

**EASWARI ENGINEERING COLLEGE
DEPARTMENT OF CIVIL ENGINEERING**

REGULATION 2017

EN 8592 WASTE WATER ENGINEERING

UNIT – 1

1. What are the two types of sewage system?

- a. Combined system Separate system

2. List the components of sewerage system.

- a. Drains, Flushing tanks , Manholes , Pumping stations , Screening chambers , Storm overflows

3. Why separate system is advantages than combined system?

- a. Separate system is advantages than combined system because,
b. In separate system, surface water may be taken in open or closed conduits or drains at or near the surface and discharged at suitable outlets thus greatly simplifying the design of sewers of storm water drains.
c. But, in combined system, the large size of the sewer may cause silting up due to low velocity.

4. Define storm water flow.

As the rain falls over the surface of ground, a part of it is lost through evaporation in the air or percolation into the ground while the remaining, overflows the surface as storm water flow.

Storm water flow is the additional flow that would occur during the rainy season. It consists of runoff available from roofs, streets, yards, open spaces etc. during rainfall.

5. Distinguish between raw sewage and combined sewage.

RAW SEWAGE	COMBINED SEWAGE
Raw sewage is waste water that has not to be treated. It comes from residential and commercial buildings.	It is the combination of sanitary sewage and storm sewage with or without industrial wastes.

6. Write the condition under which separate system is recommended.

- a. Where rainfall is uneven
b. Sanitary sewage is to have one outlet and other outlets for storm or surface water are available
c. Sanitary sewage is to be pumped

- d. Separate sewers must be placed deeper and the storm water drains nearer the surface to economize excavation
- e. The drainage area is steep, allowing water to run off quickly
- f. Sewers are to be constructed in rocky strata. The larger combined sewers would then be more expensive
- g. Finances available are small but sanitary drainage is imperative
- h. Combined sewers may back up due to excessive flows, poor grades or lack of proper cleaning and may flood basements

7. What is meant by relative stability?

It is defined as the ratio of oxygen available in the effluent to the total oxygen required to satisfy its first stage BOD demand. It is expressed as percentage of the total oxygen required and can be expressed by the equation,

$$= 100 [1 - (0.794)^{20}]$$

8. Define stroke's law.

Law states that the force retards a sphere moving through a viscous fluid is directly proportional to the velocity of the sphere, the radius of the sphere and the viscosity of the fluid.

Stroke's developed an expression known as Stroke's law. It is applicable to the discrete particles. The particles which do not change in size, shape or mass during settling are known as discrete particles.

9. How will you determine the quantity of the sewage that is likely to pass through a sewer at the end of the design period?

Design period of 30 years is normally employed for all types of sewers.

10. What are the fundamental principles of sanitation?

Sanitation is the prevention of the sporadic outbreak of diseases dangerous for the general health of the public. This can be achieved by either controlling or eliminating environmental factors as contribute in some form or the other to the transmission of the diseases. These factors include the following:

- a. Water supply
- b. Carriage or disposal of human excreta and other wastes from communities, industries and trades
- c. The menace of insects-mosquitoes, flies and rodents with regards to food and other services
- d. Ventilation and air-conditioning
- e. Atmospheric pollution and methods of purification
- f. Plumbing in the case of buildings
- g. Other hygienic factors

11. Differentiate between combined system of sewage and separate system

of sewage.

No	COMBINED SYSTEM	SEPARATE SYSTEM
	<p>In a combined system, the same sewer is intended to carry the domestic sewage, industrial wastes as well as the surface and the storm water flow.</p> <p>Rainfall is even throughout the year. Both sanitary sewage and storm water have to be pumped. Effective or quicker flows have to be provided.</p>	<p>In a separate system, the domestic sewage and industrial wastes are carried in one set of sewers whereas the storm and surface waters are carried in another set of sewers.</p> <p>Rainfall is uneven.</p> <p>Sanitary sewage is pumped. Combined sewers may back up due to excessive flows, poor grades and lack of proper cleaning.</p>

12. What are the different types of sewerage systems?

- a. Combined system
- b. Partially separate system
- c. Separate system

13. Define sewer.

It is the underground conduit or drain through which sewage is conveyed.

14. Differentiate between sullage and sewage.

No	SULLAGE	SEWAGE
1	It is the liquid discharge from bathrooms, kitchen, washing places, wash basins etc.	It is a liquid waste from a community.
2	It is merely the waste water and it creates bad smell.	It includes sullage, discharge from kitchens, bathrooms,

3	Semi solid part of sewage is called sullage.	industrial waste and storm water etc.
4	It is used for commercial purposes as a fertilizer – filter.	It is defined as the used water or liquid waste of a community, which includes human and household wastes together. Constituents of sewages are domestic sewage, industrial sewage, storm water.

15. What is meant by refuse?

In sanitary engineering, it is the waste matter which is rejected or left as worthless. It includes garbage, sewage, sullage, storm water and subsoil water.

16. Define sewerage.

It is the process of collecting and carrying sewage by water carriage system through sewers.

17. Differentiate between conservancy system and water carriage system.

. No	S CONSERVANCY SYSTEM	WATER CARRIAGE SYSTEM
1	Initial cost is less.	Initial cost is more.
2	Maintenance cost is more.	Maintenance cost is less.
3	Consumption of water is less.	Consumption of water is more.
4	Employment of labor is more.	Employment of labor is less.
5	Transportation through trenches and trollies.	Transportation through closed conduits.
6	Does not require technical person.	Requires technical person.
7	Neatness of city is poor.	Neatness of city is high.
8	Latrines should be located outside of the buildings.	Can be located within the building itself.

