

CE6605 ENVIRONMENTAL ENGINEERING II**L T P C****3 0 0 3**

OBJECTIVES: □ To educate the students on the principles and design of Sewage Collection, Conveyance, treatment and disposal.

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.

UNIT II SEWER DESIGN**8**

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 – Selection of treatment processes – Principles, Functions, Design and Drawing of Units- Onsite sanitation - Septic tank with dispersion - Grey Water harvesting – Primary treatment – Principles, functions design and drawing of screen, grit chambers and primary sedimentation tanks – Construction, operation and Maintenance aspects

UNIT IV SECONDARY TREATMENT OF SEWAGE**12**

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

UNIT V DISPOSAL OF SEWAGE AND SLUDGE MANAGEMENT**9**

Standards for Disposal - Methods – dilution – Self purification of surface water bodies – Oxygen sag curve – Land disposal – Sludge characterization – Thickening – Sludge digestion – Biogas recovery – Sludge Conditioning and Dewatering – disposal – Advances in Sludge Treatment and disposal.

OUTCOMES:

The students completing the course will have

- ability to estimate sewage generation and design sewer system including sewage pumping stations
- required understanding on the characteristics and composition of sewage, self purification of streams
- ability to perform basic design of the unit operations and processes that are used in sewage treatment

TEXTBOOKS:

1. Garg, S.K., "Environmental Engineering" Vol. II, Khanna Publishers, New Delhi, 2003.
2. Punmia, B.C., Jain, A.K., and Jain, A., "Environmental Engineering", Vol.II, Lakshmi Publications, New Delhi, 2005.

REFERENCES:

1. "Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1997.
2. Metcalf & Eddy, "Wastewater Engineering" – Treatment and Reuse, Tata McGraw Hill Company, New Delhi, 2003.
3. Karia G L & Christian R A, "Wastewater Treatment", Prentice Hall of India, New Delhi, 2013.

UNIT – I**Planning for Sewerage Systems****PART – A****1. What are the types of treatment processes?**

- 1 Preliminary treatment
- 2 Primary treatment
- 3 Complete final treatment
- 4 Secondary treatment

2. What are the various sources of wastewater generation?

- I. Industrial Wastes
- II. Domestic wastes
- III. Agricultural Wastes

3. List out the types of anaerobic biological units?

1. Anaerobic lagoons
2. Septic tank
3. Inhofe 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.

6. What are the types of screen?

1. Coarse screen
2. Medium screen
3. Fine screen

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. What is meant by movable screen?

Movable screens are stationary during their operating periods. But they can be lifted up bodily and removed from their partitions for the purpose of cleaning.

A common movable bar medium screen is a 3 – sided cage with a bottom of perforated plates. It is mainly used in deep pits ahead of pumps.

9. Define Comminutors?

Comminutors 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.

10. 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.

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

- 1 Burning
- 2 Burial
- 3 Dumping

12. Define Grit Chamber?

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

13. 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.

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

1. Physical unit operations
2. Chemical unit process

3. Biological unit process

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

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

16. Define phase transfer?

Most waste water treatment process bring about changes in concentration of a specific substances by moving the substance either in to or unit of the wastewater it self. This is called phase transfer.

17. Define definition time?

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

18. Define the term Displacement efficiency?

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

19. What is meant by principle of sedimentation?

The turbulence is retarded by offering storage to sewage the seimpurities tend to settle down at the bottom of the tank offering such storage. This is the principle of sedimentation.

20. Define the term "Sedimentation Burin"?

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

PART B

1. Explain the factors influencing sanitary sewage flow and its estimation.
2. Brief about sewage flow fluctuations and discuss the importance sod studying them.
3. Discuss the methods of estimation of storm water run off.
4. List the information to be collected while planning for sewerage systems. How will you use the corrected information?
5. List the effects of sewage on environment and explain it briefly.

