UNIT 8 SLUDGE AND EFFLUENT MANAGEMENT

Structure

8.1 INTRODUCTION

After treatment of wastewater, the organic and inorganic solids of wastewater are converted in sludge. Since the volume of sludge may be very high, therefore some treatment is required before final disposal. These treatments are thickening, stabilization, disinfection, conditioning, dewatering, drying and thermal reduction.

When solids of wastewater are separated out, the remaining part of wastewater (effluent) can be reused in many ways. In most of the cases, it is reused for irrigation, industrial or some recreational purposes and occasionally it can be reused as potable water. Effluent can also be disposed off directly to river, lake, sea and on ground.

Objectives

After studying this unit, you should be able to

- know different types of sludge treatment like thickening, stabilization, conditioning, disinfection, dewatering, drying and thermal reduction, and
- understand different methods of disposal of wastewater treatment plant effluent.

8.2 SLUDGE TREATMENT AND DISPOSAL

Sewage sludge consists of the organic and inorganic solids that were present in the raw waste and were removed in the primary clarifier, in addition to organic solids generated in secondary/biological treatment and removed in the secondary clarifier or in a separate thickening process. The generated sludge is usually in the form of a liquid or semisolid, containing 0.25 to 12% solids by weight, depending on the treatment operations and processes used. Sludge handling, treatment and disposal are complex, owing to the offensive constituents present, which vary with the source of wastewater and the treatment processes applied. Sludge is treated by means of a variety of processes that can be used in various combinations.

A generalized flow diagram showing the various unit sludge treatment operations and processes currently in use is presented in Figure 8.1. Thickening, conditioning, dewatering and drying are primarily used to remove moisture from sludge, while digestion, composting, incineration, wet-air oxidation and vertical tube reactors are used to treat or stabilize the organic material in the sludge. This section examines various sludge treatment processes with emphasis on the most commonly used technologies.

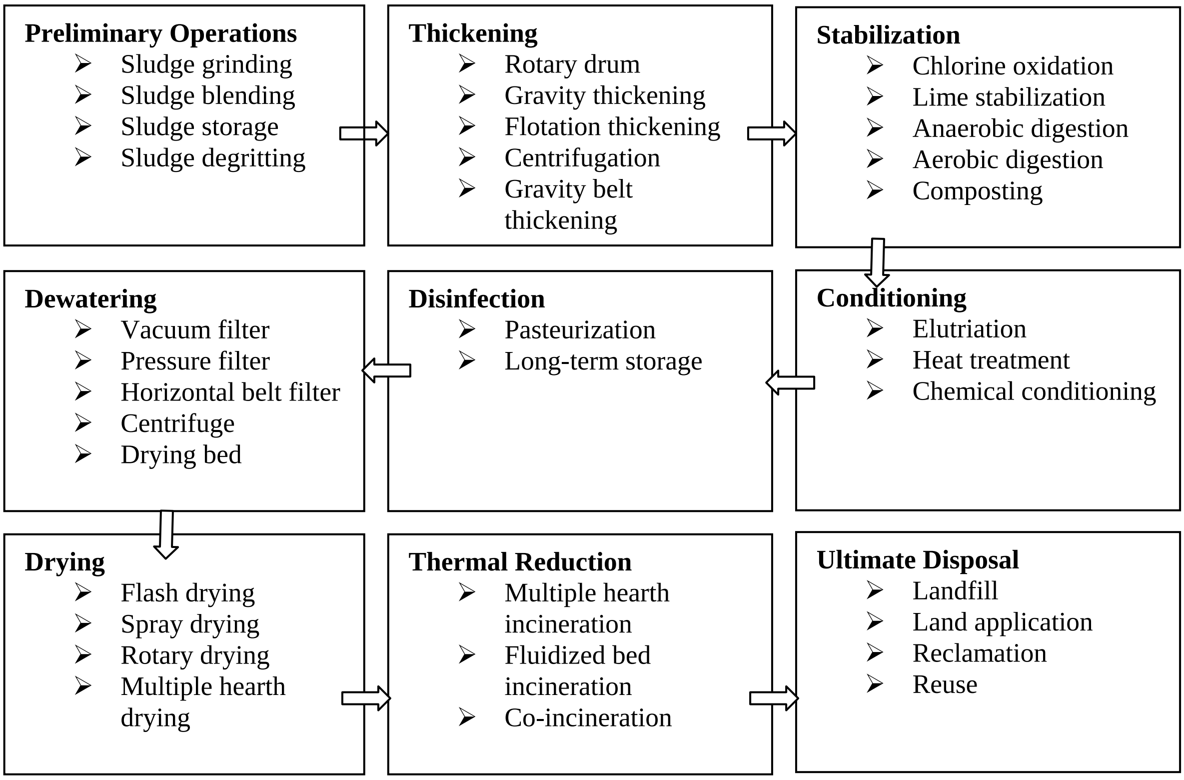


Figure 8.1 : Flow Diagram Showing the Various Unit Sludge Treatment Operations

8.2.1 Thickening

Thickening is the practice of increasing the solid content of sludge by the removal of a portion of its liquid content. A modest increase in solids content (from 3 to 6%) can decrease total sludge volume significantly (by 50%), entailing reduced size requirements for subsequent treatment units. Sludge thickening methods are usually physical in nature: they include gravity settling, flotation, centrifugation and gravity belts.

Gravity Thickening

A gravity thickener is similar to a conventional circular sedimentation basin. Dilute sludge is fed to a centre feed well and allowed to settle and compact before being withdrawn from the bottom of the basin. The sludge scraping mechanism incorporates vertical pickets, which gently agitate the sludge and contribute to its densification by releasing trapped gas and waters. The thickened sludge is pumped to digesters or dewatering equipment, while the supernatant is returned to the head works of the treatment plant, or to the primary settling tank. This method is most effective with primary sludge.

