CHAPTER V

Details of an Effluent Treatment Plant:

Details of an Effluent Treatment Plant:

Today the treatment of domestic and industrial wastewater is a matter of course in our society . It serves the protection of human health, the preservation of water as an ecosystem and it also retains the water in a state that makes it useable by humans. The nuisance free removal of wastewater from its sources of generation, followed by treatment and disposal, is not only desirable but also necessary in an industrialized society

V.1. Definition of wastewater:

The water that is used in industrial processes or even in household applications are not totally consumed. a major portion of the same is discharged as liquid effluent. The same generally is termed as wastewater In a nutshell the wastewater may be defined as the water supply of the community after it has been fouled by a variety of uses. Much of the wastewater from homes industries, and businesses must be treated before it is released back to the environment. Nature has an amazing ability to cope with small amounts of waste water and pollution. but it would be a dangerous proposition to discharge billions of gallons of wastewater and sewage produced every day without any treatment Treatment plants reduce pollutants in wastewater to a level that nature can handle It includes substances such as food scraps. oils, soaps chemicals and other effluents produced by human being. In homes. this includes water from sinks, showers bathtubs, toilets. washing machines and dishwashers. Businesses and industries also contribute their share of used water that must be treated Wastewater also includes storm runoff. Although some people assume that the rain that runs down the street during a storm is fairly clean, it isn't Harmful substances that wash off roads, parking lots, and rooftops can harm our rivers and lakes

V.2. Necessity of Wastewater Treatment:

Treatment of wastewater is in the interest of our health and environment. There are a lot of good reasons to keep the purity of water sources, otherwise existence of life will be threatened.

Fisheries-

Clean water is critical to aquatic plants and animals. This is therefore important for the fishing industry, sport fishing enthusiasts and future generations.

Wildlife Habitats-

Our rivers and ocean waters teem with life that depends on shoreline, beaches and marshes. They are critical habitats for hundreds of species of fish and other aquatic life. Migratory large number of birds use the water bodies for resting and feeding.

Recreation and Quality of Life-

The water is a great playground for of us all. The scenic and recreational values of our waters are reasons many people choose to live where they do. Visitors are drawn to water activities such as swimming, fishing, boating and picnicking.

Health Concerns-

Water treatment is of vital importance for health as dirty water can spread a number of life threatening disease. Since we live, work and play so close to water, harmful bacteria have to be removed to make water safe.

The major aim of wastewater treatment is to remove as much of the suspended solids as possible before the remaining water, called effluent, is discharged back to the environment. As solid material decays, it uses up oxygen, which is needed by the plants and animals living in the water. "Primary treatment" removes about 60 percent of suspended solids from wastewater. This treatment also involves aerating (stirring up) the wastewater, to put oxygen back in. Secondary treatment removes more than 90 percent of suspended solids.

V.3. Methods of treatment:

The contaminants in wastewater are removed by physical, chemical, and biological means. The individual methods usually are classified as physical unit operations, chemical unit processes and biological unit processes. These operations and processes occur in a variety of combinations in treatment systems.

Physical unit operations:

The treatment methods in which the application of physical forces predominate are known as physical unit operations. Because they were derived originally from the observations of the physical world, they were the first treatment methods to be used. Screening, mixing, flocculation, sedimentation, flotation, filtration and gas transfer are typical unit operations which are most commonly used in wastewater treatment. Physical operations are used for the removal of coarse solids, suspended and floating solids, grease, and volatile organic compounds.

Chemical unit processes:

The treatment methods in which the removal or conversion of contaminants is brought about by the addition of chemicals or by other chemical reactions are known as chemical unit processes. Precipitation, adsorption, and disinfection are the most common examples used in wastewater treatment. In chemical precipitation, treatment is accomplished by producing a chemical precipitate that will settle. In most cases, the settled precipitate will contain both the constituents that may have reacted with the added chemicals and the constituents that were swept out of the wastewater as the precipitate settled. Adsorption involves the removal of specific compounds from the wastewater on solid surfaces using the forces of attraction between bodies. Disinfection involves the selective destruction of disease-causing organisms with chlorine dioxide, bromine chloride, ozon etc. Chemical processes are used for the precipitation of suspended and colloidal solids, disinfection of the wastewater, and control of odors.

Biological unit processes:

The treatment methods in which the removal of contaminants is brought about by biological activity are known as biological unit processes. Biological treatment is used primarily to remove the biodegradable organic substances (colloidal or dissolved) in wastewater. Basically, these substances are converted into gases that can escape to the atmosphere and into biological cell tissue that can be removed by settling. Biological treatment is also used to remove nutrients (nitrogen and phosphorus) in wastewater. In any wastewater treatment system there is a vast array of microbes present, i.e. aerobic, anaerobic and facultative, each performing specific functions in their respective parts of the system. Each species has a tolerance of ecological minimums and maximums with regard to various conditions; pH, temperature, dissolved oxygen levels and nutrient levels. All microbes require optimal conditions in order to proliferate and infuse the system with sufficient numbers of microbes to maximize the efficiency of the wastewater treatment plant.

V.4. Application of treatment methods:

Methods of treatment of wastewater can be accomplished in many different ways. Three unit operations and processes are grouped together to provide various levels of treatment. The term "preliminary" and/or "primary" referred to physical unit operation, "secondary" referred to chemical and biological unit processes and "advanced" or "tertiary" referred to combinations of all three. The terms are arbitrary, however, and in most cases of little value. A more rational approach is first to establish the level of contaminant removal required before the wastewater can be reused or discharged to the environment. The required unit operations and processes necessary to achieve that required level of treatment can then be grouped together on the basis of fundamental considerations. Many modifications and new operations and processes have been developed and implemented to meet the increasingly stringent requirements for environmental protection and to minimize the operation and maintenance cost of plant.