6. State the classification of solids present in sewage and the removal methods of each.
7. Explain the various characteristics and composition of sewage and state their environmental significance.
8. Briefly discuss the legislation requirements for sewage treatment.

Unit-2

SEWERDESIGN

PART A

1. What are the Demerits of chemical precipitation?

1. High cost of chemicals
2. Large quantity of sludge which offers difficulty of its removal
3. Skilled attendance
4. Putrescible effluent

2. What do you mean by chemical precipitation?

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

3. What do you mean by transitional settling zone?

Grit particles however, generally lie between 0.1mm and 1mm, and hence undergo settling which lies in between stream line settling and turbulent settling. This settling zone is called the transitional settling zone.

4. What are the uses of baffle?

1. Baffles are required to prevent the movement of organic matter and it escape along with the effluent.
2. Distribute the sewage uniformly through the cross section of the tank.
3. It is used to avoid short circuiting.

5. Write the equation for finding out the critical scour velocity?

$$V_H = 3 \text{ to } 4.5 \sqrt{gdSs-1}$$

V_H = critical scour velocity

6. What are the classifications of biological process?

1. Aerobic processes
2. Anaerobic processes

3. Aerobic –anaerobic processes

7. List out the aerobic processes?

1. Activated sludge processes
2. Trickling filters
3. Aerobic stabilization pond
4. Aerated lagoon

8. List out the anaerobic process?

- a. Anaerobic sludge digestion,
- b. Anaerobic contact processes
- c. Anaerobic filters
- d. Anaerobic lagoons or ponds

9. What are the sources of waste water?

- a. Domestic waste water i.e sewage
- b. Agricultural return waste water
- c. Industrial waste water

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

Mainly classified into

1. Conventional treatment method
2. Advanced waste water treatment methods

11. What are the functions involved in the chemical unit processes?

- a. Chemical precipitation
- b. Gas transfer
- c. Adsorption
- d. Disinfection
- e. Combustion
- f. Ion exchange
- g. Electrolysis

12. What do you understand by waste water treatment?

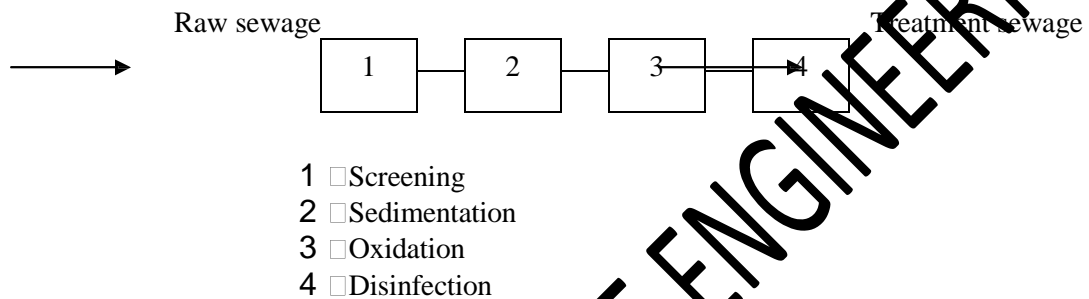
The waste water treatment or sewage treatment is a broad term that applies to any process /operation or combination of processes and operations that can reduce the objectionable properties of water carried waste and render it less dangerous with the following.

1. Removal of suspended and floatable material.
2. Treatment of biodegradable organics.
3. Elimination of pallogenic organisms.

13. What is the detention periods range for sedimentation?

The detention periods range 45to120min.

