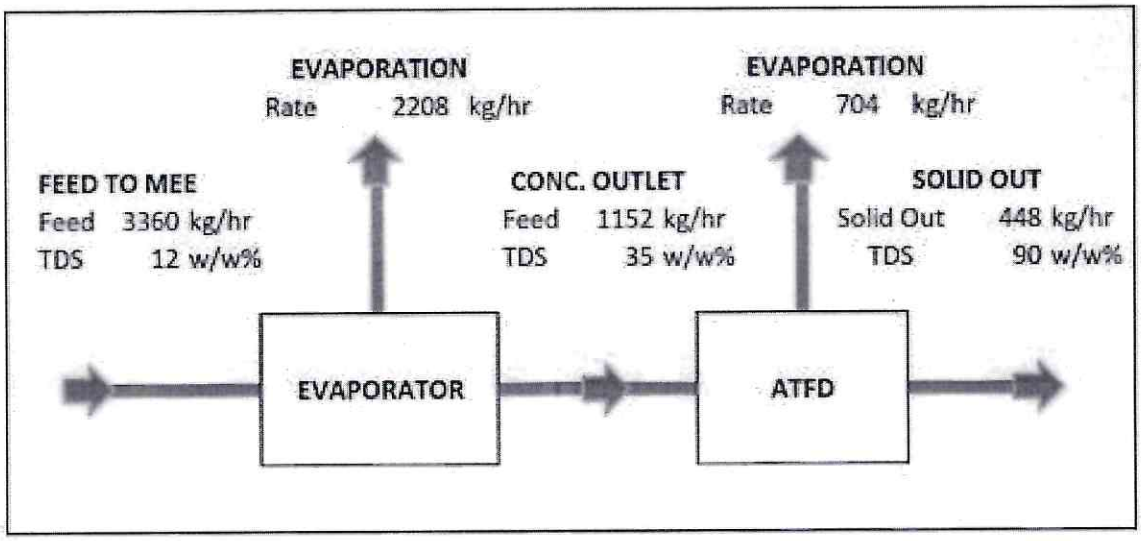


Figure 40: Flow Scheme for Evaporator & ATFD

10.4 Electro- Mechanical Equipments for Evaporator

The list of the mechanical equipment required is given below:

S. No.	Description	Unit
1.	**CALANDRIAS** Main Shell: SS 304 Tubes (Seamless): SS-316 Ti Nozzles SS-316 Tube sheet- SS-316 L Top and bottom cover –SS-316 L	3 Nos.
2.	**PREHEATERS** Main Shell: SS 304 Nozzles SS-316 tube sheet- SS-316 top and bottom cover –SS-316	3 Nos.
3.	**FEED PUMP** MOC: SS 316 Non-flameproof Electric Motor (IP – 55 , 415 V, 50 Hz, 3 Phase) Mechanical Seal, Base frame, Coupling, Coupling guard, Oil cup, Foundation	1 No.
4.	**RECIRCULATION PUMPS** MOC: SS 316 Non-flameproof Electric Motor (IP – 55 , 415 V, 50 Hz, 3 Phase) Mechanical Seal with set of Seal Water Supply Flexible Hose, Base frame, Coupling, Coupling guard, Oil cup	3 Nos.
5.	**CONDENSATE OUTLET PUMP** MOC: SS 304 Non-flameproof Electric Motor (IP – 55 , 415 V, 50 Hz, 3 Phase) Mechanical Seal with set of Seal Water Supply Flexible Hose with Base frame, Coupling, Coupling guard, Oil cup	1 No.
6.	**CONCENTRATE OUTLET PUMP** MOC: SS 304 Non-flameproof Electric Motor (IP – 55 , 415 V, 50 Hz, 3 Phase) Mechanical Seal with set of Seal Water Supply Flexible Hose with Base frame, Coupling, Coupling guard, Oil cup	1 No.
7.	**THERMAL VAPOUR RECOMPRESSION (TVR)**	1 No

	MOC: SS304	
8.	**VAPOUR SEPARATORS** MOC: SS316L	2 Nos.
9.	**SURFACE CONDENSER** MOC: Main Shell SS 304, Top Cover: SS 304 Bottom Cover: SS 304 Tube Sheet: SS 304	1 No.
10.	**FEED TANK / CONCENTRATE TANKS** MOC: SS316L	1 No.
11.	**VAPOUR SEPARATORS** MOC: SS 316 L	3 Nos.
12.	**CONDENSATE COLLECTION PIT** MOC : SS304	1 No.
13.	**WATER RING VACUUM PUMP** Non-flameproof Electric Motor (IP – 55 , 415 V, 50 Hz, 3 Phase) MOC- SS304	1 No.
14.	**Closed Loop system for Water Ring Vacuum Pump comprising of Seal Water Tank, Seal, Water Cooler (PHE), Vacuum Pot, Seal Water Piping etc.** MOC: SS	1Lot.
15.	**SEAL WATER SYSTEM FOR MECHANICAL SEAL** Plate Type Heat Exchanger Frame – Carbon Steel Plates – SS 304 **Seal Water Tank** MOC: HDPE **Seal Water Pump** Non-flameproof Electric Motor (IP – 55 , 415 V, 50 Hz, 3 Phase) MOC: Casing – CI, Impeller – CI	1 Lot.