V.4.1.Preliminary wastewater treatment:

Preliminary wastewater treatment is defined as the removal of wastewater constituents that may cause maintenance or operational problems with the treatment operations, processes and ancillary systems. Examples of preliminary operations are screening and comminution for the removal of debris and rags, grit removal for the elimination of coarse suspended matter that may cause wear or logging of equipment and flotation for the removal of large quantities of oil and grease.

V.4.2.Primary wastewater treatment:

In primary treatment, a portion of the suspended solids and organic matter is removed from the wastewater. This removal is usually accomplished with physical operations such as screening and sedimentation. The effluent from primary treatment will ordinarily contain considerable organic matter and will have a relatively high BOD. The principal function of primary treatment will continue to be as a precursor to secondary treatment.

V.4.3.Secondary wastewater treatment

The goal of all secondary treatment systems is to remove non-settling solids and the dissolved organic load from the effluents by using microbial populations. Biological treatments are generally part of secondary treatment systems. The microorganisms used are responsible for the degradation of the organic matter and the stabilization of organic wastes. The organic load present is incorporated in part as biomass by the microbial populations, and almost all the rest is liberated as gas (carbon dioxide CO_2) if the treatment is aerobic, or carbon dioxide plus methane (CH_4) if the process is anaerobic and water. Unless the cell mass formed during the biological treatment is removed from the wastewater (e.g., by sedimentation), the treatment is largely incomplete, because the biomass itself will appear as organic load in the effluent and the only pollution reduction accomplished is that fraction liberated as gases. The biological treatment processes used for wastewater treatment are broadly classified as aerobic (in which aerobic and facultative micro-organisms predominate) or anaerobic (which use anaerobic micro-organism). If the micro-organisms are suspended in the wastewater during biological operation, the operations are "called suspended growth processes", while the micro-organisms that are attached to a surface over which they grow are called "attached growth processes"

V.4.3.1 Biological treatments :

The biological treatment of wastewater can be categorised as follows:

V.4.3.1.1. Aerobic Processes

V.4.3.1.1.1 Activated Sludge Systems

V.4.3.1.1.2. Aerated lagoons

V.4.3.1.1.3. Aeration

V.4.3.1.1.4.Trickling filters

V.4.3.1.1.5. Rotating biological contractors

V.4.3.1.1.6. Selection of aerobic treatments

V.4.3.1.2. Anaerobic Treatment

V.4.3.1.1. Aerobic Processes:

In these, the reactions occurring can be summarized as:

organic load + oxygen +cells → more cells + CO_2 + NH_3 + H_2O

The most common aerobic processes are: activated sludge systems, lagoons, trickling filters and rotating disk contactors. These aerobic processes are described, together with the devices used for aeration

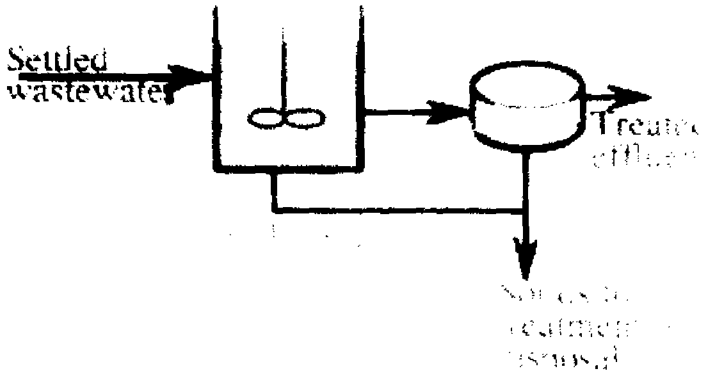


Figure V.1. Diagram of a simple activated sludge system

V.4.3.1.1.1 Activated Sludge Systems:

These systems originated in England in the early 1900's and earned their name because sludge (mass of microbes) is produced which aerobically degrades and stabilizes the organic load of a wastewater. Figure V.1 shows the lay out of a typical activated sludge system. For larger systems, especially when high variability is expected, the design involves the use of multiple aeration tanks and multiple settling tanks. The number of units employed depends on the flow of wastewater being generated.

The organic load (generally coming from primary treatment operations such as settling, screening or flotation) enters the reactor where the active microbial

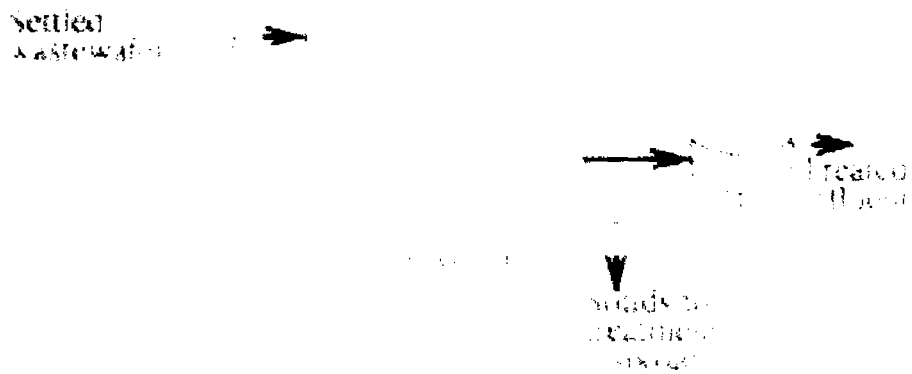


Figure V.2. Diagram of a conventional activated sludge process

population (activated sludge) is present. The reactor must be continuously aerated. The mixture then passes to a secondary settling tank where the cells are settled. The treated wastewater is generally discharged after disinfection while the settled biomass is recycled in part to the aeration basin. The cells must be recycled in order to maintain sufficient biomass to degrade the organic load as quickly as possible. The amount that is recirculated depends on the need to obtain a high degradation rate and on the need for the bacteria to flocculate properly so that the secondary settling separates the cells satisfactorily. As the cells are retained longer in the system, the flocculating characteristics of the cells improve since they start to produce extra cellular slime which favours flocculating. The most common types of activated sludge are the conventional and the continuous flow stiffed tank (Figure V.1), in which the contents are completely mixed. In the conventional process, the wastewater is circulated along the aeration tank, with the flow being arranged by baffles in plug flow mode (Figure V.2). The oxygen demand for this arrangement is maximum at the inlet as is the organic load concentration. In the completely mixed process the inflow streams are usually introduced at several points to facilitate the homogeneity of the mixing; if the mixing is complete, the properties are constant throughout the reactor. This configuration is inherently more stable to perturbations because mixing causes the dilution of the incoming stream into the tank. In all activated sludge systems, the cells are separated from the liquid and partially returned to the system to have a relatively high concentration of cells that degrade the organic load in a relatively short time. Therefore two different resident times are characteristic: the hydraulic residence time (H) given by the ratio of reactor volume (V) to flow of wastewater (Q):