Flotation

Dissolved air flotation is used for thickening of sludge that originates from suspended growth biological treatment processes. It involves the introduction of air into a sludge solution that is being held at an elevated pressure. When the solution is depressurized, the dissolved air is released as finely divided bubbles. These carry the sludge to the top, where it is skimmed. Solids concentration achieved is between 3.5-5%.

Centrifugation

Centrifuges are used to thicken and dewater waste activated sludges. They involve the settling of sludge particles under the influence of centrifugal forces. Two basic types of centrifuges are the solid bowl and the imperforate basket.

(a) The solid bowl centrifuge consists of a long, horizontally mounted bowl, tapered at one end. Sludge is introduced continuously and the solids concentrate on the periphery. This gives solids concentration between 3-6%.

(b) The imperforate basket centrifuge consists of a vertically mounted spinning bowl, operating on a batch basis. The solids accumulate against the wall of the bowl and the liquid is decanted. This gives solids concentration between 8-10%.

Gravity Belt

Gravity belt thickeners consist of a gravity belt that moves over rollers driven by a variable-speed drive unit. It is used for the thickening of raw and digested sludges after conditioning by the addition of polymer. The conditioned sludge is fed into a box, which distributes it evenly across the width of the moving belt. As the water drains through, the sludge is carried to the discharge end of the thickener. Solids concentration achieved is between 3-6%.

Rotary Drum

A rotary drum thickening system consists of a waste activated-sludge conditioning system and rotating cylindrical screens. First, polymer is mixed with thin sludge in the conditioning drum. The conditioned sludge then passes to rotating screen drums, which separate the flocculated solids from the water. Solids concentration achieved is between 5-9%.

8.2.2 Stabilization

Sludges are stabilized to reduce their pathogen content, eliminate offensive odours, and reduce or eliminate the potential for putrefaction. Technologies used for sludge stabilization include lime stabilization, heat treatment, anaerobic digestion, aerobic digestion and composting.

Lime Stabilization

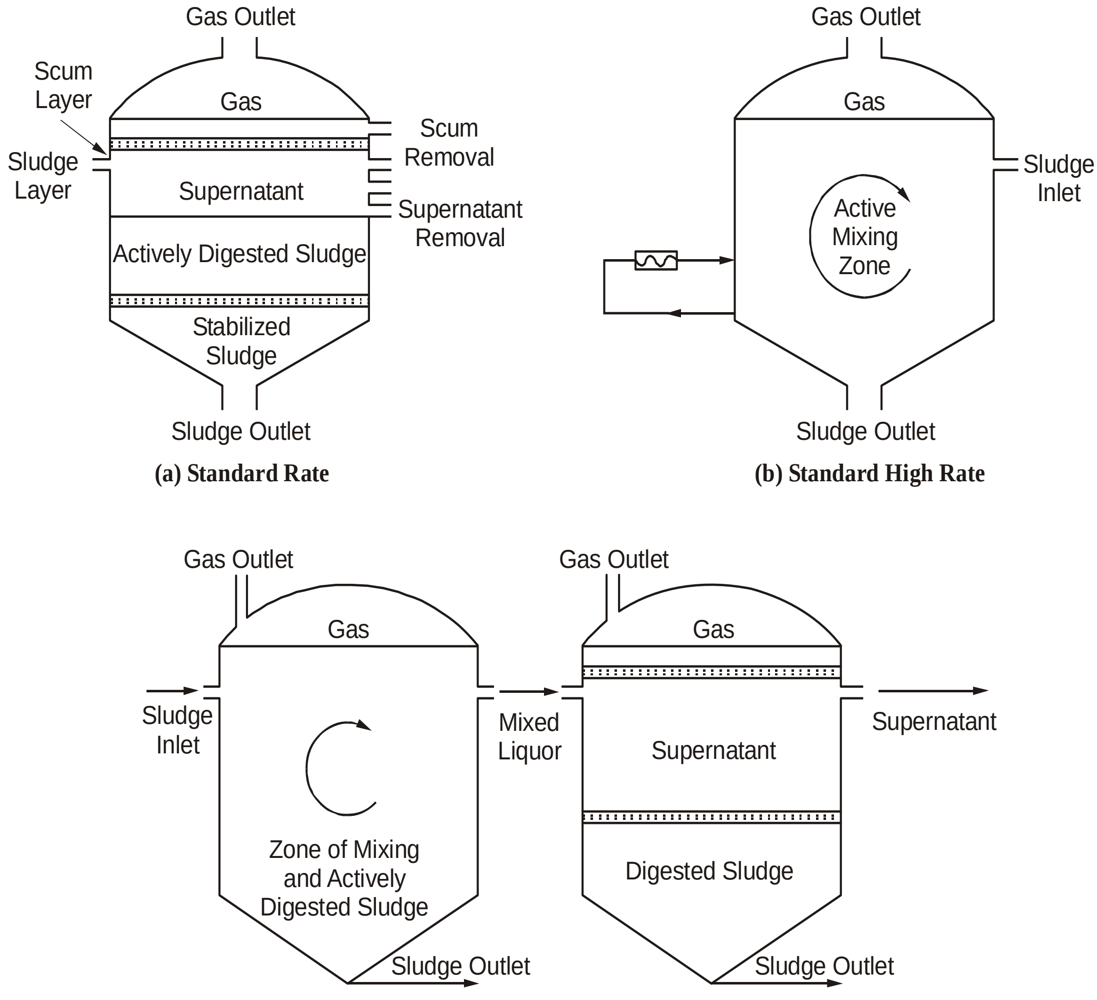
In this process, lime is added to untreated sludge to raise the pH to 12 or higher. The high pH environment inhibits the survival of micro-organisms, and thus eliminates the risk of sludge putrefaction and odour creation. Hydrated lime (Ca $(OH)_2$) and quicklime (CaO) are most commonly used for lime stabilization. Lime is added either prior to dewatering (lime pre-treatment) or after dewatering (lime post-treatment).