9	Foul smell will always be there from such latrines.	There is no foul smell from water closets.
0.	Revenue from manure is more.	Revenue from manure is less.
1.	Pollution of underground water is possible.	Pollution of underground water is impossible.
2.	Outbreak of epidemic is possible.	Outbreak of epidemic is impossible.

18. Define sewage.

It is the liquid waste from the community. It includes sullage, discharge from kitchen, bathroom, industrial wastes and storm water etc.

19. What is meant by D.W.F and W.W.F?

D.W.F: The dry weather flow is the total average discharge of sanitary sewage and is the normal flow in a sewer during the dry season of the year.

W.W.F: It is the normal flow of sewage during the rainy season of the year.

20. What is partially separate system?

It is a modification of the separate system in which the separate sewer discharging domestic sewage and industrial wastes also contains a portion of the surface water drained from back-paved yards and roofs of houses.

21. Define sullage.

It is the liquid discharge from bathrooms, kitchen, washing places, wash basins, etc. It is merely the waste water and does not create bad smell.

23. Define bacteria's.

These are the microscopic unicellular plants or organisms. In sanitary engineering, bacteria's may be divided into the following three groups.

24. What do you mean by facultative bacteria?

They exist in presence or absence of oxygen. They grow more in the absence of air.

25. Define invert.

It is the lowermost level or surface of a sewer.

26. Define garbage.

It is the dry refuse and includes decayed fruits, grass, leaves, paper pieces, ashes, street cleanings, dust, mud, sweepings, vegetables, etc.

27. Define subsoil water.

It is the ground water which finds its entry into sewers through leaks.

28. Define sludge.

It is the organic matter deposited at the bottom of the sedimentation tank during the treatment of the sewage.

29. What is peak drainage disturbance?

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

30. What are two products of sewage treatment? Define Population Equivalent (May/June 2016)

Sewage treatment is the process of removing contaminants from wastewater, including household sewage and runoff (effluents). It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants.

Population equivalent or unit per capita loading, (PE), in waste-water treatment is the number expressing the ratio of the sum of the pollution load produced during 24 hours by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time.

31. Define (a) SULLAGE (b) MINAS (May/June 2016)

SULLAGE

The waste water generated from kitchens and bathrooms due to bathing, washing cloths utensils etc.,

MINAS- Minimum National Standards

32. What is known as sewerage? What are the two types of sewerage system? List the components of sewerage system? What is peak drainage discharge? (Nov/Dec 2015) (May/June 2014)

The removal of waste water and refuse by means of sewer. It consists of a network of sewer pipe lines laid in order to carry the sewage from individual homes to the sewage treatment plant.

The two types of sewerage 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 other through two different sets of sewerage is called as separate system.



a) Combined system
system

b) Separate
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.

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

33. What are the impacts of nutrients on water bodies? (Apr/May 2015)

Excess nutrients in water bodies lead to Algal Bloom and Eutrophication. Nutrients lead to excessive growth of algae (Algae bloom) on the water surface, Which prevents penetration of sunlight and oxygen into it. The Dissolved oxygen (DO) level of water decreases and adversely affects the aquatic animals (Eutrophication)

34. What is the effect of oxygen demanding waste on water bodies? How do you estimate the storm runoff? (Apr/May 2011) (Apr/May 2015)

The aerobic condition will no longer be maintained and putrefaction will set in.

i) Rational method $Q_p = (K.P_c.A)/36$

Q_p = Peak rate of runoff in cumecs,

K = Coefficient of runoff,

A = Catchment area, in hectares, P_c = Critical rainfall intensity, in cm/hr.

ii) Empirical formulae

Intensity duration curve $P = a/(T$

+b)

$P_c = P$ = Rain intensity in cm/hr

T = Time in minutes, a & b = Constants

For T varying between 5 to 20 minutes, $a = 75$ & $b = 10$,

$P = 75/T + 10$

For T varying between 5 to 20 minutes, $a = 100$ & $b = 20$,
 $P = 100/T + 20$

For localities where rainfall is frequent $P = 343/T + 18$

iii) Kuichling's formula

Storm frequency = 10 years, $P = 267/T + 20$

Storm frequency = 15 years, $P = 305/T + 20$

35. What is the effect of oxygen demanding waste on water bodies? (Nov /Dec 2014)

a. DO levels will decrease in water bodies

a. Aquatic life will be destroyed

36. Enumerate the sources of waste water (Nov /Dec 2014)

- i) Residence (excreta, sullage)
- ii) Institutions
- iii) Commercial establishment
- a. Commercial establishment
- iv) Industrial process
- v) Ground water infiltration
- a. Storm runoff

38. Why do analyses BOD and COD usually give different results for the same waste water (Nov/ Dec 2013)

BOD (Biological Oxygen Demand) means the amount of oxygen (in mg/L) the microorganisms like bacteria need to 'eat' the organic pollutants (sugars, fat, proteins, ...). Note that not all Pollution can be removed (eaten) by bacteria. BOD value in polluted water is normally higher than the fresh water. Increased BOD can be resulted due to domestic sewage, petroleum residues and wastes of animals and crops.

COD (Chemical Oxygen Demand) is the amount of oxygen required to degenerate all pollution in a chemical way (by adding oxidising agents and heating). In general with chemical destruction you can remove more pollution than with the biological way.

As BOD is only a measurement of consumed oxygen by aquatic microorganisms to decompose or oxidize organic matter and COD refers the requirement of dissolved oxygen for the oxidation of organic and inorganic constituents both. Hence COD must be greater than BOD.

40. What is suspended solids ,What is the effect of suspended solids on water bodies (Nov/ Dec 2013)

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water column. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration.

