A Course Material on

ENVIRONMENTAL ENGINEERING II

By

Mrs. Arul selvi

ASSISTANT PROFESSOR

DEPARTMENT OF CIVIL ENGINEERING

SASURIE COLLEGE OF ENGINEERING

VIJAYAMANGALAM – 638 056

QUALITY CERTIFICATE

This is to certify that the e-course material

Subject Code : **CE 2354**

Subject : Environmental Engineering II

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Being prepared by me and it meets the knowledge requirement of the university curriculum.

Signature of the Author

Name: ARUL SELVI.B
Designation: AP/CIVIL

This is to certify that the course material being prepared by Mrs.B.Arul selvi is of adequate quality. She has referred more than five books among the minimum one is from abroad author.

Signature of HD

Name: N.SATHISH KUMAR

SEAL

TABLE OF CONTENT

CE2354 ENVIRONMENTAL ENGINEERING II L T PC

OBJECTIVE

To educate the students on the principles and design of Sewage Collection, Conveyance, treatment and disposal

UNIT I PLANNING FOR SEWERAGE SYSTEMS 9

Sources of wastewater generation – Effects – Estimation of sanitary sewage flow – Estimation of storm runoff – Factors affecting Characteristics and composition of sewage and their significance – Effluent standards – Legislation requirements.

UNIT II SEWER DESIGN 9

Sewerage – Hydraulics of flow in sewers – Objectives – Design period - Design of sanitary and storm sewers – Small bore systems - Computer applications – Laying, joining & testing of sewers – appurtenances – Pumps – selection of pumps and pipe Drainage -. Plumbing System for Buildings – One pipe and two pipe system.

UNIT III PRIMARY TREATMENT OF SEWAGE 9

Objective – Unit Operation and Processes – Selection of treatment processes – Onsite sanitation - Septic tank, Grey water harvesting – Primary treatment – Principles, functions design and drawing of screen, grit chambers and primary sedimentation tanks – Operation and Mintenance aspects

.

UNIT IV SECONDARY TREATMENT OF SEWAGE 9

Objective – Selection of Treatment Methods – Principles, Functions, Design and Drawing of Units - Activated Sludge Process and Trickling filter, other treatment methods – Oxidation ditches, UASB – Waste Stabilization Ponds – Reclamation and Reuse of sewage - Recent Advances in Sewage Treatment – Construction and Operation & Maintenance of Sewage Treatment Plants.

UNIT V DISPOSAL OF SEWAGE AND SLUDGE 9

Standards for Disposal - Methods – dilution – Self purification of surface water bodies – Oxygen sag curve – Land disposal – Sewage farming – Deep well injection – Soil dispersion system - Sludge characterization – Thickening – Sludge digestion – Biogas recovery – Sludge Conditioning and Dewatering – disposal – Advances in Sludge Treatment and disposal

TEXT BOOKS

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2.Punmia, B.C., Jain, A.K., and Jain.A., Environmental Engineering, Vol.II, LakshmiPublications, Newsletter, 2005.

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UNIT I PLANNING FOR SEWERAGE SYSTEMS

Sources of wastewater generation – Effects – Estimation of sanitary sewage flow – Estimation of storm runoff – Factors affecting Characteristics and composition of sewage and their significance – Effluent standards – Legislation requirements.

1.1 INTRODUCTION:

Necessity for sanitation

Every community produces both liquid and solid wastes .The liquid portion –waste water– is essentially the water supply of the community after it has been fouled by a variety of uses such as spent water from bathroom kitchen, lavatory basins, house and street washings, from various industrial processes semi solid wastes of human and animal excreta, dry refuse of house and street sweepings, broken furniture, wastes from industries etc are produced daily**.**

If proper arrangements for the collection, treatment and disposal are not made, they will go on accumulating and create foul condition. If untreated water is accumulating, the decomposition of the organic materials it contains can lead to the production of large quantity of mal odorous gases. It also contains nutrients, which can stimulate the growth of aquatic plants and it may contain toxic compounds. Therefore in the interest of community of the city or town, it is most essential to collect, treat and dispose of all the waste products of the city in such a way that it may not cause any hazardous effects on people residing in town and environment.

Waste water engineering is defined as the branch of the environmental engineering where the basic principles of the science and engineering for the problems of the water pollution problems. The ultimate goal of the waste water management is the protection of the environmental in manner commensurate with the economic, social and political concerns.

Although the collection of stream water and drainage dates from ancient times the collection of waste water can be treated only to the early 1800s. The systematic treatment of waste water followed in the 1800s and 1900s.

1.2 Importance of sewerage system

One of the fundamental principles of sanitation of the community is to remove all decomposable matter, solid waste, liquid or gaseous away from the premises of dwellings as fast as possible after it is produced, to a safe place , without causing any nuisance and dispose it in a suitable manner so as to make it permanently harmless.

Sanitation though motivated primarily for meeting the ends of preventive health has come to be recognized as a way of life. In this context, development of the sanitation infrastructure of any country could possibly serve as a sensitive index of its level of prosperity. It is needless to emphasize that for attaining the goals of good sanitation, sewerage system is very essential. While provision of potable drinking water takes precedence in the order of provision of

Environmental Engineering Services, the importance of sewerage system cannot be last sight and cannot be allowed to lag behind, as all the water used by the community has to flow back as the sewage loaded with the wastes of community living , unless properly collected , treated and disposed off , this would create a serious water pollution problems.

1.3 Definitions of some common terms used in the sanitary engineering.

REFUSE:

This is the most general term to indicate the wastes which include all the rejects left as worthless, sewage, sullage – all these terms are included in this term.

GARBAGE:

It is a dry refuse which includes, waste papers, sweepings from streets and markets, vegetable peelings etc. The quantity of garbage per head per day amounts to be about .14 to .24 kg for Indian conditions. Garbage contains large amount of organic and putrifying matter and therefore should be removed as quickly as possible.

RUBBISH:

It consists of sundry solid wastes from the residencies, offices and other buildings. Broken furniture, paper, rags etc are included in this term. It is generally dry and combustible.

SULLAGE:

It is the discharge from the bath rooms, kitchens, wash basins etc., it does not include discharge from the lavatories , hospitals , operation theaters , slaughter houses which has a high organic matter .

SEWAGE:

It is a dilute mixture of the wastes of various types from the residential, public and industrial places. It includes sullage water and foul discharge from the water closets, urinals, hospitals, stables, etc.

STORM WATER:

It is the surface runoff obtained during and after the rainfall which enters sewers through inlet. Storm water is not foul as sewage and hence it can be carried in the open drains and can be disposed off in the natural rivers without any difficulty.

SANITARY SEWAGE :

It is the sewage obtained from the residential buildings & industrial effluents establishments‘. Being extremely foul it should be carried through underground conduits.

DOMESTIC SEWAGE:

It is the sewage obtained from the lavatory basins, urinals &water closets of houses, offices & institutions. It is highly foul on account of night soil and urine contained in it. Night soil starts putrefying & gives offensive smell. It may contain large amount of bacteria due to the excremental wastes of patients. This sewage requires great handling &disposal.

INDUSTRIAL SEWAGE:

It consists of spent water from industries and commercial areas. The degree of foulness depends on the nature of the industry concerned and processes involved.

SEWERS:

Ewers are underground pipes which carry the sewage to a point of disposal.

SEWERAGE:

The entire system of collecting, carrying &disposal of sewage through sewers is known as sewerage.

DRY WEATHER FLOW (DWF):

Domestic sewage and industrial sewage collectively, is called as DWF. It does not contain storm water. It indicates the normal flow during dry season.

BACTERIA:

These are the microscopic organisms. The following are the groups of bacteria:

-Aerobic bacteria: they require oxygen &light for their survival.

-Anaerobic bacteria: they do not require free oxygen and light for survival.

- Facultative bacteria: they can exist in the presence or absence of oxygen. They grow more in absence of air.

Invert:

It is the lowest point of the interior of the sewer at any c/s.

SLUDGE:

It is the organic matter deposited in the sedimentation tank during treatment.

1.4 Methods of domestic waste water disposal

After the waste water is treated it is disposed in the nature in the following two principal methods

a. Disposal by Dilution where large receiving water bodies area available
b. Land disposal where sufficient land is available

The choice of method of disposal depends on many factors and is discussed later.
Sanitary engg starts at the point where water supply engg ends.It can be classified as

- Collection works
- Treatment works
- Disposal works

The collection consists of collecting tall types of waste products of town. Refuse is collected separately. The collection works should be such that waste matters can be transported quickly and steadily to the treatment works. The system employed should be self cleaning and economical.

Treatment is required to treat the sewage before disposal so that it may not pollute the atmosphere & the water body in which it will be disposed of .The type of treatment processes depend on the nature of the waste water characteristics and hygiene, aesthetics and economical aspects.

The treated water is disposed of in various ways by irrigating fields or discharging in to natural water courses.

1.4 Different Methods of domestic waste water disposal include (Systems of Sanitation)

1) CONSERVENCY SYSTEM
2) WATER CARRIAGE SYSTEM

1.5.1CONSERVENC SYSTEM

Sometimes the system is also called as dry system. This is out of date system but is prevailing in small towns and villages. Various types of refuse and storm water are collected conveyed and disposed of separately. Garbage is collected in dustbins placed along the roads from where it is conveyed by trucks ones or twice a day to the point of disposal. all the non combustible portion of garbage such as sand dust clay etc are used for filling the low level areas to reclaim land for the future development of the town. The combustible portion of the garbage is burnt. The decaying matters are dried and disposed of by burning or the manufacture of manure.

Human excreta are collected separately in conservancy latrines. The liquid and semi liquid wastes are collected separately after removal of night soil it is taken outside the town in trucks and buried in trenches. After 2-3 years the buried night soil is converted into excellent manure. In conservancy system sullage and storm water are carried separately in closed drains to the po int

of disposal where they are allowed to mix with river water without treatment.

WATER CARRIAGE SYSTEM

With development and advancement of the cities urgent need was felt to replace conservancy system with some more improved type of system in which human agency should not be used for the collection and conveyance of sewage .After large number of experiments it was found that the water is the only cheapest substance which can be easily used for the collection and conveyance of sewage. As in this system water is the main substance therefore it is called as WATER CARRIAGE SYSTEM.

In this system the excremental matter is mixed up in large quantity of water their ars taken out from the city through properly designed sewerage systems, where they are disposed of after necessary treatment in a satisfactory manner.

The sewages so formed in water carriage system consist of 99.9% of water and .1% solids .All these solids remain in suspension and do not changes the specific gravity of water therefore all the hydraulic formulae can be directly used in the design of sewerage system and treatment plants.

SEWERAGE SYSTEMS:

CONSERVENCY SYSTEM	**WATER CARRIAGE SYSTEM**
Very cheap in initial cost.	It involves high initial cost.
Due to foul smells from the latrines, they are to be constructed away from living room so building cannot be constructed as compact units.	As there is no foul smell latrines remain clean and neat and hence are constructed with rooms, therefore buildings may be compact.
The aesthetic appearance of the city cannot be improved	Good aesthetic appearance of city can be obtained.
For burial of excremental matter large area is required.	Less area is required as compared to conservancy system.
Excreta is not removed immediately hence its decomposition starts before removal,	Excreta are removed immediately with water, no problem of foul smell or hygienic trouble.
This system is fully depended on human agency .In case of strike by the sweepers; there is danger of insanitary conditions in	As no human agency is involved in this system ,there is no such problem as in case of conservancy system

1) SEPARATE SYSTEM OF SEWAGE
2) COMBINED SYSTEM OF SEWAGE
3) PARTIALLY COMINED OR PARTIALLY SEPARATE SYSTEM

1.4.1 **SEPARATE SYSTEM OF SEWERAGE**

In this system two sets of sewers are laid .The sanitary sewage is carried through sanitary sewers while the storm sewage is carried through storm sewers. The sewage is carried to the treatment plant and storm water is disposed of to the river.

Advantages:

1) Size of the sewers are small

2) Sewage load on treatment unit is less

3) Rivers are not polluted

4) Storm water can be discharged to rivers without treatment.

Disadvantage

1) Sewerage being small, difficulty in cleaning them

2) Frequent choking problem will be their

3) System proves costly as it involves two sets of sewers

4) The use of storm sewer is only partial because in dry season the will be converted in to dumping places and may get clogged.

1.4.2 **COMBINED SYSTEM OF SEWAGE**

When only one set of sewers are used to carry both sanitary sewage and surface water. This system is called combined system.

Sewage and storm water both are carried to the treatment plant through combined sewers

Advantages:

1) Size of the sewers being large, chocking problems are less and easy to clean.

2) It proves economical as 1 set of sewers are laid.

3) Because of dilution of sanitary sewage with storm water nuisance potential is reduced

Disadvantages:

1) Size of the sewers being large, difficulty in handling and transportation.
2) Load on treatment plant is unnecessarily increased
3) It is uneconomical if pumping is needed because of large amount of combined flow.
4) Unnecessarily storm water is polluted

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1.5 **PARTIALLY COMINED OR PARTIALLY SEPARATE SYSTEM**

A portion of storm water during rain is allowed to enter sanitary sewer to treatment plants while the remaining storm water is carried through open drains to the point of disposal.

Advantages:-

The sizes of sewers are not very large as some portion of storm water is carried through open drains.
Combines the advantages of both the previous systems.
Silting problem is completely eliminated.

Disadvantages:-

1. During dry weather, the velocity of flow may be low.
2. The storm water is unnecessary put load on to the treatment plants to extend.
3. Pumping of storm water in unnecessary over-load on the pumps.

1.5.1**Suitable conditions for separate sewerage systems:-**

A separate system would be suitable for use under the following situations:
Where rainfall is uneven.
Where sanitary sewage is to be pumped.
The drainage area is steep, allowing to runoff quickly.
Sewers are to be constructed in rocky strata. The large combined sewers would be more expensive.

1.5.2 Suitable conditions for combined system:-

Rainfall in even throughout the year.
Both the sanitary sewage and the storm water have to be pumped.
The area to be sewered is heavily built up and space for laying two sets of pipes is not enough.
Effective or quicker flows have to be provided.

After studying the advantages and disadvantages of both the systems, present day construction of sewers is largely confined to the separate systems except in those cities where combined system is already existing. In places where rainfall is confined to one season of the year, like India and even in temperate regions, separate system are most suitable.

Sl. no.	Separate system	Combined system
1.	The quantity of sewage to be treated is less, because no treatment of storm water is done.	As the treatments of both are done, the treatment is costly.
2.	In the cities of more rainfall this system is more suitable.	In the cities of less rainfall this system is suitable.
3.	As two sets of sewer lines are to laid, this system is cheaper because sewage is carried in underground sewers and storm	Overall construction cost is higher than separate system.
4.	In narrow streets, it is difficult to use this system.	It is more suitable in narrow streets.
5.	Less degree of sanitation is achieved in this system, as storm water is disposed without any treatment.	High degree of sanitation is achieved in this system.

1.6 Sources of Sewage:-

Sanitary sewage is produced from the following sources:

1. When the water is supplied by water works authorities or provided from private sources, it is used for various purposes like bathing, utensil cleaning, for flushing water closets and urinals or washing clothes or any other domestic use. The spent water for all the above needs forms the sewage.
2. Industries use the water for manufacturing various products and thus develop the sewage.
3. Water supplied to schools, cinemas, hotels, railway stations, etc., when gets used develops sewage.
4. Ground water infiltration into sewers through loose joints.
5. Unauthorized entrance of rain water in sewer lines.

1.6.1 Nature of Sewage:-

Sewage is a dilute mixture of the various types of wastes from the residential, public and industrial places. The characteristics and composition i.e. The nature of sewage mainly depends on this source. Sewage contains organic and inorganic matters which may be dissolved, suspension and colloidal state. Sewage also contains various types of bacteria, Virus, protozoa, etc. sewage may also contain toxic or other similar materials which might have got entry from industrial discharges. Before the design of any sewage treatment plant the knowledge of the nature of sewage is essential.

1.6.2 Quantity of Sanitary Sewage and Storm Water:-

The determination of sanitary sewage is necessary because of the following factors which depend on this:

1. To design the sewerage schemes as well as to dispose a treated sewage efficiently.
2. The size, shape and depth of sewers depend on quantity of sewage.
3. The size of pumping unit depends on the quantity of sewage.

1.6.3 Estimate of Sanitary Sewage:-

Sanitary sewage is mostly the spent water of the community into sewer system with some groundwater and a fraction of the storm runoff from the area, draining into it. Before designing the sewerage system, it is essential to know the quantity of sewage that will flow through the sewer.

The sewage may be classified under two heads:

1. The sanitary sewage, and
2. Storm water

Sanitary sewage is also called as the Dry Weather Flow (D.W.F), which includes the domestic sewage obtained from residential and residential and industrials etc., and the industrial
sewage or trade waste coming from manufacturing units and other concerns.

