Wastewater Treatment in Textile, Tanneries and Electroplating Industries especially by Activated Sludge Method- A technical report

Muhammad Irfan,

Abstract

Our biosphere is under constant threat from continuing environmental pollution. Impact on its atmosphere, hydrosphere and lithosphere by anthropogenic activities can not be ignored. Man made activities on water by domestic, industrial, agriculture, shipping, radio-active, aquaculture wastes; on air by industrial pollutants, mobile combustion, burning of fuels, agricultural activities, ionization radiation, cosmic radiation, suspended particulate matter; and on land by domestic wastes, industrial waste, agricultural chemicals and fertilizers, acid rain, animal waste have negative influence over biotic and abiotic components on different natural eco-systems. In recent years, different approaches have been discussed to tackle man made environmental hazards. Clean technology, eco-mark and green chemistry are some of the most highlighted practices in preventing and or reducing the adverse effect on our surroundings. Textile sector has its very high contribution in Pakistan export. There are too man tanneries well as in different cities of Pakistan making involvement to country economy. The aim with this report is to describe wastewater treatment technologies used in textile, tanneries & electroplating industries especially by activated sludge process. This process is based on the aeration of wastewater with flocculating biological growth, followed by separation of treated wastewater from this growth. Part of this growth is then wasted, and the remainder is returned to the system.

Introduction

According to currently updated official figures, the Pakistan textile industry contributes more than 60 per cent to the country's total exports, which amounts to around 5.2 billion US dollars. The industry contributes around 46 per cent to the total output produced in the country. In Asia, Pakistan is the 8th largest exporter of textile products. The contribution of this industry to the total GDP is 8.5 per cent. It provides employment to 38 per cent of the work force in the country, which amounts to a figure of 15 million. However, the proportion of skilled labour is very less as compared to that of unskilled labour. All Pakistan Textile Mills Association is the chief organization that determines the rules and regulations in the Pakistan textile industry[1].

imilarly there are lot of tanneries and electroplating industries in different cities of Pakistan. According to the Leather Industry Development Organization, There are more than five hundereds tanneries in big cities of Pakistan including Karachi, Lahore, Multan, Kasur, Faisalabad, Peshawar, Gujranwala, and Sialkot,

**Institute of Chemical Engineering, University of the Punjab Lahore, Pakistan,*
[1] *Corresponding author:* ddfc.northbd@ddfcgroup.com

with the majority of leather production taking place in medium size tanneries. The leather tanning industry produces about 6 million hides and 36 million skins annually.

Unfortunately most of these industries have absence of any waste water treatment plant to treat their effluents. Yet there are some limited companies having WWT plants based on different technologies but more of these are using activated sludge method due to its ease operation.

All of these comapnies use domestic wastewater for a fixed charge dependant upon the volume of water discharged. However, when water is to be used as part of a process, the cost for discharging the wastewater will vary dependant upon volume and quantity of the contaminants, within the water. The main objective and calcuation are used to calculate the cost per cubic meter of wastewater discharged. Pollution & hydulic laod both effect the degree of your wastewater contaminants, and change the cost per cubic meter for discharge [2].

Need for Industrial Waste Water Treatment Plants

Industry always makes their efforts to treat their generated effluent at the possible lowest cost, which may necessitate considerable study, research, and pilot investigations. Planning ahead will provide time to make appropriate decisions.

The public approach toward pollution control, which bordered on apathy during the first half of the twentieth century, has undergone drastic change in the early 1970s as part of the surge in public concern for the quality of the environment. Sincere public concern will be required over a long period of time to make the necessary changes in society to bring about significant improvements in our environment. Major changes in our political, social, legal, and economic approaches to pollution control will be required and therefore much more than clever technological advances will be needed [3].

.

To avoid any health risk cause by discharging wastewater to water streams and canals, the wastewater must be treated. Such treatment should comply with the terms of the legislation defining the characteristics of the effluent discharging in water streams. There are many standards such as NEQ's, Levis, WB and Nike which describe the treated water parameter which should be met by all these industries. The concept of planning and development should be based on the criteria to protect land, water resources, aquatic life in streams and rivers and marine life from pollution and to safeguard public health as a high priority. The environmental inspection conducted by diffrent enveiormental lobbies on wastewater treatment plants aims to support and strengthen the Protection of both the environment and the public health.

Most of textile industries have export orienteated business. They could have better enviremtnal system to attract their export's customer for their product marketing. During my meeting with CEO of one of the textile industry, he pointed that we are planning to use this waste water in a fishpond after treating it so that we could be able to put a significant message to our export customers that we have very good enviromental system and our waste water is not creating any health hazards to living bodies. This will enable us to fascinate our export customers and in this way indirectly improve our marketing strategies to cater future business orders.

Effluent characteristics

Characteristics of Effluent water in Textile industries.