Suspended solids can clog fish gills, reducing their growth rate. They also

This reduces the ability of algae to produce food and

oxygen. When the water slows down, the suspended sediment settles out and drops to the bottom, a process called siltation

41. Name sewage characteristics with which organic matter concentration is expressed (May/June 2013)

BOD- Biological Oxygen Demand COD- Chemical Oxygen Demand
TOC- Total Organic Carbon Total solids

42. Distinguish between “dry weather flow” and “wet weather flow” (May/June 2012), (Nov/Dec 2012)

Dry weather flow /sanitary sewage

It is the quantity of waste water that flows through a sewer in dry weather when no storm water in the sewer.

Wet weather flow/storm weather flow

Is the additional flow that would occur during the rainy season .it consists of runoff available from, yards, roofs, streets, open spaces etc., during rainfall.

State the necessity of waste water characterization. (May/June 2012)

Reduce the spread of communicable diseases caused by pathogenic organisms in the sewage Prevent the pollution of surface and ground water.

43. Explain the meaning and significance of time of concentration.(Apr/May 2011) (Nov / Dec 2011)

Time of concentration is the period after which the entire catchment area starts contributing to the runoff in drains.

$TC = T_i + T_f$

T_i –Inlet Time

T_f - Flow Time

It is used to indicate the

- a) Inlet time
- b) Outlet time
- c) Peak time
- d) Maximum Runoff

It is used to drain the storm water drains.

44. Distinguish between “self cleansing velocity” and “Non scouring velocity” (Nov/Dec2013)

Self cleansing velocity

The silting of sewers can be avoided by generating high velocities that would not permit the solids to settle down i.e. the velocity should be such as to cause automatic self cleaning velocity.

Non scouring velocity

The smooth interior surface of a sewer pipe gets scoured due to the continuous abrasion caused by the suspended solids present in sewage .this scouring and wear and tear of the pipe interior is much more pronounced at velocities higher

than what can be tolerated by the pipe materials. This wear and tear of the sewer pipes will not only reduce their life span but also reduce their carrying capacities. In order to avoid these complications, it is therefore necessary to limit the maximum velocity that will be produced in the sewer pipe at any time. This velocity is known as non-scouring velocity.

45. What is suspended solids, What is the effect of suspended solids on water bodies

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water column. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration.

Suspended solids can clog fish gills, reducing their growth rate. They also reduce light penetration. This reduces the ability of algae to produce food and oxygen. When the water slows down, the suspended sediment settles out and drops to the bottom, a process called siltation.

47. What is BOD (Biochemical oxygen demand), COD (Chemical oxygen demand)?

Biochemical oxygen demand or BOD is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period.

Chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water. It is expressed in milligrams per liter (mg/L).

48. What is critical rainfall duration? What is intensity of rainfall?

Maximum runoff will be obtained from the rain having duration equal to the time of concentration. This is called critical rainfall duration.

The intensity of a rain is the rate at which it is falling, and it is expressed in cm/hr.

UNIT – 2

1. What are the physical and chemical characteristics of sewage? Physical characteristics are,

- a. Colour
- b. Odour
- c. Solids
- d. Temperature

Chemical characteristics are,

- a) Organic
 - i) Carbohydrates
 - ii) Fats, oils and greases
 - iii) Nitrogen contents
 - iv) Pesticides
 - v) Phenols
 - vi) Proteins
 - vii) Surfactant
- b) Inorganic
 - i) Alkalinity
 - ii) Chloride
 - iii) Heavy metal
 - iv) Oxygen
 - v) pH
 - vi) Phosphorus
 - vii) Sulphur
 - viii) Toxic compounds

2) Define BOD.

Biochemical Oxygen Demand is oxygen required by aerobic decomposers for the biochemical degradation of bio-degradable organic matters in water.

3. What do you mean by COD?

Chemical Oxygen Demand is oxygen required for the oxidation of both biodegradable and non-biodegradable organic matters in water.

4. Define the aerobic bacteria and anaerobic bacteria.

AEROBIC BACTERIA: They require light and free oxygen for their existence and development.

ANAEROBIC BACTERIA: They do not require light and free oxygen for their existence and development.

5. Give the chemical characteristics of sewage.

Chemical characteristics indicate the state of sewage decomposition, its strength and type of treatment required. Fresh sewage is alkaline and good for bacterial action. Stale or septic sewage is acidic and difficult to be efficiently treated. The chemical characteristics are dependent upon the substances contained in sewage.

7. Define suspended solids.

Suspended solids (S_s) are those which can be filtered out on an asbestos mat or filter paper (i.e.) suspended solids are non-filterable solids.

8. Express the difference between raw sludge and digest sludge.		
	RAW SLUDGE	DIGEST SLUDGE
a	The sludge, which is deposited in primary sedimentation tank, is called	The process of decomposing organic matter of sewage – sludge anaerobically under conditions of adequate operational control and solid matter with reduced moisture content.
	raw sludge. Raw sludge is colourless, contains highly perceptible organic matter, and is thus very objectionable. It contains	
	from 3 to 8% solids.	

9. Differentiate between colloidal solid and settleable solids.

Colloidal solids are finely divided solids either in solution or in suspension. Settleable solids are portions of solid matter which settle out if sewage is allowed to remain undisturbed for a period of 2 hours.

10. What is the importance of determination of dissolved oxygen present in sewage?

The concentration of oxygen dissolved in a running stream into which sewage effluents discharge must be such as not to deplete the level of DO concentration to a level as to endanger the life of aquatic animals.

The important point that DO concentration should be maintained to a level of 4 – 8 mg/l at all times. This is the amount of oxygen dissolved in sewage. The presence of dissolved oxygen in sewage indicates that it is fresh or weak. Its presence in the effluent of a treatment works indicates good treatment.