1.6.4 Quantity of Sewage:-

It is usual to assume that the rate of sewage flow, including a moderate allowance for infiltration equals to average rate of water consumption which is 135 litre/ head /day according to Indian Standards. It varies widely depending on size of the town etc. this quantity is known as Dry Weather Flow (D.W.F). It is the quantity of water that flows through sewer in dry weather when no storm water is in the sewer.

Rate of flow varies throughout 24 hours and is usually the greatest in the fore-noon and very small from midnight to early morning. For determining the size of sewer, the maximum flow should be taken as three times the D.W.F.

Design Discharge of Sanitary Sewage

The total quantity of sewage generated per day is estimated as product of forecasted population at the end of design period considering per capita sewage generation and appropriate peak factor. The per capita sewage generation can be considered as 75 to 80% of the per capita water supplied per day. The increase in population also result in increase in per capita water demand and hence, per capita production of sewage. This increase in water demand occurs due to increase in living standards, betterment in economical condition, changes in habit of people,and enhanced demand for public utilities.

Factors affecting the quantity of sewage flow:-

The quantity of sanitary sewage is mainly affected by the following factors:

1. Population
2. Type of area
3. Rate of water supply
4. Infiltration and exfiltration

In addition to above, it may also be affected by habits of people, number of industries and water pressure etc.

The quantity of sanitary sewage directly depends on the population. As the population increases the quantity of sanitary sewage also increases. The quantity of water supply is equal to the rate of water supply multiplied by the population. There are several methods used for forecasting the population of a community.

The quantity of sanitary sewage also depends on the type of area as residential, industrial or

commercial. The quantity of sewage developed from residential areas depend on the rate of water supply to that area, which is expressed a litres/ capita/ day and this quantity is obtained by multiplying the population with this factor.

The quantity of sewage produced by various industries depends on their various industrial processes, which is different for each industry.

Similarly the quantity of sewage obtained from commercial and public places can be determined by studying the development of other such places.

Rate of water

Truly speaking the quantity of used water discharged into a sewer system should be a little less than the amount of water originally supplied to the community. This is because of the

fact that all the water supplied does not reach sewers owing to such losses as leakage in pipes or such deductions as lawn sprinkling, manufacturing processes etc. However, these losses may be largely be made up by such additions as surface drainage, groundwater infiltration, water supply from private wells etc. On an average, therefore, the quantity of sewage maybe considered to be nearly equal to the quantity of water supplied. Ground water infiltration and exfiltration.

The quantity of sanitary sewage is also affected by groundwater infiltration through joints. The quantity will depend on, the nature of soil, materials of sewers, type of joints in sewer line, workmanship in laying sewers and position of underground water table.

Infiltration causes increase to the —legitimate‖ flows in urban sewerage systems. Infiltration represents a slow response process resulting in increased flows mainly due to seasonally-elevated groundwater entering the drainage system, and primarily occurring through defects in the pipe network.

Exfiltration represents losses from the sewer pipe, resulting in reduced conveyance flows and is due to leaks from defects in the sewer pipe walls as well as overflow discharge into manholes, chambers and connecting surface water pipes. The physical defects are due to a combination of factors including poor construction and pipe joint fittings, root penetration, illicit connections, biochemical corrosion, soil conditions and traffic loadings as well as aggressive groundwater.

It is clear that Infiltration and Exfiltration involve flows passing through physical defects in the sewer fabric and they will often occur concurrently during fluctuations in groundwater levels, and particularly in association with wet weather events; both of which can generate locally high hydraulic gradients. Exfiltration losses are much less obvious and modest than infiltration gains, and are therefore much more difficult to identify and quantify. However, being dispersed in terms of their spatial distribution in the sewer pipe, exfiltration losses can have potentially significant risks for groundwater quality. The episodic but persistent reverse –pumping‖ effect of hydraulic gain and loss will inevitably lead to long term scouring of pipe surrounds and foundations resulting in pipe collapse and even surface subsidence.

Suggested estimates for groundwater infiltration for sewers laid below ground water table are as follows:

	Minimum	Maximum
Litre/ day/ hectare	5,000	50,000
Lpd/ km of sewer/cm dia.	500	5,000

Design period

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Following design period can be considered for different components of sewerage scheme.

1. Laterals less than 15 cm diameter : Full development
2. Trunk or main sewers : 40 to 50 years
3. Treatment Units : 15 to 20 years
4. Pumping plant : 5 to 10 years

Variations in sewage flow:-

The sewage flow, like the water supply flow, is not constant in practice but varies. The fluctuation may, in a similar way, be seasonal or monthly, daily and hourly.

Variation occurs in the flow of sewage over annual average daily flow. Fluctuation in flow occurs from hour to hour and from season to season. The typical hourly variation in the sewage flow is shown in the Figure . If the flow is gauged near its origin, the peak flow will be quite pronounced. The peak will defer if the sewage has to travel long distance. This is because of the time required in collecting sufficient quantity of sewage required to fill the sewers and time required in travelling. As sewage flow in sewer lines, more and more sewage is mixed in it due to continuous increase in the area being served by the sewer line. This leads to reduction in the fluctuations in the sewage flow and the lag period goes on increasing. The magnitude of variation in the sewage quantity varies from place to place and it is very difficult to predict.

For smaller township this variation will be more pronounced due to lower length and travel time before sewage reach to the main sewer and for large cities this variation will be less.

The seasonal variations are due to climatic effect, more water being used in summer than in winter. The daily fluctuations are the outcome of certain local conditions, involving habits and customs of people. Thus, in U.S.A. and other European countries, Monday is the washing day, as such, amount of sewage flow would be much greater than on any other day. In India, however, Sundays or other holidays involve activities which permit greater use of water. Hourly variations are because of varying rates of water consumption in different hours of the day.

The first peak flow generally occurs in the late morning it is usually about 200 percent of the average flow while the second peak flow generally occurs in the early evening between 6 and 9 p.m. and the minimum flow occurring during the night after twelve or early hours of the morning is generally about half of the average flow.

1.7 Effects of Flow Variation on Velocity in a Sewer

Due to variation in discharge, the depth of flow varies, and hence the hydraulic mean depth (r) varies. Due to the change in the hydraulic mean depth, the flow velocity (which depends directly on $r^{2/3}$) gets affected from time to time. It is necessary to check the sewer for maintaining a minimum velocity of about 0.45 m/s at the time of minimum flow (assumed to be $1/3^{rd}$ of average flow). The designer should also ensure that a velocity of 0.9 m/s is developed atleast at the time of maximum flow and preferably during the average flow periods also. Moreover, care should be taken to see that at the time of maximum flow, the velocity generated does not exceed the scouring value.

1.8 Quantity of storm water

When rain falls over the ground surface, a part of it percolates into the ground, a part is evaporated in the atmosphere and the remaining part overflows as storm water. This quantity of storm water is very large as compared with sanitary sewage.

Factors affecting storm water**:-**

The following are factors which affect the quantity of storm water:

1. Rainfall intensity and duration.
2. Area of the catchment.
3. Slope and shape of the catchment area.
4. Nature of the soil and the degree of porosity.
5. Initial state of the catchment.

If rainfall intensity and duration is more, large will be the quantity of storm water available. If the rainfall takes place very slowly even though it continues for the whole day, the quantity of storm water available will be less.

Harder surface yield more runoff than soft, rough surfaces. Greater the catchment area greater will be the amount of storm water. Fan shaped and steep areas contribute more quantity of storm water. In addition to the above it also depends on the temperature, humidity, wind etc.

Estimate of quantity of storm water:-

Generally there are two methods by which the quantity of storm water is calculated:

1. Rational method
2. Empirical formulae method

In both the above methods, the quantity of storm water is a function of the area, the intensity of rainfall and the co-efficient of runoff.

Rational method:-

Runoff from an area can be determined by the Rational Method. The method gives a reasonable estimate up to a maximum area of 50 ha (0.5 Km^2).

Assumptions and Limitations

Use of the rational method includes the following assumptions and limitations: Precipitation is uniform over the entire basin.

- Precipitation does not vary with time or space.
- Storm duration is equal to the time of concentration.

A design storm of a specified frequency produces a design flood of the same frequency.

- The basin area increases roughly in proportion to increases in length.
- The time of concentration is relatively short and independent of storm intensity. The runoff coefficient does not vary with storm intensity or antecedent soil moisture.
- Runoff is dominated by overland
- Basin storage effects are negligible.

The minimum duration to be used for computation of rainfall intensity is 10 minutes. If the time of concentration computed for the drainage area is less than 10 minutes, then 10 minutes should be adopted for rainfall intensity computations.

This method is mostly used in determining the quantity of storm water. The storm water quantity is determined by the rational formula:

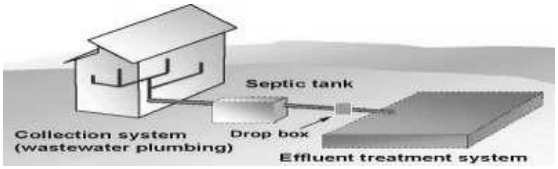
$$Q = \frac{C.i.A}{360}$$

UNIT II SEWER DESIGN

Sewerage – Hydraulics of flow in sewers – Objectives – Design period - Design of sanitary and storm sewers –

Small bore systems - Computer applications – Laying, joining & testing of sewers – appurtenances – Pumps –

selection of pumps and pipe Drainage -. Plumbing System for Buildings – One pipe and two pipe system.



2 Learning objectives

Upon successful completionof this lecture, the participants will be able to:
Describe and perform the required step for designing sewer system networks
Design philosophy

Constraints and assumptions

Design steps

Design criteria

Design example

2.1 Design philosophy

ssssA sewer system is a network of pipes used to convey storm runoff and/or wastewater in an area.

The design of sewer system involves the determination of

Diameters,

Slopes, and

Crown or invert elevations for each pipe in the system

2.1.2Constraints and assumptions

Free surface f low exits for the design discharges; that is, the sewer system is designed for "gravity of low";

pumping stations and pressurized sewers should be avoided as much as possible (are not considered here)

The sewers are of commercially available circular sizes

The design diameter is the smallest commercially available pipe having f low capacity equal to or greater than the design discharge and satisfying all the appropriate constraints

Sewers must be placed at a depth such that they

Will not be susceptible to frost,

Will be able to drain basements, and

Will have sufficient cushioning to prevent breakage due to ground surface loading.
To these ends, minimum cover depths must be specified.

The sewers are joined at junctions such that the crown elevation of the upstream sewer is no lowerothe downstream sewer

To prevent or reduce excessive deposition of solid material in the sewers, a minimum permissible flow velocity at design discharge or at barely full-pipe gravity flow I specified
To prevent scour and other undesirable effects of high- velocity f low, a maximum permissible flow velocity is also specified
At any junction or manhole, the downstream sewer cannot be smaller than any of the upstream sewers at that junction

The sewer system is a dendritic, or branching, network converging in the downstream direction without closed loops

2.2 Design Steps

2.2.1 Step 1 - Topographical map

Obtain or develop a map of the contributing area
Add location and level of existing or proposed details such as:

Contours

Physical features (e.g. rivers)

Road layout

Buildings

Sewers and other services

Outfall point (e.g. near lowest point, next to receiving water body)

2.2.2 Step 2 - Preliminary horizontal layout

Sketch preliminary system layout (horizontal alignment):

Locate pipes so all potential users can readily connect into the system

Try to locate pipes perpendicular to contours

Try to follow natural drainage patterns

Locate manholes in readily-accessible positions

2.2.3Step 3- Preliminary sewer sizing

Establish preliminary pipe sizes and gradients

Step 4 - Preliminary vertical layout

Draw preliminary longitudinal profiles (vertical alignment):
Ensure pipes are deep enough so all users can connect into the system
Try to locate pipes parallel to the ground surface

Ensure pipes arrive above outfall level

Avoid pumping if possible

Step 5 - Revise layout

Revise the horizontal and/or vertical alignment to minimise system cost by reducing pipe:

Lengths

Sizes

Depths

Design of certria

The following criteria need to be formulated for design of sewer systems:

Peak rates of dry weather flow (wastewater + groundwater infiltration) heavy producers of wastewater allowance for illicit rain water connections to sanitary sewers design storm runoff coefficient.

Pipe profiles (and materials)

Hydraulic friction constants

Minimum slopes of sewers

Outlet levels (maximum water level, invert for storm water)

2.3 Infiltration to sewer pipes

Assume specific rate of groundwater infiltration (in l/s/ ha) for sewers with their invert located below the groundwater table

Allowance for illicit inflow

Compile available sewer sizes

2.4 Storm water quantities

The amount of storm water to be transported is determined with the rational method.

Indicate what design frequency (return period) is used

Determine the rainfall intensity - duration curve for the required frequency
Indicate runoff coefficients
Determine the hydraulic performance of selected profiles

Establish partial flow diagrams if necessary

2.5 Design of sanitary sewer systems

Public sanitary sewers perform two primary functions:
Safely carry the design peak discharge,
Transport suspended materials to prevent deposition in the sewer. In designing a sewer system, the designer must conduct preliminary investigations, review design considerations

and select basic design data and criteria,
Design the sewers which include preparation of a preliminary sewer system and design of individual sewers, and
Prepare contract drawings and specifications.
Comprehensive preliminary investigations of the area to be served are required not only to obtain the data needed for design and construction but also to record pertinent information about the local conditions before construction begins. These are

Maps and other drawings of the area;

Locations of streets, alleys, railways public parks and buildings, ponds, streams, drainage ditches and other features and structure which may be influenced or influence the sewer systems;

A bench mark on each block of every street;

If possible contours at suitable intervals, high and bw points and changes in surface slopes;

Local rainfall and runoff data, if any, otherwise measurements in the field should be taken;

Character of the soil in which the sewers are to construct; and

Local wages of unskilled and skilled labor.

Designing a sanitary sewer involves estimation of waste flow rates for the design data and evaluation of any local
conditions, which may affect the hydraulic operation of the system; the selection of the hydraulic-design
equation, alternative sewer pipe materials and minimum and maximum sizes, minimum and maximum
velocities and slopes; the evaluation of alternative alignments or designs.

*Design flow:*Peak hourly flow and peak infiltration allowances for the entire service area are used for the design
of new sanitary sewers.

Hydraulic design equation: Manning equations are commonly used.

$$v = \frac{1}{n} R^{2/3} S^{1/2}$$

2.5 Design Procedures

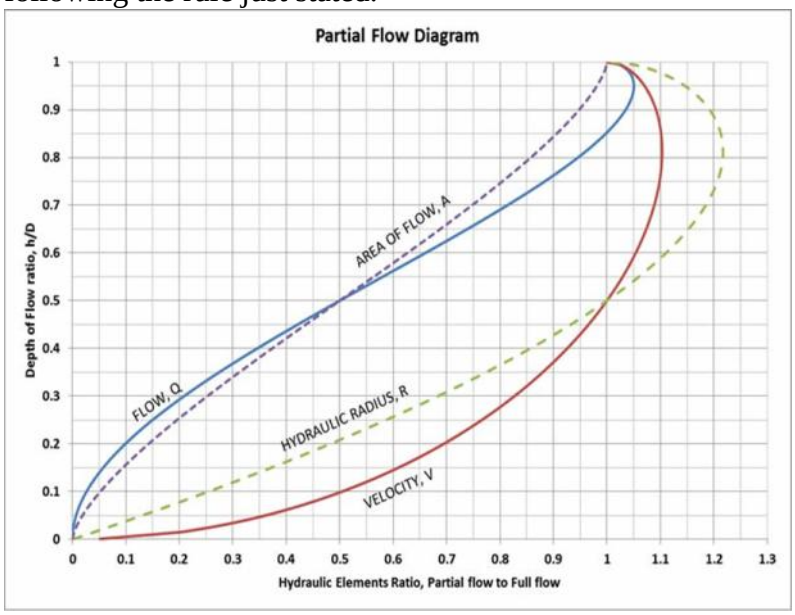
Layout the sewer: Draw a line to represent the proposed sewer in each street or alley to be served. Near of on the line; indicate by an arrow the direction in which the wastewater is to flow. Except in special cases, the sewer should slope with the surface of the street. It is usually more economical to plan the system so that the wastewater from any street will flow to the point of disposal by the most direct (and, consequently; the shortest) route. In general, the laterals connect with the mains and these; in turn connect with the trunk sewer, which leads to the point of discharge or to an intercepting sewer.
Locate the manholes: Locate a manhole at: (1) Changes in direction;
(2) Changes in slope;
(3) At pipe junctions with the exception of building connections;
(4) At the upper end and ends of all laterals for cleansing and flushing the lines; and
(5) At intervals from 90 to 120 m or less, as required. Give each manhole an identification number.
Establishing the limits of the service area: Sketch the limits of the service areas. Search the limits of the service area for each lateral. If a single lateral will be required to

accommodate an area larger than can be served by the minimum size of sewer with the minimum slope the area should be subdivided further. Where the streets are laid out assume that the limits are midway between them. If the street layout is not shown on the plan, the limits of the different service areas cannot be determined as closely and the topography may serve as a guide.
Determine the area of each service area. Measure the area of each service area by using a scale, and enter the value on the map.