$$H = V/Q$$

and the cell residence time (c) given by the ratio of cells present in the reactor to the mass of cells wasted per day. Typical H values are in the order of 3-6 hours, while c fluctuates between 3 and 15 days. Such difference in resident times is obtained by discharging the clarified effluent but wasting only a small fraction of the sludge. This in turn can be accomplished by discarding a portion of the sludge from the settling tank or by wasting a fraction of the outlet of the reactor before entering the settling tank. In activated sludge systems, organic load removals of 85-95% are the most common. A key factor in the success of these systems is its proper operation, which requires trained manpower.

Problems may appear during the operation of activated sludge systems, including:

- High solids content in clarified effluent, which may be due to too high or too low solids retention time and to growth of filamentous micro-organisms.

- Rising sludge, occurring when sludge that normally settles rises back to the surface after having settled. In most cases, this is caused by the denitrification process, where nitrate present in the effluent is reduced to nitrogen gas, which then becomes trapped in the sludge causing this to float. This problem can be reduced by decreasing the flow from the aeration basin to the settling tank or reducing the sludge resident time in the settler, either by increasing the rate of recycle to the aeration basin, increasing the rate of sludge collection from the bottom or increasing the sludge wasting rate from the system.

- Bulking sludge, that which settles too slowly and is not compactable, caused by the predominance of filamentous organisms. This problem can be due to several factors of which the most common are nutrient balance, wide fluctuations in organic load, oxygen limitation (too low levels), and an improper sludge recycle rate.

- Insufficient reduction of organic load, probably caused by a low solids retention time, insufficient amount of nutrients such as P or N, short-circuiting in the settling tank, poor mixing in the reactor and insufficient aeration or presence of toxic substances.

- Odours, caused by anaerobic conditions in the settling tanks or insufficient aeration in the reactor.

V.4.3.1.1.2 Aerated lagoons:

The aerated lagoons are basins, normally excavated in earth and operated without solids recycling into the system. This is the major difference with respect to activated sludge systems. Two types are the most common: the completely mixed lagoon (also called completely suspended) in which the concentration of solids and dissolved oxygen are maintained fairly uniform and neither the incoming solids nor the biomass of microorganisms settle, and the facultative (aerobic-anaerobic or partially suspended) lagoons. In the facultative lagoons, the power input is reduced causing accumulation of solids in the bottom which undergo anaerobic decomposition, while the upper portions are maintained aerobic (Figure V.3 gives an example). The main operational difference between these lagoons is the power input, which is in the order of 2.5-6 Watts per cubic metre (W/m^3) for aerobic lagoons while the requirements for facultative lagoons are of 0.8-1 W/m^3. Being open to the atmosphere, the lagoons are exposed to low temperatures which can cause reduced biological activity and eventually the formation of ice. This can be partially alleviated by increasing the depth of the basin. These units require a secondary sedimentation unit, which in some cases can be a shallow basin excavated in earth, or conventional settling tanks can be used. If excavated basins are used for settling, care should be taken to provide a residence time long enough for the solids to settle and there should also be provision for the accumulation of sludge. There is a very high possibility of offensive odour development due to the decomposition of the settled sludge and algae might develop in the upper layers contributing to an increased content of suspended solids in the effluent. Odours can be minimized by using minimum depths of up to 2 m, while algae production is reduced with liquid retention time of less than two days. The solids will also accumulate, all along the aeration basins in the facultative lagoons and even in comers, or between aeration units in the completely mixed lagoon. These accumulated solids will, on the whole, decompose in the bottom, but since there is always a non-biodegradable fraction, a permanent deposit will build up. Therefore, periodic removal of these accumulated solids becomes necessary.

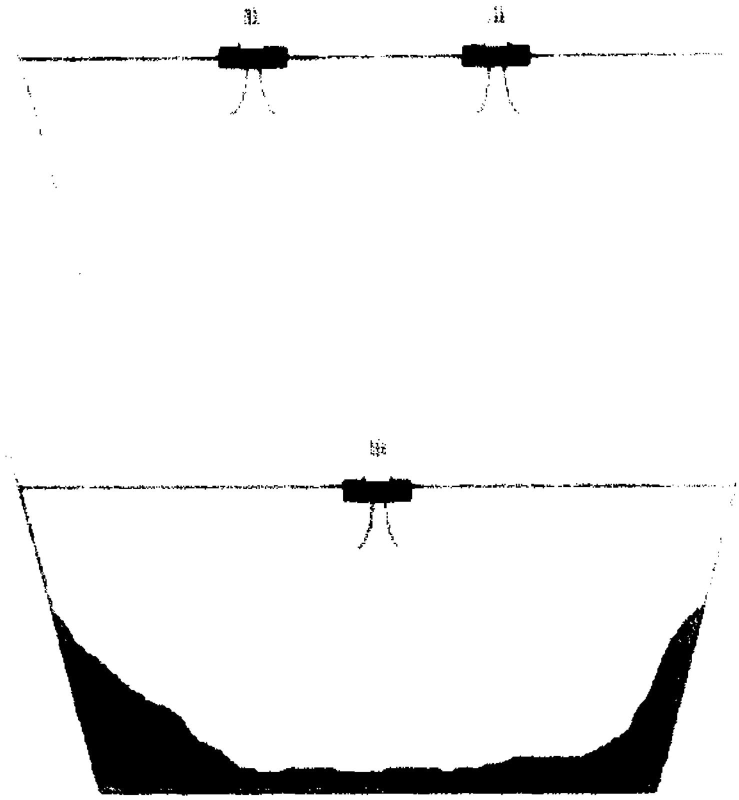


Figure V.3. Diagram of aerobic (top) and facultative (bottom) aerated lagoons

V.4.3.1.1.3 Aeration:

