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Section : A

Quiz : Waste water Engineering

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Answer No.1

Wastewater Engineering:

Definition:

Sanitary engineering, also known as public health engineering or wastewater engineering, is the application of engineering methods to improve sanitation of human communities, primarily by providing the removal and disposal of human waste, and in addition to the supply of safe potable water.

- Wastewater, also known as sewage is the liquid wastes originates from household wastes, human and animal wastes,industrial wastewaters, storm runoff, inflow and infiltration.

Applications in Safeguarding the Enviornment:

sewerage system in a city is provided for safe disposal of wastewater. For this purposes sewer lines are used, it also prevent flooding of the area following a rainfall. The main purpose of sewerage system are as;

i: To provide a good sanitary environmental condition in a city

ii. Thus sanitary Engineering aims at the creation of such conditions of living which will not result into serious outbreak of epidemic (wahbai merz)diseases in a community

iii. The disposal of human excreta to a safe place by a safe and protective means

iv. To dispose of all liquid wastes from a community to a proper place for preventing a favorable

condition for mosquito, flies breeding or bacteria growing

v. To treat the sewage so as not to endanger the water bodies, or land to get polluted where it is finally disposed of

vi. Proper disposal method should be adopted to protect sub soil water from contamination.

vii. **Reclamation and utilization of sewage**: The recovery of sewage is an effective means of saving water resources and promoting the reuse of water resources. It is also an important measure to reduce the pollution of sewage and protect the environment. However, the recovery and treatment of sewage must be treated with caution and prevent the expansion of water pollution caused by personnel problems and technical problems and the re-use of non-compliance.

viii. Recycling of solid waste: In addition to the above-mentioned sewage treatment, another difficulty in the process of urbanization is the solid waste that urban residence form and discharge in production and life. This is an important bi-product of urban life and production, if according to there nature, they can be divided in two catagories i-e Recyclable and non-recyclable.

ix. Application of energy saving and emission reduction technology: As one of the key elements of eco city construction, the key of energy saving and emission reduction technology is to control, detect and minimize the carbon dioxide emission and energy use of the target city, so as to support the construction quality and efficiency of the ecological city.

Answer No. 2

Relationship between wastewater generation and water supply:

Average daily per capita consumption varies from 130 to 200 Liters. Local use depends on:

1) **Size of the city:**

Small communities tend to have more limited use of water. Unsewered homes have less use of water usually less than 40L/cap/day. Cities having water using industries may result in high per capita use, thus wastewater generation increases.

2) **Industry and Commerce:**

Effect of industry has to be studied for individual type of industry. The industrial use has an indirect relation with the population. Also industries use auxiliary water supplies for some purposes. Wastewater obtained from this area is highly contaminated and require special treatment.

3) **Commercial:**

Commercial consumption largely depends upon the number of people employed in the business district. Uses of water in commerce are for sanitary and air conditioning etc. The typical commercial consumption taken is 10 to 15 L/m^2 of the floor area or 95 L/m^2 of the ground area. This wastewater is easy to treat and therefore economical.

4) **Characteristics of population:**

Economic level of the population determines the use of water which usually ranges from 50 to 380 liter/capita/day. In the slum districts it usually varies from 50 to 100 Liter/Capita/day. The quantity of wastewater is directly proportional to the characteristic of population.

5) **Metering:**

Metering of water supplies to the individual users has been shown to reduce the consumption substantially. As the consumer has to pay in proportion to the quantity of water consumed.

6) Quality of Water:

Water which is of poor quality will be used less than the water which is satisfactory to consumer.

7) Pressure:

High pressure maintained in the system results in greater use, In addition it increases losses in the leaks.

8) Maintenance:

A well designed program of maintenance will reduce loss and waste in the system. (Detection of leaks, presence of unauthorized connection from survey.)

Answer No. 3

Importance of wastewater characterization:

A characterization of the wastewater, which provides a wide variety of information regarding the type and concentration of the contaminants present, must be carried out to determine the type of contamination concerned.

FOOD AND BEVERAGE INDUSTRIES WASTEWATER

A major concern is that groundwater is susceptible to pollutants from residential and commercial sources. Therefore, food and beverage industry generated wastewater discharged to the subsurface in must provide reasonable assurance of meeting groundwater quality standards. Due to the variability in contaminant concentrations in wastewater across the food and beverage sector, facility-specific and possibly production-specific characterization of wastewater plays a significant role in treatment determinations and design. Setting effluent limitations based on dispersal area soils, flow analyses, and depth to groundwater can strengthen efforts to ensure that drinking water sources and the environment is protected for future generations.