1. Summarize the basic design criteria.

a. Design period (usually saturation period used);
b. Population density;
c. Residential wastewater flow (Obtain the peaking factor);
d. Infiltration allowances;
e. Inflow allowances
f. Hydraulic design equation;
g. Minimum pipe size ;
h. Minimum velocity; and
i. Minimum cover.

Prepare tabulation form to record the data and steps in the compilations for each section of sewer between Manholes.
N.B. If sewer changes direction in a manhole without change of size, a drop of 30 mm should be provided in the manhole. If the sewer changes size, the crowns of the inlet and outlet sewers should be at the same elevation. Branches coming into manholes should have their crowns at the same elevation as that of the large sewer. Drop manholes are used only if the invert of the branch is 0.6 m or more above what its location would be when following the rule just stated.



Minimum slopes of sewers

To assure that sewers will carry suspended sediment, two approaches have been used:
The minimum (o r self-cleansing) velocity and

The minimum boundary shear stress method, also called the"tractive force"

Self-cleansing - a full-pipe velocity of at least 0.6 m/s
Minimum slopes of sewers

To assure that sewers will carry suspended sediment, two approaches have been used:

The minimum (or self-cleansing) velocity and the minimum boundary shear stress method, also called "tractive force"

self-cleansing - a full-pipe velocity of at least 0.6 m/s

Design of storm sewers

Generally, storm sewers are designed to provide safe passage of vehicles, and to collect, convey and discharge for frequently occurring, low-return-period storms. Storm sewer design involves estimation runoff from an area design of the sewer and other hydraulics structures in the drainage system.

Design flow

Design flow is the maximum flow that can pass through a specified structure safely. In determining this design flow the possibility of occurrence has be fixed. Once this is fixed the design flow magnitude can be determined.

Generally, a design frequency is selected to match the facility's cost, amount of traffic, potential flood hazard to property, expected level of service, political considerations, and budgetary constraints, considering the magnitude and risk associated with damages from larger flood events.

The frequency with which a given flood can be expected to occur is the reciprocal of the probability or chance that the flood will be equaled or exceeded in a given year. If a flood has a 20 percent chance of being equaled or exceeded each year, over a long period of time, the flood will be equaled or exceeded on an average of once every five years. This is called the **Recurrence Interval**(RI). Thus the exceedence probability equals 100/RI. Generally, to design drainage facilities the recurrence interval shown in table 4-1 can be used.

Table 4-1 Return Period Based on Type of Structures.

Drainage Type	**Return Period**
Side Ditch	10
Pipe Culvert	10
Slab/Box Culvert	25
Bridge	50/100

The commonly used hydrologic methods used to estimate are the following:

• **Rational Method** - only for drainage areas less than 50 hectares (0.5 kilometer^2);

• **SCS and other Unit Hydrograph Methods** - for drainage areas greater than 50hectares;

• **Suitable Computer Programs** - such as HYDRAIN's HYDRO, HEC 1, and TR-20 will be used to facilitate tedious hydrologic calculations.

Rational Method

Runoff from an area can be determined by the Rational Method. The method gives a reasonable estimate up to a maximum area of 50 ha (0.5 Km^2.

The rational method makes the following assumptions:

- Precipitation is uniform over the entire basin.
- Precipitation does not vary with time or space.
- Storm duration is equal to the time of concentration.
- A design storm of a specified frequency produces a design flood of the same frequency.
- The basin area increases roughly in proportion to increases in length.
- The time of concentration is relatively short and independent of storm intensity.
- The runoff coefficient does not vary with storm intensity or antecedent soil moisture.
- Runoff is dominated by overland flow.
- Basin storage effects are negligible.

Thus, the peak runoff is calculated according to the following formula:

$$\mathbf{Q = CiA/360}$$

Where,

Q = runoff [m^3/s]
C = runoff coefficient which can be given for a land use or surface type
i = design rainfall intensity [mm/hr] A
= area [ha]

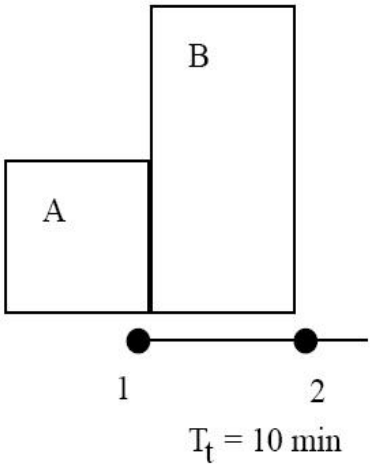
The sewer design procedure is as follows

Establish the layout of the storm sewer
Estimate the design runoff by the Rational Method
Determine the sewer size by the Manning formula

$$Q = \frac{1}{n} R^{2/3} S^{1/2} A$$

Check for velocity; if not in the range change the sewer diameter
Determine sewer invert elevations

Example A storm sewer is proposed to drain a 12 hectares drainage area shown in the figure below. With given data in the table below determine the design discharge needed to convey 5-year peak discharge.



Site	Area (ha)	C	Inlet time (min)
A	4	0.8	10
B	8	0.5	30

Solution

Upstream Area (Manhole 1): $A = 4$ ha

$C = 0.8$

$t_c = 10$ min

$i = 2700/(10+15) = 108$ mm/hr

$Q_p = CiA/360 = (0.8)(108)(4)/360 = 0.96$ m^3/sec

Downstream Area (Manhole 2):

$A = 4 + 8 = 12$ ha

$C = (0.8 \times 4 + 0.5 \times 8)/ 12 = 0.6$

Time from A – 1 – 2 = 10 + 10 = 20 min

Time from B – 2 = 30 min (**max**)

$t_c = 30$ min

$i = 2700/(30+15) = 60$ mm/hr

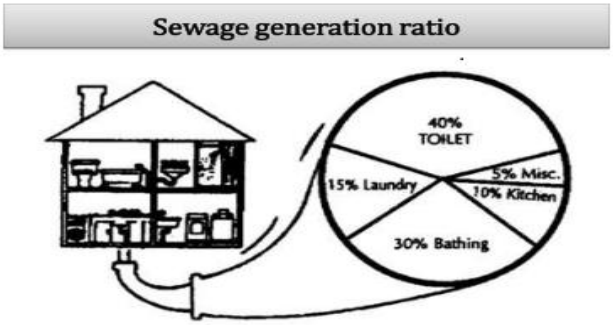
$Q_p = CiA/360 = (0.6)(60)(12)/360 = 1.2$ m^3/sec

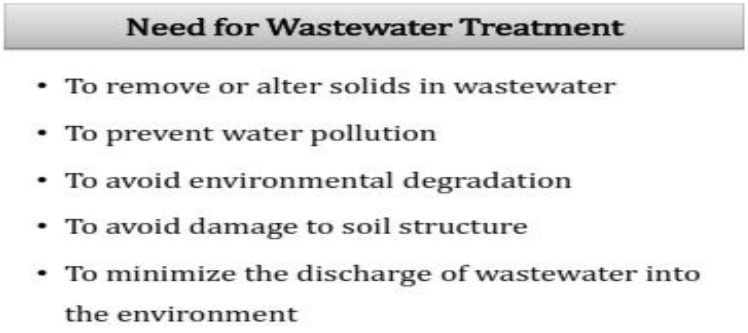
UNIT III PRIMARY TREATMENT OF SEWAGE

Objective – Unit Operation and Processes – Selection of treatment processes – Onsite sanitation - Septic tank, Grey water harvesting – Primary treatment – Principles, functions design and drawing of screen, grit chambers and primary sedimentation tanks – Operation and Mintenance aspects.

3.1 Introduction

The most modern of Watercare's wastewater treatment plants– including the plants at Mangere and Rosedale – use primary (mechanical), secondary (biological), tertiary (filtration) and ultraviolet (radiation) methods to treat domestic and industrial wastewater (sewage) and storm water. The average volume of wastewater treated is 300,000 cubic metres per day. Wastewater treatment is designed to safeguard public health and to protect the environment. Wastewater (sewage) is 99 percent water and usually contains:





Organic material – solid organic wastes such as food

scraps, toilet wastes, paper etc. (including leaves/wood etc from storm water infiltration). Food processing and textile industries contribute large quantities of organic materials, ie fruit/vegetable pulp, wool etc.

Grease and oils – household wastes contain cooking oil/ fat, soap and body oils from baths / showers. Industrial wastes can contain greasy organic compounds and inorganic (mineral) oils.

Inorganic material – wastewater contains sand, silt and gravel (grit). Most of this comes from stormwater infiltration.

Nutrients – our bodies need nutrients like phosphorus and nitrogen and these are naturally excreted in our wastes. Some industrial wastes also contain nutrients.

Metals – tiny amounts of metals, ie iron, copper and zinc, are naturally present in human wastes. Others such as lead, chromium and cadmium can be present from stormwater run-off and industry.

Chemicals – as a result of household cleaning (eg dish washing detergents and shampoos) or through process wastes from industry, many different chemicals are contained in wastewater, some of which are toxic.
Micro-organisms – bacteria, viruses and other micro- organisms that live in the human gut and are excreted in large numbers. Most of these organisms are harmless and some are even beneficial. Sick people, however, can excrete large numbers of pathogenic (disease-causing) micro- organisms, which end up in the wastewater flow.

The contents of the stream will vary depending on the season, day, time and the type of industries being served.

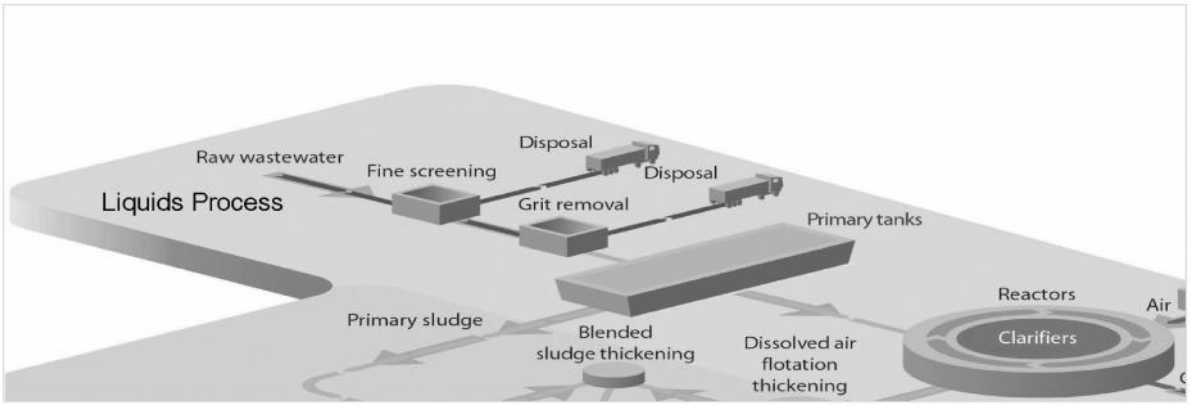
3.2 Pre-treatment

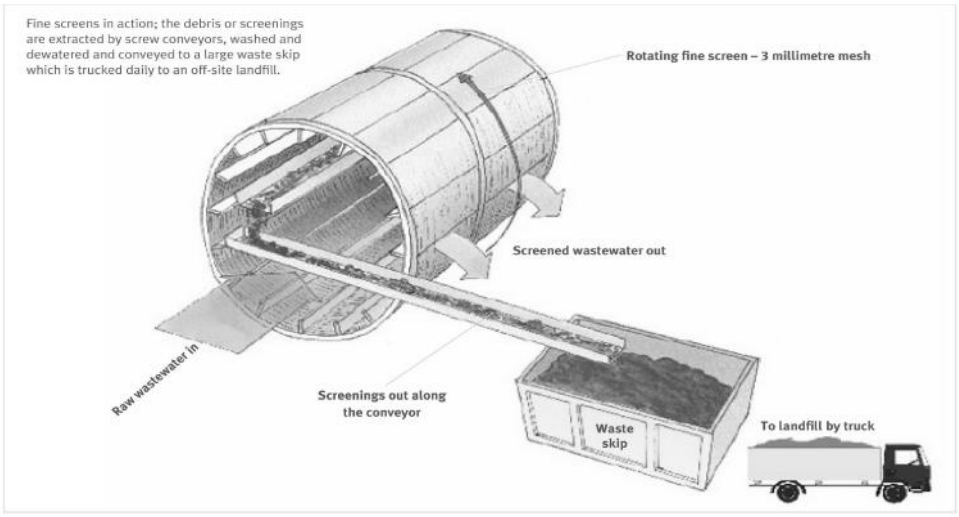
Pre-treatment, which includes screening and grit removal, is carried out at the start of the treatment process. Pre-treatment is designed to remove solid objects, along with grease and oil, which impede efficient wastewater treatment and are undesirable in the end product biosolids.

Removal of solid objects is also undertaken to protect machinery
(especially pumping equipment) and to prevent blockages in
Smaller pipes and channels, which transport the wastewater around the treatment plant.

Pre-treatment also reduces the biochemical oxygen demand (BOD) of the wastewater. BOD is a measure of the strength or pollution potential of the wastewater.

Pre-treatment occurs when wastewater from Auckland's wastewater
Interceptors enters a mixing chamber at the start of processing. The interceptors – Western, Eastern, Southwestern and Southern interceptors – are Auckland's main sewers (the Southern interceptor combines with the Eastern before it enters the treatment plant.) Odorous air and gases are extracted at this point and at numerous stages throughout the treatment process and passed through odour control biofilters. After the mixing chamber, the wastewater flows into six channels, each capable of taking 2,700 litres per second.





3.1 Screening

Screening is the first line of treatment at the entrance to the wastewater treatment plant where six new fine screens, arranged in parallel channels, intercept solid material in the influent wastewater.

The fine screens replace the old-technology (19 millimetre bar screens) and have a stainless steel mesh with apertures of three millimetres. The drum-shaped screens are not static pieces of equipment but are large revolving mechanisms, constantly rotated by hydraulic drives. The screens break up the raw sewage flowing into the plant and extract material such as paper, fruit and vegetable pulp, plastic, wood and sanitary items.

Banks of water jets within the rotating screens constantly blast the debris from the mesh. The debris or screenings (up to eight tonnes per day) are extracted by screw conveyors, washed and dewatered and conveyed to a large waste skip which is trucked daily to an off-site landfill.

3.2 Pre-aeration tanks

The 12 grit removal tanks, also known as pre-aeration tanks, are
14 metres x 12 metres with a water depth of 4.6 metres. Each tank has a volume of 703 cubic metres and is partially divided into two sections (north and south) with one air sparge pipe and one grit ejector in each section.

Air, pumped from a perforated pipe running along the side of the tank floors, generates a

swirling motion which reduces the effective density of the wastewater. This encourages the inorganic material (finer than three millimetres), namely, sand, silt and fine gravel to settle out. The aeration process also adds oxygen to the wastewater which, by the time it reaches the treatment plant, can be oxygen deficient.

The organic solids remain in suspension. The settled grit is collected in a hopper at one end of the steeply sloping floor. Here grit pumps automatically extract the grit and transfer it through a pipe network to grit washing facilities above the truck loading bay. It is then removed by water ejection to a washing tank and fed into another hopper by a screw conveyor where it is dewatered. The extracted grit is trucked off-site for disposal in landfills

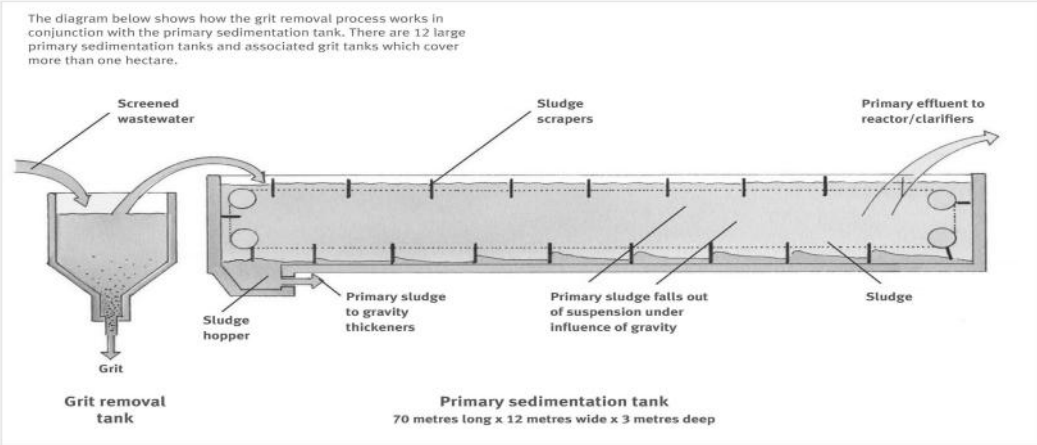
3.3 Primary sedimentation tanks

The 12 primary sedimentation tanks are each 70 metres long and 12 metres wide, with an average water depth of 2.8 metres. These are large tanks which are designed to allow the wastewater to flow slowly through in a smooth motion, free from turbulence enabling the organic solids to settle to the bottom. Retention time in the primary tanks is two to three hours.