Heat Treatment

This process involves the treatment of sludge by heating in a pressure vessel to temperatures of up to 260ºC at pressures of up to 2,760 kN/m^2 for approximately 30 seconds. The exposure of sludge to such conditions results in the hydrolysis of proteinaceous compounds, leading to cell destruction and the release of soluble organic compounds and nitrogen. This process also serves for conditioning, as the thermal activity releases bound water and results in the coagulation of solids.

Anaerobic Sludge Digestion

This process involves the anaerobic reduction of organic matter in the sludge by biological activity. The methane produced can be recovered and reused for heating and incineration. Four types of anaerobic digesters are commonly used for sludge stabilization. These are standard-rate, standard high-rate, two-stage and separate. These digesters are outlined below and illustrated in Figure 8.2.



(a) Standard Rate **(b) Standard High Rate**

(c) Two-stage

Figure 8.2 : Typical Anaerobic Sludge Digesters

Standard Rate

This is a single-stage process in which digestion, sludge thickening and supernatant formation take place simultaneously. The untreated sludge is added to the active digestion zone, where it is heated by an external source. Mesophilic conditions are maintained within the reactor. The resulting gas rises to the surface, carrying oils and grease with it (Figure 8.2(a)).

Standard High-Rate

This process is a modification of the standard rate process. The solids loading is much greater, and the sludge is mixed by gas recirculation, pumping or mechanical mixing (Figure 8.2(b)).

Two-stage

This method features two tanks. The first serves for digestion and is fitted with heating and mixing facilities, while the second is used for the storage and concentration of digested sludge and for the formation of a clear supernatant (Figure 8.2(c)).

Thermophilic

Thermophilic digestion occurs between 49^{o}C and 57^{o}C. A rapid digestion rate, increased bacterial destruction and improved sludge dewatering characterize this process. However, the process is characterized by higher energy requirements, produces poorer quality supernatant and generates odours.

Aerobic Sludge Digestion

Aerobic sludge digestion is similar to the activated-sludge process. It involves the direct oxidation of biodegradable matter and microbial cellular material in open tanks for an extended period of time. Aeration occurs either naturally or by means of mechanical aerators and diffusers (Figure 8.3).

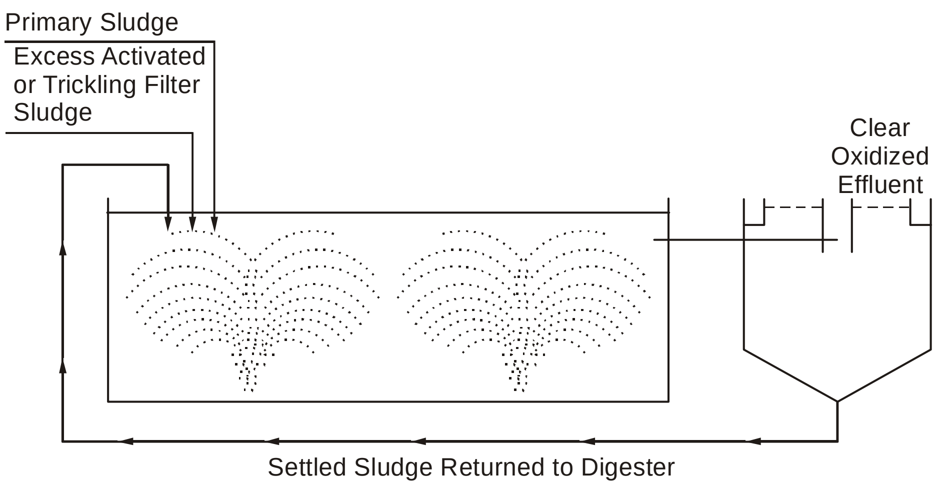


Figure 8.3 : Typical Aerobic Sludge Digestion

This process is preferably used only for the treatment of waste activated sludge, a mixture of waste activated or trickling filter sludge with primary sludge, or waste sludge from extended aeration plants or activated-sludge treatment plants designed without primary settling. As compared to anaerobic processes, aerobic digestion affords both advantages and disadvantages (Table 8.1).

Table 8.1 : Advantages and Disadvantages of Aerobic Sludge Digestion

Advantages	Disadvantages
➢ Volatile solids reductions approximately the same as anaerobic digestion ➢ Supernatant liquor with lower BOD concentrations ➢ Production of an odourless, humus-like, biologically stable end-product ➢ Recovery of most of the basic fertilizer values in the sludge ➢ Operation relatively easier ➢ Lower capital cost	➢ Higher power cost associated with supplying oxygen ➢ Produces a digested sludge with poor mechanical dewatering characteristics ➢ The process is significantly affected by temperature, location, and type of tank ➢ High operating cost

Composting

Composting is used for both sludge stabilization and final disposal. During composting, organic material undergoes biological degradation, resulting in a 20 to 30 per cent reduction of volatile solids. Entire micro-organisms are also destroyed due to the rise in temperature of the compost. Composting includes the following operations :

(a) Mixing dewatered sludge with a bulking agent.

(b) Aerating the compost pile by mechanical turning or the addition of air.

(c) Recovery of the bulking agent.

(d) Further curing and storage.

(e) Final disposal.

The resulting end product is stable and may be used as a soil conditioner in agricultural applications. Aerobic composting is more commonly used than anaerobic composting. The three major types of aerobic composting systems are the static aerated pile, windrow and in-vessel systems.

Aerated Static Pile

Consists of an aeration grid over which a mixture of dewatered sludge and bulking agent is placed. The sludge and the bulking agent are mixed by means of a rotary drum or front end loaders. The cured compost is screened for recovery of the bulking agent.

Windrow

Windrows are similar to static piles in terms of mixing and screening operations. However, no mechanical aeration is used. Aerobic conditions are maintained by periodic mixing of the compost.

In-vessel

Composting takes place in a closed container. Airflow, temperature and oxygen concentration are mechanically maintained.

SAQ 1

(a) What are different units of sludge treatment? Draw a flow diagram of it. Also discuss about sludge thickening, sludge stabilization and sludge dewatering.

(b) Discuss advantages and disadvantages of anaerobic and aerobic sludge digestions.