11. Define total solids.

Sewage normally contains 99.9% of water and 0.1% of solids. Analytically, the total solids content (S_T) of a wastewater is defined as all the matter that remains as residue upon evaporation to 103 to 105°C. Total solids in wastewater exist in three different forms such as suspended solids, colloidal solids and dissolved solids.

12. Define DO.

This is the amount of oxygen dissolved in sewage. The presence of dissolved oxygen in sewage indicates that it is fresh or weak. Its presence in the effluent of a treatment works indicates good treatment.

13. Define toxic compounds.

Copper, lead, silver, chromium, arsenic and boron are some of the cations which are toxic to micro-organisms resulting in the manufacturing of the biological treatment plants. These are results from industrial wastewaters. Some toxic anions, including cyanides and chromates, present in some industrial wastes also hinder the wastewater treatment facilities. Hence their presence should be taken into consideration in the design of biological treatment plants.

14. What is meant by biodegradable organic matter?

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

15. Mention some shapes of sewer pipes? What are the forces acting on sewer pipes?

Shapes of sewer x

Circular shape

- x Egg shape
- x Horse shoe shape
- x Parabolic shape
- x Elliptical shape
- x Rectangular shape

Forces acting on sewer pipes

- Internal pressure of sewage
- Pressure due to external loads
- Temperature stress
- Flexural stress

16. What are the materials used for constructing sewer pipes? Give some qualities of the good sewer pipes

Materials used for constructing sewer pipes

- Vitrified clay
- Cement concrete
- Asbestos cement
- Cast iron
- Lead sewers
- Plastic sewers
- Brick sewers

Qualities of the good sewer pipes

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

17. What is meant by catch basins?

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

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

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

19. What is Small Bore Sewer? Write some Construction Benefits of Small Bore Sewer

The Small Bore Sewer is a watertight small diameter wastewater collection system that provides servicing with superior operational and environmental performance at a significantly lower cost as compared to historic gravity sewers

- x Overall system is flexible, modular and adaptable
- x Shallow gradient piping installations eliminate need for heavy equipment – local manpower and hand tools can be used for trenching
- x Piping is not sensitive to curvilinear alignment, inflective gradients or sharp slope changes

20. Write some Environmental Benefits of Small Bore Sewer

- a. 21x reduction of greenhouse gases through methane capture when compared to equivalent carbon dioxide gas impact
- b. Conveyance of methane for reuse in electricity generation
- c. Sealed system means zero groundwater infiltration and zero sewage seepage

21. How to Test leakage in sewer pipes?

The ends of the sewer is plugged, the water is now filled in the manhole at the upper end and is allowed to flow through the sewer line. The depth of the water in the man hole is maintained to the testing head of about 1.5m. The sewer line is watched by moving along the trench.

22. Explain One pipe system in sewerage Two pipe systems in sewerage?

The pipe of waste water from sinks, baths and wash basins and branches of soil pipes is connected to one main pipe. This main pipe is directly connected to sewerage system. Gully (gutter) traps and waste pipes are completely distributed but all traps of water closets, basins, etc. are completely ventilated to preserve water seal.

Soil and waste pipes are distinct and separate. The soil pipes are connected to sewer directly whereas waste pipes are connected through a trapped gully (gutter). All traps of all appliances are completely ventilated.

23. What is the significance of self cleansing velocity in sewer design and what is the maximum velocity

Sewage should flow at all times with sufficient velocity to prevent the settlement of solid matter in the sewer. Self Cleansing Velocity is the minimum velocity that ensures non settlement of suspended matter in the sewer.

The following minimum velocities are generally employed

x Sanitary sewer = 0.6 m/sec

x Storm sewer = 1.0 m/sec

x Partially combined sewer = 0.7 m/sec

The maximum velocities in the sewer pipes should not exceed more than 2.4 m/sec. This max velocity in the sewer should not exceed this limit of 2.4 m/sec. It is to avoid the excessive sewer abrasion and also to avoid steep slopes.

24. What are the component parts of Manhole?

Access Shaft, Working chamber, The Benching (i.e) the bottom or invert portion of manhole

The sidewalls, Steps or ladders, Cover and Frame

25. Define design period? What are the factors governing the design period? (Apr/May 2011)

The future period for which a provision is made in the water supply scheme is known as design period.

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 year

The factors governing design period are,

- a. Design period should not exceed the life period of the structure.
- b. If the funds are not in a sufficient, the design period as to be decreased.
- c. The rate of interest on borrowing and the additional money invested.

26. Computer Applications of sewer design (May/June 2016)

Optimal design of Sewer Systems

Hydraulics performance

Defect Coding

Defect Mapping

Defect Rating

Renewal method selection

Failure probability

Failure consequences

Site considerations

Design review

H2OMAP Sewer is a powerful, stand-alone GIS-based computer program for use in the planning, design, analysis, and expansion of sanitary, storm and combined sewer collection systems.

EPA SWMM model to design the sanitary sewer system

GWN-STORM Pipe, manhole and drainage information are stored in dBASE III files. Once the input is completed, the storm sewer network can be automatically sized and located by invert elevations.

SewCAD, GIS applications (CAD-GIS, Browser-GIS) based Fortran computer program called OGSDP to design a least-cost gravity sanitary sewer system

27. How to select a pump?

1. Non-clog Submersible pumps as appropriate are proposed. The pumps shall be of single speed with low rpm
2. All pumps in a pumping station shall be of equal capacities
3. For all pumping stations, provision is made for automatic and manual operations
4. Manual operation: Two starts and two stops
5. Automatic operation: Six starts and stops
6. Screens shall be provided ahead of wet well to prevent large size solids entering the

28. **A sewer has to be designed considering both minimum and maximum velocity of flows-state true or false and justify your answer. (May/June 2012)**

It is true. In order to keep the suspended form, a certain minimum velocity of flow is required; otherwise the solid particle will settle in the sewer, resulting in clogging. At higher velocity the flow becomes turbulent, resulting in continuous abrasion of the interior surface of the sewer. Hence maximum velocity of the flow should be maintained.