The sludge is collected by two parallel, chain-driven flight scrapers. These move continuously along the sloping floors of the tanks, slowly ploughing the sludge towards the end of the tank where a cross collector (also chain and flight) moves the sludge into a deep hopper. From here, it is removed by new centrifugal pumps to a sludge sump.

Scum, which rises to the surface of the tanks, is directed by fan- shaped water jets to the inlet end of the tank. Here, it is lifted over a wall and into a trough by rotating scum collectors and carried into the sludge sump. The sludge and scum from the primary
Sedimentation tanks are pumped to the gravity thickeners. After the sludge has been thickened in the gravity thickeners, it is sent to the gravity belt thickeners for further thickening before being sent to
the digesters. At this stage, over 70 percent of the suspended solids have been separated from the liquid waste stream with 40 percent
of the BOD removed.

After separation in the primary sedimentation tanks, the liquid stream is conveyed via the interstage pump station at a rate of up to nine cubic metres per second to the reactor/clarifiers for secondary treatment. (See the information sheet *Secondary treatment – liquid*).



3.4 Odour control

Odour control is an important aspect of the wastewater treatment process. Odorous air is collected at various stages of treatment by ventilation fans and ducted to booster fans, which pass it through earth filters (biofilters).

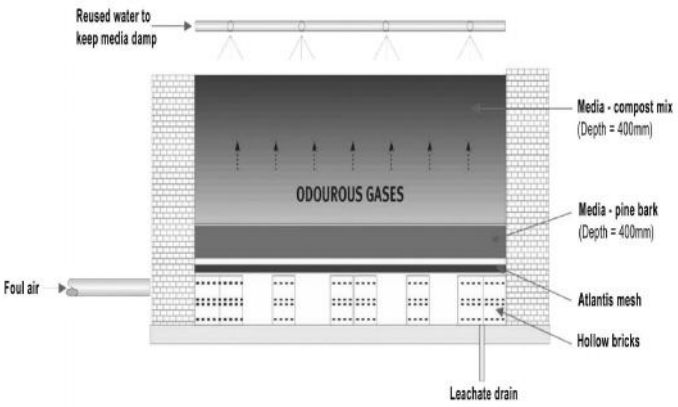
There are six earth filter beds covering the primary treatment stage. Each filter bed is 800 millimetre deep and divided in two sections. The filters cover a combined area of about 6,200 square metres.

Each filter has been upgraded with new media (designed by Watercare scientists) made up of scoria and bark insteadof scoria and soil. Bark has the advantage over soil in that its quality is more easily controlled and it allows for a less dense mixture, giving less resistence to airflow.

The new improved biofilter media is more effective and has a longer working life.

Odorous air is evenly distributed beneath the media by a system of header and distribution pipes. As it percolates upwards, the odorous compounds are treated by bacteria within the media. Odorous compounds are removed by physical and bacterial processes before being discharged to air.

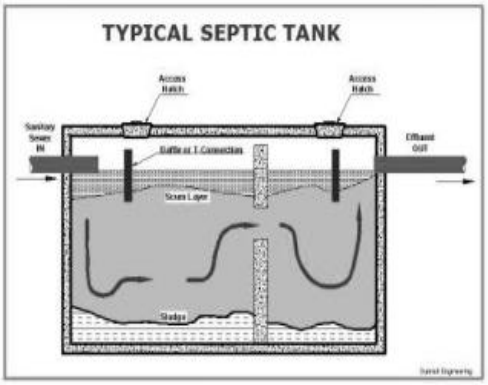
Biofilters also treat air extracted from other areas of the treatment plant including the pre-treatment mixing chamber, gravity thickeners, the splitter boxes and the biosolids dewatering building



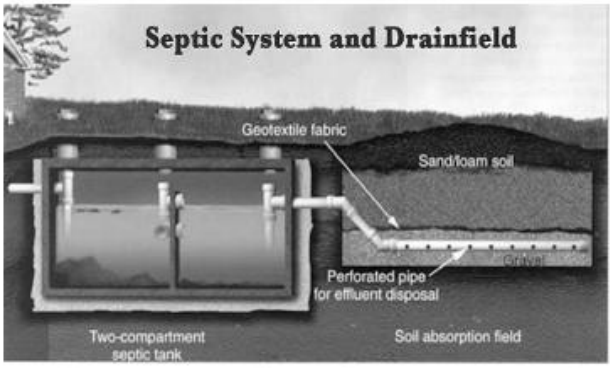
3.5 Septic Tank

- Primary Sedimentation tank
- Detention period – 12 to 36 hours
- Works on the principle of anaerobic decomposition
- Rectangular chambers – either single or multiple compartment type – constructed below GL
- Removes about 60 to 70% dissolved matter from it

Septic tank



Septic tank



Design Considerations

Number of souls per house hold: **5**

Number of fixtures per house hold: **1**

% of unit discharging simultaneously: **60**

Discharge from each unit: **10 Lpm at peak hours**

Surface area of sedimentation: **1 m^2/10Lpm of peak discharge**

Minimum depth for sedimentation: **30cm**

Minimum detention time: **24 hours**

Volume of fresh sludge: **0.0005m³ / capita / day**

Digestion period: **45 days**

Digested sludge: **0.03 to 0.07 m³ / capita / annum**

Minimum total volume of septic tank: **2 times the daily DF**

Cleaning interval: **1 to 4 years**

Length to width ratio: **2 to 3 : 1**

Recommended size of Septic Tank

No of Users	Length	Breadth	Liquid depth, m (Cleaning interval of)	
	m	m	2 years	3 years
5	1.5	0.75	1.0	1.05
10	2.0	0.90	1.0	1.40
15	2.0	0.90	1.3	2.00
20	2.3	1.10	1.3	1.80

09-Nov-13 M.R.Emilkumar - AP/Civil 19

Construction Aspects

- Baffle or tee is to penetrate at least 150mm below the liquid level
- Inspection pipes at the top of the tank
- No tank shall have more than 3 compartments
- Structure with more than 1 compartment produce better quality effluent
- First compartment is twice the size of second
- Liquid depth – 1.0 to 1.8m

M.R.Emilkumar - AP/Civil 20

Design a septic tank for a population of 150 in a housing colony.

Given:

Population of the colony: 150 persons

Solution:

Peak discharge = 150 x 1 x 0.6 x 10 / 5 = 180 Lpm

Surface area required = 180 / 10 = 18 m^2

At 30 cm depth for sedimentation,

Volume for sedimentation = 18 x 0.3 = 5.40 m^3

Volume for fresh sludge = 0.0005 x 150 x 45 = 3.38 m^3

Assume a cleaning interval of one year and sludge accumulation at 0.05 m^3 / capita / year,

Volume of digested sludge = 0.05 x 150 x 1 = 7.50 m^3

Total volume required = 5.40 + 3.38 + 7.50 = 16.28 m^3

Depth required = 16.28 / 18 = 0.90 m

Total depth including free board = 1.20 m

Result:

Size of the **first compartment** at L:W ratio of 2:1,

6.0 m x 3.0 m

Size of the **second compartment** is 50% of the first,

3.0 m x 3.0 m

Overall dimension of the septic tank,

9.0 m x 3.0 m x 1.20 m

UNIT IV SECONDARY TREATMENT OF SEWAGE

Objective – Selection of Treatment Methods – Principles, Functions, Design and Drawing of Units - Activated Sludge Process and Trickling filter, other treatment methods – Oxidation ditches, UASB – Waste Stabilization Ponds – Reclamation and Reuse of sewage - Recent Advances in Sewage Treatment – Construction and Operation & Maintenance of Sewage Treatment Plants.

4.1INTRODUCTION

The quality of effluent provided by secondary treatment may not be always sufficient to meet discharge requirements. i.e.

When large quantities are discharged into small streams

Delicate ecosystems are encountered

Further treatment may be required to remove nutrients (N, P), suspended solids, dissolved inorganic salts and refractory organics

2.1 Nutrient Removal

a. Nitrogen Removal

-Nitrification-denitrification

-Air Stripping

b. Phosphorus Removal

The quality of effluent provided by secondary treatment may not be always sufficient to meet discharge requirements. i.e.

When large quantities are discharged into small streams

Delicate ecosystems are encountered

Further treatment may be required to remove nutrients (N, P), suspended solids, dissolved inorganic salts and refractory organics

Nitrogen Removal using Nitrification-Denitrification

4.2Ammonification

Nitrogen compounds results in wastewater from biological decomposition of proteins and from urea discharged in body waste.

This nitrogen is bound in complex organic molecules and is called **Organic Nitrogen**.

While traveling through sewer pipes, the majority of organic-nitrogen is converted to ammonia through the process of hydrolysis.

4.2.1 Biological Characteristics

Microorganisms may be classified according to nutrient requirements
All organisms require:

An Energy source– for (1) maintenance and (2) biosynthesis
A Carbon Source– for growth of microbes

Heterotrophic – these are microorganisms that uses organic compounds as BOTH a carbon source and as an energy source.

These organisms are mostly employed in WWT

Chem-Autotrophs – these are organisms that uses inorganic compounds as BOTH an energy source and a carbon source.

4.3 Nitrification

Typical wastewater influent can contain 85 mg/L total Nitrogen.
Though conventional treatment can remove 20 – 30 % ,
Nitrification-Denitrification can remove 70 – 90%
Ammonia Nitrogen is the most reduced nitrogen compound found in wastewater. This compound can be converted to Nitrogen by biological processes.This process is done in two (2) steps:

Ammonia is first oxidized to Nitrate
Nitrate is reduced to molecular Nitrogen

The organisms responsible for nitrification are chem-autotrophic bacteria, *nitrosomonas* and *nitrobacter.* These are aerobic bacteria and therefore need free oxygen to work.

Ammonia Nitrogen can be biologically oxidized by chem-autotrophic bacteria to nitrates if molecular oxygen is present:

$$NH_4^+ + \frac{3}{2}O_2 \xrightarrow{Nitrosomonas} NO_2^- + 2H^+ + H_2O$$

$$NO_2^- + \frac{1}{2}O_2 \xrightarrow{Nitrobacter} NO_3^-$$

These reactions require a great supply of oxygen. Contact time in secondary treatment may be sufficient to convert organic nitrogen to ammonia nitrogen but not sufficient to convert ammonia nitrogen to nitrates.

This reaction consumes about 4.6 mg of O2 7.1 mg alkalinity per mg ammonia nitrogen.
Under favourable conditions this process can be accomplished in combination with carbonaceous removal in secondary systems.

e.g. Extended Aeration System **or** done more efficiently, using a separate nitrification reactor.

4.4 De-Nitrification

Nitrate is reduced to nitrogen gas by the same facultative, heterotrophic bacteria involved in oxidation of carbonaceous material.

Denitrification occurs when oxygen levels are depleted and nitrate becomes the primary oxygen source for microorganisms.

The process is performed under anoxic conditions, when the dissolved oxygen concentration is less than 0.5 mg/L, ideally less than 0.2.

When bacteria break apart nitrate (NO_3^-) to gain the oxygen (O_2), the nitrate is reduced to nitrous oxide (N_2O), and, in turn, nitrogen gas (N_2).

For the process to proceed, the bacteria needs a carbon source. This can be obtained from carbon within the waste or a small amount of primary effluent can be added. Alternatively, an external source of carbon can be provided (Methanol).

After leaving the anoxic tank, the wastewater is aerated for
10 to 15 minutes to drive off the Nitrogen gas and add oxygen to the wastewater before sedimentation

The Air Stripping Process

The process consist of converting the ammonium to the gaseous phase and then dispersing the liquid in air

The gaseous phase NH_3 and the aqueous phase NH_4^+ exist together in equilibrium and the dominance of any one is dependent on pH and Temperature. A pH of >11 is required for complete conversion to NH_3

4.5 The Operation

Lime is used to raise the pH to >11

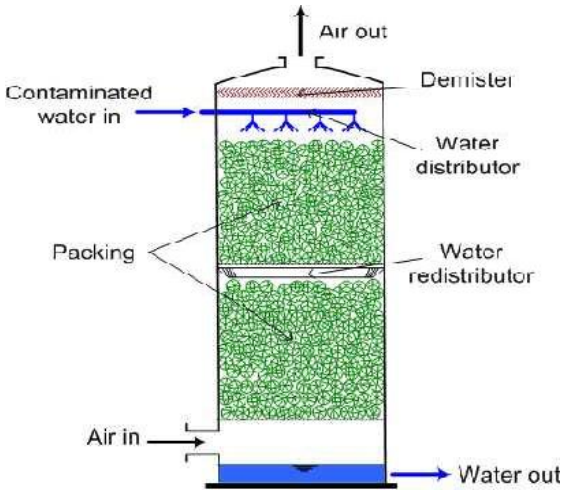
Stripping of de-gasification is most efficiently done using a counter current spray tower.

Design Parameters are:

2000-6000 m^3 of air / m^3 wastewater

Tower Depths > 7.5 m

HRL 40– 46 L/min/m^2 of tower



Advantages and Disadvantages of the air Stripping

Air stripping is the most economical means of removing nitrogen, however, as temperature approaches freezing the efficiency drops significantly.

Noise pollution by roaring fans.

Air pollution by odor caused by release of ammonia gas.

Addition of lime cause softening of WW of alkalinity.
The precipitation of calcium carbonate on the packed media therefore requires continuous cleaning.

4.6 Phosphorus Removal

Characteristics of Phosphates in WW

Phosphorus is a constituent of municipal wastewater, averaging around 15 – 10 mg/L. It exist in 3 forms

Organically bound phosphorus–Body waste and food waste

Polyphosphates- Used extensively in detergents and contributes to about half the phosphorus in WW

Orthophosphates – Results due to biological decomposition of organically bound phosphates and hydrolysis of polyphosphates

Thus, the principal phosphate found in WW is Orthophosphates

Orthophosphates consist of (phosphate) PO_4^{3-}, HPO_4^{2-} and $H_2PO_4^-$ and form chemical bonds with cations and positive radicals.

These compounds are highly soluble, thus negligible removal occurs in primary treatment. However, < 3mg/L is removed in biomass from secondary treatment due to utilization by microorganisms.

4.6.1 At Slightly Acidic pH

Chemical precipitation is the principal method used to remove phosphorus. At slightly acidic pH, orthophosphates combine with trivalent aluminum or iron cations to form a ppt.

Since domestic wastewater only contains trace amounts of iron and aluminum, thus, Alum (aluminum sulphate) or Ferric Chloride will have to be added.

At Higher pH

Calcium forms an insoluble complex with phosphate at pH >9.0.
The addition of lime can provide both the calcium and pH adjustments necessary.

4.7 Process Selection

The removal of phosphorus can occur as part of the primary or secondary treatment process or as a tertiary process.The choice of process depends on efficiency requirements,

a. If up to 1mg/L is acceptable for discharge, iron or aluminum salts added to the primary or secondary process is often done.

b. If greater efficiency is needed, tertiary system is employed with the addition of lime.

Solids Removal- Suspended Solids Removal

The removal of suspended solids from wastewater refers to the removal of particles and floc to small or too lightweight to be removed in gravity settling

These particles may have been brought over from secondary treatment or ppt in tertiary treatment.

4.7.1Methods of removal

1 Centrifugation
2 Air Floatation
3 Mechanical Micro straining
4 Filtration (most common)

Filtration

Slow Sand Filters

This method is most successful as a polishing step in oxidation ponds.
(Not suitable for effluent from conventional treatment due to clogging)

Granular-media Filtration

The bed comprise duel or multimedia beds and is most suited for effluent from secondary treatment

Moving Bed Filters

These are continuous cleaned, with the rate of cleaning adjusted to match the solids loading rate. This system as the ability to filter raw sewage.

Pulse-bed Filters

Compressed air is periodically injected to break up the thin surface mat of deposits.This system as the ability to filter raw sewage.

Solids Removal- Dissolved Solids Removal

Secondary treatment as well as nutrient removal decreases the dissolved organic solids present in WW However, neither process completely removes ALL organic dissolved solids OR significant amounts of inorganic dissolved solids.

If substantial reduction in dissolved solids is required, further treatment would be needed. These techniques are similar to that used in the advanced treatment ofWater for removal:

Ion Exchange

Microporous Membrane Filtration

Adsorption

Chemical Oxidation

4.8 Chemical Oxidation

This technique can be used as an alternative to adsorption for the removal of refractory organic compounds from water and wastewater treatment systems

The target contaminants include; large complex organic, ring-structured detergents, phenolics & humic compounds. These are broken down into simple compounds by strong oxidants e.g. Ozone, Chlorine.

Advantage and Disadvantages

Advantages

Removal of ammonia

Oxidation of inorganic substances as iron and manganese

Disinfection

Disadvantage

Chlorine reacts with some organics to form haloform

High doses of ozone is required 3:1

Wastewater Disposal

The most common method of disposal is by dilution. Disposal to a stream is dependent of the level of dilution capable by the stream as well as the sensitivity of the stream to small changes

Otherwise, tertiary treatment may be needed before discharge. This is normally in the form of nutrient removal.