Miso Production Facility

Miso is a fermented bean paste food product typically made from soybeans or other legumes. It is used as a seasoning and is high in protein. Miso is produced by cooking soybeans and then combining the cooked beans with a mold that is cultivated on rice (koji) and salt. The combined ingredients are fermented over time to produce a thick paste. Wastewater generated by miso production can contained high concentrations of organic constituents. Miso production wastewater treatment conducted examined treatment of constituents such as

COD, BOD, suspended solids, phosphorus, and nitrogen. Concentrations of COD ranged from as low as 840 mg/L to as high as 15,000 mg/L and BOD average results of 5210+260 mg/L.

Answer 4

PHYSICAL CHARACTERISTICS OF WASTE WATER:

The physical characteristics are its total solids content, odor, temperature, density, color and turbidity. Fresh sewage is usually gray, light brown, yellowish and having no unpleasant odor. Foul and unpleasant odor may develop as a result of septic or stale condition. Its color changes to black or dark brown when sewage becomes stale. Its odor changes within 2 -4 hours due to exhaustion of oxygen and presence of H_2S gas in sewage. Temperature affect chemical reaction and biological activities. Solid content in wastewater are important factor for wastewater treatment processes. Solids like total suspended solids (TSS), volatile suspended solids (VSS) and settle able solids affect the operation and sizing of treatment units.

Solids: Solids comprise matter suspended or dissolved in water and wastewater. Solids are divided into several different fractions and their concentration provide useful information for characterization of wastewater and control of treatment processes.

Total solids: Total solids (TS) are the sum of total suspended solids and total dissolved solids (TDS). Each of these groups can be further divided into volatile and fixed fractions. Total solids are the material left in the evaporation dish after it has dried at 103-105^{0}C. Total solids can be expressed in mg/L.

Total suspended solids: Total suspended solids (TSS) are referred to as non-filterable residue. It is determined by filtering a well-mixed sample through 0.45μm to 2 μm pore sized membrane. The residue retained on the filter is dried in an oven at a temperature of 103-105^{0}C for at least 1 hour. TSS is in mg/L.

Total dissolved solids: Dissolved solid are also known as filterable residues. To determine total dissolved solids a well-mixed sample is filtered through a standard glass fiber filter of 2 μm or less pore size, and the filtrate is evaporated for at least one hour in an oven at 180 C. The increase in dish weight represents the TDS. It is expressed in mg/L.

Fixed and Volatile Solids: The residue for total solids, total suspended solids or total dissolved solids tests is ignited to constant weight at 500 ^{o}C ± 50. The weight lost on ignition is called volatile solids, whereas the remaining solids represent the fixed total suspended or dissolved solids. The determination of volatile portion of solids is useful in controlling waste water treatment plant operations because it gives a rough estimation of the amount of organic matter present in the solid fraction of waste water, activated sludge and industrial waste.

Settle able Solid: Settle able solids is the term applied to the material settling out of suspension within a defined time. It may include floating material. Its units are mg/L.

CHEMICAL CHARACTERISTICS OF WASTE WATER:

In sanitary sewage about 75 % of suspended solids and 40% of filterable solids are organic. These solids are derived from both animals and plant along with human. Organic compounds are usually consisting of C; H; O; N along with S; P and Iron. The organic substances found in sewage are Protein (40-60%); Carbohydrates (25-50%) and 10% as fats and oils. Along with these organic compounds small amount of synthetic organic compounds like VOCs, Pesticides, insecticides, Organic Priority Pollutants are also presents in sewage. Sewage also contain inorganic substances. All the test representing these organic and inorganic constituents come under the heading of chemical characteristics. Test like BOD, COD, Nitrogen, phosphorus, alkalinity etc. give the chemical characteristics of sewage.

BOD (Biochemical Oxygen Demand): When biodegradable Organic Matters is released into a water body, microorganisms feed on the wastes, breaking them into simpler organic and inorganic substances. When this decomposition occurs in ***aerobic environment*** the process produces non-objectionable, stable end products like CO_2, SO_4, PO_4 and NO_3. A simplified form of Aerobic decomposition is

O.M + O_2 +Microorganisms $CO_2 + H_2O + C_5 H_7 NO_2$ (New Cells) + stable Products like NO_3; PO_4; NO_3….)

When insufficient O_2 is available ***Anaerobic decomposition*** occurs by different microorganisms. They produce end products that can be highly objectionable, including H_2S; NH_3 and CH_4. The reaction is O.M +Microorganisms $CO_2 + H_2O + C_5 H_7 NO_2$ (New Cells) + Unstable Products (NH_3; H_2S; CH_4….). CH_4 is a stable gas, while other products are usually unstable. Bacteria placed in contact with organic matter will utilize it as food source. In the utilization of the organic material it will eventually be oxidized to stable end products such as CO_2 and H_2O etc. The amount of oxygen required by the bacteria to oxidize the organic matter present in sewage to stable end products is known as biochemical oxygen demand.