29. **Enumerate the various steps involved in the layout and construction of sewers. (Nov/Dec 2012)**

- x Setting out
- x Alignment and gradient
- x Excavation of trenches, timbering and dewatering
- x Laying and jointing
- x Testing and
- x Backfilling

30. **Sewage pumps are not widely used in the sewage pumping –state true or false and justify your answer. (Nov/Dec 2012)**

It is true. Reciprocating pumps are more obsolete in modern sewage pumping station .since they are liable to be clogged by solids or fibrous material, even though sewage may have passed through coarse screens.

ors influencing the fixing of design period.(Apr/May 2011)

- x Presence of solid matter
- x Pressure

32. How is the capacity of wet well in a sewage pumping station determined? (Nov/Dec 2011)

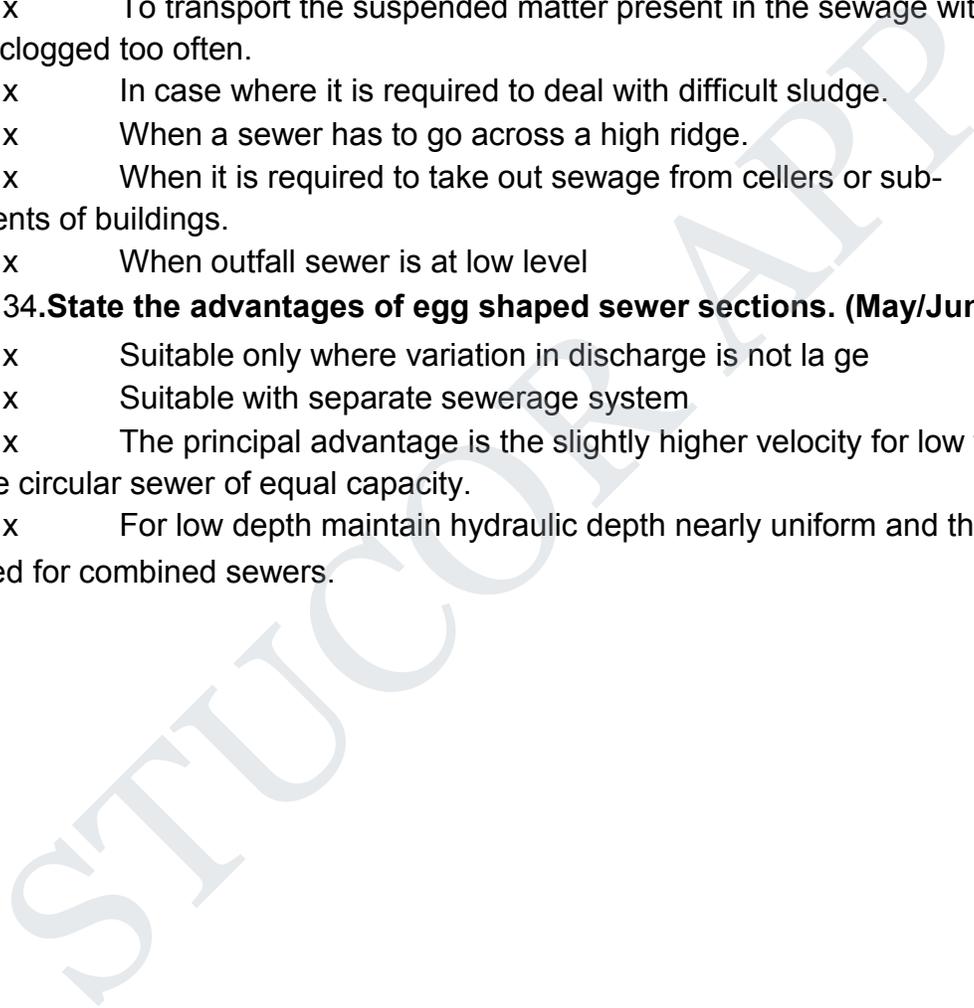
The capacity of the wet well is reckoned between the level at which air affects the suction line of the pump of minimum duty installed in the pump house and the designed sewage level in the incoming sewer, i.e., the portion of the well below the upper most starting point and the lower most stopping point.

33. What are the situations where the pumping of sewage becomes essential in sewage management? (May/Jun 2013)

- x To transport the suspended matter present in the sewage without getting clogged too often.
- x In case where it is required to deal with difficult sludge.
- x When a sewer has to go across a high ridge.
- x When it is required to take out sewage from cellars or sub-basements of buildings.
- x When outfall sewer is at low level

34. State the advantages of egg shaped sewer sections. (May/Jun 2014)

- x Suitable only where variation in discharge is not large
- x Suitable with separate sewerage system
- x The principal advantage is the slightly higher velocity for low flows over the circular sewer of equal capacity.
- x For low depth maintain hydraulic depth nearly uniform and therefore preferred for combined sewers.