Natural Evaporation

The process is most useful in climates where evaporation exceeds precipitation.

The system is essentially large oxidation ponds with a surface area suited to the

rate of inflow.

Ocean Disposal

This is a efficient and cost effective method. The effluent is transported out to sea by pipelines along the ocean floor and discharged at multiple points. The length of the outfall depends on the ocean currents and volume of wastewater.

Land Application

Land application can be a form of disposal as well as a method of reuse. These include Irrigation and Rapid Infiltration

Irrigation

1. Wastewater is applied to land surface to provide both water and nutrients for plant growth.

2. Applications include agriculture, silviculture, maintain vegetation in parks, golf courses, along roadways and airport runways.

3. In most cases food chain crops (i.e. crops consumed by humans and those animals whose products are consumed by humans) may not be irrigated by effluent. However, field crops such as cotton, sugar beets, and crops for seed production are grown with wastewater effluent.

UNIT V DISPOSAL OF SEWAGE AND SLUDGE

Standards for Disposal - Methods – dilution – Self purification of surface water bodies – Oxygen sag curve – Land disposal – Sewage farming – Deep well injection – Soil dispersion system - Sludge characterization – Thickening – Sludge digestion – Biogas recovery – Sludge Conditioning and Dewatering – disposal – Advances in Sludge Treatment and disposal.

1.1INTRODUCTION

As research into the characteristics of wastewater has become more extensive, and as the techniques for analyzing specific constituents and their potential health and environmental effects have become more comprehensive, the body of scientific knowledge has expanded significantly. Many of the new treatment methods being developed are designed to deal with health and environmental concerns associated with findings of recent research. However, the advancement in treatment technology effectiveness has not kept pace with the enhanced constituent detection capability. Pollutants can be detected at lower concentrations than can be attained by available treatment technology. Therefore, careful assessment of health and environment effects and community concerns about these effects becomes increasingly important in wastewater management. The need to establish a dialogue with the community is important to assure that health and environmental issues are being addressed.

Water quality issues arise when increasing amounts of treated wastewater are discharged to water bodies that are eventually used as water supplies. The waters of the Mississippi River and many rivers in the eastern United States are used for municipal and industrial water supplies and as repositories for the resulting treated wastewater. In southern California, a semiarid region, increasing amounts of reclaimed wastewater are being used or are planned to be used for groundwater recharge to augment existing potable water supplies. Significant questions remain about the testing and levels of treatment necessary to protect human health where the commingling of highly treated waste- water with drinking water sources results in indirect potable reuse.

5.2 WASTEWATER CHARACTERISTICS

Prior to about 1940, most municipal wastewater was generated from domestic sources. After 1940, as industrial development in the United States grew significantly, increasing amounts of industrial wastewater have been and continue to be discharged to municipal collection systems. The amounts of heavy metals and synthesized organic compounds generated by industrial activities have increased, and some 10,000 new organic com- pounds are added each year. Many of these compounds are now found in the wastewater from most municipalities and communities.

As technological changes take place in manufacturing, changes also occur in the compounds discharged and the resulting wastewater characteristics. Numerous compounds generated from industrial processes are difficult and costly to treat by conventional wastewater treatment processes. Therefore, effective industrial pretreatment

becomes an essential part of an overall water quality management program. Enforcement of an industrial pretreatment program is a daunting task, and some of the regulated pollutants still escape to the municipal wastewater collection system and must be treated. In the future with the objective of pollution prevention, every effort should be made by industrial dischargers to assess the environmental impacts of any new com- pounds that may enter the wastewater stream before being approved for use. If a com- pound cannot be treated effectively with existing technology, it should not be used.

5.3 Improved Analytical Techniques

Great strides in analytical techniques have been made with the development of new and more sophisticated instrumentation. While most constituent concentrations are reported in milligrams per liter (mg/L), measurements in micrograms per liter (µg/L) and nanograms per liter (ng/L) are now common. As detection methods become more sensitive and a broader range of compounds are monitored in water supplies, more contaminants that affect humans and the environment will be found. Many trace compounds and microorganisms, such as *Giardia lamblia* and *Cryptosporidium parvum,* have been identified that potentially may cause adverse health effects. Increased analytical sophistication also allows the scientist and engineer to gain greater knowledge of the behavior of wastewater constituents and how they affect process performance and effluent quality.

5.4 Importance of Improved Wastewater Characterization

Because of changing wastewater characteristics and the imposition of stricter limits on wastewater discharges and biosolids that are used beneficially, greater emphasis is being placed on wastewater characterization. Because process modeling is widely used in the design and optimization of biological treatment processes (e.g., activated sludge), thorough characterization of wastewater, particularly wastewaters containing industrial waste, is increasingly important. Process modeling for activated sludge as it is currently conceived requires experimental assessment of kinetic and stoichiometric constants. Fractionization of organic nitrogen, chemical oxygen demand (COD), and total organic carbon into soluble and particulate constituents is now used to optimize the performance of both existing and proposed new biological treatment plants designed to achieve nutrient removal. Techniques from the microbiological sciences, such as RNA and DNA typing, are being used to identify the active mass in biological treatment processes.

Waste water Disinfection.

Changes in regulations and the development of new technologies have affected the design of disinfection systems. Gene probes are now being used to identify where specific groups of organisms are found in treated secondary effluent (i.e., in suspension or particle-associated). Historically, chlorine has been the disinfectant of choice for wastewater. With the increasing number of permits requiring low or non detectable amounts of chlorine residual in treated effluents, dechlorination facilities have had to be added, or chlorination systems have been replaced by alternative disinfection systems such as ultraviolet (UV) radiation (see Fig. 1–6). Con- cerns about chemical safety have also affected design considerations of chlorination and dechlorination systems. Improvements that have been made in UV lamp and bal- last design within the past 10 years have improved significantly the performance and reliability of UV disinfection systems. Effective guidelines have also been developed for the application and design of UV systems (NWRI, 2000). Capital and operating costs have also been lowered. It is anticipated that the application of UV for treated drinking water and for storm water will continue to increase in the future. Because UV produces essentially no troublesome by-products and is also effective in the reduction of NDMA and other related compounds, its use for disinfection is further enhanced as compared to chlorine compounds.

5.5 Combined Sewer Overflows (CSOs), Sanitary Sewer Overflows (SSOs), and Nonpoint Sources.

Overflows from combined sewer and sanitary sewer collection systems have been recognized as difficult problems requiring solution, especially for many of the older cities in the United States. The problem has become more critical as greater development changes the amount and characteristics of storm water runoff and increases the channelization of runoff into storm,

combined, and sanitary collection systems. Combined systems carry a mixture of wastewater and storm water runoff and, when the capacity of the interceptors is reached, overflows occur to the receiving waters. Large overflows can impact receiving water quality and can prevent attainment of mandated standards. Recreational beach closings and shell-fish bed closures have been attributed to CSOs (Lape and Dwyer, 1994). Federal regulations for CSOs are still under development and have not been issued at the time of writing this text (2001).

A combination of factors has resulted in the release of untreated wastewater from parts of sanitary collection systems. These releases are termed sanitary system over- flows (SSOs). The SSOs may be caused by (1) the entrance of excessive amounts of storm water, (2) blockages, or (3) structural, mechanical, or electrical failures. Many overflows result from aging collection systems that have not received adequate upgrades, maintenance, and repair. The U.S. EPA has estimated that at least 40,000 overflows per year occur from sanitary collection systems. The untreated wastewater from these overflows represents threats to public health and the environment. The U.S. EPA is proposing to clarify and expand permit requirements for municipal sanitary collection systems under the Clean Water Act that will result in reducing the frequency and occurrence of SSOs (U.S. EPA 2001). At the time of writing this text (2001) the pro- posed regulations are under review. The U.S. EPA estimates that nearly $45 billion is required for constructing facilities for controlling CSOs and SSOs in the United States (U.S. EPA, 1997).

The effects of pollution from nonpoint sources are growing concerns as evidenced by the outbreak of gastrointestinal illness in Milwaukee traced to the oocysts of *Cryp- tosporidium parvum,* and the occurrence of *Pfiesteria piscicida* in the waters of Mary- land and North Carolina. *Pfiesteria* is a form of algae that is very toxic to fish life. Runoff from pastures and feedlots has been attributed as a potential factor that triggers the effects of these microorganisms.

5.5.1 Future Trends in Wastewater Treatment

In the U.S. EPA Needs Assessment Survey, the total treatment plant design capacity is projected to increase by about 15 percent over the next 20 to 30 years . During this period, the U.S. EPA estimates that approximately 2,300 new plants may have to be built, most of which will be providing a level of treatment greater than secondary. The design capacity of plants providing greater than secondary treatment is expected to increase by 40 percent in the future (U.S. EPA, 1997). Thus, it is clear that the future trends in wastewater treatment plant design will be for facilities providing higher levels of treatment.

Some of the innovative treatment methods being utilized in new and upgraded treatment facilities include vortex separators, high rate clarification, membrane bioreactors, pressure-driven membrane filtration (ultra filtration and reverse osmosis), and ultraviolet radiation (low-pressure, low- and high-intensity UV lamps, and medium-pressure, high-intensity UV lamps). Some of the new technologies, especially those developed in Europe, are more compact and are particularly well suited for plants where available space for expansion is limited.

In recent years, numerous proprietary wastewater treatment processes have been developed that offer potential savings in construction and operation. This trend will likely continue, particularly where alternative treatment systems are evaluated or facilities are privatized. Privatization is generally defined as a public-private partnership in which the private partner arranges the financing, design, building, and operation of the treatment facilities. In some cases, the private partner may own the facilities. The reasons for privatization, however, go well beyond the possibility of installing proprietary processes. In the United States, the need for private financing appears to be the principal rationale for privatization; the need to preserve local control appears to be the leading pragmatic rationale against privatization.

5.6 WASTEWATER RECLAMATION AND REUSE

In many locations where the available supply of fresh water has become inadequate to meet water needs, it is clear that the once-used water collected from communities and municipalities must be viewed not as a waste to be disposed of but as a resource that

must be reused. The concept of reuse is becoming accepted more widely as other parts of the country experience water shortages. The use of dual water systems, such as now used in St. Petersburg in Florida and Rancho Viejo in California, is expected to increase in the future. In both locations, treated effluent is used for landscape watering and other non potable uses. Satellite reclamation systems such as those used in the Los Angeles basin, where wastewater flows are mined (withdrawn from collection systems) for local treatment and reuse, are examples where transportation and treatment costs of reclaimed water can be reduced significantly. Because water reuse is expected to become of even greater importance in the future, reuse applications are considered in Chap. 13.

Current Status

Most of the reuse of wastewater occurs in the arid and semiarid western and southwestern states of the United States; however, an increasing number of reuse projects are occurring in the south including Florida and South Carolina. Because of health and safety concerns, water reuse applications are mostly restricted to non potable uses such as landscape and agricultural irrigation. In a report by the National Research Council (1998), it was concluded that indirect potable reuse of reclaimed water (introducing reclaimed water to augment a potable water source before treatment) is viable. The report also stated that direct potable reuse (introducing reclaimed water directly into a water distribution system) was not practicable. Because of the concerns about potential health effects associated with the reclaimed water reuse, plans are proceeding slowly about expanding reuse beyond agricultural and landscape irrigation, groundwater recharge for repelling saltwater intrusion, and non potable industrial uses (e.g., boiler water and cooling water).

New Directions and Concerns

Many of the concerns mentioned in the National Research Council (NRC, 1998) report regarding potential microbial and chemical contamination of water supplies also apply to water sources that receive incidental or unplanned wastewater discharges. A number of communities use water sources that contain a significant wastewater component. Even though these sources, after treatment, meet current drinking water standards, the growing knowledge of the potential impacts of new trace contaminants raises concern. Conventional technologies for both water and wastewater treatment may be incapable of reducing the levels of trace contaminants below where they are not considered as a potential threat to public health. Therefore, new technologies that offer significantly improved levels of treatment or constituent reduction need to be tested and evaluated. Where indirect potable reuse is considered, risk assessment also becomes an important component of a water reuse investigation. Risk assessment is addressed in Chap. 13.

Future Trends in Technology

Technologies that are suitable for water reuse applications include membranes (pressure-driven, electrically driven, and membrane bioreactors), carbon adsorption, advanced oxidation, ion exchange, and air stripping. Membranes are most significant develop- ments as new products are now available for a number of treatment applications. Mem- branes had been

limited previously to desalination, but they are being tested increasingly for wastewater applications to produce high-quality treated effluent suitable for reclamation. Increased levels of contaminant removal not only enhance the product for reuse but also lessen health risks.

5.7 BIOSOLIDS AND RESIDUALS MANAGEMENT

The management of the solids and concentrated contaminants removed by treatment has been and continues to be one of the most difficult and expensive problems in the field of wastewater engineering. Wastewater solids are organic products that can be used beneficially after stabilization by processes such as anaerobic digestion and com- posting. With the advent of regulations that encourage biosolids use, significant efforts have been directed to producing a "clean sludge" that meets heavy metals and pathogen requirements and is suitable for land application. Regulations for Class B biosolids call for reduced density in pathogenic bacteria and enteric viruses, but not to the levels of Class A biosolids. Further, the application of Class B biosolids to land is strictly regulated, and distribution for home use is prohibited.

Other treatment plant residuals such as grit and screenings have to be rendered suit- able for disposal, customarily in landfills. Landfills usually require some form of dewatering to limit moisture content. With the increased use of membranes, especially in wastewater reuse applications, a new type of residual, brine concentrate, requires further processing and disposal. Solar evaporation ponds and discharge to a saltwater environment are only viable in communities where suitable and environmental geographic conditions prevail; brine concentration and residuals solidification are generally too complex and costly to implement.

Current Status

Treatment technologies for solids processing have focused on traditional methods such as thickening, stabilization, dewatering, and drying. Evolution in the technologies has not occurred as rapidly as in liquid treatment processes, but some significant improvements have occurred. Centrifuges that produce a sludge cake with higher solids content, egg-shaped digesters that improve operation, and dryers that minimize water content are just a few examples of products that have come into use in recent years. These developments are largely driven by the need to produce biosolids that are clean, have less volume, and can be used beneficially.

Landfills still continue to be used extensively for the disposal of treatment plant solids, either in sludge-only mono fills or with municipal solid waste. The number and capacity of landfills, however, have been reduced, and new landfill locations that meet public and regulatory acceptance and economic requirements are increasingly difficult to find. Incineration of solids by large municipalities continues to be practiced, but incineration operation and emission control is subject to greater regulatory restrictions and adverse public scrutiny. Alternatives to landfills and incineration include land application of liquid or dried biosolids and composting for distribution and marketing. Land application of biosolids is used extensively to reclaim marginal land for productive uses and to utilize nutrient content in the biosolids. Composting, although a more

Expensive alternative is a means of stabilizing and distributing biosolids for use as a soil amendment. Alkaline stabilization of biosolids for land application is also used but to a lesser extent.

New Directions and Concerns

Over the last 30 years, the principal focus in wastewater engineering has been on improving the quality of treated effluent through the construction of secondary and advanced wastewater

treatment plants. With improved treatment methods, higher levels of treatment must be provided not only for conventional wastewater constituents but also for the removal of specific compounds such as nutrients and heavy metals. A by-product of these efforts has been the increased generation of solids and biosolids per person served by a municipal wastewater system. In many cases, the increase in solids production clearly taxes the capacity of existing solids processing and disposal methods.

In addition to the shear volume of solids that has to be handled and processed, management options continue to be reduced through stricter regulations. Limitations that affect options are: (1) landfill sites are becoming more difficult to find and have per- mitted, (2) air emissions from incinerators are more closely regulated, and (3) new requirements for the land application of biosolids have been instituted. In large urban areas, haul distances to landfill or land application sites have significantly affected the cost of solids processing and disposal. Few new incinerators are being planned because of difficulties in finding suitable sites and obtaining permits. Emission control regulations of the Clean Air Act also require the installation of complex and expensive pollution control equipment.

More communities are looking toward (1) producing Class A biosolids to improve beneficial reuse opportunities or (2) implementing a form of volume reduction, thus lessening the requirements for disposal. The issue—"are Class A biosolids clean—will be of ongoing concern to the public. The continuing search for better methods of solids processing, disposal, and reuse will remain as one of the highest priorities in the future. Additionally, developing meaningful dialogue with the public about health and environmental effects will continue to be very important.

5.8 Future Trends in Biosolids Processing

New solids processing systems have not been developed as rapidly as liquid unit operations and processes. Anaerobic digestion remains the principal process for the stabilization of solids. Egg-shaped digesters, developed in Europe for anaerobic digestion, are being used more extensively in the United States because of advantages of easier operation, lower operation and maintenance costs, and, in some cases, increased volatile solids destruction (which also increases the production of reusable methane gas) (see Fig. 1–8). Other developments in anaerobic and aerobic digestion include temperature-phased anaerobic digestion and auto thermal aerobic digestion (ATAD), another process developed in Europe. These processes offer advantages of improved volatile solids destruction and the production of stabilized biosolids that meet Class A requirements.