The aerated systems described above need an oxygen supply. Depending on the characteristics of the process, different designs may be used. The oxygen can be supplied to the activated sludge by either diffused aeration, by turbine agitation, by static aerators, or by surface coarse or large bubble diffusers. The last two are used also in the lagoon systems. The diffused aeration systems are also divided into fine bubble, medium and coarse or large bubble diffusers. The fine bubble diffusers are built of porous materials (grains of pure silica or aluminum oxide are bonded ceramically or by resins) which provide very small bubbles of high surface area that favour the oxygen transfer from the air to the wastewater. The medium bubble diffusers are perforated pipes or tubes wrapped with plastic or woven fabric. The coarse or large bubble diffusers can be orifice devices of various types, some of which are designed to be non-clogging.

With the small or fine bubble diffusers, it is important to use air free of particles that would otherwise clog them. Although somewhat less efficient for oxygen transfer, the coarse bubble diffusers are sometimes preferred because the presence of particles in the air is not a critical problem, and also for their lower cost and maintenance requirements. The diffusers are placed along air manifolds, close to the bottom of the aeration tanks.

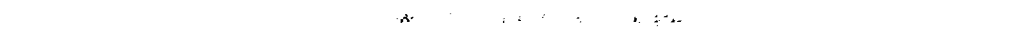


Figure V.4. Sketch of a static aeration system

The static aerators (Figure V.4) are vertical tubes placed at the bottom of the aeration tank, with packing material along its length. The compressed air is supplied from the bottom of the tubes, forcing a mixture of air and water through the packing, where most of the oxygen transfer to the wastewater takes place. They have been used mainly in aerated lagoons

The turbine aerators are one of the most common and simple aeration devices and consist of an electric motor-driven turbine impeller rotating at high speed above a pipe or a sparging ring which discharges the compressed air (Figure V.5).

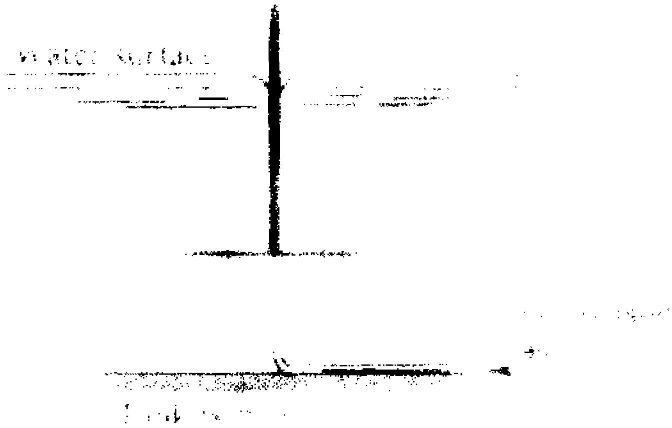


Figure V.5. Turbine aeration system

The air bubbles discharged from the pipes are dispersed by the rotation of the turbine. Depending on the depth of the aeration basin, more than one impeller may be used in the same axis. The power drawn by the turbine systems is used for maintaining the micro- organisms in suspension and to break down and disperse the air bubbles, the latter demanding most of the power.The most common surface aeration units (Figure V.6) are mounted on a float and consist of a propeller installed inside a rising tube and driven by a non-immersed motor. The propeller draws the liquid from under the unit and sprays it above the surface of the tank. The oxygen transfer takes place from the air to the droplets sprayed and to the turbulent surface of the liquid surrounding these units. Other surface aeration units are the so-called "brush" aerators which are basically blades mounted on a cylinder which rotates through the liquid (Figure V.7). Usually, these units require baffles to direct the flow and insure turbulent velocity.

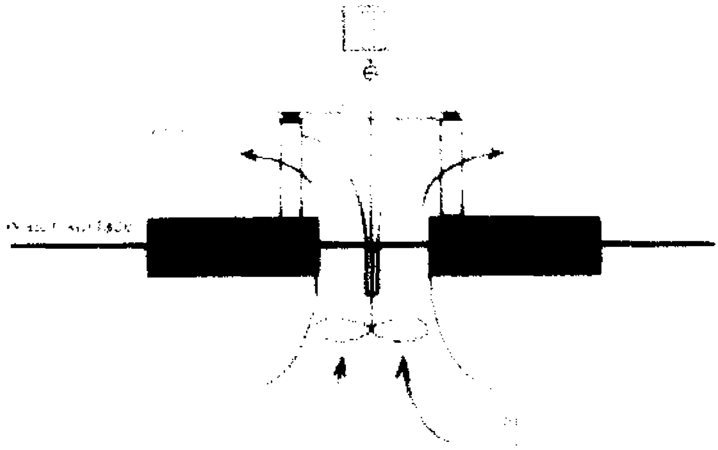


Figure V.6. Diagram of a floating surface aerator

Figure V.7. Sketch of a surface brush aerator

The oxygen transfer rates of the different devices fluctuate between 0.7 and 1.4 kg of oxygen per Kilo Watt-hour when used in actual wastewater. Most catalogues give much higher transfer capacities, because these values are based on test under standard conditions (typically clean, tap water at 20°C and no dissolved oxygen at the start of the test). When selecting aeration equipment, care should be taken in interpreting these values and transfer rates in actual wastewater should be requested for proper evaluation.