UNIT – 3**1. What are the materials used for constructing sewer pipes?**

- a. Asbestos cement , Cast iron ,Concrete , Steel ,Vitrified clay

2. List out the types of pumps that are commonly employed for pumping sewage.

Air-lift pump ,Centrifugal pump ,Pneumatic pump or ejector, Propeller pump,Reciprocating pump

3. List four important factors in the selection of sewer pumps.

- a. **To assist treatment processes**
- b. To lift the sewage from low-lying areas to main sewers
- c. To lift the sewage from interceptors to treatment plants
- d. To lift the sewage from low-lying outfall sewer to treatment works
- e. To cross the obstacles such as stream etc., instead of inverted siphons
- f. To transfer the sludge from settling tanks to disposal processes
- g. To re-circulate the contents of the sludge digestion tanks
- h. To return the activated sludge to aeration process
- i. To drain off low-lying and sub-basements

4. Mention some shapes of sewer pipe.

- a. Circular section
- b. Non-circular section
 - Basket-handle sewer section
 - Box rectangular sewer section
 - Egg-shaped or O void sewer
 - Horse-shoe sewer section
 - Parabolic sewer section
 - Semi-circular sewer section
 - Semi-elliptical sewer section
 - U-shaped sewer section

5. What is meant by surface loading rate?

The surface loading rate is a hydraulic loading factor expressed in terms of flow per surface area. SLR is used to determine if the sedimentation tanks and clarifiers are under or over loaded.

6. List the demerits of septic tanks.

- b. The cost of having a septic tank can be very expensive to install and maintain.
- c. The maintenance of the septic tank must be checked frequently, if it is not that things could go wrong.

- d. Roots from trees in immediate area of absorption line may clog system.
 - e. Keep swimming pools away from absorption lines.
-

7. Enumerate the factors on which the cross section of sewers would expand.

Cross section of sewer depends on,

- c. Cost
- d. Ease of maintenance and operation
- e. Efficiency of flow
- f. Resistance to corrosion
- g. Resistance to internal and external pressures
- h. Structural stability

8. What are the severe problems associated with using u-lined cement concrete pipes as sewers?

- i. Clogged may happened due to algae growth
- j. Difficult to make connection in them
- k. Porosity may cause leakage
- l. Repairing is very difficult

9. What are the requirements of good sewer joints?

It should be,

- b. Durable and non-absorbent
- c. Easy to construct
- d. Economical
- e. Flexible
- f. Resistant to acidic, alkaline or gaseous action of the sewage
- g. Resistant to penetration of tree roots
- h. Watertight

10. What is self-cleaning velocity?

It is the velocity of flow in the sewers, at which the solid matter in the sewage does not settle down on the bottom or sides of the sewer.

11. Define non-scouring velocity.

The permissible maximum velocity to prevent eroding is termed as non-scouring velocity and it should be limited to 3.0 m/s. This limiting or non-scouring velocity will mainly depend upon the material of the sewer.

12. What are the problems to be faced during the pumping of sewerage?

- b. Nuisance due to bad smell resulting decomposition of the sewage
- c. Splashing May causes while pumping of sewage
- d. Unhygienic to humans

13. What are the different types of traps?

- a. P – trap
- b. Q – trap
- c. S – trap

Based on use,

- d. Floor trap
- e. Gully trap
- f. Intercepting trap

14. What are the advantages of asbestos pipe?

these pipes possess considerable strength against internal pressure

They are light in weight, due to which these can be easily handled

They can be easily cut and easily jointed

These pipes offer good resistance to salts and other corrosive materials normally present in the sewers

a. The inside surface is relatively smooth. Hence they are hydraulically more efficient

15. Define open joints.

If there is no objection to infiltration, open joints are adopted. The bell and spigot ends are simply placed together, without inserting filling material in the annular space. Gasket may however be inserted, to maintain alignment. The joint is merely covered with tar paper, to prevent entry of subsoil into the sewer.

16. Define simplex joints.

It is also known as ring tie coupling, is similar to collar joints, and are used for asbestos cement pipes. The joint, consists of a pipe sleeve or coupling of asbestos cement and two rubber rings which are compressed between the exterior of the pipes and the interior of the sleeve. Such a joint is quite flexible.

17. Define mechanical joints.

Such joints use mechanical devices like flanged rings, bolts, screwed ends etc. to keep the two ends together. They are used for metallic sewers made of cast iron, steel etc.

18. Define imperviousness.:The sewer material should be impervious and should not allow seepage of the sewage from the sewer.

19. Define outfall sewer.:It is a sewer that receives the sewage from the collecting systems and conduits it to a point of final discharge or to a disposal plant.

20. Disadvantages of plain concrete sewer.

- a. These pipes can get corroded and pitted by the action of H_2SO_4 .
- b. The carrying capacity of the pipe reduces with time because of corrosion.
- c. The pipes are susceptible to erosion by sewage containing silt and grit.
- d. The concrete sewers can be protected internally by vitrified clay linings. With protection lining they are used for almost all the branch and main sewers.
- e. Only high alumina cement concrete should be used when pipes are exposed to corrosive liquid like sewage.

21. What are the forces acting on sewer pipes?

- a. Internal pressure of sewage
- b. Pressure due to external loads
- c. Temperature stress
- d. Flexural stress

22. What is the purpose of using velocity control device in a grit 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

23. Mention the classification of treatment process of sewage

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

24. 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

25. 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

26. What is screening? What are the types of screens?**What are the methods of disposing screening waste**

Screening is the Removal of large floating, suspended and settleable solids by passing the sewage through screens

Coarse screens Medium screens Fine screens

Incineration Composting Dumping Digestion

27. What is Incineration? composting?

The process of burning is called Incineration

The screenings may also be disposed by burial. This process is technically called composting

28. What is the principle behind sedimentation?

The turbulence is retarded by offering storage to sewage; these impurities tend to settle down at the bottom of the tank offering such storage.

29. What are the types of grit channels? Explain Vaccuators

Horizontal flow type Aerated type Grease can also be removed from the sewage by vacuum floatation method, by subjecting the aerated sewage to a vacuum pressure of about 0-25 cm of mercury for 10-15 minutes in a vacuator. This causes

the air bubbles to expand and move upward through the sewage to the surface. The rising bubbles lift the grease and the lighter waste solids to the surface, where they are removed troughs. Heavier solids settle to the tank bottom, where they are collected and carried away for sludge treatment and disposal.