High solids centrifuges and heat dryers are expected to be used more extensively. High solids centrifuges extract a greater percentage of the water in liquid sludge, thus providing a dryer cake. Improved dewatering not only reduces the volume of solids

requiring further processing and disposal, but allows composting or subsequent drying to be performed more efficiently. Heat drying provides further volume reduction and improves the quality of the product for potential commercial marketing

IIIYEAR

Civil Engineering

ENVIRONMENTAL ENGINEERING II
(Two Mark Question and Answers)

25. What are the factors governing design period?

The factors governing design period are,

a. Design period should not exceed the life period of structure.
b. If the funds are not in the sufficient the design period should has to be decreased.
c. The rate of interest is less for the borrowing funds.
d. The of population increases due to industries and commercial establishment.

26. What are the various methods of purification of water?

The various methods of purification of water are,

a. Screening.
b. Plain sedimentation.
c. Sedimentation aided with coagulation.
d. Filteration.
e. Disinfection.
f. Aeration.
g. softening.
h. Miscellaneous treatments such as fluoridation, recarbornation, liming, desalination.

27. Define detention period?

Detention period of settling tank may be defined as the average theoretical time required for the water to flow through tank length.

28. Define coagulation?

The process of addition and mixing the chemical is called coagulation.

29. Define filtration? What are the 2 types of filter?

The process of passing the water through the beds of such granular materials is known as filtration.

The two types of filters are,

a. Slow sand gravity filter.
b. Rapid sand gravity filter.

30. What is schmutzdecke or dirty skin?

The harmless compound so formed, generally form a layer on the top which is called schmutzdecke or dirty skin. The layer helps in absorbing and straining out the impurities.

31. Define uniform coefficient?

It is defined as the ratio of the sieve size in mm through which 60% of the samples of sand will pass, to the effective size of the sand.

32. Differentiate between slow and rapid sand filter with respect to (a). Rate of filtration.
(b). loss of head.

S.NO	ITEMS	SLOW SAND FILTER	RAPID SAND FILTER
1.	Rate of filtration	Small, such as 100 to 20 l/hr/sq .m of filter area.	Large, such as 3000 to 6000 l/hr/sq. m of filter area
2.	Loss of head	Approx 10cm is the initial loss & 0.8 to 1.2m is final limit when cleaning is required	Approx 0.3m is the initial loss & 2.5 to 3.5m is final limit when cleaning is required.

33. Define sterilization?

The chemical used in killing these bacteria are known as disinfectants and the process is known as disinfection or sterilization.

34. What is chloramine?

Chloramine is the disinfectant compounds which are formed by the reaction between ammonia and chlorine.

35. What is softening?

The reduction or removal of hardness from water is known as water softening.

36. What are the methods of removing permanent hardness? The methods removing permanent hardness are,

a. Lime soda process.
b. Base exchange process called zeolite process.
c. Demineralization.

37. Define alkalinity?

It is defined as the quantity of ions in water that will react to neutralize the hydrogen ion. It will thus represent the ability of water to neutralize acid.

38. What is permutit?

The most common artificial zeolite is a white colored substance called permutit manufactured from feldspar, kaolin, clay, and soda.

39. How are aeration water carried out?

Aeration water are carried out as follows,

a. By using spray nozzles.
b. By permitting water to trickle over the cascades.
c. By air diffusion.
d. By using trickling beds.

40. Define fluoridation?

The process of adding fluoride compounds in excess is called as the fluoridation.

41. What are the methods of desalination? The methods of desalination are,

a. Desalination by evaporation & distillation.
b. Electro dialysis method.
c. Reverse osmosis method.
d. Freezing process.
e. Solar distribution method.
f. Other method.

42. What is different system of distribution networks? The different system of distribution networks is,

a. Dead end system.
b. Grid iron system.
c. Ring system.
d. Radial system.

43. What are various methods of distribution system?

The various methods of distribution system are,

a. Gravity system.
b. Pumping system.
c. Combined gravity and pumping system.

44. Define fire storage?

It is sufficient amount of water available in the reservoir for throwing it over the fire in case of fire accidents is called fire storage.

45. Enumerate various chemical parameter of water?

Various chemical parameter of water are,

a. Chlorine content.
b. Nitrogen content.
c. Iron content.
d. Manganese and other metal content.

46. What are the two types of sewage system ?t he two types of sewage system are,

a. Combined system:

When the drainage is taken along with the sewage then it is called as combined system.

b. Separate system:

When the drainage and sewage are taken independently of each through two different sets of sewage is called as separate system.

47. What are the two types of water meter?

The two types of water meter are,

a. Inferential meter.
b. Displacement meter.

48. Define time of concentration?

The period after which the entire area will start contributing to the runoff is called time of concentration.

49. List the components of sewerage system?

The components of sewerage system are,

a. House sewers.
b. Lateral sewers.
c. Branch sewers.
d. Main sewers.
e. Outfall sewers.
f. Man holes.

50. What is peak drainage disturbance?

The method estimating the maximum rate of storm runoff is called as peak drainage disturbance.

51.Mention some shapes of sewer pipes

- Circular shape
- Egg shape
- Horse shoe shape
- Parabolic shape
- Elliptical shape

Rectangular shape

52.What are the forces acting on sewer pipes?

- Internal pressure of sewage

- Pressure due to external loads
- Temperature stress
- Flexural stress

53.What are the materials used for constructing sewer pipes?

- Vitrified clay
- Cement concrete
- Asbestos cement
- Cast iron

54.Give some qualities of the good sewer pipes

- Resistance to corrosion
- Resistance to abrasion
- Strength and durability
- Light weight
- Economy and cost

55.What are the tests conducted in sewer pipes after laying?

- Test for leakage(water test)
- Test for straightness of alignment and obstruction

56.Define sewer appurtenances

- Sewer appurtenances are those structures which are constructed at suitable interval along a sewerage system and help in its efficient operation and maintenance

57.Mention the classification of manholes

- Shallow manholes
- Normal manholes
- Deep manholes

58.What is meant by catch basins?

- Catch basins are nothing but street inlets provided with additional small setting basins for avoiding the entry of the particles like grit, sand ,debris in to the sewer pipes

59.Define inverted siphons

- Inverted siphon is defined as the sewer section constructed lower than the adjacent sewer section and it runs full under gravity with pressure greater than the atmosphere

60.What are the various methods of ventilation for sewers?

- Use of ventilating columns
- Use of ventilating manhole covers
- Proper design of sewers
- Use of mechanical devices

61.What are the different types of pumps used commonly for pumping the sewage?

- Centrifugal pump
- Reciprocating pump
- Pneumatic ejectors (or) Air pressure pumps

62. What is the purpose of using velocity control device in a grid chamber?

- The velocity control device in a grid chamber is providing for settling the grid particles in the sewer pipes and then it is removed by an endless chain to which perforated buckets are fixed

63. Mention the classification of treatment process of sewage

- Preliminary treatment
- Primary treatment
- Secondary treatment
- Complete final treatment

64. State the purpose of using the skimming tanks

- The skimming tanks are employed for removing oils & grease from the sewage and placed before the sedimentation tanks

65. Why baffles are provided in the sedimentation tank in sewage treatment?

- Baffles are required to prevent the movement of organic matters and it escapes along with the effluent and to distribute the sewage uniformly through the cross section of the tank and thus to avoid short circuiting

66. What are the types of trickling filters?

- Conventional trickling filter
- High rate trickling filter

67. What are the operational troubles in trickling filter?

- Fly nuisance
- Odour nuisance
- Ponding troubles

68. Define sludge age

- The sludge age is defined as the average time for which particles of suspended soil remain under aeration

69. Define sludge volume index

- sludge volume index is defined as the volume occupied in ml by 1 gm of solids in the mixed liquor after settling for 30 minutes and is determined experimentally

70. What is meant by biodegradable organic matter?

- The organic matters is decomposed by bacteria under biological action is called biodegradable organic matter

71. What are the various tests for finding the quality of sewage?

- Turbidity test
- Colour test
- Odour test
- Temperature test

72.What is meant by relative stability of a sewage effluent?

- The relative stability of a sewage effluent is nothing but the ratio of oxygen available in the effluent to the total oxygen required to satisfy its first stage BOD demand

73. What are the methods of disposing the sewage effluent

- Disposal in water(dilution)
- By disposal on land

74.What are the different types of sewage treatment?

- Contact beds
- Intermittent sand filters
- Trickling filters
- Miscellaneous type of filters

75.Define sludge digestion

- The process of stabilization of the sewage particles are called sludge digestion

76.What are the stages in the sludge digestion process?

- Acid fermentation
- Acid regression
- Alkaline fermentation

77.What is meant by ripened sludge?

- The ripened sludge is nothing but the digested sludge is collected at the bottom of the digestion tank and it is alkaline in nature

78.What are the factors affecting sludge digestion and their control?

- Temperature
- pH value
- mixing and stirring of raw sludge with digested sludge

79.What are the types of incinerators has primary designed?

- multiple hearth furnace
- fluid bed furnace and infra red furnace

80.What are the methods of aeration ?

- diffused air aeration
- mechanical aeration
- combined aeration

81.What is meant by sludge concentrator unit ?

- the sludge obtained in a sludge digestion plant contains too much of moisture and is therefore very bulky may be reduced in its moisture content by sending into sludge thicker unit (or) sludge concentrator unit

82.Give different types of thicker unit

- Gravity thickener
- Floating thickener
- Centrifugal thickener

83.What are the methods of disposal of septic tank effluent?

- Soil absorption system

- Biological filters
- up flow anaerobic filters

84.Define percolation rate

- peculation rate is defined as the time in minuets required for sewage of water through that ground by one cm

85.what are the soil absorption system

- dispersion trench
- seepage pit (or) soak pit

86.What are the methods of applying sewage effluents to forms ?

- surface irrigation
- free flooding
- border flooding
- check flooding

87.What is meant by oxygen sag curve?

- The amount of resultant oxygen deflect can be obtained by algebraically adding the de -oxygenation and re -oxygenation curves. The resultant curve so obtained is called oxygen sag curve

88.What is meant by sewage sickness?

- The phenomena of soil getting clogged when the sewage is applied continuously on a piece of land is called sewage sickness

89.What are the preventive methods for sewage sickness?

- Primary treatment of sewage
- Choice of land
- Under drainage of soil
- Giving rest to land and Rotation of crops

90.Define dilution factor

- The dilution factor is defined as the ratio of the amount of river water to the amount of the sewage

91.What is meant by self purification?

- The automatic purification of natural water is known as self purification 92.List various natural forces of self purification

- Physical forces

- Chemical forces

93.What are the factors affecting the reduction ?

- Temperature

- Turbulence effect of wind

- Hydrographic

- Available dissolved oxygen

- Rate of re -aeration

94.What is meant by prim lake pollutant ?

- The phosphorus which contains in domestic sewage as well as in the industrial waste which affect the water quality of the lake and its called prim lake pollutant

95.What is meant by de oxygenation curve?

- The curve which represents (or) showing the depletion of D.O with time at the given temperature

96.How the river maintaining its clearness?

- The turbulence in the water body helps in breaking the surface of the stream and helps in rapid re aeration from the atmosphere. Thus it helps in maintaining aerobic conditions in the stream and keeping it clear

97.Name the biological zone in lakes

- Euphonic zone
- Littoral zone
- Benthic zone

98. What is meant by re -oxygenation?

- In order to counter balance the consumption of D.O due to the de – oxygenation ,atmosphere supplies oxygen to the water and the process is called the re -oxygenation

99. What is meant by zone of recovery?

- The zone in which the river water tries to recover from its degraded conditions to its former appearance is called zone of recovery

100. What is meant by sludge banks?

- When the solid waste are thrown into the sea water, chemical react with the dissolved matter of sea water and resulting in some precipitation of solid waste giving a milky appearance to sea water forming the sludge banks

16 MARKS QUESTIONS

1.Describe the step involved in the design of septic tank .And also explain the working of a trickling filter with neat sketch.

2.Explain the methods available and limitations of land disposal of sewage.

3.Explain the different water distribution system layouts with neat sketches.

4.Explain the principles in designing of water supply and drainage in buildings.

5.Explain the different plumbing systems with neat sketches .And also compare the plumbing systems.

6.Explain the operational principles of stabilization ponds and Oxidation ditch.

7.Explain the Streeter Phelps model and its applications. Explain also the different techniques for waste water reclamation.

8.Discuss the various principles of designing drainage system for buildings.

9.Explain the construction steps involved in laying of a sewer line.

10.Explain the design procedure of trickling filter with neat sketches.

11. The population of 5 decades from 1930 to 1970 is given below in the table. Find out the population of 1, 2, 3 decade beyond the last known decade by using arithmetic increase method.

YEAR	1930	1940	1950	1960	1970
POPULATION	25000	28000	34000	42000	47000

12. What are the factors affecting per capita demand?

13. What are intake towers? Explain in brief with neat diagram?

14. What are joints? What are the different types of joints? Explain in brief with neat diagram?

15. What are pipe appurtenances? Explain in brief with neat diagram?

16. What is sedimentation tank? What are the different types of sedimentation tanks?

17. Sketch and explain the salient points of the various types of distribution network?

18. Write the difference between slow sand and rapid sand gravity filter?

19. Explain distribution reservoirs briefly?

20. Explain the method of purification of water?

21. Explain the design of an inverted siphon?

22. Explain pumping station with neat diagram?

23. Write short notes on
    a. Drop man holes.
    b. Lamp holes.
    c. Cleanouts.
    d. Street inlet called gullies.

24. What are the shapes of sewer pipes? Explain in detail.

25. Design the sewer to serve a population of 36000, the daily per capita water supply allowable being 135 L, of which 80% finds its way in to the sewer. The slope available for sewer to be laid is 1 in 625 and the sewer should be designed to carry four times the dry weather flow when running fall. What would be the velocity of flow in sewer when running fall?

DEPARTMENT OF CIVIL ENGINEERING

CE 2354 ENVIRONMENTAL ENGINEERING - II

TWO MARK QUESTIONS WITH ANSWERS

VI - SEMESTER

BY

Ms. P. B. CATHERIN STELLA(AP/CIVIL)

CHENDU COLLEGE OF ENGINEERING AND TECHNOLOGY

Zamin Endathur Village , Madurantakam taluk, Kancheepuram |District – 603 311

UNIT – I

PLANNING FOR SEWARAGE SYSTEMS

1.What are the types of treatment processes?

- Preliminary treatment
- Primary treatment
- Complete final treatment
- Secondary treatment

2. What are the various sources of wastewater generation?

- Industrial Wastes
- Domestic wastes
- Agricultural Wastes

3. List out the types of anaerobic biological units?

- Anaerobic lagoons
- Septic tank
- Inhoff tank

4. What is means by screening?

Screening is the very first operation carried out at a sewage treatment plant and consists of passing the sewage through different types of screens so as to trap and remove the floating matter such as process of cloth, paper, wood, cork, hair, fiber etc.

5. What is the purpose of providing screen?

The main idea of providing screens is to protect the pumps and other equipments from the possible damages due to the floating matter of the sewage.It should be used for removing the floating matters.

6. What are the types of screen?

Classification based on size of the opening

- Coarse screens
- Medium screens
- Fine screens

7. Define bar screen?

Rectangular shaped coarse and medium screens are made of steel bars fixed parallel to one another at desired spacing on a rectangular frame and are called bar screen.

8. Define Communicators?

Comminutes or shredders are the patented devices, which break the larger sewage solids to about 6 mm in size. When the sewage is screened through them such devices are used only in developed countries like USA.

9. What is meant by Screening?

The material separated by screens is called the screenings. It contains 85 to 90% of mixture and other floating matter. It may also contain some organic load which may putrefy, lacing bad smells and nuisance.

10. What are the methods adopted for disposal of screenings?

- Burning
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11. Define Grit Chamber?

Grit chambers, also called or grit channels or grit basins, are intended to remove the inorganic particles (specific graving about 2.65) such as sand, graver, grit, egg, shells, bones etc of size 2 mm or larger to prevent damager to the pumps and to prevent their accumulation in sludge digesters.

12. Define unit process?

Methods of treatment in which the application of physical forces predominate are known as unit operations while methods of treatment in which chemical or biological activities are involved are known as unit process.

13. What are the types of unit operations & processes?

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- Biological unit process

14. Give any two advantages of unit operations/ process?

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The definition time (t) of a settling tank may be defined as the average theoretical time required for the sewage to flow through the tank. Otherwise known as definition period or retention period

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The ratio of the "Flowing through period" to the "detention period" is called the displacement efficiency.

18. What is meant by principle of sedimentation?

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19. Define the term "Sedimentation Burin"?

The burin in which the flow of sewage is retarded is called the settling tank or the sedimentation Tank or the sedimentation Burin.

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Sedimentation aided with coagulation produces better efficient with lesser BOD and suspended solids, as compared to plain sedimentation. Coagulated settling tank requires less space than that required by an ordinary plain settling tank.