As discussed textile sector is putting enormous impact on Pakistan economy yet this industry is currently facing several challenges. Out of various activities in textile industry, chemical processing contributes about 70% of pollution. It is well known that cotton mills consume large volume of water for various processes such as sizing, desizing, and scouring, bleaching, mercerization, dyeing, printing, finishing and ultimately washing. In fact, in a practical estimate, it has been found that 45% material in preparatory processing, 33% in dyeing and 22% are re-processed in finishing [4]. But where is the real problem? The fact is that the effluent generated in different steps is well beyond the standard and thus it is highly polluted and dangerous. This is demonstrated in Table 1.

Table 1: Properties of Waste Water from Textile Chemical Processing

Property	Standard	Cotton	Synthetic	Wool
Ph	5.5-9.0	8.0-12.0	7.0-9.0	3.0-10.0
BOD, mg/l, 5 days	30-350	150-750	150-200	5000-8000
COD, mg/l, day	250	200-2400	400-650	10000-20000
TDS	2100	2100-7700	1060-1080	10000-13000

Characteristics of Effluent water in Tanneries.

Tanning industries is growing very sharply in Pakistan but some Pakistani exports of tanned leather are on the increase following a decline of leather production in the developed world due to more stringent environmental controls. The increase of tanneries in Pakistan is causing severe environmental degradation as the untreated effluent used in the tanning process is released into nearby water reservoirs and the sea. Most of tanning industries are discharging Cr ion in their effluent which is highly carcinogenic element both for aquatic life as well as human being. In addition, air pollution is on the rise with the tanneries burning residuals (i.e. hair) from the tanning process into the atmosphere. Due to a need for foreign exchange, the national government is encouraging the growth of tanneries by offering these industries export rebates while at the same time lagging on implementing the sparse existing governmental environment regulations in leather tanning. The combination of an increasing demand for the product and a lack of government regulation are exacerbating whatever fragile balance existed between the Pakistani leather trade and the environment.

.

A one noted Pakistani news journalist [5] commented, "The tanning industry is notorious for its heavy pollution through effluents containing organic and inorganic matter, dissolved and suspended solids, accompanied by requirements of high oxygenic demand and having toxic metal salt residues...these tanneries discharge effluents without any treatment into water reservoirs and the sea."

The primary pollutants that leather tanning in Pakistan creates are heavy metals (chromium, cadmium, etc.), various organic chemicals, and acids. The sample of tannery effluent contained .30 copper milligrams per liter, .15 cadmium milligrams per liter, 7 zinc milligrams per liter, 1.14 nickel milligrams per liter, and 1.8 lead milligrams per liter [6]. These levels were almost all well above the suggested standard for toxic substance concentrations in effluent. Very few of the tanneries have any type of waste treatment facility and this runoff is released into the nearest drain (most likely an open one) or body of water such as the sea or a river. The effluent is uncontrolled by any process treatment, waste recycling, or end-of-pipe treatment.

Characteristics of Effluent water in electroplating industries.

The role of the electroplating industry toward environment is almost the same as textile & tanneries effluent as it is discharging indiscriminately in to the environment with out proper treatment. This poses havoc to the water body, which could be seen in the physiology and biochemistry of the chosen fish, Oreochromis mossambicus. The metals strongly present in the electroplating effluent is chromium and nickel which is being tested individually and collectively to assess its toxic nature. The intensity of the toxicity of synergetic action of these metals is much stronger than individual effect. The result is being noticed in feeding budget and respiratory physiology of the fish, Oreochromis mossambicus. A serious threat is observed in the environment by these metals and a proper treatment is suggested before releasing into the environment. There are different processes used in electroplating industries including Anodizing process, Nickel/ Brass plating & combination of both of these [7]. The effluent discharged by these processes contain heavy metal such Ni, Cr, Cu etc. and also contain Ca & Mg due to use of hard water. Characteristics parameters of these effluents are given in Table 2.

Table: 2 Effluent Characteristics of different processes in electroplating industries.

	Anodizing Process	Nickel /Brass/Plating Process	Anodizing+ Nickel/Brass/Plating Process
Ph	1.4-3.0	1.4-3.0	1.4-3.0
Colour	200 NTU	200 NTU	200 NTU
Oil	20 ppm	30 ppm	80 ppm
Metal Part	Grit	Grit	Grit
Metal Ions	Al. Cr, Ca, Mg	Cu, Cr. Fe, Zn, Ca, Mg	Cu, Fe, Zn, Cr, Ca, Mg
Conc.	300 ppm	300 ppm	350 ppm
Non metallic ions	Cl, SO4, PO4	Cl, SO4, PO4, CN	Cl, SO4, PO4, CN

Wastewater Treatment Methods

Satisfactory disposal of wastewater, whether by surface, subsurface methods or dilution, is dependent on its treatment prior to disposal. Adequate treatment is necessary to prevent contamination of receiving waters to a degree which might interfere with their best or intended use, whether it be for water supply, recreation, or any other required purpose.