10.5 Electro- Mechanical Equipments for ATFD

The list of the mechanical equipment required is given below:

S. No.	Description	Qty.
1.	**ATFD FEED TANK** MOC :SS 316	1 No
2.	**ATFD FEED PUMP** MOC :SS 316	1 No
3.	**AGITATED THIN FLIM VESSEL** Inner Vessel: SS304 Shell- SS 316L Rotor- SS 316L Blades- SS 316 Top Cover and Flange- MS+ SS 316 Lines Body Flanges- MS+ SS 316 Lines Shaft Seal- Standard Top Bearing- SKF Bottom Bush- Graphite ATFD Motor with Gear Box- Standard Drive Stool Assembly- MS	1 Set
4.	**CONDENSATE PUMP** MOC :SS	1 No
5.	**BLOWER** MOC :SS	1 No
6.	**SURFACE CONDENSER** MOC: Main Shell SS 304,Top Cover Carbon Steel, Bottom Cover Carbon Steel, Tube Sheet SS 304	1 No.
7.	**CONDENSATE COLLECTION PIT** MOC : SS	1 No.
8.	**SALT SETTLER TANK** MOC- MSFRP	1 No.

Note: The Design criteria & specifications mentioned in above scope of supply for ETP, UF/RO, evaporator, ATFD may change when the actual designing will be done during execution of the Project.

11.PIPING WORKS

Piping works for Supply, Erection and Testing of piping works including suction and delivery of transfer pumps with necessary supports, alignment with following specifications:		
Piping & Fittings For ETP	MOC: uPVC/ MS	1 Lot.
Piping & Fittings For UF/RO	MOC: uPVC/SS-304	
Piping & Fittings For Evaporator	MOC: SS-304	
Piping & Fittings For Cooling Tower	MOC: MS "B"	
Make	Prince/ Jindal/ Astral / Eqt.	

12. ELECTRICAL WORKS

Description	PLC Based Main Control panel will be fabricated in 14 SWG/ 16 SWG CRCA sheet with compartment cubical Type, dust and vermi proof, self-mounted.
Electrical works for ETP & UF RO Plant	**CENTRALIZED CONTROL PANEL WITH PLC/HMI** Fabricated in 14 SWG/ 16 SWG CRCA sheet with non-compartment, dust & vermin proof, machine mounted. One incoming feeder will be provided which will have ammeter, voltmeter, indicating lamps. Outgoing feeders will be as per drives of mechanical equipment. Each outgoing feeder shall have MCCB, contactor, overload relay, on/off push button, indicating lamp, neutral link and one set of terminal block.
Make	Make of Switchgears- Siemens / ABB/ Schneider/ L&T
Electrical works for Evaporator	**CONTROL PANEL WITH PLC BASED SCADA SYSTEM** Electrical Panel (Non-compartmentalized, Non-flameproof) Electrical Panel MS with 14 / 16 SWG Sheet, RAL 7035 Powder coat. PLC Based Main Control panel will be fabricated in 14 SWG/ 16 SWG CRCA sheet with compartment cubical Type, dust and vermi proof, self-mounted.
Cabling	All cable will be Flame Proof. Electrical cabling shall be provided from control panel to various units of Plant. The cable will be heat proof Size of cable- As per the capacity of the motors / drives MOC: Al unarmored, Make of Cable: Make: CCI / Polycab / Eqt.

13.CHEMICAL CONSUMPTION

Sr. No.	Name of Raw Materials	Tentative Quantity (kg/ l)
1.	Acid/ Alkali for Equalization Tank	200
2.	Lime/ Caustic	700
3.	Alum/ PAC	500
4.	Poly	15
5.	SMBS	300
6.	Antiscalent	50
7.	Hypochloride for Membrane Cleaning	400
8.	Hydro Chloric Acid for Membrane Cleaning	50
9.	RO cleaning Chemicals	50

14. DETAILS OF INSTRUMENTATION

S. NO	DESCRIPTION
I.	**PRESSURE GAUGES AT PUMPS**
	Type - Bourdon / Diaphragm glycerin filled
	Make - Waree / H guru / eqt
II.	**LEVEL SWITCHES**
	Make: Aster
III.	**ELECTROMAGNETIC FLOW METER WITH TOTALIZER**
	Make: Adept / Federal
	Location
	ETP inlet & outlet
	RO Permeate
	Evaporator inlet & Condensate
IV.	**ROTA METERS**
	Capacity of Rota meter- Max 8000 LPH
	Application- To indicate flow, make- Aster / Eqt.
V.	**PRESSURE SWITCHES**

	For Filters - 2 Nos. & UF/RO, Make- Aster/ Danfoss
VI.	**TDS METER / CONDUCTIVITY METER**
	Location: At RO inlet, RO permeate line - 2 Nos. & Reject line
	Make: Aster
VII.	**SOLENOID VALVES FOR UF/ RO**
	Make: Aira/ Air Flow / Danfoss
VIII.	**ORP METER**
	Application- To indicate ORP
IX	**Vacuum Gauge for evaporator**
X	**Temperature gauge for evaporator**