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- Cost of chemicals is added to the cost of sedimentation, with out much use, and thereby making the treatment costlier.
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- Temperature
- Violence of agitation

26. What are the merits of chemical precipitation?

- More rapid and through clarification
- Removal of higher percentage of suspended solids.
- Simplicity of operation
- Small size tank is enough

UNIT-II

SEWER DESIGN

1. What are the Demerits of chemical precipitation?

- High cost of chemicals
- Large quantity of sludge which offers difficulty of its removal
- Skilled attendance
- Putrescible efficient

2. What do you mean by chemical precipitation?

When certain chemicals are added to, sewage they produce a precipitate known as flow which in insoluble or slightly soluble in water. The flow attracts small particles to form large size and thus size goes on increasing during the process of settlement.

3. What is do you mean by transitional setting zone?

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- Baffler are required to prevent the movement of organic matter and its escape along with the efficient
- Distribute the sewage uniformly through the cross section of the tank.
- It is used to avoid short circuiting

5.What are the classifications of biological process?

- Aerobic processes
- Anaerobic processes
- Aerobic – anaerobic processes

6.List out the aerobic processes?

- Activated sludge processes
- Trickling filters
- Aerobic stabilization pond
- Aerated lagoon

7.List out the anaerobic process?

- Anaerobic sludge digestion,
- Anaerobic contact processes
- Anaerobic filters
- Anaerobic lagoons or ponds

8.What are the sources of waste water?

- Domestic waste water (i.e sewage)
- Agricultural return waste water
- Industrial waste water

9.What are the methods involved in the treatment of waste water?

Mainly classified into

- Conventional treatment methods
- Advanced waste waster treatment

Conventional treatment methods

- Preliminary processes
- Primary treatment
- Secondary treatment

Advanced waste water treatment

- Tertiary treatment

10.What are the functions involved in the chemical unit processes

- Chemical precipitation
- Gas transfer
- Adsorption
- Disinfection
- Combustion

11. What do you understand by waste water treatment?

The waste water treatment or sewage treatment is a broad term that applies to any process/operation or combination of processes and operations that can reduce the objectionable properties of water carried waste and render it less dangerous with the following.

- Removal of suspended and floatable material
- Treatment of biodegradable organics
- Elimination of patheogenic organisms

UNIT-III

PRIMARY TREATMENT OF SEWAGE

1.Define humus tank?

The efficient of the filter is therefore, passed through a sedimentation take called Humus tank otherwise called secondary clarifier or secondary setting take.

2.What are the distinct stages in the sludge digestion processes?

- Acid fermentation
- Acid repression
- Alkaline fermentation

3.Define the term ripened sludge?

This digested sludge is collected at the bottom of the digestion tank and is also called repented sludge.

4. What are the factors effecting sludge digestion?

Temperature

- Pit value
- Seeding wotu digested sludge
- Mixing and stirring of the raw sludge with digested sludge.

5.What are functions of aeration in ASP?

- Oxygenation of the mixed log wor
- Flocculation of the colloid in sewage influent
- Suspension of activated sludge

6.What are the methods employed for the purpose of certain in ASP?

- Diffused air aeration air aeration
- Mechanical aeration
- Combined diff used air and Mechanical aeration

7.What are the patterns of mechanical aeration?

- Haworth paddle or Sheffield aeration system
- Hartley paddle or bir Mangham Bio flocure lation system
- Simplex aeration system
- Link belt aeration system
- Kessner Brush aeration system

8.List out the important aeration processes in the ASP?

- Conventional process
- Tapered aeration process
- Step aeration process
- Contact slabolisection process
- Completely mixed process
- Modified aeration
- Extended aeration

9.What are the advantage of stabilization ponds or cagoins

- Lower initial lost than required for a mechanical plant.
- Tower operation costs
- Regulation of efficient discharge possible their provoelving control of pollection during critical times of the year.

10.What are the disadvantage of tagoons?

- Requires extensive land area.
- Hence the method can be used only on rural area.
- If used in urban areas, expansion of town and new developments may encroach on the lagoon site.

11.What do you understand by facultative ponds?

A facultative panel combine the features of the acrobite and anacrobic ponds.

- Constructed of intermediate depta (1, to 1.5m)
- A facilitative bond consists of three
    - ✓ Aaerobic Zone
    - ✓ Faculative zone
    - ✓ Anacrobic zone

12.What are remedial measurement for rising sludge problem?

- Increasing the return sludge age
- Increasing the speed of the sludge scroper mechanism, where possible
- Decreasing the mech cell residence come by increasing the sludge write rate

13.What is meant by sludge bulking?

Sludge with poor setting characteristics is termed bulking sludge. It results on poor influent due to thee presence of excessive suspended solids and also in rapid loss of MISS from aeration tank.

14.What are the advantage of increment 8 and filters?

- The efficient from intermittent sand filter is of better quality. It is more clean and more stable and hence does not need further treatment before disposal
- The filter work under acrobic conditions, and hence there is no trouble of odour, files and inserts
- The operation is very simple, requiring no mechanical equipment except for dosing

15.What are the disadvantages of intermittent sand filters?

- The rate of filtration and hence that of load long is very small per unit surface area of the filter hence they cannot be employed for medium size or bigger plants

- They requires large area and large quantity of sand due to which their construction is very lostly.

16.What do you understand by contact beds?

- Confact beds, also called confact filters, are similar to inter mitten sand filters in construction, except that th filtering media is very coarse, consisting of broken stones called ballart of 20 to 50mm gauge.
- A contact bed is a water trough take of masonry walls and of rectangular shape.
- The depth of filtering media is kept b/w 1 to 1.8m

17.What are the operations involved in the contact beds?

- Filling
- Contact
- Emptying
- Oxidation

18.What are the advantage of contact of beds? i) Contact beds can work under small heads.

- Contact beds can be operated without exposing the sewage efficient to view.
- There is no nuisance of filter flows
- The problem of odour is much less as compared to trill long filters.

19.What are the disadvantage of contact beds in T.F?

- Rate of loading is mech less in comparison to trilling filters.
- Large areas of land is required for their installation
- intermittent operation requires continceoces attendance
- The cost of contact beds is mech more as compared to trick long filters

19.What do you mean by tracking filters?

Tricking filters, also as percolating filters or sprinkling filters or sprinkling filters are similar to contact beds in construction, but their operation is confinceous and they allow constant aeration In this system sewage is allowed to sprinkle or trickle over a bed of coarse, rough hard filter media and it is then collected through the under drainage system

20.What are the purpose of under drainage system?

The purpose of under drainage system is two fold

- To carry away the liquid efficient and sloughed biological solids.
- To distribute air through the bed

21.What are the merits of conventional trickling filter?

- The efficient obtained from truckling filters is highly nitrified and stabilized. The efficient can there fore be disposed of in smaller quantity of deputation water
- It has good dependability to produce good efficient under very widely varying whether and other conditions
- The working of truckling filter is simple and sheep and does not require any skilled supervision

22.What are the demerits of conventional trickling filters?

- The loss of head through the filter system is high their making the automatic dosing through siphonic doing tank necessary.
- The cost of construction of the filter is high .
- They require large area in comparison to their biological treatment processes.

23.What is the necessary of Recirculation in T.F?

Recirculation is necessary to provide uniform hydraulic loading as well as to dilute the high strength waste waters. In constant to the low rate filters, in high rate filters a part of settled or filter efficient is recycled through the filter.

UNIT – IV

SECONDARY TREATMENT OF SEWAGE

1. Give any four advantages of activated sludge process?

- Lesser land area is required
- The head loss on the plant is quite low
- There is no fly ash or odour nuisance
- Capital cost is less

2. What are the disadvantages of the activated sludge process?

- High cost of operation, tooth greater power consumption
- A lot of machinery to be handled
- The sudden change in the quantity and character of sewage may produce adverse effects on the working of the process thus producing inferior efficient

3.What are the types of track long filters?

- Conventional track long filter or ordinary or standard rate or low rate trick long filter
- High rate filters or high rate trick long filter

4.What are the disadvantages of trick long filters?

- The head loss through these filters is high, making automatic during of the filters necessary
- The cost of construction is high
- There filters cannot treat ratio sewage and primary sedimentation is a must

5.What are the special types of filters?

- Durban filter
- Magnetic filters
- Rapid sand filters

6.What do you mean by magnetic filters?

In this type of filter, a layer of crashed magnetic ore of Iron is provided in about 80mm, thickness, and is supported on a non-magnetic metal wire screen sewage is filtered through the magnetic layer which removes the impurities purely by mechanical starching action.

7.What are the types of high late Filters?

- Bio filters
- Accelo filters
- Aero filters

UNIT – V

DISPOSAL OF SEWAGE AND SLUDGE

1. Define the term "Dilution Factor"?

The ratio of the quantity of the diluting water to that of the sewage is known as the Dilution Factor.

2.What are the methods adopted for sewage disposal?

- Dilution is disposal in water.
- Effluent Irrigation or Broad Irrigation or Sewage forming is disposal on land.

3.What are the conditions adopted for disposal by dilution?

- When sewage is comparatively fresh (4 to hr old) and free from floating and settlable solids.
- When the dilution water has a high dissolved oxygen (D.O.) content.
- When the out fall sewer of the city or the treatment plant is situated near some natural waters having large volumes.

4.What are the natural forces of purification?

- Dilution and dispersion.
- Sedimentation
- Oxidation – reduction in sun-light.
- Oxidation
- Reduction

5.What are the factors affecting self purification of polluted streams?

- Temperature
- Turbulence
- Hydrography such as the velocity and surface expanse of the river stream.
- Dissolved oxygen and the amount and type of organic matter.
- Rate of re aeration.

6.What are the types of self purification?

The self purification divided into four zones.

- Zone of degradation.
- Zone of active decomposition.
- Zone of recovery
- Zone of Cleaner water

7. What is meant by "Self purification phenomenon"?

When sewage is discharged into a natural body of water, the receiving water gets polluted due to waste products, present in sewage effluent. The natural forces of purification such as dilution, sedimentation, oxidation – reduction in sun light go on acting upon the pollution elements and bring back the water into its original condition. This automatic purification of polluted water, in due coarse is called the self purification phenomenon.

8.What is meant by photo synthesis?

The sun light has a bleaching and stabilizing effect of bacteria. It also helps certain micro organisms to derive energy from it and convert themselves into food for other forms of life, thus absorbing Co_2 and releasing O_2 by a process known as Photo synthesis.

9. What do you mean by Oxidation?

The oxidation of the organic matter prevent in sewage effluents, will start as soon as the sewage out falls into the river water containing dissolved oxygen. The deficiency of oxygen so created will be filled up by the atmospheric oxygen. The process of oxidation will continue till the organic matter has been completely oxidized. This is the most important action responsible for effecting self purification of rivers.

10. What do you understand by Reduction?

Reduction occurs due to hydrolysis of organic matter settled at the bottom either chemically or biologically. An aerobic bacteria will help in splitting the complex organic constituents of sewage into liquids and gases and thus paving the way for their ultimate stabilization by oxidation.

11. Define the term Re-oxygenation curve?

In order to counter – balance the consumption of D.O. due to de-oxygenation, atmosphere supplies oxygen to the water and the process is called re-oxygenation.

12. What is mean by "Oxygen sag curve"?

The amount of resultant oxygen deficit can be obtained by algebraically adding the de-oxygenation and re-oxygenation curves. The resultant curve so obtained is called the oxygen sag curve or the oxygen deficit curve.

13. Write the equation for find out the B.O.D. of the diluted water.

B.O.D. of the diluted mixture

$$C = \frac{C_s.Q_s + C_R.Q_R}{Q_s + Q_R}$$

Where

C_s -B.O.D. of sewage

C_R - B.O.D. of river

Q_s - Sewage discharge

Q_R- Discharge of the river

14. What is meant by epilimnion zone?

The water of a lake gets stratified during summers and winters. Since such turbulence extends only to a limited depth from below the water surface, the top layers of water in the lake become well mixed and aerobic. This warmer, well mixed and aerobic depth of water is called epilomnion zone.

15. What is meant by hypolimnion zone?

The lower depth of water in the lake which remains cooler, poorly mixed and an aerobic, is called are hypolimnion zone.

16. What do you understand by monocline? Give example.

The water of a lake gets stratified during summers and winters. The change from epilimnion to hypolimnion can be experienced while swimming in a lake. When you swim in top layers horizontally you will feel the water warmer and if you dive deeper, you will find the water cooler. The change line will represent monocline.

17.What are the advantage of land filling methods of dispoal?

- It is simple and economical
- No plant / equipment is required
- There are no by products and hence there is no problem of the disposal of the by-products.
- Separation of varies materials of the refuge is not required.

18.What are the disadvantages of land filling methods of disposal?

- Proper site may not be available near by
- Wind direction map not be favourable.
- Large band areas are required.
- It may be difficult to get large quantities of covering material.

19.What do you understand by pulverization?

In this method, the dry refuse is pulverized into power form, without changing its chemical form. The power can either be used as a poor quality manure, or else be disposed of by land filling.

20.What are the disadvantages of incineration of method of disposal?

- Large initial expenditure.
- Improper operation results in air pollution problems and incomplete reduction of the waste materials.
- Disposal of the remaining residue is required.
- High slacks needed for natural draft chimneys present safety problems.

21. What do you understand by mechanical composting?

The open window method of composting is very laborious and time consuming process. Also it requires large area of land which may not be available in big cities these difficulties are overcome by adopting mechanical composting in which the process of stabilization is expedited by mechanical devices of turning the compost.

22. What are the methods adopted for composting?

- Composting by trenching.
- Open window composting.
- Mechanical composting.

23.What is meant by "humus"?

The refuge gets stabilized in about 4.5 months period, and gets changed into a brown coloured odourless innocuous powdery form known as humus, which has high manure value became of its nitrogen content.

24.What are methods adopted for sludge drying?

- Drying the sludge on prepared sand beds.
- Drying the sludge on centrifuges.
- Drying the sludge by heat dryers

25.What is meant by house refuse?

This consists of vegetable and animal waste matters, ashes, cinders, rubbish, debries from cleaning and demolition of structures.

26.What is meant by organic waste?

It includes dry animal and vegetable refuse, cow dung, excreta of birds, tree leaves, sticks, plastic bottles, paper waste, rags. This waste is subject to decay with time and evolve highly offensive odour and gases which are highly detrimental to health.

27.What are the types of preventive measure in adopted for sewage sickness?

- Primary treatment of sewage
- Choice of land
- Under-drainage of sool.
- Giving rest to the land.
- Rotation of crops
- Applying shallow depths.

28.Define the term "Raw sludge"?

The sludge, which is deposited in a primary sedimentation tank is called Raw sludge. Raw sludge contains highly puterscible organic matter, and is thus, very objectionable.

29.What is meant by "conditioning"?

Conditioning improves the drainability of digested sludge. Prior conditioning of sludge before application of dewatering methods renders it more amenable to dewatering.

30. What are the purpose of dewatering?

The purpose of dewatering is to further reduce the volume of sludge and thereby increase the solids concentration.

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- Trickling filters
- Aerobic stabilization pond
- Aerated lagoon

7.List out the anaerobic process?

- Anaerobic sludge digestion,
- Anaerobic contact processes
- Anaerobic filters
- Anaerobic lagoons or ponds

8.What are the sources of waste water?

- Domestic waste water (i.e sewage)
- Agricultural return waste water
- Industrial waste water

9.What are the methods involved in the treatment of waste water?

Mainly classified into

- Conventional treatment methods
- Advanced waste waster treatment

Conventional treatment methods

- Preliminary processes
- Primary treatment
- Secondary treatment

Advanced waste water treatment

- Tertiary treatment

10.What are the functions involved in the chemical unit processes

- Chemical precipitation
- Gas transfer
- Adsorption
- Disinfection
- Combustion

11. What do you understand by waste water treatment?

The waste water treatment or sewage treatment is a broad term that applies to any process/operation or combination of processes and operations that can reduce the objectionable properties of water carried waste and render it less dangerous with the following.

- Removal of suspended and floatable material
- Treatment of biodegradable organics
- Elimination of patheogenic organisms

UNIT-III

PRIMARY TREATMENT OF SEWAGE

1.Define humus tank?

The efficient of the filter is therefore, passed through a sedimentation take called Humus tank otherwise called secondary clarifier or secondary setting take.

2.What are the distinct stages in the sludge digestion processes?

- Acid fermentation
- Acid repression
- Alkaline fermentation

3.Define the term ripened sludge?

This digested sludge is collected at the bottom of the digestion tank and is also called repented sludge.

4. What are the factors effecting sludge digestion?

Temperature

- Pit value
- Seeding wotu digested sludge
- Mixing and stirring of the raw sludge with digested sludge.

5.What are functions of aeration in ASP?

- Oxygenation of the mixed log wor
- Flocculation of the colloid in sewage influent
- Suspension of activated sludge

6.What are the methods employed for the purpose of certain in ASP?