Wastewater treatment consists of applying known technology to improve or upgrade the quality of a wastewater. Usually wastewater treatment will involve collecting the wastewater in a central, segregated location (the Wastewater Treatment Plant) and subjecting the wastewater to various treatment processes. Most often, since large volumes of wastewater are involved, treatment processes are carried out on continuously flowing wastewaters (continuous flow or "open" systems) rather than as "batch" or a series of periodic treatment processes in which treatment is carried out on parcels or "batches" of wastewaters. While most wastewater treatment processes are continuous flow, certain operations, such as vacuum filtration, involving as it does storage of sludge, the addition of chemicals, filtration and removal or disposal of the treated sludge, are routinely handled as periodic batch operations.

Wastewater treatment, however, can also be organized or categorized by the nature of the treatment process operation being used; for example, physical, chemical or biological.

.

Examples of these treatment steps are shown below. A complete treatment system may consist of the application of a number of physical, chemical and biological processes to the wastewater.

Some Physical, Chemical and Biological Wastewater Treatment Methods

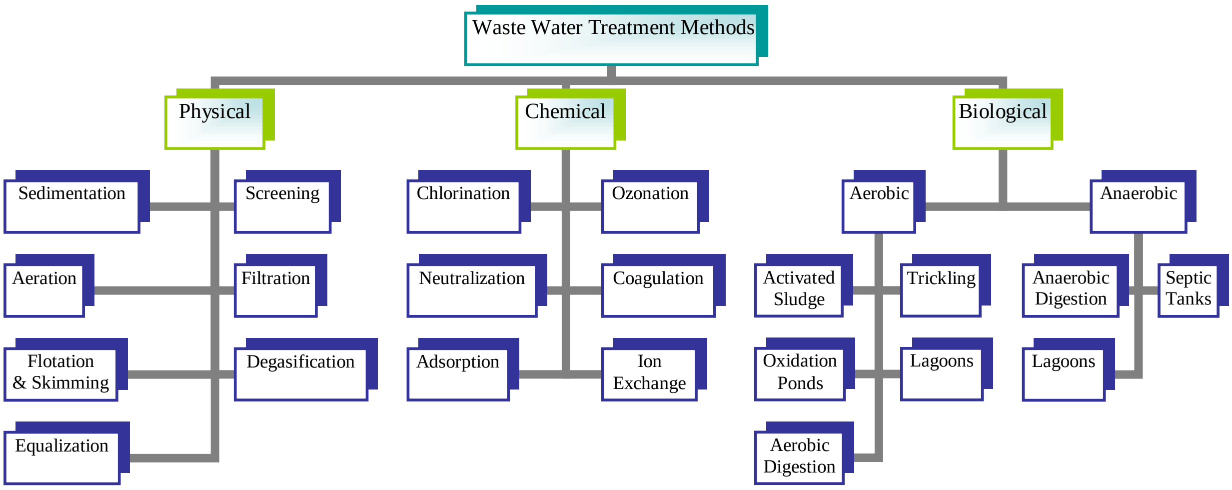

Fig. 1: Waste Water Treatment methods

Unit Operations

Treatment methods in which the application of physical forces predominates are known as physical unit operations. Because most of these methods evolved directly from man's first observations of nature, they were the first to be used for wastewater treatment. Screening, mixing, flocculation, sedimentation, flotation, filtration, and gas transfer are typical unit operations [8].

Physical methods include processes where no gross chemical or biological changes are carried out and strictly physical phenomena are used to improve or treat the wastewater. Examples would be coarse screening to remove larger entrained objects and sedimentation (or clarification). In the process of sedimentation, physical phenomena relating to the settling of solids by gravity are allowed to operate. Usually this consists of simply holding a wastewater for a short period of time in a tank under quiescent conditions, allowing the heavier solids to settle, and removing the "clarified" effluent. Sedimentation for solids separation is a very common process operation and is routinely employed at the beginning and end of wastewater treatment operations. While sedimentation is one of the most common physical treatment processes that is used to achieve treatment, another physical treatment process consists of aeration -- that is, physically adding air, usually to provide oxygen to the wastewater. Still other physical phenomena used in treatment consist of filtration. Here wastewater is passed through a filter medium to separate solids. An example would be the use of sand filters to further remove entrained solids from a treated wastewater.

.

Unit Processes

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.

Chemical treatment consists of using some chemical reaction or reactions to improve the water quality. Probably the most commonly used chemical process is chlorination. Chlorine, a strong oxidizing chemical, is used to kill bacteria and to slow down the rate of decomposition of the wastewater. Bacterial kill is achieved when vital biological processes are affected by the chlorine. Another strong oxidizing agent that has also been used as an oxidizing disinfectant is ozone.

A chemical process commonly used in many industrial wastewater treatment operations is neutralization. Neutralization consists of the addition of acid or base to adjust pH levels back to neutrality. Since lime is a base it is sometimes used in the neutralization of acid wastes.

Coagulation consists of the addition of a chemical that, through a chemical reaction, forms an insoluble end product that serves to remove substances from the wastewater. Polyvalent metals are commonly used as coagulating chemicals in wastewater treatment and typical coagulants would include lime (that can also be used in neutralization), certain iron containing compounds (such as ferric chloride or ferric sulfate) and alum (aluminum sulfate).

.