Significance: -

- Used in design of waste water treatment plants.
- Used to measure efficiently of waste water treatment plant.

Chemical Oxygen Demand (COD): The biodegradable organic matters are degraded completely by microorganisms either of CBOD or NBOD. There are some organic matters like cellulose, phenols, benzene and tannic acid which are resists to biodegradation. Similarly, other organic matters like pesticides, insecticides and various industrial chemicals are non-biodegradable and they are toxic to microorganisms. The COD is a measured quantity that does

not depend on microorganisms. To calculate the concentration of oxygen for non-biodegradable materials a strong oxidizing agent known as potassium dichromate will be used. The reaction is Organic matter ($C_aH_bO_c$) $+Cr_2O_7^{-2}$ + H2O -→Cr^{+3} + CO_2 + H_2O. The COD test is much quicker than BOD test, but it does not distinguish between the biodegradable and non-biodegradable organic matter. The measured COD is usually more than BOD if there is non-biodegradable impurity present. If all are the biodegradable organic matter, then COD remains the same as that of BOD. Roughly the BOD/COD is 0.4 to 0.8.

Theoretical Oxygen Demand (TheoD): Organic matter of animal or vegetable origin in wastewater is generally a combination of carbon, hydrogen, oxygen, nitrogen and other elements. If the chemical composition of an organic matter is known, then the amount of oxygen required to oxidize it to carbon dioxide and water can be calculated using stoichiometry. This amount of oxygen is known as Theoretical Oxygen Demand. If that oxidation is carried out by bacteria then it is BOD, if by chemical process then it is COD. If a combination of both then it is TheoD.

BIOLOGICAL CHARACTERISTICS OF WASTE WATER:

In sewage a lot of Suspended, colloidal or dissolved degradable organic material, present in certain quantities and ratios which depends on the nature of the wastewater. Most biological waste and wastewater treatment processes employ bacteria as primary microorganisms; certain other microorganisms may also play an important role. Bacteria is a single cell organism. Their mode of reproduction is usually binary fission. The three categories of bacteria are spherical (0.5 to 1.0 μm in dia.), cylindrical (0.5 to 1.0 μm in width by 1.5 to 3.0 μm in length) or helical (0.5 to 5.0 μm in width by 6.0 to 15.0 μm in length). Bacteria are usually consisting of 80% water and 20% dry material, of which 90% is organic and 10% in organics. An approximate formula for organics fraction is C_5 H_7 O_2 N, when phosphorus is considered then the formula is C_{60} H_{87} O_{23} N_{12} P.

The inorganic portion is P_2O_5, SO_3, Na_2O, CaO, Mg O, K_2O and Fe_2 O_3. As all of these elements and compounds are derived from environment, a shortage of any of these substances would limit and in some cases, change the growth. Population dynamics of bacteria in biological treatment depends on environmental factors which include: pH; temperature; type and concentration of the substrate; essential nutrient concentration and its availability; (nitrogen, phosphorous, sulfur, etc.); essential minerals; media toxicity; byproducts; and degree of mixing.

Answer 5

Classification of sewerage system: There are usually three types of sewerage system. They are combined, separate and partially separate system.

Separate System: When sanitary sewage and storm water flow in separate sewerage system then it is known as separate system and the sewers are terms as separate sewers. As storm water are carried separately it is not contaminated and is usually disposed of into natural water bodies.

Advantages and Disadvantage of Separate System:

- As the storm water is not treated, the quantity of sewage is less, hence economical
- This system is cheaper in construction, as the sanitary sewage is carried in underground sewers while storm water is removed in open drains.
- Where the intensity of rainfall is high and duration is less a separate system is used.
- In case of pumping of sewage, such system is not suitable.
- Such system is not suitable where the rainfall intensity is less.
- If the streets are narrow, there may not be enough space for two sets and is not recommended.
- Storm water which is disposed of without treatment may be polluted. So proper sanitation is not possible.

Combined system: When all the waste water from sanitary sewage, industrial sewage and storm water is removed in one set of sewer. Such sewerage system is combine sewerage system and the pipe to carry such sewage is combine sewer.

Advantages and Disadvantages of Combine System:

- In narrow streets a combined system is preferred.
- In this system treatment of both sanitary and storm water can be done, so a better sanitary condition is created.
- Where rainfall intensity is less, a combine system is preferred as it keep the sewage in suspension
- In areas with high intensity of rainfall and concentrated for short duration this system is not suitable as the storm water and dry weather flow becomes high, while in dry season only sewage flow will be there causing siltation problem.
- Treatment cost is high due to large amount of sewage.
- Construction of large sectioned underground sewer is costly.
- Pumping cost of combined system is more as compared to separate system.

Justification

I will suggest combine sewaerge system because both domestic sewarge and strom water are carried in single sewer so construction cost is less and sewer are of large size so they are easily to clean.