14. Draw a generally out for sewage treatment process?



15. Give example for single & Double storied sedimentation tank?

- Single stored tanks
 septic tank
 Double stored tank
 Inhofe tank

16. What is the detention period for detritus tank?

3-5 minutes

17. Write the expression for finding out the settling velocity?

$$V_s = \frac{S_s - 1}{18} d^2$$

For particle < 0.1 mm

Where

- V_s □ Settling velocity in m/s
 □ □ □ Unit □ t of water
 □ □ □ Absolute or dynamic velocity on kgsec/

m²

d □ dia of particle in m

18. What are the chemical used for precipitation of sediment?

1. Alum
2. Ferroussulphate
3. Ferricsulphate
4. Ferricchlorides
5. Sodiumaluminate
6. Sulphuricacid
7. lime
8. copperas

19. What are the factors that affect the precipitation?

1. Kind of chemical
2. Quality of chemical
3. Character and concentration of sewage
4. Ph values of sewage
5. timeof mixingandflowlations
6. Temperature
7. Violenceofagitation

20. What are the merits of chemical precipitation.

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

PART B

1. Explain the step by step procedure of laying and testing of sewer line.
2. Explain the method of laying sewer line for the designed alignment and gradient.
3. Determine the diameter and slope of a sewer carrying 0.0125m³/s of peak flow at half full depth.
4. Discuss with neat sketch a drop manhole and indicate where it used.
5. With the help of a neat sketch discuss the one-pipe and two-pipe systems of plumbing used for drainage.
6. Describe the various plumbing systems their formation, advantages and disadvantages.
7. Explain the various systems of sanitary plumbing for building and write down the main characteristics.
8. Compare the formation , advantages and disadvantages of one-pipe and two-pipe plumbing systems.

Unit-3

PRIMARY TREATMENT OF
SEWAGE**1. Define humus tank?**

The effluent of the filter is therefore, passed through a sedimentation tank called Humus tank otherwise called secondary clarifier.

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

1. Acid fermentation
2. Acid repression and Alkaline fermentation

3. Define the term ripened sludge?

This digested sludge from Alkaline fermentation stage is collected at the bottom of the digestion tank is called ripened sludge.

4. What are functions of aeration in ASP?

1. Oxygenation of the mixed liquor
2. Flocculation of the colloid in sewage influent
3. Suspension of activated sludge

5. What are the methods employed for the purpose of aeration in ASP?

1. Diffused air aeration
2. Mechanical aeration
3. Combined used air and Mechanical aeration

6. What are the patterns of mechanical aeration?

- i) Haworth paddle or Sheffield aeration system
- ii) Hartley paddle or bir Mangham Biofloculation system
- iii) Simplex aeration system
- iv) Linkbelt aeration system
- v) Kessner Brush aeration system

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

- 1 Conventional process
- 2 Tapered aeration process
- 3 Step aeration process

8. What are the advantage of stabilization ponds?

1. Lower initial cost than required for a mechanical plant.
2. Lower operation costs
3. Regulation of effluent discharge possible their providing control of pollution during critical times of the year.

9. What are the disadvantage of lagoons?

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

10. What do you understand by facultative ponds?

A facultative pond combine the features of the aerobic and anaerobic ponds. Constructed of intermediate depth 1 to 1.5m

A facultative pond consists of three

- i A aerobic Zone-□Top
- ii Facultative zone
- iii Anaerobic zone

11. What are remedial measurement for rising sludge problem?

- I Increasing the return sludge age
- II Increasing the speed of the sludge scraper mechanism, where possible

12. What is meant by sludge bulking?

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

13. What are the advantage of intermittent sand filters?

- i. The effluent from intermittent sand filter is of better quality. It is more clean and more stable and hence does not need further treatment before disposal
- ii. The filter work under aerobic conditions, and hence there is no trouble of odour, fine sand inserts

14. What are the disadvantages of intermittent sand filters?

The rate of filtration and hence that of load long is very small permit it surface area of the filter hence they can not be employed.

15. What do you understand by contact beds?

Contact beds, also called contact filters, are similar to intermittent sand filters in construction, except that filtering media is very coarse, consisting of broken stones called ballast of 20 to 50 mm gauge.

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

1. filling
2. Contact
3. Emptying
4. Oxidation

17. What are the advantage of contact of beds?

- i Contact beds can work under small heads.
- ii Contact beds can be operated without exposing the sewage effluent to view.
- iii There is no nuisance of filter flows
- iv) The problem of odour is much less as compared to rill long filters.