V.4.3.1.1.4 Trickling filters:

The trickling filter is one of the most common attached growth processes. Rather than being suspended as in activated sludge or aerated lagoons, most of the biomass is attached to some support media over which they grow (Figure V.8).

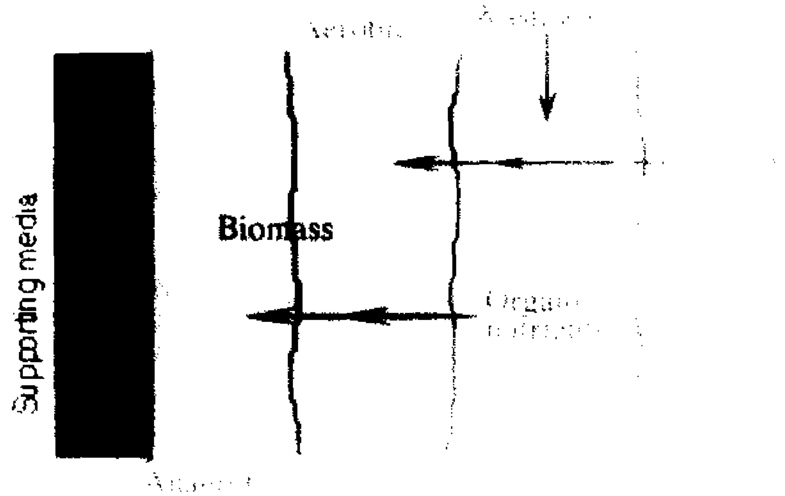


Figure V.8. Cross-section of an attached growth biomass film

The organic contents of the effluents are degraded by the attached growth population which absorbs these organic contents from the surrounding water film. Oxygen from the air diffuses through this liquid film and enters the biomass. As this organic matter grows, the biomass layer becomes thicker and eventually some of the inner portions of the biomass will be deprived of oxygen or nutrients and will separate from the support media over which a new layer will start to grow. The separation of biomass occurs in relatively large flocs which settle relatively quickly compared with suspended cells. Air circulates between the interstitial spaces of the supporting material. The media that can be used are beds of rocks (ranging in size from 5 to 10 cm) randomly packed, although regular packings of plastic material (Figure V.9) are becoming more common recently in view of its much lighter weight, better flow distribution, larger void space and specific area.

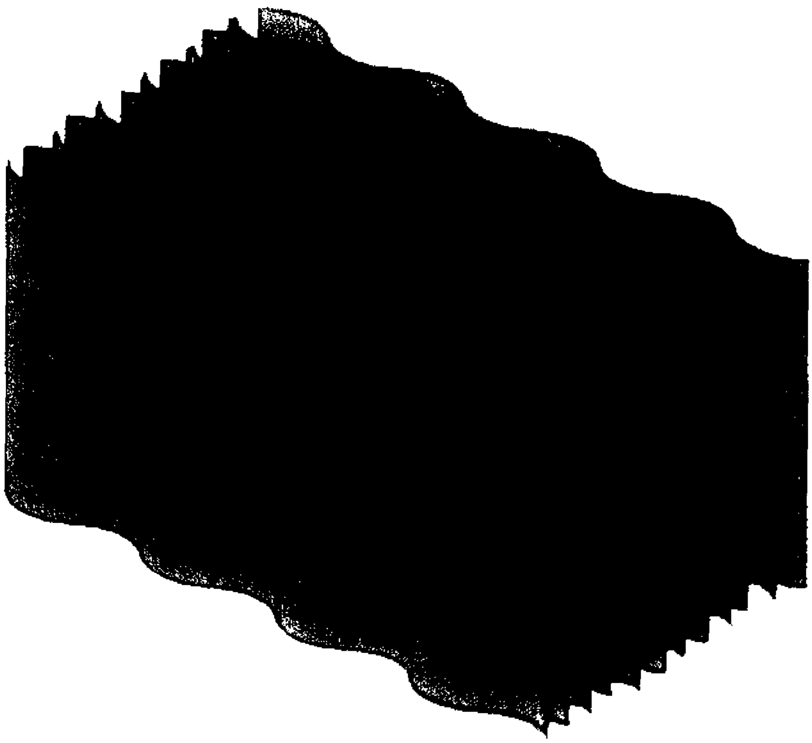


Figure V.9. Typical packing for trickling filters

The trickling filter units consist of a circular tank filled with the packing media in depths from 1 to 2.5 m, or 10 m if synthetic packing is used. The bottom of the tank must be constructed rigid enough to support the packing and also designed to collect the treated wastewater which is either sprayed by regularly-spaced nozzles or (more common) by rotating distribution arms (Figure V.10). The liquid percolates through the packing and the organic load is absorbed and degraded by the biomass while the liquid drains to the bottom where it is collected.

With regard to the packing over which the biomass grows, the void fraction and the specific surface area are important features: the first is necessary to ensure a good circulation of air and the second to accommodate as much biomass as possible to degrade the organic load of the wastewaters. Although initially more costly, the

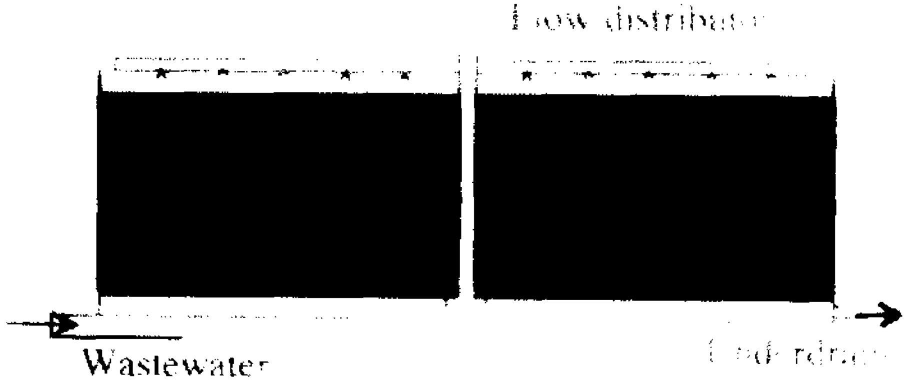


Figure V.10. Sketch of a trickling filter unit

synthetic packings have larger void space, larger specific area and are lighter. Usually, the air circulates naturally, but in some high-strength wastewaters forced ventilation is used. They can be used with or without recirculation of the liquid after the settling tank. The need for recirculation is dictated by the strength of the wastewater and the rate of oxygen transfer to the biomass. Typically, recirculation is used when the BOD_5 of the wastewater to be treated exceeds 500 mg/litre.