Certain processes may actually be physical and chemical in nature. The use of activated carbon to "adsorb" or remove organics, for example, involves both chemical and physical processes. Processes such as ion exchange, which involves exchanging certain ions for others, are not used to any great extent in wastewater treatment.

Biological Processes

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) from 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 & phosphorus) from wastewater. With proper environmental control, wastewater can be treated biologically in most cases.

Biological treatment methods use microorganisms, mostly bacteria, in the biochemical decomposition of wastewaters to stable end products. More microorganisms, or sludge's, are formed and a portion of the waste is converted to carbon dioxide, water and other end products. Generally, biological treatment methods can be divided into aerobic and anaerobic methods, based on availability of dissolved oxygen.

Steps involved in Waste water treatment

The purpose of wastewater treatment is generally to remove from the wastewater enough solids to permit the remainder to be discharged to receiving water without interfering with its best or proper use. The solids which are removed are primarily organic but may also include inorganic solids [9]. Treatment must also be provided for the solids and liquids which are removed as sludge. Finally, treatment to control odors, to retard biological activity, or destroy pathogenic organisms may also be needed. The typical waster water treatment plant is designed to achieve many different purposes, which are

- Protect public health
- Protect public water supplies
- Protect aquatic life
- Preserves the best use of water
- Protect adjacent land

Waste water treatment is series of steps. Each of steps can be accomplished using one or more treatment process or types of equipments. While the devices used in wastewater treatment are numerous and will probably combine physical, chemical and biological methods. The major categories of treatment steps are illustrated in Fig.2

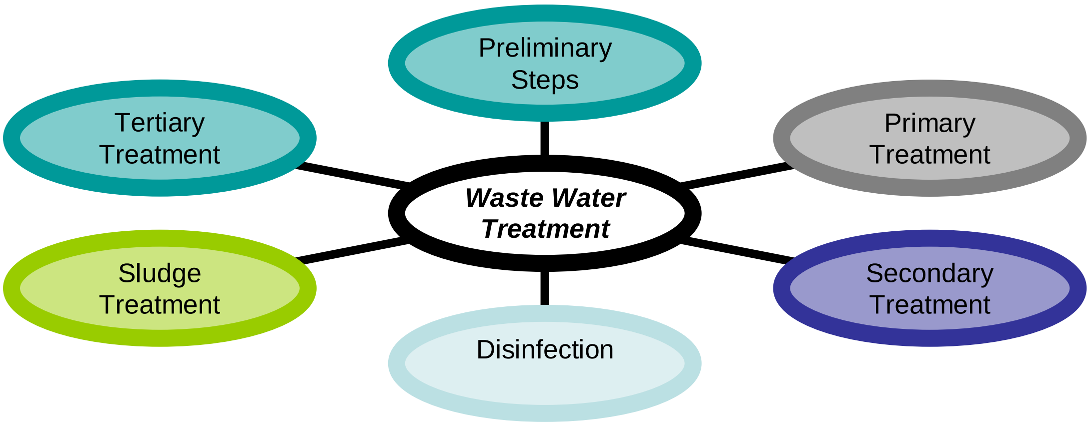

Fig 2: Steps used in Waste Water Treatment

Degrees of treatment are sometimes indicated by use of the terms primary, secondary and tertiary treatment. Tertiary treatment, properly, would be any treatment added onto or following secondary treatment.

Preliminary Treatment

At most plants preliminary treatment is used to protect pumping equipment and facilitate subsequent treatment processes. Preliminary devices are designed to remove or cut up the larger suspended and floating solids, to remove the heavy inorganic solids, and to remove excessive amounts of oils or greases.

To affect the objectives of preliminary treatment, the following devices are commonly used:

.

1. Screens -- rack, bar or fine
2. Comminuting devices -- grinders, cutters, shredders
3. Grit chambers
4. Pre-aeration tanks

In addition to the above, chlorination may be used in preliminary treatment. Since chlorination may be used at all stages in treatment, it is considered to be a method by itself. Preliminary treatment devices require careful design and operation.

Primary Treatment

In this treatment, most of the settle able solids are separated or removed from the wastewater by the physical process of sedimentation. When certain chemicals are used with primary sedimentation tanks, some of the colloidal solids are also removed. Biological activity of the wastewater in primary treatment is of negligible importance.

The purpose of primary treatment is to reduce the velocity of the wastewater sufficiently to permit solids to settle and floatable material to surface. Therefore, primary devices may consist of settling tanks, clarifiers or sedimentation tanks. Because of variations in design, operation, and application, settling tanks can be divided into four general groups:

1. Septic tanks
2. Two story tanks -- Imhoff and several proprietary or patented units
3. Plain sedimentation tank with mechanical sludge removal
4. Upward flow clarifiers with mechanical sludge removal

Dissolved Air Flotation System

Usually in these sector including textile, tanneries & electroplating and many other similar industries, DAF System is preferably used for primary treatment to remove the contaminant load.