30. What is primary sedimentation, secondary sedimentation?

Sewage treatment, the sedimentation once before the biological treatment is called primary sedimentation.

Sewage treatment, the sedimentation once after the biological treatment is called secondary sedimentation.

31. What is detention time (or) detention period (or) Retention period?

It is the average theoretical time required for the sewage to flow through the tank.

$$\begin{aligned} \text{Detention time for rectangular tank} &= (\text{Volume of the tank} / \text{Rate of flow}) \\ &= B.L.H / Q \end{aligned}$$

11. What is displacement efficiency?

The ratio of the 'flowing through period' to the 'Detention period' is called displacement efficiency

12. What are the uses of Baffles? What are comminutors?

Baffles are required to prevent the movement of organic matter and its escape along with the effluent; and to distribute the sewage uniformly through the cross-section of the tank, and thus to avoid short circuiting.

Comminutors or shredders are devices which break the larger sewage solids to about 6mm in size, when the sewage is screened through them.

13. Differentiate between unit operation and unit processes waste water treatment give atleast two examples in each. (Nov/Dec 2012)

Methods of treatment in which the application of physical forces predominate are known as unit operations. eg. screening, mixing, flocculation sedimentation. While methods of treatment in which chemical or biological activities are involved are known as unit process. Eg. chemical precipitation, gas transfer, disinfection.

14. Distinguish between grit chamber and plain sedimentation tank. (April/may 2011)

Grit chambers: Grit chambers are provided to protect moving mechanical equipment from abrasion and accompanying abnormal wear. They are intended to remove the grit present in the wastewater.

Sedimentation tank: the finely divided suspended organic matters are present in the sewage. This organic matter undergoes a change of character, only due to biological oxidation and nitrification taking place in the filter the

organic solids are converted in to coagulated suspended mass which is heavier and bulkier and would thus settle by gravity in the sedimentation tanks.

15. What are the differences in the functions of screen chamber and grit chamber in the sewage treatment? (Nov/Dec 2011)

Screen chamber: screen chambers are used to remove the floating materials like dead bodies of animals, pieces of wood, papers, rags, metal containers plastic or rubber containers, grease etc., and also heavy settleable inorganic solids like grit and fragments of masonry etc.

Grit chambers: grit chambers are intended to remove the grit present in the waste water. They reduce the formation of heavy deposits in pipelines, channels and conduits. They also reduce the frequency of digester cleaning.

16. State the objectives of preliminary treatment of sewage. (May/June 2012)

The object is to remove those constituents of the waste water, the presence of which would otherwise interfere with subsequent treatment process or mechanical equipment preliminary treatment process remove the floating matter present in the sewage.

17. What do you mean by on-site sanitation? Mention the methods of onsite sanitation. (May/June 2012), (May/June 2013), (May/June 2016)

On-site sanitation means collecting, treating and disposing or reuse of all the wastewater within the boundaries of the premises.

Methods

Septic Tanks, Pit latrines, Ventilated improved Pit latrines, composting toilets.

18. State the objectives of grey water harvesting. (May/June 2012), (Nov/Dec 2013)

It can be used for the purposes that don't require potable water such as landscaping, agriculture or for flushing toilets and thereby reducing potable water use.

UNIT – 4**1. What are the operational troubles in trickling filter?**

- a. High head loss through the filter, making automatic dosing of filters as necessary.
- b. Odour and fly nuisance due to *Psychoda* which may be carried away into human habitation and may prove a serious nuisance to man. The latter may be overcome by flooding the filter or by the use of D.D.T or other insecticides.
- c. Large land area is required. Cost of construction is relatively higher.
- d. They require preliminary treatment and, therefore, cannot treat raw sewage.

2. What are the factors affecting sludge digestion?

- m. Acid fermentation
- n. Acid regression
- o. Alkaline fermentation
- p. Mixing and stirring of raw sludge with digested sludge
- q. pH value
- r. Temperature

3. What are the types of trickling filters?

- s. High rate or high capacity trickling filter
- t. Low rate or standard rate trickling filter

4. What are the stages in sludge digestion?

- u. Acidification
- v. Gasification
- w. Liquefaction

5. What are the advantages of primary treatment?

- a. In the primary treatment, physical operations like screening and sedimentation are used to remove the floating and settleable solids from waste water.
- b. Reduction in suspension solids
- c. Removal of floating matter (oil and grease)
- d. Partial equalization of flow rates and organic load
- e. Reduction in the amount of waste activated sludge in the activated sludge plant

6. What are the gases emanating from anaerobic digestion?

- a. Carbon-dioxide (CO_2)
 - b. Hydrogen (H_2)
- (H₂S)

- d. Nitrogen (N₂)
- e. Oxygen (O₂)
- f. Water vapor (H₂O)

- g. What is meant by sewage sickness?

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

7. . Mention the composition and uses of sludge gas.

The amount of sludge gas produced varies from 0.014 to 0.028 m³ per capita. The sludge gas is normally composed of 65% methane and 30% carbon-dioxide and remaining 5% of nitrogen and other inert gases, with a calorific value between 5400 to 5850kcal/m³.

8. What is recirculation ratio? Show the relationship between recirculation ratio and recirculation factor.

The ratio of the volume of sewage re-circulated (R) to the volume of raw sewage (I) is called re-circulation ratio.

The recirculation ratio is connected to another term, recirculation factor (F). The recirculation factor F also indicates the number of effective passages through the filters.

9. . What is skimming tank?

A skimming tank is a chamber so arranged that floating matter rises and remains on the surface of the waste water until removed, while the liquid flows out continuously through deep outlets or under baffles. This may be accomplished in a separate tank or combined with primary sedimentation, depending on the process and nature of the waste water.