As with all biological systems, low temperatures reduce the degrading capacity of trickling filters. In cold areas trickling filters may be covered. The BOD_5 removal efficiency varies with the organic load imposed but usually fluctuates between 45 and 70% for a single-stage filter. Removal efficiencies of up to 90% can be achieved in two stages.

V 4.3.1.1.5 Roating biological contractors:

Rotating biological contractors (RBC) units are another form of attached growth processes. In RBC units the biomass is attached to disks (up to 3.5 m in diameter) which rotate at 1 to 3 rpm while immersed up to 40% in the wastewater .The disks are made of corrugated, light plastic material.

When exposed to air the attached biomass absorbs air and when immersed the microorganisms absorb the organic load. A biomass of 1-4 mm grows on the surface and its excess is teared off the disks by shearing forces and is separated from the liquid in the secondary settling tank. A small portion of the biomass remains suspended in the liquid within the basin and is also responsible in minor part for the organic load removal. Rotation speeds of more than 3 rpm are seldom used because this increases electric power consumption while the oxygen transfer does not increase sufficiently. The ratio of surface area of disks to liquid volume is typically 5 l/m^2. For high-strength wastewaters, more than one unit in series (staging) is used. The effect of lower temperatures is partially mitigated by the use of housing for the disk units. These systems are normally operated without recycling the liquid. The power consumption is in the order of 2 kW/1000 m^3/day of capacity. They have been used to upgrade activated sludge existing plants, placing the disk units in the aeration basins (Antonie, 1978).

V.4.3.1.1.6 Selection of aerobic treatments:

Several factors (apart from the economics) influence the choice of a particular aerobic treatment system. There is no universal solution and the decision of which system to use (or even if using an aerated system or not) depends on many aspects. Key factors are: the area available, which sometimes is the deciding aspect; the ability to operate intermittently is critical for several industries which do not operate in a continuous fashion or work only seasonally; the skill needed for operation of a particular treatment cannot be neglected; and finally the costs (both operating and initial investment) are also sometimes decisive. The following table-V.1 summarizes these factors when applied to aerobic treatment processes:

Table V.1. Factors affecting the choice of aerobic processes:

(a) OPERATING CHARACTERISTICS			
System	**Resistance to shock loads of organics or toxics**	**Sensitivity to intermittent operations**	**Degree of skill needed**
Lagoons	Maximum	Minimum	Minimum
Trickling filters	Moderate	Moderate	Moderate
Activated	Minimum	Maximum	Maximum
(b) COST CONSIDERATIONS			
System	**Land needed**	**Initial costs**	**Operating costs**
Lagoons	Maximum	Minimum	Minimum
Trickling filters	Moderate	Moderate	Moderate
Activated	Minimum	Maximum	Maximum

(Adapted from Rich, 1980.)

V.4.3.1.2 Anaerobic Treatment:

The anaerobic treatment of wastewater proceeds with degradation of the organic load to gaseous products (mainly methane and carbon dioxide) which constitute most of the reaction products and biomass. Anaerobic treatment is the result of several reactions: the organic load present in the wastewater is first converted to soluble organic material which in turn is consumed by acid producing bacteria to give volatile fatty acids, plus carbon dioxide and hydrogen. The methane producing bacteria consume these to produce methane and carbon dioxide. This is summarized in Figure V 11.These processes are reported to be better applied to high-strength wastewaters (e.g.. blood water or stick water).

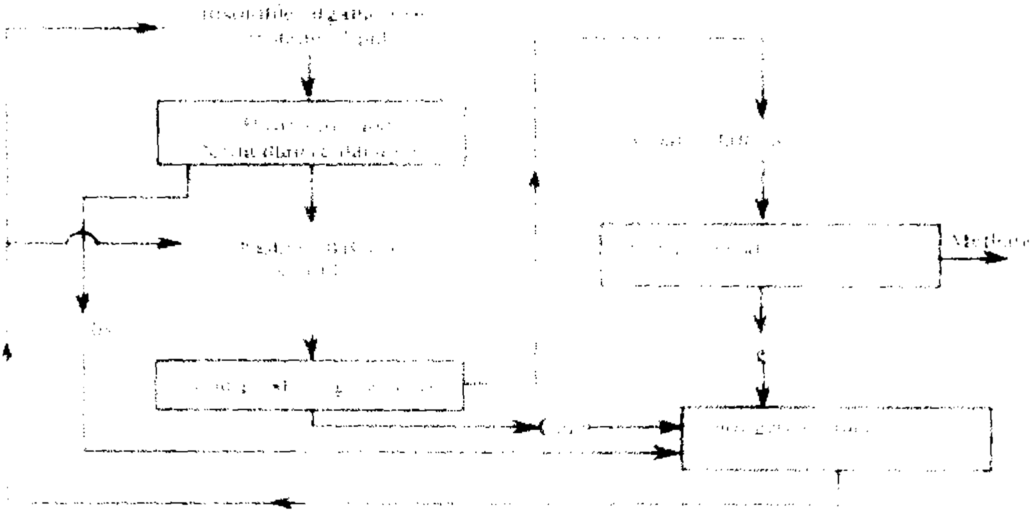


Figure V.11. Scheme of reactions produced during anaerobic treatment

V.4.4. Tertiary Treatment:

Tertiary treatment is only required when the final effluent must be so clean that 95% or more of the contaminants must be removed by wastewater treatment. In tertiary treatment, the concentrations of phosphorus or nitrogen are reduced through biological or chemical processes

Tertiary treatment may include

1. Filtration

2. Removal of Ammonia and other specific contaminants

3. Disinfection, to destroy bacteria which can cause disease in humans is done most commonly through chlorination. Sludge, the collection of solids that are removed during wastewater treatment, requires processing to reduce odor and water content. Depending on the disposal method, the sludge also may undergo treatment to decompose organic matter or kill disease-causing organisms.