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

- i Rate of loading is much less in comparison to trickling filters.
- ii Large areas of land is required for their installation
- iii intermittent operation requires constant attendance
- iv) The cost of contact beds is much more as compared to trickling filters.

19. What do you mean by trickling filters?

Trickling filters, also as percolating filters or sprinkling filters or trickling filters are similar to contact beds in construction, but their operation is continuous and the yellow 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

- I To carry away the liquid effluent and sloughed biological solids.
- II To distribute air through the bed.

PART B

1. Design a bar screen for a peak average flow of 30 million liters per day.
2. Discuss in brief the various types of settling and design considerations of sedimentation tank.
3. Explain the working of grit chamber and their types.
4. State the design criteria for a grit chamber and brief its functioning and construction.
5. Describe the on-site sanitation methods.

6. Design a primary settling tank unit for a peak flow of 40 MLD in a treatment plant.
7. Explain the inlet and outlet arrangements of a settling tank and their purpose and requirements.
8. Name the various types of settling and discuss the significance of surface overflow rate in the design of sedimentation tanks.

UNIT -4

SECONDARY TREATMENT OF SEWAGE PART - A

1. What is the difference between activated sludge processes and Trickling filter

Trickling filter	Activated sludge process
The bacterial film coating the grains of the filter media is stationary	the bacterial film which is kept moving is the constant agitation

2. Give any 4 advantages of activated sludge process.

- i Lesser land area is required
- ii The head loss in the plant is quite low
- iii There is no fly or odour nuisance
- iv) Capital cost is less

5. What do you mean by secondary treatment?

The effluent from the primary sedimentation tank contains about 60 to 80% of the unstable organic matter originally present in sewage. Thus colloidal organic matter, which passes through primary clarification, without settling, has to be removed by further treatment. This is called secondary or biological treatment.

6. What are the filter in sewage treatment?

1. Contact beds very small plant
2. Intermittent filters small plant
3. Trickling filters commonly used
- 4.

7. Define the term eutrophication?

The excess growth of algae and other aquatic plants in a river stream is called eutrophication.

8. What are the types of high rate Filters?

1. Biofilters
2. Accelerated filters
3. Aerofilters

9. What are the special types of filters?

1. Durban filter
2. Magnetic filters
3. Rapid sand filters

10. 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.

11. What are the methods adopted for sewage disposal?

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

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

1. When sewage is comparatively fresh to mold and free from floating and settleable solids.
2. When the dilution water has a high dissolved oxygen D.O. content. When the outfall sewer of the city or the treatment plant is situated near some natural waters having large volumes.

13. What are the natural forces of purification?

1. Dilution and dispersion.

14. What is meant by photosynthesis?

The sunlight has a stimulating and stabilizing effect of bacteria. It also helps certain microorganisms 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.

15. What do you mean by Oxidation?

The oxidation of the organic matter present 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.

16. What do you understand by 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. 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 epilimnion zone.

18. What is meant by hypolimnion zone?

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

19. What do you understand by monoclinal? 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 monoclinal.

20. What is meant by Benthic zone? Give example

The bottom sediments in a lake comprises what is called the benthic zone. As the organisms living in the overlying water die, they settle down to the bottom, where they are decomposed by the organisms living in the benthic zone. Bacteria are always present in this zone.

PART B

1. Discuss the operational problems of standard rate trickling filter and their remedies.
2. With the help of a neat sketch explain the functional and operation mechanism of UASB.
3. Explain the components and the operational principles of activated sludge process.
4. Discuss the loading criteria of aeration tank of an activated sludge process.
5. Explain the algae-bacterial symbiosis with respect to waste stabilization pond.
6. Draw a typical flow diagram of an oxidation ditch and explain the working principle.
7. Design an oxidation ditch for a design sewerage flow of 50 MLD. Assume suitable data wherever necessary. Draw a neat sketch of the unit.
8. Briefly discuss the functioning and advantages of

an USAB.