8.2.3 Conditioning

Conditioning involves the chemical and or physical treatment of sludge to enhance its dewatering characteristics. The two most commonly applied conditioning methods are the addition of chemicals and heat treatment. Other conditioning processes include freezing, irradiation and elutriation.

Chemical Conditioning

Chemical conditioning is associated principally with mechanical sludge dewatering systems. It reduces the moisture content of incoming sludge from 90-99 per cent to 65-85 per cent by causing solids to coagulate, so that the absorbed water is released. Both organic and inorganic chemicals are used for this purpose. The two most commonly used inorganic conditioners are ferric chloride and lime. Upon being added, ferric chloride forms positively charged soluble iron complexes that neutralize the negatively charged sludge solids, causing them to aggregate. Ferric chloride also reacts with the bicarbonate alkalinity in the sludge to form hydroxides that cause flocculation. Lime, for its part, is ordinarily used with ferric iron salts. It reacts in the sludge to produce calcium carbonate, thus creating a granular structure that increases sludge porosity and reduces sludge compressibility. Organic polymers are also widely used in sludge conditioning. Organic polyelectrolytes dissolve in water to form solutions of varying viscosity. The electrolytes adhere to the surface of the sludge particles, causing desorption of bound surface water, charge neutralization, and agglomerization by bridging between particles.

Thermal Conditioning

Thermal conditioning involves heating the sludge to a temperature of 248-464 ºF in a reactor at a pressure of 1,720-2,760 kN/m^2 for 15-40 minutes. The applied heat coagulates the solids, breaks down the gel structure and reduces affinity for water, resulting in a sterilized, deodourized, and dewatered sludge. The supernatant from the heat treatment unit has a high BOD and may require special treatment before redirection into the mainstream wastewater treatment process.

8.2.4 Dewatering

A number of techniques are used for dewatering, which is a physical unit operation aimed at reducing the moisture content of sludge. The selection of the appropriate sludge-dewatering technique depends on the characteristics of the sludge to be dewatered, available space, and moisture content requirements of the sludge cake for ultimate disposal. When land is available and sludge quantity is small, natural dewatering systems such as drying beds and drying lagoons are most attractive. Mechanical dewatering methods include vacuum filter, centrifuge, filter press and belt filter press systems.

Sludge Drying Beds

Sludge drying beds are typically used to dewater digested sludge. After drying, the sludge is either disposed of in a landfill or used as a soil conditioner. The various types of drying beds in current use are described below.

Conventional Sand Drying Beds

Typical sand beds consist of a layer of coarse sand supported on a graded gravel bed with perforated pipe underdrains. Sludge is placed on the bed and allowed to dry. Drying occurs by evaporation and drainage. The sludge cake is removed manually.

Paved Drying Beds

These are similar to conventional beds in terms of their underdraining system. Two types are commonly used: a drainage type and a decanting type. The drainage type involves agitation to facilitate dewatering and uses a front-end loader for sludge removal. The decanting type uses low-cost impermeable paved beds that rely on supernatant decanting and mixing of the drying sludge for enhanced evaporation.

Vacuum-Assisted

In this system, dewatering and drying is accelerated by the application of vacuum to the underside of porous filter plates.

Drying Lagoons

Sludge-drying lagoons, which are suitable only for the treatment of digested sludge, consist of shallow earthen basins enclosed by earthen dykes. The sludge is first placed within the basin and allowed to dry. The supernatant is decanted from the surface and returned to the plant while the liquid is allowed to evaporate. Mechanical equipment is then used to remove the sludge cake.

Vacuum Filtration

The vacuum filtration process consists of a horizontal cylindrical drum that is partially submerged in a tank of conditioned sludge. The surface of the drum is covered with a porous medium (cloth belts or coiled springs) and is divided into sections around its circumference. As the drum rotates, the sections function in sequence as three distinct zones: cake formation, cake dewatering and cake discharge. An internal vacuum that is maintained inside the drum draws the sludge to the filter medium.

Belt Filter Press

Belt filter presses use single or double moving belts to dewater sludge continuously. The filtration process involves four basic stages.

(a) Polymer conditioning zone.

(b) Gravity drainage zone for excess water.

(c) Low pressure zone.

(d) High-pressure zone.

Polymer Conditioning Zone

It consists of a tank located close to the press, a rotating drum attached to the press, or an in-line injector.

Gravity Drainage Zone

It consists of a flat or slightly inclined belt. Sludge is thickened by the gravity drainage of free water. This section may be vacuum-assisted.

Low Pressure Zone

This is the area where the upper and lower belts come together with the sludge in between. It prepares the sludge by forming a firm sludge cake that is able to withstand the shear forces within the high-pressure zone.

High Pressure Zone

In this stage, forces are exerted on the sludge by the movement of the upper and lower belts relative to each other, as they go over and under a series of rollers with decreasing diameters. Scraper blades remove the resulting sludge cake.