V.5. Effluent treatment process at Mokamehghat tannery of Bata India Limited (Bihar):

Bata India's tannery at Mokamehghat (Bihar) is the largest tannery in the world wide Bata Shoe units and probably the single largest tannery on the Indian sub-continent. Daily input of hides in Mokamehghat average 2000-2500 pieces. Wet salted cow and buffalo hides are converted into leather using three different tanning systems- Chrome, Semi-chrome and Vegetable tanning.

After evaluation of the unsatisfactory performance of the treatment plants in several European and American tanneries, it was decided in 1986 to develop a new system of treatment of effluents. This avant-garde concept required implementation of several technical measures not common in combined effluent treatment plants.

The treatment concept and technology, as well as all in-plant actions, have been developed by the environmental team of Bata India in co-operation with the environmental division of M/s Greaves Cotton Ltd., Calcutta. The whole project was completed within 18 months and Commissioned in December 1988.

The effluent treatment plant of Bata at Mokamehghat, Bihar represents the new beginning in the treatment of tannery effluents. The "Segregation and Pretreatment" concept introduced in this plant for the first time in the Indian sub-continent, has proved to be effective and simple in management of pollutants such as Chromium, Sulphides, Organic solids, Polyphenols etc. The treatment concept of Bata Mokamehghat ETP has widely influenced the design and construction of several tannery effluent treatment plants in south India and elsewhere in the country. Equally important are the huge inplant actions implemented in this tannery for reduction of pollution at source. Innovation in this field includes the phasing out of chromium from Mokamehghat tannery.

The use of chromium compound has been halved substitued by environment friendly Al-tanning systems. In addition to core aspects of environmental management through strict monitoring of treatment facilities. Bata Tannery at Mokamehghat has constantly associated itself with mass communication programme, voluntary afforestation etc. involving its employees, overall Bata Tannery at Mokamehghat is now a zero discharge tanner

V.5.1 The design and functioning of the plant is based on the following principles:

a. Implementation of In-plant actions

b. Segregation and Equalization of Effluents

c. Pre-treatment of segregated effluents

d. Regulated mixing of pre-treated effluents

e. Primary treatment of combined effluent (Physical, Chemical)

f. Secondary treatment (Biological-Extended Aeration).

g. Dewatering. Utilization and Disposal of sludges.

Individual effluents have been directed into 5 different streams. screened and collected in a set of collection/equalizing tanks of 200-600 KL capacity each.

TYPE OF EFFLUENTS	MAIN POLLUTANTS	TREATMENT
Soak liquor	NaCl	Solar Evaporation
Lime Liquor	Lime, Na_2S	Catalytic oxidation of S
Chrome Liquors	Cr^{3+} salt	Precipitation as $Cr(OH)_3$
Vegetable Tanning Liquors	Vegetable and Synthetic Tannins	Absorption of Cr and Al Hydroxide
Unpolluted water	Light Mechanical impurities	Re use

Pre-treatment of soak and Lime Liquors start in Equalizing tanks

V.5.2. Pre-treatment & treatment systems:

Mechanical removal of salt:

NaCl is commonly used as preservative for storing cow and buffalo hides. The amount of loose salt in hide varies between 12-18% of raw hide weight (upto 3 kg/hide). NaCl is strong pollutant and is highly persistent due to its easy solubilty. In Mokamehghat mechanical drumming of raw hides has been introduced just before soaking, whereby the entry of avoidable NaCl in effluent is prevented.

Soak Liquor:

Soak liquor from the collection pits are pumped directly to a series of solar evaporation ponds for drying and the salt reclaimed. However, mechanical removal of salt from hides before soaking, processing of "Green Hides" are more advantageous.

Lime Liquor:

The segregated lime liquor from collection tanks is subjected to catalytic oxidation at three different stages to eliminate sulphides. By proper adjustment of Manganous Sulphate ($MnSO_4.4H_2O$) dosage, it is ensured that the free Sulphide in the lime liquor emerging after the tertiary oxidation stage is always less than 2 mg/l. The Sulphide free lime liquor mixes with the chrome liquor stream and collects in the lime chrome clarifier for further treatment.

Chrome Liquor:

The chrome liquor from the collection pits is pumped directly to lime chrome clarifier through flash mixer I. The trivalent chromium metal present in the chrome liquor is best eliminated as its hydroxide at an alkaline pH of 8.5 - 9.0. The sulphide free lime liquor fraction (pH 9 - 11) of the waste is usefully utilized to increase the pH of the acidic chrome liquor to the desired level in the lime chrome clarifier. Inorganic coagulants are added in the flash mixer I for solid settlement. Around 25 - 30% of suspended solid reduction can be expected in lime chrome clarifier. The overflow of partially treated lime chrome liquor flows to flash mixture II.

Vegetable Tan Liquor:

The vegetable tan liquor from the collection pits are pumped to flash mixer II, where it mixes with the partially treated lime chrome combined liquor. The vegetable tan liquor fraction is the strongest in terms of organic solids. A stronger dosage of alum added in flash mixer II combined with bentonite helps in substantial separation of solids from the waste water and considerable absorption of dissolved polyphenols on the active surface of hydroxide follicles. 30 – 35% of suspended solid reduction is possible in the main clarifier. The overflow of the combined liquor is then taken for biological treatment

Biological Treatment:

Dissolved, colloidal and sizeable fraction of suspended organic solid can be best removed by micro-organisms in anaerobic or aerobic conditions. Any complex system without biological treatment is therefore, in-complete. Among over 15 varieties of oxidation systems available, "Extended Aeration – Activated sludge system" has been selected, as it is less space consuming with proven efficiency.