UNIT -V

DISPOSAL OF SEWAGE AND SLUDGE

PART -A

1. Define the term “productivity of a lake”?

The productivity of a lake is defined as a measure of its ability to support a food chain. Since the algae form the base of this food chain, which is required by the other forms of living organisms to thrive. Its presence measures the lake productivity.

2. What are the types of lakes?

Depending upon the increasing level of productivity the lakes may be classified as

- a. Oligotrophic lakes
- b. Mesotrophic lakes
- c. Eutrophic lakes
- d.

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

1. Proper site may not be available near by
2. Wind direction may not be favourable.
3. Large land areas are required.
4. It may be difficult to get large quantities of covering material.

4. What do you understand by pulverization?

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

5. What are the methods adopted for composting?

- a. Composting by trenching.
- b. Open window composting.
- c. Mechanical composting.

6. What is meant by “humus”?

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

7. Describe the term open window composting.

In this method, a large proportion of mineral matter like dust, stone, broken glass pieces etc. are first removed from the refuse. The refuse is then dumped on the ground in the form of 0.6 to 1 m high, 6 m long and 1 to 2 m wide.

8. What are methods adopted for sludge drying?

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

9. What is meant by house refuse?

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

10. 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.

11. What do you understand by inorganic waste?

This consists of non-combustible materials such as grit, dust, mud, metal pieces, metal containers, broken glass and crockery, tiles waste building material. It is not subjected to decay and is therefore no harm to public health.

12. What are the unit operation/ process on the sludge treatment?

Sludge treatment may include all or a combination of the following unit operations and processes

- a. Thickening or concentration
- b. Digestion
- c. Conditioning
- d. Dewatering
- e. Drying
- f. in coneration

13. What is the purpose of thickening?

The purpose of thickening is to reduce moisture content of the sludge, and consequently to increase the solids concentration.

14. What are the types of thickening?

- a. Gravity thickening
- b. Air floatation.
- c. Centrifugation.

15. Define the term dissolved air floatation?

Air floatation units employ floatation of sludge by air under pressure or vacuum the former process more commonly used is known as dissolved air floatation or pressure type floatation.

16. What is meant by centrifugal thickening?

Centrifuges are used both to thicken and to dewater sludge. Their application in thickening is normally limited to waste activated sludge. Thickening by centrifugation involves the settling of sludge particles under the influence of centrifugal forces.

17. What are the advantages of aerobic digestion?

1. Lower BOD concentration in digester supernatant
2. Production of odourless and easily degradable biologically stable digested sludge.
3. Lower capital cost

18. What are the disadvantages of aerobic digestion?

1. Higher power costs generate higher operating costs comparable with anaerobic digestion.
2. No methane gas is produced for recovery as a by-product.

19. What is meant by "Flutriation"?

Elutriation is literally a "washing" of the sludge. It is a unit operation in which a solid or a solid-liquid mixture is immediately mixed with liquid for the purpose of transferring certain components to the liquid.

20. Define the term "high rate digestion"?

The process of sludge digestion using a sludge thickener before the digestion tank, helps in reducing the capacity of the digestion tank which further reduces their capacity and the rate of digestion is also made high. Such a digestion which is used in modern large sized plants is called high rate digestion.

PART B

1. Discuss the principle of the self purification process of stream and factors influencing the process.
2. Explain the self purification process of rivers and the various stages of oxygen sag curve.

3. Explain about oxygen sag curve and its importance.
4. Explain the Streeter-Phelps equation and its applications.
5. Draw a neat sketch of a high rate stage anaerobic sludge digester and explain its salient features.
6. Discuss the need for sludge dewatering and explain the various sludge dewatering methods.
7. Explain the mechanism of biogas recovery from sludge.
8. Describe the anaerobic sludge digestion process and explain the effects of pH and temperature on it.

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