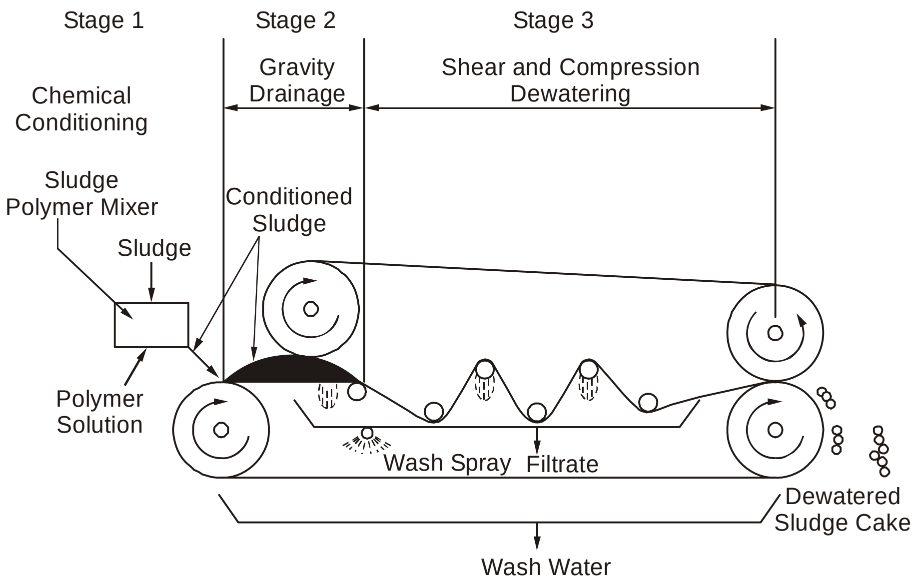


Figure 8.4 : Belt Filter Press

Filter Presses

In a filter press, dewatering is brought about by the use of high pressure to force the water out of the sludge. Advantages of the filter press are high sludge cake concentration, filtrate clarity and high solids capture. On the other hand, the system is characterized by high mechanical complexity, high chemical costs, high labour costs and limited cloth life. The two most widely used filter presses are the fixed-volume and the variable-volume recessed-plate types. The fixed-volume filter press consists of a series of rectangular plates that are supported face to face in a vertical position, with a filter cloth hung over each plate. The conditioned sludge is pumped into the space between the plates and subjected to high pressure for 1 to 3 hours, so that the liquid is forced through the cloth and plate outlet ports. The plates are then separated and the sludge is removed. The variable-volume recessed-plate filter press is similar to the fixed-volume type except that a rubber diaphragm is placed between the plates to help reduce cake volume during compression.

8.2.5 Drying

The purpose of sludge drying is to reduce the water content to less than 10% by evaporation, making the sludge suitable for incineration or processing into fertilizer. Drying is performed mechanically by the application of auxiliary heat. Mechanical processes used for this purpose are described briefly below and illustrated in Figure 8.5.

Flash Dryer

Sludge is pulverized in a cage mill or by means of an atomized suspension technique in the presence of hot air.

Spray Dryer

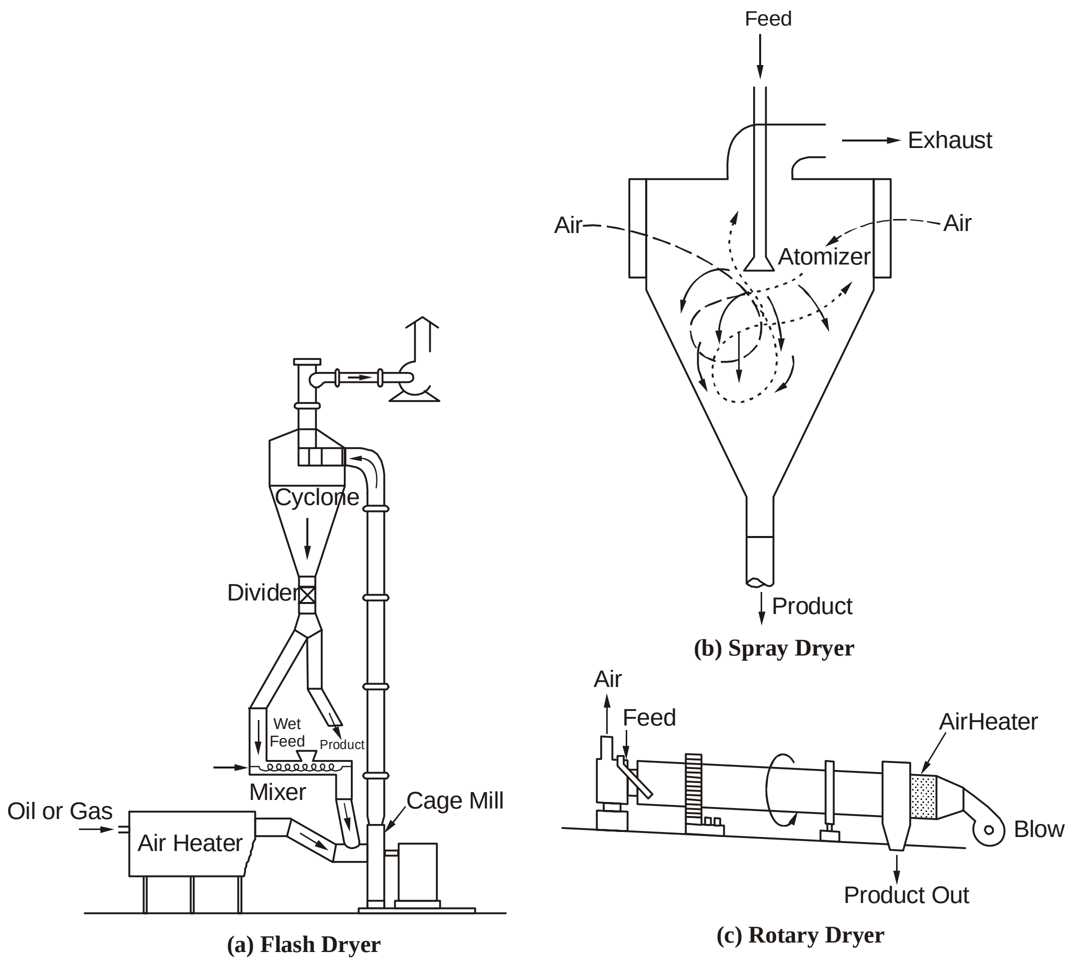
Liquid sludge is fed into a high-speed centrifuge bowl. Centrifugal forces atomize the sludge into fine particles and spray them into the top of a drying chamber.

Rotary Dryer

Involves direct or indirect heating. Direct-heat dryers bring the sludge into physical contact with hot gases, while in indirect-heat dryers, the central cell containing the sludge material is surrounded with steam.

Multiple-Hearth Dryer

Heated air and products of combustion are passed over finely pulverized sludge that is raked continuously to expose fresh surfaces.