15. DETAILED CIVIL DESIGN

This section treats the detailed design of all the civil structures for Effluent Treatment Plant for Capacity 600 KLD. The following point should be kept in mind while giving layout of the Effluent treatment plant:

- All the plant's unit should be located in the order of sequence, so that effluent from one process should directly go to other process.
- If possible all the plant should be located at such elevation that effluent can flow from one plant into next under its force of gravity only.
- All the treatment units should be arranged in such a way that minimum area is required it will also ensure economy in its cost.
- Sufficient area should be occupied for future extension.
- Staff quarter and office also should be provided near the treatment plant, so that operators can watch the plant easily.
- The site of treatment plant should be very neat and give very good appearance.

16.1Design of Civil Tanks for CETP

BAR SCREEN CHMABER

Effluent, 600 m^3/d will be passed through bar screen chamber. The tank is constructed in R.C.C with and internally lined by PP for acid proofing and finished with smooth plaster and corrosion proof lining.

Effluent	300 m^3/d
Peak Flow	600 m^3/d
Capacity of tank	1 KL

OIL AND GREASE CHAMBER

Effluent, 600 m^3/d will then be passed through Oil and Grease chamber. The tank is constructed in R.C.C with and internally lined by PP for acid proofing and finished with smooth plaster and corrosion proof lining

Effluent	300 m^3/d
Peak Flow	600 m^3/d
Capacity of tank	2 KL

EFFLUENT EQUALIZATION TANKS

Effluent, 600 m^3/d is collected in collection cum Equalization tank. The tank is constructed in R.C.C with and internally lined by PP for acid proofing and finished with smooth plaster and corrosion proof lining

Effluent	300 m^3/d
Peak Flow	600 m^3/d
Retention Tame	24 hrs
Capacity of tank	600 KL
No. Tanks for Batch Treatment	150 KL each (4 Nos. Tanks)

FLASH MIXER TANK

Effluent from equalization tank will be sent to flash mixer tank where lime will be added.

Effluent	600 m^3/d
Retention Time	30 min
Capacity of tank	20 KL

PRIMARY TUBE SETTLER TANK -1, 2 & 3

Effluent from flash mixer will be sent to Primary Tube Settler Tank where the sludge is settled.

Effluent	600 m^3/d
Retention Time	2.5 hr
Capacity of tank	75 KL

FLOCCULATION TANK

Effluent from flash mixer tank will be sent to Flocculator tank where lime will be added.

Effluent	600 m^3/d
Retention Time	45 min
Capacity of tank	25 KL

POLISHING TANK

Effluent from Primary Tube Settler Tank-2 will be sent to polishing tank.

Effluent	600 m^3/d
Retention Time	4 hr
Capacity of tank	150 KL

FILTER FEED TANK

Filter Feed tank is used to hold the partial treated effluent before feeding it to the filters.

Effluent	600 m^3/d
Retention Time	2 hr
Capacity of tank	60 KL

UF FEED TANK

UF Feed tank is used to hold the partial treated effluent before feeding it to the Ultra Filtration System.

Effluent	600 m^3/d
Retention Time	5 hr
Capacity of tank	150 KL

UF PERMEATE TANK

Effluent	600 m^3/d
Retention Time	2 hr
Capacity of tank	60 KL

RO PERMEATE TANK

Effluent	480 m^3/d
Retention Time	4 hr
Capacity of tank	100 KL

RO REJECT/ MEE FEED TANK

Effluent	120 m^3/d
Retention Time	8 hr
Capacity of tank	50 KL

16.2 Summarized Capacity of Civil Tanks for CETP

S. No.	Description	Unit	Capacity	No of Units	MOC
1.	Screen Chamber	KL	2	1	RCC
2.	Oil & grease chamber	KL	10	1	RCC
3.	Effluent Equalization Tank	KL	150	4	RCC
4.	Lime Preparation Tank	KL	30	1	RCC
5.	Flash Mixer Tank	KL	20	1	RCC
6.	Flocculation Tank	KL	25	1	RCC
7.	Primary Tube Settler Tank - 1 & 2	KL	75	1	RCC
8.	Polishing Tank	KL	150	1	RCC
9.	Tube Settler Tank	KL	75	1	RCC
10.	Filter Feed Tank	KL	60	1	RCC
11.	UF Feed Tank	KL	150	1	RCC
12.	UF Permeate Tank	KL	60	1	RCC
13.	RO Permeate Tank	KL	100	1	RCC
14.	RO Reject Tank	KL	50	1	RCC
15.	Sludge Holding Tank	KL	100	1	RCC
16.	Interconnecting Pathways		As per requirement	1 Lot	PCC / RCC
17.	Ladder, Railings & Platforms		As per requirement	1 Lot	MS / RCC
18.	Foundation for new Electromechanical Equipments		As Required	1 Lot	RCC

KL: kilo liter
MS: Mild steel
BW: Brick works
PCC: Plain cement & concrete
RCC: Reinforced cement & concrete