- Diffused air aeration air aeration
- Mechanical aeration
- Combined diff used air and Mechanical aeration

7.What are the patterns of mechanical aeration?

- Haworth paddle or Sheffield aeration system
- Hartley paddle or bir Mangham Bio flocure lation system
- Simplex aeration system
- Link belt aeration system
- Kessner Brush aeration system

8.List out the important aeration processes in the ASP?

- Conventional process
- Tapered aeration process
- Step aeration process
- Contact slabolisection process
- Completely mixed process
- Modified aeration
- Extended aeration

9.What are the advantage of stabilization ponds or cagoins

- Lower initial lost than required for a mechanical plant.
- Tower operation costs
- Regulation of efficient discharge possible their provoelving control of pollection during critical times of the year.

10.What are the disadvantage of tagoons?

- Requires extensive land area.
- Hence the method can be used only on rural area.
- If used in urban areas, expansion of town and new developments may encroach on the lagoon site.

11.What do you understand by facultative ponds?

A facultative panel combine the features of the acrobite and anacrobic ponds.

- Constructed of intermediate depta (1, to 1.5m)
- A facilitative bond consists of three
    - ✓ Aaerobic Zone
    - ✓ Faculative zone
    - ✓ Anacrobic zone

12.What are remedial measurement for rising sludge problem?

- Increasing the return sludge age
- Increasing the speed of the sludge scroper mechanism, where possible
- Decreasing the mech cell residence come by increasing the sludge write rate

13.What is meant by sludge bulking?

Sludge with poor setting characteristics is termed bulking sludge. It results on poor influent due to thee presence of excessive suspended solids and also in rapid loss of MISS from aeration tank.

14.What are the advantage of increment 8 and filters?

- The efficient from intermittent sand filter is of better quality. It is more clean and more stable and hence does not need further treatment before disposal
- The filter work under acrobic conditions, and hence there is no trouble of odour, files and inserts
- The operation is very simple, requiring no mechanical equipment except for dosing

15.What are the disadvantages of intermittent sand filters?

- The rate of filtration and hence that of load long is very small per unit surface area of the filter hence they cannot be employed for medium size or bigger plants

- They requires large area and large quantity of sand due to which their construction is very lostly.

16.What do you understand by contact beds?

- Confact beds, also called confact filters, are similar to inter mitten sand filters in construction, except that th filtering media is very coarse, consisting of broken stones called ballart of 20 to 50mm gauge.
- A contact bed is a water trough take of masonry walls and of rectangular shape.
- The depth of filtering media is kept b/w 1 to 1.8m

17.What are the operations involved in the contact beds?

- Filling
- Contact
- Emptying
- Oxidation

18.What are the advantage of contact of beds? i) Contact beds can work under small heads.

- Contact beds can be operated without exposing the sewage efficient to view.
- There is no nuisance of filter flows
- The problem of odour is much less as compared to trill long filters.

19.What are the disadvantage of contact beds in T.F?

- Rate of loading is mech less in comparison to trilling filters.
- Large areas of land is required for their installation
- intermittent operation requires continceoces attendance
- The cost of contact beds is mech more as compared to trick long filters

19.What do you mean by tracking filters?

Tricking filters, also as percolating filters or sprinkling filters or sprinkling filters are similar to contact beds in construction, but their operation is confinceous and they allow constant aeration In this system sewage is allowed to sprinkle or trickle over a bed of coarse, rough hard filter media and it is then collected through the under drainage system

20.What are the purpose of under drainage system?

The purpose of under drainage system is two fold

- To carry away the liquid efficient and sloughed biological solids.
- To distribute air through the bed

21.What are the merits of conventional trickling filter?

- The efficient obtained from truckling filters is highly nitrified and stabilized. The efficient can there fore be disposed of in smaller quantity of deputation water
- It has good dependability to produce good efficient under very widely varying whether and other conditions
- The working of truckling filter is simple and sheep and does not require any skilled supervision

22.What are the demerits of conventional trickling filters?

- The loss of head through the filter system is high their making the automatic dosing through siphonic doing tank necessary.
- The cost of construction of the filter is high .
- They require large area in comparison to their biological treatment processes.

23.What is the necessary of Recirculation in T.F?

Recirculation is necessary to provide uniform hydraulic loading as well as to dilute the high strength waste waters. In constant to the low rate filters, in high rate filters a part of settled or filter efficient is recycled through the filter.

UNIT – IV

SECONDARY TREATMENT OF SEWAGE

1. Give any four advantages of activated sludge process?

- Lesser land area is required
- The head loss on the plant is quite low
- There is no fly ash or odour nuisance
- Capital cost is less

2. What are the disadvantages of the activated sludge process?

- High cost of operation, tooth greater power consumption
- A lot of machinery to be handled
- The sudden change in the quantity and character of sewage may produce adverse effects on the working of the process thus producing inferior efficient

3.What are the types of track long filters?

- Conventional track long filter or ordinary or standard rate or low rate trick long filter
- High rate filters or high rate trick long filter

4.What are the disadvantages of trick long filters?

- The head loss through these filters is high, making automatic during of the filters necessary
- The cost of construction is high
- There filters cannot treat ratio sewage and primary sedimentation is a must

5.What are the special types of filters?

- Durban filter
- Magnetic filters
- Rapid sand filters

6.What do you mean by magnetic filters?

In this type of filter, a layer of crashed magnetic ore of Iron is provided in about 80mm, thickness, and is supported on a non-magnetic metal wire screen sewage is filtered through the magnetic layer which removes the impurities purely by mechanical starching action.

7.What are the types of high late Filters?

- Bio filters
- Accelo filters
- Aero filters

UNIT – V

DISPOSAL OF SEWAGE AND SLUDGE

1. Define the term "Dilution Factor"?

The ratio of the quantity of the diluting water to that of the sewage is known as the Dilution Factor.

2.What are the methods adopted for sewage disposal?

- Dilution is disposal in water.
- Effluent Irrigation or Broad Irrigation or Sewage forming is disposal on land.

3.What are the conditions adopted for disposal by dilution?

- When sewage is comparatively fresh (4 to hr old) and free from floating and settlable solids.
- When the dilution water has a high dissolved oxygen (D.O.) content.
- When the out fall sewer of the city or the treatment plant is situated near some natural waters having large volumes.

4.What are the natural forces of purification?

- Dilution and dispersion.
- Sedimentation
- Oxidation – reduction in sun-light.
- Oxidation
- Reduction

5.What are the factors affecting self purification of polluted streams?

- Temperature
- Turbulence
- Hydrography such as the velocity and surface expanse of the river stream.
- Dissolved oxygen and the amount and type of organic matter.
- Rate of re aeration.

6.What are the types of self purification?

The self purification divided into four zones.

- Zone of degradation.
- Zone of active decomposition.
- Zone of recovery
- Zone of Cleaner water

7. What is meant by "Self purification phenomenon"?

When sewage is discharged into a natural body of water, the receiving water gets polluted due to waste products, present in sewage effluent. The natural forces of purification such as dilution, sedimentation, oxidation – reduction in sun light go on acting upon the pollution elements and bring back the water into its original condition. This automatic purification of polluted water, in due coarse is called the self purification phenomenon.

8.What is meant by photo synthesis?

The sun light has a bleaching and stabilizing effect of bacteria. It also helps certain micro organisms to derive energy from it and convert themselves into food for other forms of life, thus absorbing Co_2 and releasing O_2 by a process known as Photo synthesis.

9. What do you mean by Oxidation?

The oxidation of the organic matter prevent in sewage effluents, will start as soon as the sewage out falls into the river water containing dissolved oxygen. The deficiency of oxygen so created will be filled up by the atmospheric oxygen. The process of oxidation will continue till the organic matter has been completely oxidized. This is the most important action responsible for effecting self purification of rivers.

10. What do you understand by Reduction?

Reduction occurs due to hydrolysis of organic matter settled at the bottom either chemically or biologically. An aerobic bacteria will help in splitting the complex organic constituents of sewage into liquids and gases and thus paving the way for their ultimate stabilization by oxidation.

11. Define the term Re-oxygenation curve?

In order to counter – balance the consumption of D.O. due to de-oxygenation, atmosphere supplies oxygen to the water and the process is called re-oxygenation.

12. What is mean by "Oxygen sag curve"?

The amount of resultant oxygen deficit can be obtained by algebraically adding the de-oxygenation and re-oxygenation curves. The resultant curve so obtained is called the oxygen sag curve or the oxygen deficit curve.

13. Write the equation for find out the B.O.D. of the diluted water.

B.O.D. of the diluted mixture

$$C = \frac{C_s.Q_s + C_R.Q_R}{Q_s + Q_R}$$

Where

C_s -B.O.D. of sewage

C_R - B.O.D. of river

Q_s - Sewage discharge

Q_R- Discharge of the river

14. What is meant by epilimnion zone?

The water of a lake gets stratified during summers and winters. Since such turbulence extends only to a limited depth from below the water surface, the top layers of water in the lake become well mixed and aerobic. This warmer, well mixed and aerobic depth of water is called epilomnion zone.

15. What is meant by hypolimnion zone?

The lower depth of water in the lake which remains cooler, poorly mixed and an aerobic, is called are hypolimnion zone.

16. What do you understand by monocline? Give example.

The water of a lake gets stratified during summers and winters. The change from epilimnion to hypolimnion can be experienced while swimming in a lake. When you swim in top layers horizontally you will feel the water warmer and if you dive deeper, you will find the water cooler. The change line will represent monocline.

17.What are the advantage of land filling methods of dispoal?

- It is simple and economical
- No plant / equipment is required
- There are no by products and hence there is no problem of the disposal of the by-products.
- Separation of varies materials of the refuge is not required.

18.What are the disadvantages of land filling methods of disposal?

- Proper site may not be available near by
- Wind direction map not be favourable.
- Large band areas are required.
- It may be difficult to get large quantities of covering material.

19.What do you understand by pulverization?

In this method, the dry refuse is pulverized into power form, without changing its chemical form. The power can either be used as a poor quality manure, or else be disposed of by land filling.

20.What are the disadvantages of incineration of method of disposal?

- Large initial expenditure.
- Improper operation results in air pollution problems and incomplete reduction of the waste materials.
- Disposal of the remaining residue is required.
- High slacks needed for natural draft chimneys present safety problems.

21. What do you understand by mechanical composting?

The open window method of composting is very laborious and time consuming process. Also it requires large area of land which may not be available in big cities these difficulties are overcome by adopting mechanical composting in which the process of stabilization is expedited by mechanical devices of turning the compost.

22. What are the methods adopted for composting?

- Composting by trenching.
- Open window composting.
- Mechanical composting.

23.What is meant by "humus"?

The refuge gets stabilized in about 4.5 months period, and gets changed into a brown coloured odourless innocuous powdery form known as humus, which has high manure value became of its nitrogen content.

24.What are methods adopted for sludge drying?

- Drying the sludge on prepared sand beds.
- Drying the sludge on centrifuges.
- Drying the sludge by heat dryers

25.What is meant by house refuse?

This consists of vegetable and animal waste matters, ashes, cinders, rubbish, debries from cleaning and demolition of structures.

26.What is meant by organic waste?

It includes dry animal and vegetable refuse, cow dung, excreta of birds, tree leaves, sticks, plastic bottles, paper waste, rags. This waste is subject to decay with time and evolve highly offensive odour and gases which are highly detrimental to health.

27.What are the types of preventive measure in adopted for sewage sickness?

- Primary treatment of sewage
- Choice of land
- Under-drainage of sool.
- Giving rest to the land.
- Rotation of crops
- Applying shallow depths.

28.Define the term "Raw sludge"?

The sludge, which is deposited in a primary sedimentation tank is called Raw sludge. Raw sludge contains highly puterscible organic matter, and is thus, very objectionable.

29.What is meant by "conditioning"?

Conditioning improves the drainability of digested sludge. Prior conditioning of sludge before application of dewatering methods renders it more amenable to dewatering.

30. What are the purpose of dewatering?

The purpose of dewatering is to further reduce the volume of sludge and thereby increase the solids concentration.

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Fifth Semester

Civil Engineering

CE 2304/CE 53/10111 CE 504 — ENVIRONMENTAL ENGINEERING — I

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the objective of Water Supply Scheme?

2. Define design period.

3. How do you select pipe material for water supply scheme?

4. What is the loss of head in a CI transmission main of 300 mm in diameter and 2 km length with C-value 100, when it carries a flow of 10 m^3/min?

5. What are the differences between Unit Operations and Unit Process?

6. What are the advantages of chlorine as disinfectant?

7. What is the maximum permissible limit of fluoride in drinking water?

8. How do you protect water treatment plants from corrosion?

9. What is the role of computer applications in Water Supply Systems?

10. How do you identify leakage in pipelines?

PART B — (5 × 16 = 80 marks)

11. (a) The population of a town as per part census records are given below for the years 1951 to 2001. Forecast the population in the years 2026 and 2041 respectively using the following methods.

(i) Arithmetical increase method

(ii) Incremental increase method

(iii) Geometrical increase method. (16)

Census Year :	1951	1961	1971	1981	2001
Population :	44,487	62,356	78,538	98,861	1,33,582

Or

(b) (i) List out 10 parameters of Water Quality Standards as per the Tamilnadu pollution Control Board Standards. (8)

(ii) Write a short notes on various characteristics of water. (8)

12. (a) Explain the different joints used in water supply distribution system. (16)

Or

(b) What is intake structure? Explain with neat sketches, the various type of intake structures based on sources. (16)

13. (a) Design a sedementation tank for water treatment plant to treat 8 MLD of water. Assume a surface loading rate of 30 $m^3/m^2/day$. Check the adequacy of detention time. Draw the plan of the water treatment plant. (16)

Or

(b) With the help of the diagram, explain the process of Rapid sand filter. (16)

14. (a) What is aerators? Explain different type of aerators with sketches.

Or

(b) Write notes on :

(i) Membrane process. (8)

(ii) Desalination process. (8)

15. (a) Discuss with neat sketches the various types of layout of distribution system. (16)

Or

(b) Discuss the various possible water distribution arrangements in multistoraged buildings. (16)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21208

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fifth Semester

Civil Engineering

CE 2304/CE 53/10111 CE 504 — ENVIRONMENTAL ENGINEERING — I

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the components of a water supply (scheme) system?

2. What are the acceptable quality standards as per BIS10500 : 1983 for Fluoride and Nitrates?

3. What are the two types of 'Intake' according to their position?

4. How will you calculate the total head in the design of pumbs for water supply schemes?

5. Define : Detention time and surface overflow rate for a sedimentation tank.

6. What are tests to be done to find the residual chlorine in water?

7. Mention the type of aerators used in the water treatment.

8. Write any two effects of hardness in water.

9. What are the layouts of water distribution system?

10. What is 'Ferrule' in house service connection?

PART B — (5 × 16 = 80 marks)

11. (a) Explain the different sources of water and their characteristics with respect to turbidity, Hardness, Chloride and microbiology. (16)

Or

(b) (i) Write a note on water demand. (6)

(ii) In two periods each of 20 years a city has grown from 50000 to 110000 and 160000 find the population expected in the next 20 years and also the saturation population. (10)

12. (a) (i) What are the classification of intakes based on source also explain with a sketch any one of the intakes? (10)

(ii) What are the different pipe materials used in the water transmission? (6)

Or

(b) (i) List the classification of pipe joints depending their ability to movement and briefly explain the factors that influence the decision on the type of joints. (10)

(ii) Write a note on pumps used in water supplier. (6)

13. (a) (i) Draw the longitudinal section of a rectangular sedimentation tank indicating the various zones. (8)

(ii) The following data are corresponding to a clariflocculator find the volume of the flocculation and its diameter.

Detention time : 30 min, Depth : 3 m, Outer diameter of the inlet shaft = 0.9 m, Water to be treated : 10 ML/d. (8)

Or

(b) (i) With a neat sketch (cross section) explain the working of a rapid sound filter. (12)

(ii) Write a note on 'Break Point Chlorination'. (4)

14. (a) (i) What are the effects of excess concentration of Fluoride in water and list the methods available for defluoridation and explain any one of them. (10)

(ii) Write a note on iron removal from water for small communities. (6)

Or

(b) (i) What are the types of hardness present in water? (4)

(ii) Explain the Ion exchange method of water softening with a sketch. (12)

15. (a) (i) What are the general design guidelines for a water distribution system? (8)

(ii) Briefly explain the house service connection with a sketch. (8)

Or

(b) Find the equivalent pipe AD for the network ABCD shown in Fig Q15(b) by equivalent pipe method. (16)

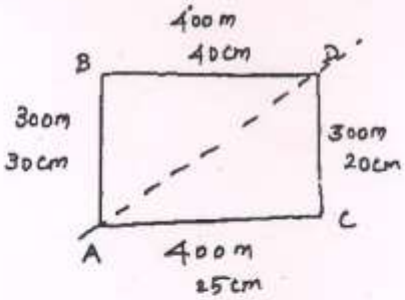

Fig. Q15(b)