(a) Flash Dryer

(b) Spray Dryer

(c) Rotary Dryer

Figure 8.5 : Sludge Dryer Technologies

8.2.6 Thermal Reduction

The thermal reduction of sludge involves two main processes :

(a) Total or partial conversion of organic solids to oxidized end products, primarily carbon dioxide and water, either by incineration or by wet-air oxidation.

(b) Partial oxidation and volatilization of organic solids, either by pyrolysis or by starved air combustion, to end-products with energy contents, including gases, oil, tar and charcoal. The main objective of this conversion process is the reduction of the volume of solids, as required for final disposal.

Multiple-Hearth Furnace

It consists of a steel shell the interior of which is divided into a series of hearths. The sludge is fed through the furnace roof by a screw-feeder or a belt and flapgate. Rotating rabble arms and rabble teeth push the sludge across the hearth to drop holes, where it falls to the subsequent hearths and continues downward until sterile phosphate-laden ash is discharged at the bottom.

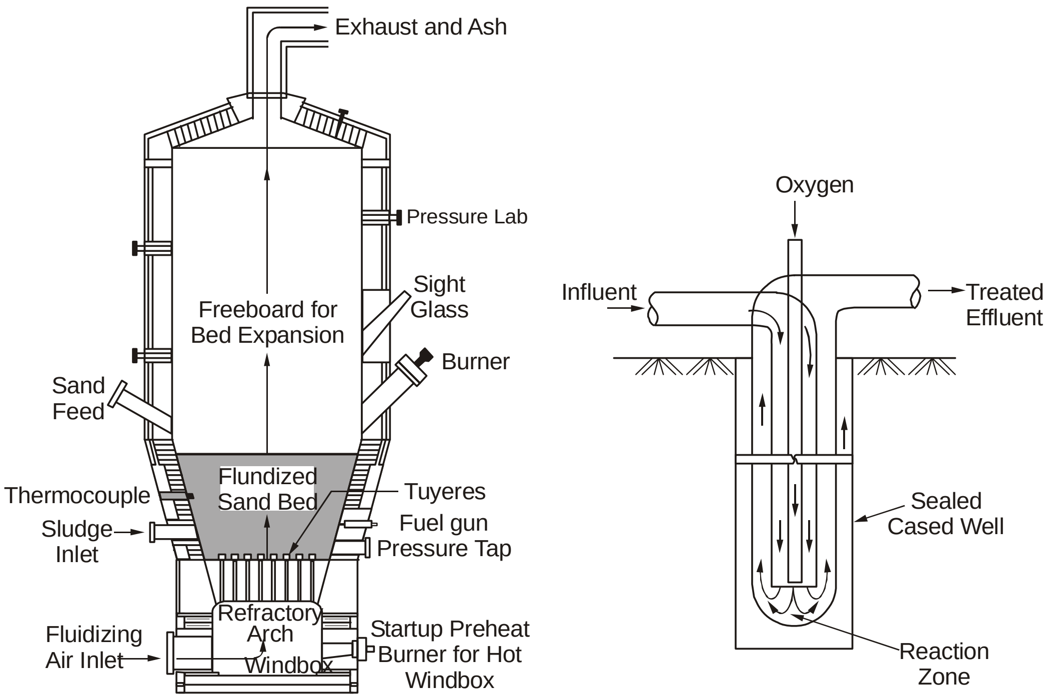
Wet Air Oxidation

A reactor held at high temperature (200-300ºC) and high pressure (5-20 kN/m^2). Sludge and sufficient air pumped into the reactor are oxidized in a liquid phase. The liquid and solid residues are separated by settling or filtration.

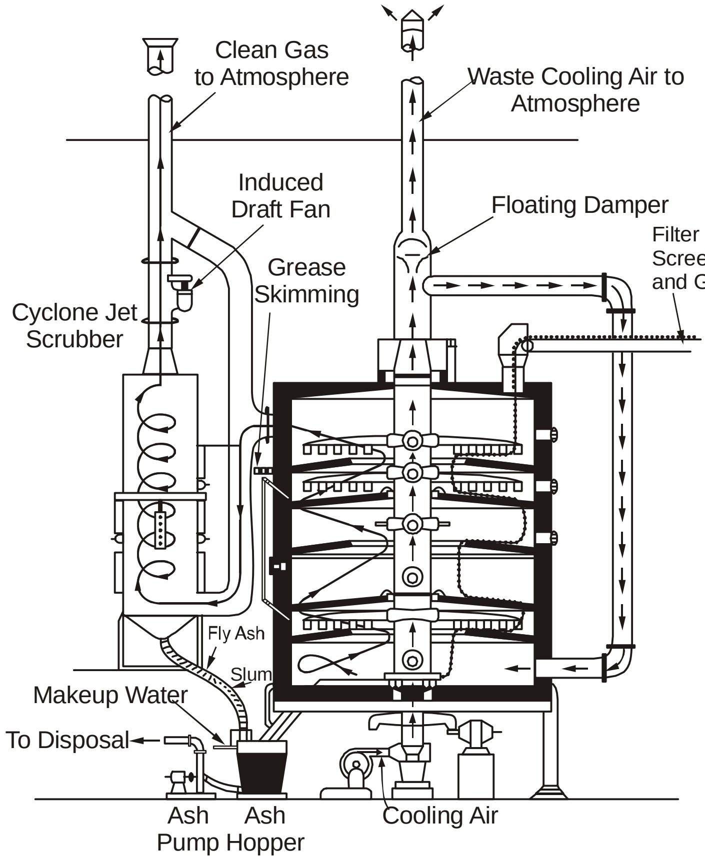
Fluidized-Bed Incinerator

A vertical, cylindrical, refractory-lined steel shell that contains a sand bed and fluidizing air orifices to produce and sustain combustion. Sludge is mixed quickly within the fluidized bed by its turbulent action, resulting in evaporation of the water and combustion of the sludge solids.

The principal thermal reduction methods are described below and illustrated in Figure 8.6.