4.2.1 Primary Settling Tanks - The oldest and most widely used form of water and wastewater treatment uses gravity settling to remove particles from water. The shape of the tanks can be round, square or rectangular. Sedimentation takes place in the primary settling tanks and is relatively simple and inexpensive. Particulates suspended in surface water can range in size from 10-1 to 10-7 mm in diameter, the size of fine sand and small clay respectively. Turbidity or cloudiness in water is caused by those particles larger than 10-4 mm, while particles smaller than 10-4 mm contribute to the water's color and taste. Such very small particles may be considered for treatment purposes, to be dissolved rather than particulate.

Water containing particulate matter flows slowly through a sedimentation tank and is thus detained long enough for the larger particles to settle to the bottom before the clarified water leaves the tank over a weir at the outlet end. Particles that have settled to the bottom of the tank are removed manually or by mechanical scrapers on the site pending their treatment and/or removal. Detention time is typically 3 h in tanks 3 to 5m (10 to 15 ft) deep.

Dissolved air Flotation:

Dissolved Air Flotation (DAF) is a water treatment process that clarifies wastewaters (or other waters) by the removal of suspended matter such as oil or solids. The removal is achieved by dissolving air in the water or wastewater under pressure and then releasing the air at atmospheric pressure in a flotation tank or basin. The released air forms tiny bubbles which adhere to the suspended matter causing the suspended matter to float to the surface of the water where it may then be removed by a skimming device [10, 11, 12]. Dissolved Air Floatation (DAF) technology has been frequently used to float contaminates from wastewater. This flotation system is well-suited for the removal of light solids such as oils, fibers, proteins, starches, blood, inks, dyes, and other substances which do not settle well by gravity. Air is dissolved into a recycled portion of the treated water flow and is mixed with the untreated water entering the flotation cell. As the air comes out of solution, it forms sub-micron bubbles which attach themselves to the suspended solids and oils. These solids float to the surface where a simple, single shaft skimmer removes them for further processing or disposal.

4.2.3 Process description: The feed water is to the DAF float tank is often (but not always) dosed with a coagulant (such as ferric chloride or aluminum sulfate) to flocculate the suspended matter.

.

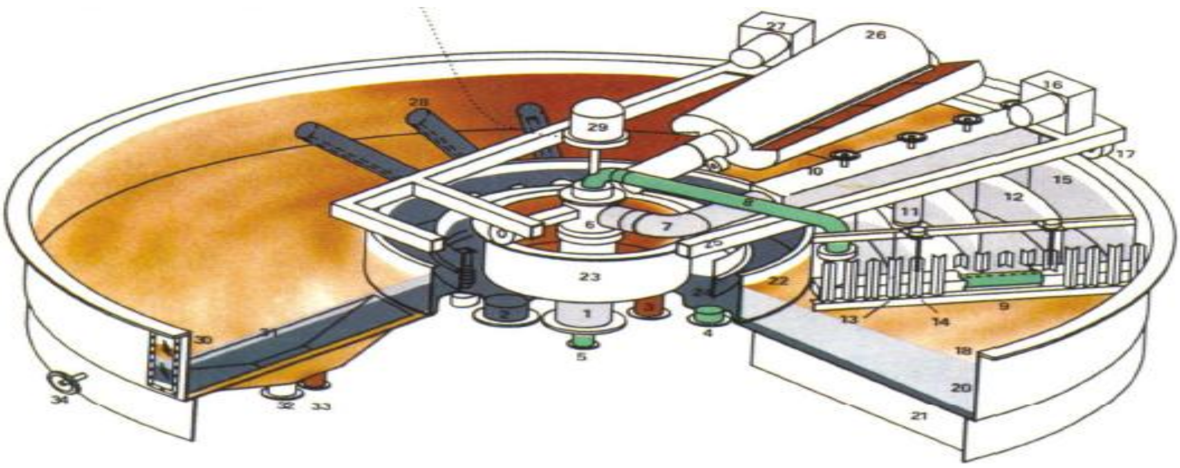

Fig. 3 Layout diagram of DAF Unit

A portion of the clarified effluent water leaving the DAF tank is pumped into a small pressure vessel (called the air drum) into which compressed air is also introduced. This results in saturating the pressurized effluent water with air. The air-saturated water stream is recycled to the front of the float tank and flows through a pressure reduction valve just as it enters the front of the float tank, which results in the air being released in the form of tiny bubbles. The bubbles adhere to the suspended matter, causing the suspended mater to float to the surface and form a froth layer which is then removed by a skimmer. The froth-free water exits the float tank as the clarified effluent from the DAF unit [13]. A layout of DAF unit is also illustrated in fig [8A].

Advantages of DAF

- Efficient at removing particles and turbidity resulting in more economical filter designs
- Allow for short detention times (5-10 min) in flocculation tanks
- Can use higher hydraulic loading rates than most settling processes
- More efficient at removing floc particles than most settling processes

.