The process mainly consists of bringing chemically conditioned tannery effluents into intimate contact with air and biologically active sludge. Pair of compressors each of 50 H.P. supplies diffused air to the system. The light and flocculent sludge oxidise organic matter both in suspension and solution. As the sludge moves rapidly through the effluent it absorbs suspended and colloidal matter from the waste. The activated sludge is a light brown flocculant material whose gelatinous portion contains many filamentous and unicellular bacteria and whose mass teem with ciliated protozoans and some metazoans. Along with aerobic and facultative bacteria these organisms ingest and assimilate the organic matter of the effluent. thereby, the organic matter (colloidal, dissolved, suspended) is greatly removed.

The overflow from the aeration tank is settled in secondary clarifier for over 5 hours. Unlike in the lime chrome and main clarifier, biological sludge is collected at the bottom of the secondary clarifier. As the sludge contains useful micro-organisms, it is returned back to aeration tank depending on the need.

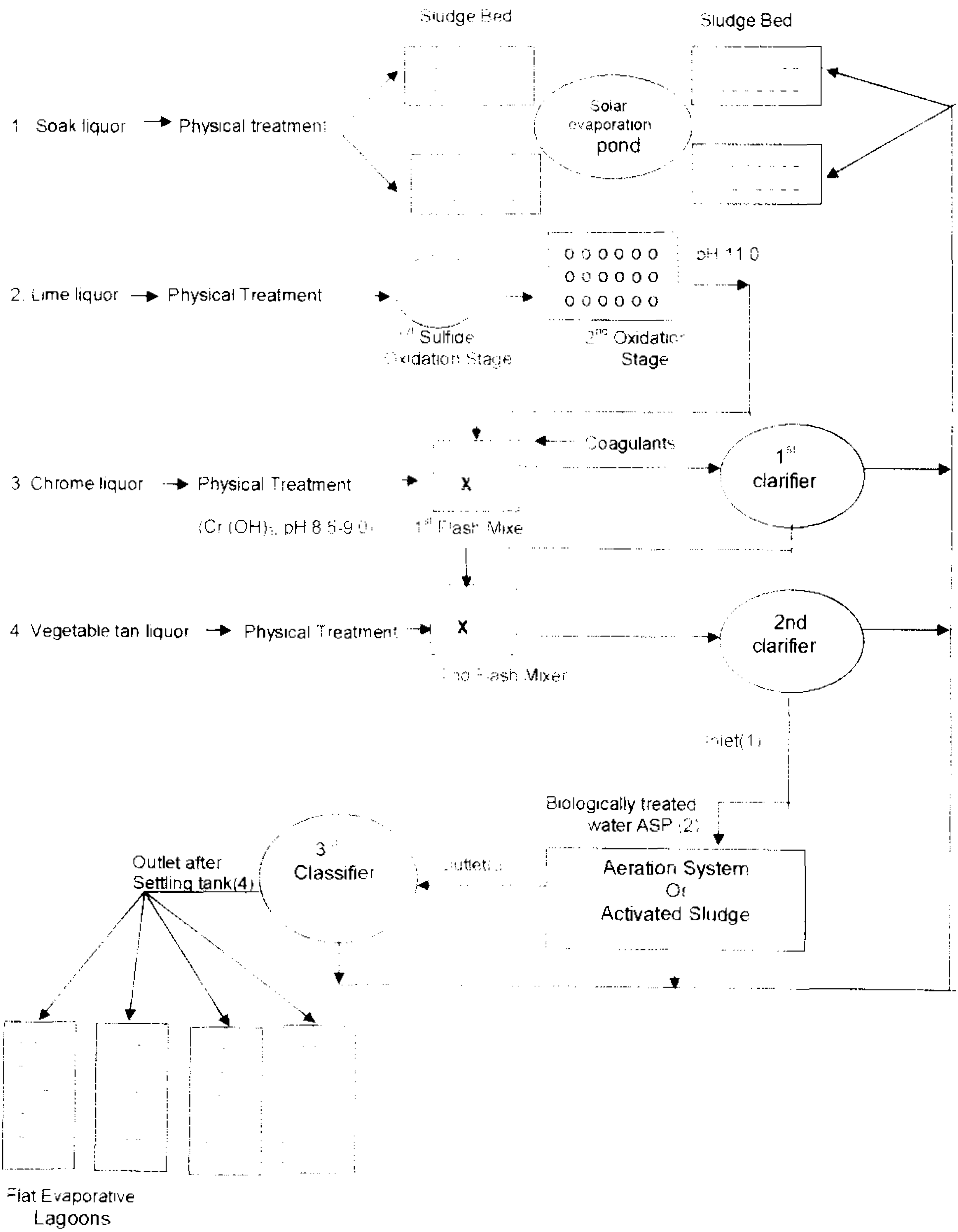
Final disposal:

The overflow from the secondary clarifier is the final tested effluent. With such an extensive treatment that the effluent is subjected to, the values of different parameters in the treated effluent is always within the statutory specifications.

V.5.3 Zero discharge system:

The latest & very important part of our Mokamehghat project is the installation of the "zero discharge system". It is a system in which not any single amount of treated amount is discharged on the bed of the Ganga. The total water is collected in a reservoir of 30 M x 30 M x 2 M from the final clarifier. Then with the help of pump the water from the reservoir is sprinkled on the adjacent "Power Field" and on all the trees and plants in the factory and residential colony.

FIG.V.12. Flow Diagram of E.T.P. at Mokamehghat (MKG)



CENTRAL VIEW OF E.T.P. PLANT – BATA INDIA LTD. MOKAMEHGHAT