(a) Fluidized Bed (b) Wet Air Oxidation



(c) Multiple Hearth

Figure 8.6 : Sludge Incineration Technologies

8.2.7 Sludge Disposal and Reuse

There was a time when sludge was commonly disposed off in sanitary landfills and lagoons. However, the beneficial uses of sludge are attracting more attention nowadays. Treated and digested sludge may be used as a soil amendment and conditioner. Sludge may also be used for landscaping or land reclamation projects.

SAQ 2

Write short notes on sludge thermal reduction and sludge conditioning.

8.3 MANAGEMENT OF TREATED EFFLUENT

After treatment, wastewater is either reused or discharged into the environment. Highly treated wastewater effluent from municipal wastewater treatment plants can be reused as a reliable source of water for agricultural irrigation, landscape irrigation, industrial recycling and reuse, groundwater recharge, recreational uses, non-potable urban reuse or even potable reuse. If not reused, treated wastewater is commonly discharged into a water body and diluted. Environmental regulations, guidelines and policies ensure acceptable discharge of wastewater effluent.

8.3.1 Effluent Reclamation and Reuse

Effluent reclamation and reuse has received much attention lately, owing to growing demand for water and unsustainable rates of consumption of natural water resources. A major concern in reuse applications is the quality of the reclaimed water, which is the main factor dictating the selection of the wastewater treatment process sequence. This section describes the various effluent reuse applications with emphasis on effluent quality issues.

Irrigation

Treated wastewater effluent can be used for the irrigation of crops or landscaped areas. The main consideration associated with this effluent application method is the quality of the treated water and its suitability for plant growth. Some constituents in reclaimed water that are of particular significance in terms of agricultural irrigation include elevated concentrations of dissolved solids, toxic chemicals, residual chlorine and nutrients. Another highly important consideration is public health and safety hazards resulting from the potential presence of bacterial pathogens, intestinal parasites, protozoa and viruses. Concerns vary with the intended irrigation use and the degree of human contact. Potential constraints associated with the use of reclaimed wastewater for irrigation include the marketability of crops and public acceptance, surface and groundwater pollution in the absence of adequate management, and high user costs, notably the cost of pumping effluent to irrigated land.

Industrial Use

Reclaimed water is ideal for industries using processes that do not require water of potable quality. Industrial uses of reclaimed water include evaporative cooling water, boiler-feed water, process water, and irrigation and maintenance of the grounds and landscape around the plant. Each type of reuse is associated with a number of constraints on its applicability; the use of reclaimed water in cooling towers, for example, creates problems of scaling, corrosion, biological growth, fouling and foaming. These problems are also encountered when fresh water is used, but less frequently. Reclaimed water used as boiler feed water must be softened and demineralized, while process water quality is dependent on the requirements of the manufacturing process involved.

Recreational Uses

Reclaimed water is widely used for recreational purposes, including landscape maintenance, aesthetic impoundments, recreational lakes for swimming, fishing, and boating, ornamental fountains, snow making and fish farming. The required treatment level for reclaimed water is dictated by the intended use: the greater the potential for human contact, the higher the treatment level required. For example, non-restricted recreational water use requires the treatment of secondary effluent by coagulation, filtration, and disinfection to achieve a total coliform count of fewer than 3 per 100 millilitres.

Groundwater Recharge

Groundwater recharge using reclaimed wastewater serves to mitigate water table decline, protect groundwater in coastal aquifers against salt-water intrusion, and store reclaimed water for future use. Groundwater recharge methods include surface spreading in basins and by direct injection into aquifers. Surface spreading utilizes flooding, ridge and furrow, constructed wetlands and infiltration basins. This application method improves the quality of the reclaimed water considerably as it percolates successively through soil, unsaturated zone and aquifer. Direct injection involves the pumping of reclaimed water directly into an aquifer. Drawbacks of this method include high effluent treatment cost and the high cost of the necessary injecting facilities. The major disadvantage of groundwater recharge using reclaimed water is the increased risk of groundwater contamination.

Potable Reuse

The issue of the use of reclaimed water for drinking purposes has been approached with extreme caution because of public rejection and because of health, safety and aesthetic concerns. Although extensive research is being conducted in this field, many constraints remain, notably the determination of appropriate quality criteria for such water. At the present time, the option of direct potable use of reclaimed municipal wastewater is limited to extreme situations.

8.3.2 Effluent Disposal

Treated wastewater effluent, if not reused, is disposed off either on land or into water bodies. Discharge into water bodies is the most common disposal practice. It takes advantage of the self-purification capacity of natural waters to further treat the effluent. However, wastewater effluent discharge must be based on sound engineering practice if the receiving environment is not to be adversely affected. Excessive quantities of organic material may cause rapid bacterial growth and depletion of the dissolved oxygen resources of the water body. In addition, changes in pH or concentrations of some organic and inorganic compounds may be toxic to particular life forms. Accordingly, outfall structures must be designed for adequate dispersal of the effluent in the receiving waters in order to avoid localized pollution. Depending on the characteristics of the receiving waters, many factors are considered for proper mixing and dispersal of effluent. These factors include flow velocity, depth stratification due to salinity and temperature, shape, reversal of current and wind circulation. The temperature and salinity of the effluent should also be taken into consideration. The disposal area should be downstream from any location where water is to be withdrawn for human consumption. This section addresses major considerations that need to be taken into account when treated wastewater effluent is discharged into water bodies, including rivers and streams, lakes, and seas and oceans. Specific mathematical models devised to assess the effect of effluent discharge on receiving bodies and to aid in the design of outfalls will not be discussed here.

Discharge into Rivers and Streams

Wastewater effluent discharged into rivers should be such as to ensure rapid vertical mixing of the effluent over the full river depth and avoid foaming problems. This can be achieved by using a multiport diffuser that extends across the width of the river. A diffuser is a structure that discharges the effluent through a series of holes or ports along a pipe extending into the river (Figure 8.7).