- More efficient than sedimentation in removing low-density floc formed from coagulation of TOC
- Allows for lower coagulant dosages resulting in smaller chemical storage and less sludge
- Smaller footprints with stacked flotation over filtration arrangement
- Improved algae removal and cold water performance
- Less sensitive to flow variations
- Process flexibility through air loading

4.2.5 Aeration Tanks - The waste water flows into an aeration tank as hown as in fig. 4 & 5. It consists of chamber usually constructed of steel, poly, fiberglass, or concrete. The aeration chamber normally provides 6 to 24 hours retention time for the waste water. The contents of the aeration tank are referred to as mixed liquor, and the solids are called mixed liquor suspended solids (MLSS). The latter includes inert material as well as living and dead microbial cells. In the aeration tank, microorganisms are kept in suspension for 4 to 8 hours by mechanical mixers and/or diffused air, and their concentration in the tank is maintained by the continuous return of the settled biological floc from a secondary settling tank to the aeration tank.

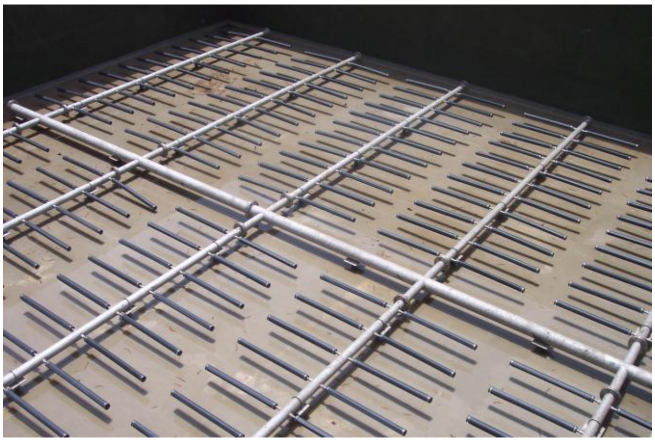

Fig. 4 Empty Aeration tank (Air diffuser pipes)

Fig. 5 Filled Aeration tank

When chemicals are used, other auxiliary units are employed. These are:

1. Chemical feed units
2. Mixing devices
3. Flocculators

The results obtained by primary treatment, together with anaerobic sludge digestion as described later, are such that they can be compared with the zone of degradation in stream self-purification. The use of chlorine with primary treatment is discussed under the section on Preliminary Treatment.

Secondary Treatment

Secondary treatment depends primarily upon aerobic organisms which biochemically decompose the organic solids to inorganic or stable organic solids. It is comparable to the zone of recovery in the self-purification of a stream.

The devices used in secondary treatment may be divided into four groups:

1. Trickling filters with secondary settling tanks
2. Activated sludge and modifications with final settling tanks
3. Intermittent sand filters
4. Stabilization ponds

Most of industries in Pakistan are using activated sludge process for secondary treatment as described below

The Activated Sludge Process

Definition of the process: In general, the activated sludge process is a continuous or semi continuous (fill and draw) aerobic method for biological wastewater treatment, including carbonaceous oxidation and nitrification. This process is based on the aeration of wastewater with flocculating biological growth, followed by separation of treated wastewater from this growth. Part of this growth is then wasted, and the remainder is returned to the system. Usually, the separation of the growth from the treated wastewater is performed by settling (gravity separation) but it may also be done by flotation and other methods. In Pakistan, numbers of industries are using this technique for waste water treatment and these types of plants are running very successfully to meet the environmental standards. There are some necessary conditions for activated sludge treatment process which are mentioned in Table 03.

Advantages

- Diverse; can be used for one household up a huge plant
- Removes organics
- Oxidation and Nitrification achieved
- Biological nitrification without adding chemicals
- Biological Phosphorus removal
- Solids/ Liquids separation
- Stabilization of sludge
- Capable of removing ~ 97% of suspended solids
- The most widely used wastewater treatment process

Disadvantages

- Does not remove color from industrial wastes and may increase the color through formation of highly colored intermediates through oxidation
- Does not remove nutrients, tertiary treatment is necessary
- Problem of getting well settled sludge
- Recycle biomass keeps high biomass keeps high biomass concentration in aeration tanks allowing it to be performed in technologically acceptable detention times

Compact Treatment Plant

i) Construction

CTP unit is composed of a circular outer shell and concentric inner tank. The outer tank acts as an aeration tank, while the inner one acts as Settlement Tank.

A baffle wall in the annulus space of each CTP unit is provided to ensure that the influent completes the full circle before being admitted into the inner settlement tank via specially designed pipe work. An overview of CPT which is installed in ICI with capacity of 25.92 m^3/ hr is also illustrated in Fig. 1.

ii) Treatment Process

Each CTP unit provides the requisite treatment in a single compact unit. The effluents from balancing tank enter into the aeration tank of each CTP unit. After taking sufficient air by completing the full circle of aeration tank, the aerated effluent discharges into a Stilling Well hung by the overhead walkway of each CTP unit settlement tank. The downward flow of each CTP unit stilling well settles down the heavier sludge particles while clear water overflows into specially constructed channel via V- Notched circumferential weir plate.

To assist in flocculation, polymer would be added in Aeration zone of each CTP. For this purpose, polymer suspension would be prepared in 02 No. HDPE tanks equipped with manually driven agitator and 02 Nos. polymer dosing pumps located at Aeration zone of each CTP unit.