Skimming tank is to separate the lighter floating substances from the waste water. The floating substances include oil, grease, soap, pieces of cork and wood, vegetable debris and fruit skins originating from households and industry.

- 10. Write the classification of treatment process.
 - a. Preliminary treatment
 - b. Primary treatment
 - c. Secondary or biological treatment
 - d. Complete final treatment

11. Define grit chamber.

Grit chambers, also called grit channels or grit basins, are intended to remove the inorganic particles (specific gravity about 2.65) such as sand, gravel, grit, egg shells, bone chips etc. of size 2 mm or larger to prevent damage 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. Give any two advantages of unit process.

- a. It gives better understanding of the process as inherent in the treatment and of the capabilities of these processes in attaining the objectives.
- b. It helps in the development of mathematical and physical models of treatment mechanisms and the consequent design of treatment plants.

14. What are the merits and demerits of trickling filter?

MERITS:

- a. The effluent is highly nitrified and stabilized. Hence, it can be easily disposed of in smaller quantity of dilution water.
- b. Flexible in operation and therefore, can withstand the application of variety sewage.
- c. Moisture content of sludge obtained is as high as 92% or so.
- d. Self-cleansing
- e. Cheap and simple in operation
- f. Mechanical wear and tear is very small.

DEMERITS:

- a. High loss of head warrants automatic dosing of the filters.
- b. Nuisance due to odour and Psychoda fly.
- c. Require large area of land
- d. Require preliminary treatment. Therefore cannot treat raw sewage.
- e. Costly

15. What are the advantages of chemical coagulation process?

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

16. What are the disadvantages of chemical coagulation process?

- a. Cost of chemicals is added to the cost of sedimentation, without much use, and thereby making the treatment costlier.
- b. The process of coagulation requires skilled supervision and handling of chemicals.

UNIT – 5**1. What are the methods of disposing the sewage effluence?**

- a. Dilution or the disposal of sewage in water
- b. Irrigation or the disposal of sewage on land

2. 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 and sunlight go on acting upon the pollution elements and bring back the water into its original condition. This automatic purification of polluted water, in due course is called the self-purification phenomenon.

3. Define population equivalent.

The population equivalent of sewage is the expression of some characteristics. E.g.: BOD, total solids etc., of the per capita flow of the sewage in terms of same characteristic of the capita flow of some standard sewage. A standard sewage may be taken as a normal domestic sewage of a separate system.

4. What are the zones of population in a river system?

- a. Clear water zone
- b. Zone of active decomposition
- c. Zone of degradation
- d. Zone of recovery

5. Mention how industrial waste water differs from domestic waste water. Domestic waste water, which includes human excreta as well as discharges from kitchens, baths and lavatories etc. from public and private buildings.

But, the Industrial wastes are the solid wastes resulting from many manufacturing processes and often result in causing health hazard, if left indisposed.

6. Give an example of by-products recovery.

- a. Dust and fine particles,
- b. Tailings,
- c. Slag waste,
- d. Gas cleaning sludge,
- e. Liquor residues,
- f. Dewatering and conserving water

7. What is meant by oxygen sag curve?

Both de-oxygenation and re-aeration are occurring simultaneously in any polluted stream exposed to air and producing in the dissolved oxygen concentration called the oxygen sag curve.

8. **Enumerate the factors on which rate of de-oxygenation depend?**
- Temperature of the diluting water
 - Time available for decomposition and
 - Volume of sewage and BOD

9. The 5-day BOD of sewage coming out from an industry is worked out to be 300 kg/day. The average standard 5-day BOD of domestic sewage is worked out to be about 0.08 kg/day per person.

10. **Why is clearing of sewage required?**

The sewage after treatment may be disposed either into a water body such as lake, stream, river, Estuary, ocean or land. It may also be utilized for several purposes such as Industrial reuse or reclaimed sewage effluent cooling system, boiler feed, process water, etc. Reuse in agriculture and horticulture, watering of lawns, golf courses and similar purpose, and Ground water recharge for augmenting ground water resources for downstream users or for preventing saline water intrusion in coastal areas.

11. **What is meant by non-scoring velocity?**

The velocity of water which is necessary to dislodge stranded solids from the stream bed

12. **Define dilution factor.**

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

13. **What are the conditions adopted for disposal by dilution?**

- When sewage is comparatively fresh and free from floating and settleable solids.
- When the dilution water has high dissolved oxygen content.
- When the out fall sewer of the city or the treatment plant is situated near some natural waters having large volumes.

14. **What are the factors affecting self-purification of polluted stream?**

- 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.

15. **What do you know about oxidation?**

The oxidation of the organic matter present in sewage effluents will start as soon as the sewage outfalls 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 affecting self-purification of rivers.

16. What is reduction?

Reduction occurs due to hydrolysis of organic matter settled at the bottom either chemically or biologically. Anaerobic 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.

17. Define the 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.

18. What are the merits and demerits of land filling method of disposal?

MERITS:

- a. It is simple and economical
- b. No plant / equipment is required
- c. There are no by products and hence there is no problem of the disposal of the by-products.
- d. Separation of various materials of the refuse is not required.

DEMERITS:

- e. Proper site may not be available near by
- f. Wind direction may not be favorable.
- g. Large land areas are required.
- h. It may be difficult to get large quantities of covering material.

19. What are the merits and demerits of incineration method of disposal?

MERITS:

- a. This is most hygienic method, since it ensures complete destruction of pathogens
- b. There is no odour trouble or dust nuisance
- c. The heat generated can be used for saving steam power
- d. Clinker produced can be used for road purposes.

DEMERITS:

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