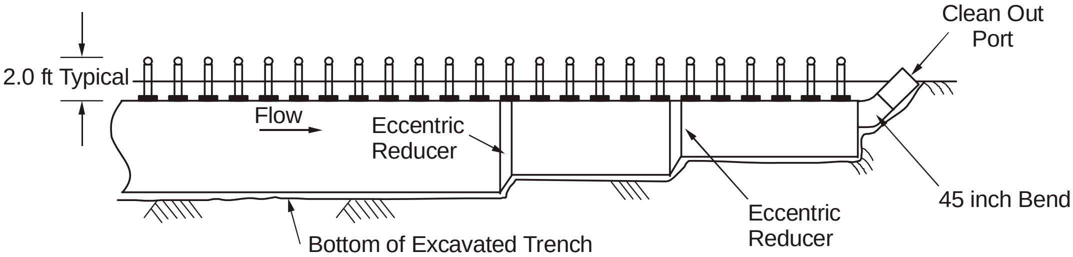


Figure 8.7 : Typical River Diffuser Outfall

Discharge into Lakes

Being larger and deeper than rivers, lakes are subject to temperature stratification and less pronounced natural mixing via currents. Consequently, the lower strata in a lake are usually subject to conditions of low temperature and low dissolved oxygen, which slow down the decomposition of organic matter. Consequently, it is essential to ensure that appropriate mixing occurs when wastewater effluent is discharged into a lake in order to prevent the formation of an anaerobic stratum. In shallow lakes, effluents are adequately dispersed by wind-induced currents that ensure appropriate mixing.

Discharge into Seas and Oceans

Oceans are extensively used for wastewater disposal because of their great assimilation capacity. Wastewater is of lower density than seawater, and consequently, upon discharge, the effluent forms a rapidly rising water plume, which entrains large amounts of ambient water, enhancing wastewater dilution. If the water is not stratified, the plume will rise to the surface, where ambient currents will dilute the wastewater. A marine outfall should be designed to ensure sufficient dilution of the effluent before it reaches the surface of the water or is carried inshore by ambient currents. The outfall carries the wastewater to an offshore discharge point through a pipe laid on or buried in the ocean floor. The discharge may be through a single-port or a multiport outfall structure that is similar to a river outfall (Figure 8.7).

SAQ 3

What are various ways of final disposal of effluent of a sewage treatment plant?

8.4 EMERGING TRENDS IN SLUDGE AND EFFLUENT MANAGEMENT

A worldwide trend toward acceptance of the concept of reuse is currently observable, as water shortages have intensified. This has led to an increase in the use of dual water systems and satellite reclamation systems. At the same time, however, potential microbial and chemical water contamination, especially from new trace contaminants, has become a growing source of concern, and consequently direct potable reuse of reclaimed water is likely to remain impracticable.

In response to these increasing concerns, new technologies offering significantly higher removal rates are being designed and implemented. These technologies include pressure-driven membranes, carbon adsorption, advanced oxidation, ion exchange and air stripping systems. Membrane technologies, which were formerly restricted to water desalination applications, are now being tested for the production of high-quality water for indirect potable reuse, and are expected to become the predominant treatment technologies in the near future.

In the field of sludge reclamation and reuse technologies, increased attention is being devoted to the production of sludge that is clean, has less volume and can be safely reused. Developments in this area have been slower than in the field of wastewater treatment, but a number of new technologies have emerged, including high-solids centrifuges, egg-shaped digesters and powerful heat dryers. Other developments include temperature-phased anaerobic digestion and auto-thermal aerobic digestion processes, which destroy volatile solids more effectively and yield enhanced production of biosolids.

Sludge landfilling and incineration continue to decrease due to stricter regulations and increased public awareness. The current trend is in the direction of more reuse opportunities. Volume reduction with a view to decreased disposal requirements is also an emerging area.

8.5 SUMMARY

After treatment of wastewater, sludge is treated. In the sludge thickening process, moisture content of sludge is reduced to reduce the volume of sludge. Sludge also contains very large number of pathogens and to reduce it, sludge stabilization is carried out. Sludge dewatering is required before final disposal of sludge. To enhance dewatering characteristics of sludge, conditioning is required. The final volume of sludge can be greatly reduced by thermal reduction.

Effluent of treatment plant can be reused for irrigation, industrial and recreational purposes otherwise it can be disposed off into rivers, lakes and/or sea.

8.6 ANSWERS TO SAQs

SAQ 1

(a) Please refer Figure 8.1

(b) Please refer section 8.2.2

SAQ 2

Please refer section 8.2.3

SAQ 3

Please refer section 8.3.2

FURTHER READING

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ENVIRONMENTAL ENGINEERING

Safe water supply and hygienic sanitation facilities are the two basic amenities the community needs on a top priority for healthy living of human kind. Civil

Engineers have profound role in ensuring safe water in adequate quantity, conveniently and as economically as possible. At the same time, the management of wastewater is also essential to protect our water resources. The course on "Environmental Engineering" covers the key aspects of water supply as well as wastewater management.

The course comprises eight units. Units 1 to 4 cover important engineering aspects of water supply whereas Units 5 to 8 present description of key features of wastewater engineering.

Unit 1 explains the planning aspects of water supply including water requirements and water supply sources. Water quality aspects with respect to various
physico-chemical and biological parameters have been discussed in Unit 2. Engineering design concepts involved in the treatment of water so as to meet desired standards have been covered in Unit 3. Water distribution network including pipe layouts and appurtenances have been dealt with in Unit 4.

Unit 5 explains concepts in wastewater characteristics. Collection and conveyance of sewage is discussed in Unit 6. Design aspects of various treatment processes for wastewater including physico-chemical and biological methods have been discussed in Unit 7. Unit 8 covers management of sludge being generated from wastewater treatment plants and management of the treated effluent.

The Self Assessment Questions (SAQs) are intended to help you in verifying whether you have grasped the presentation and provides the needed feedback about your progress. You are advised to study the text carefully. Try to solve the SAQs on your own and verify your answers with those given at the end of each unit. This will definitely develop your confidence.

At the end, we wish you all the best for your all educational endeavours.