The settled sludge is recycled from each CTP Settlement Tank to each CTP Aeration zone by means of specially designed air lifts system. Also a slow speed scraper agitator is installed in the Settlement Tank in order to scrap & divert the surplus settled sludge in the central sludge well of each CTP unit. Surplus sludge is expelled outwards via buried pipe at the bottom of each CTP unit.

iii) Aeration for Oxygen Supply

The soluble organic matter is removed by biological treatment. Biomass converts organic matter into water, carbon dioxide and new biomass with the addition of oxygen. For this purpose the aeration is carried out by means of positive displacement air blowers.

Air header, drop pipes equipped with valves and coarse bubble diffusers are installed to provide necessary quantity of air required for oxygen dissolution [8].

.

Fig. 6 Compact Treatment Plant at ICI, (Capacity 25.92 M3/Hr.) CTP UNIT [8]

Microorganisms in the Activated Sludge Process [14]

- The activated sludge process is a treatment technique in which wastewater and reused biological sludge full of living microorganisms is mixed and aerated.
- The biological solids are then separated from the treated wastewater in a clarifier and returned to the aeration process or wasted.
- The microorganisms are mixed thoroughly with the incoming organic as food. As they grow and are mixed with air, the individual organisms clump together (flocculate). Once flocculated, they more readily settle in the secondary clarifier.
- The activated sludge is constantly growing and more is produced that can be returned for use in the aeration basin. Some of this sludge must, therefore be wasted to a sludge handling system for treatment and disposal.
- The volume of sludge returned to the aeration basins is normally 40 to 60 percent of the wastewater flow; the rest is wasted.

.

- A fixed growth of microorganisms develops on synthetic media similar to trickling filters. By means of sludge recalculation, a population of suspended growth microbes is developed in addition to the fixed growth on the media.

Chlorination

This is a method of treatment which has been employed for many purposes in all stages in wastewater treatment, and even prior to preliminary treatment. It involves the application of chlorine to the wastewater for the following purposes:

1. Disinfection or destruction of pathogenic organisms
2. Prevention of wastewater decomposition –
   (a) odor control, and
   (b) protection of plant structures

While chlorination has been commonly used over the years, especially for disinfection, other methods to achieve disinfection as well as to achieve similar treatment ends are also used. Among the most common is the use of ozone. In view of the toxicity of chlorine and chlorinated compounds for fish as well as other living forms, ozonation may be more commonly used in the future.

Sludge Treatment

The solids removed from wastewater in both primary and secondary treatment units, together with the water removed with them, constitute wastewater sludge. It is generally necessary to subject sludge to some treatment to prepare or condition it for ultimate disposal. Such treatment has two objectives -- the removal of part or all of the water in the sludge to reduce its volume, and the decomposition of the putrescible organic solids to mineral solids or to relatively stable organic solids. This is accomplished by a combination of two or more of the following methods:

1. Thickening
2. Digestion with or without heat
3. Drying on sand bed -- open or covered
4. Conditioning with chemicals
5. Elutriation
6. Vacuum filtration
7. Heat drying
8. Incineration
9. Wet oxidation
10. Centrifuging

Operational Cost

OPERATIONAL COST (For Flow rate of 100 M^3/hr)*

a- ELECTRIC LOAD & CONSUMPTION PER DAY

Sr. #	Description	No. of units	Working / Assist	standby	Load of each Unit (kWh)	Total connected load (kWh)	Operational Load (kWh)	Working Hrs./Day	Total consumption (kW/day)
1	Air Blowers	2	2	0	160	320	272	24	6,528.00
2	pump for DAF unit	1	1	0	11.25	11.25	9.56	24	229.50
3	Effluent transfer pumps for Reception Sump to DAF	2	2	0	11.25	22.5	9.56	24	229.50
4	Sludge disposal pump	2	2	0	3.75	7.5	6.38	24	153.00
5	Polymer dosing pumps	3	3	0	0.25	0.75	0.43	24	10.20
6	Acid dosing pump	2	2	0	0.25	0.5	0.21	24	5.10
7	Refurbished geared motor for Clarifier	1	1	0	0.55	0.55	0.94	24	22.44
						363.05	**299.07**		**7,177.74**

NOTE:

1 Power consumption may vary ± 10%

2 Estimated power absorption for each unit is 85% approx.

3 * To be used occasionally

.

b- **Chemicals consumption & cost per day**

S.No.	Chemicals	Qty./day (kg)	Rate/kg (Rs.)	Cost/ day (Rs.)
1	Urea	100	21	2,100
2	DAP	35	63	2,205
3	Sulphuric Acid	350	7	2,450
4	Polymer	25	130	3,250
				10,005

NOTE:

1 Exact Acid consumption would be determined during operation.

2 Chemicals cost could change according to market rates fluctuation.

3 Chemicals consumption may vary with changes in effluent characteristics.

c- **Electricity Cost per CU. M**

1	Power consumption per day	kWh	7,178
2	Rate per unit (Information need from customer)	Rs.	5.00
3	Cost per day	Rs.	35,889
4	Flow rate per day	CU. M	2,400
	Cost per CU. M	**Rs.**	**14.95**

d- **Chemical cost per CU. M**

1	Chemical cost per day	Rs.	10,005
2	Flow rate per day	CU. M	2,400
	Cost per CU. M	**Rs.**	**4.17**

e- **Operators Cost = 4 operators @ Rs. 12,000/- per month each = Rs. 48,000/-**

Operators Cost per day = Rs. 1,600/-

Operators Cost per CU. M = Rs.0.36 /-

***Operational cost* (including electricity, chemical & operators) per CU. M treated water = PKR 19.5**

- Operational cost will decrease by increase in flow rate / day, also Change with pollution load

.

Wastewater Treatment Products Selection Guide

Plant cleaners [2]

CL 472 CL 472 is a low viscosity, phosphate free, low foam alkaline dispersant. It is safe on all common metals and is ideally suited for pre-commission and routine cleaning.

Coagulant additives

WT 100 range Aluminum Based Products/Blends

WT 200 range Iron Based Products/Blends

WT 300 range Synthetic Organic Products/Blends

WT 400 range Natural Tannin Based Products/Blends

Flocculant additives

FT 100 range Solid Anionic Flocculant

FT 200 range Solid Cationic Flocculant

FT 300 range Emulsion Anionic Flocculant

FT 400 range Emulsion Cationic Flocculant

pH correction

pH UP pH UP is a Sodium Hydroxide solution

pH DOWN pH DOWN is a Sulphuric Acid solution

Biocides

MT2027 MT2027 is a broad-spectrum biocide. MT2027 controls legionellosis, bacteria, algae and fungi, which causes troublesome glues and bad smells.

MT2078 MT2078 is one-component stabilized liquid bromine. MT2078 controls bacteria, algae and fungi, which causes troublesome glues and bad smells.

Anti foams

AF2052 AF2052 is a multipurpose hydrocarbon based anti foam.

AF2053 AF2053 is a water-based mixture of surface actives.

AF2054 AF2054 is a glycol based anti foam

Summary

The activated sludge process is an aerobic (oxygen-rich), continuous-flow biological method for the treatment of domestic and biodegradable industrial waster water, in which organic matter is utilized by microorganism for life-sustaining processes, that is, for energy for reproduction, digestion, movement, etc. and as a food source to produce cell growth and more microorganisms. This is very common techniques utilized by all types of industries. The operating cost using this technology for water treatment is very attractive. This aeration required in this system can be done in many ways. It can be done by air pipe diffusers or by surface aeration. Surface aeration can further lead to less electricity cost as required oxygen is supplied by floating aerators. In Pakistan numbers of textile, papers and food industries are using this technique due to its ease of operation. It also required low capital cost with much better efficiency to achieve the requisite parameters of waste water as per different environmental standards as discussed in section 2.0.

Acknowledgement

The author thanks to Prof. Dr, Mahmood Saleem for his support, encouragement, for proofreading of article drafts, and helping throughout writing this article. I am grateful to

.

office staff members and especially thanks to Mr. Manzar Shamim Managing Director of DDFC group of industries for their help & support.

References

1. Pakistan, Government of (2008-09) Pakistan Economic Survey
2. Advanced Water Technologies Ltd, Unit 39, Burtonwood Industrial Estate, Burtonwood, Warrington, WA5 4HX
3. Industrial Wastewater Treatment Plants Self-Monitoring Manual EWATEC, 2002
4. Sivaramakrishnan, C.N., 2004, Colourage, LI, No.9, 27-32. Kazmi, Shabbir. "Leather Industry in Pakistan" Pakistan & Gulf Economist. 28 January - 3 February 1995, pg 6.
5. Dr. G.R. Sandhu. NCS Agriculture Sector Paper.
6. Navaraj, P. S.; Kumaraguru, A. K., Journal de Physique IV (Proceedings), Volume 107, Issue 1, May 2003, pp.929-934
7. DDFC Group of industries, Technical collaboration with Krofta Engineering Limited (Krofta), New Delhi, India
8. Wu, M., Eiteman, A and Law, S.E., 1998, Journal of Environmental Engineering, 124, 3, 272-277. a b Beychok, Milton R. (1967). Aqueous Wastes from Petroleum and Petrochemical Plants (1st edition ed.). John Wiley & Sons. LCCN 67019834.
9. Lawrence K. Wang, Yung-Tse Hung, Howard H. Lo and Constantine Yapijakis (2004). [12] Handbook of Industrial and Hazardous Wastes Treatment (2nd edition ed.). CRC Press. ISBN 0-8247-4114-5.
10. Kiuru, H.; Vahala, R., eds. (2000), "Dissolved air flotation in water and waste water treatment", International conference on DAF in water and waste water treatment No. 4, Helsinki, Finland, IWA Publishing, London, ISBN 1-900222-81-7
11. Beychok, Milton R. (1967). Aqueous Wastes from Petroleum and Petrochemical Plants (1st edition ed.). John Wiley & Sons. LCCN 67019834.
12. Wastewater treatment: troubleshooting and problem solving, By Glenn M. Tillman, Page 69

.