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IQRA UNIVERSITY PESHAWAR

**Question NO.1:**

**What is wastewater engineering? Briefly describe its applications in safeguarding the environment?**

**Answer:**

## Wastewater:

Used water from residential, commercial, and industrial areas.

- Dirty and unwanted.
- Contains pathogenic micro-organisms, and potentially harmful compounds.
- Harmful to health.
- Breeding sites for insects, pests and microorganism.
- Environmental pollution and affect ecosystem.

## Wastewater Engineering:

It is the branch of environmental engineering in which the basic principles of science and engineering are applied to the problems of water pollution control. So, as an overview, this wastewater engineering includes wastewater treatment, sludge disposal and reuse, wastewater reclamation and reuse, effluent disposal and the role of engineer.

## Applications:

Every community produces both solid and liquid wastes. The liquid waste is known as the wastewater. It may be defined as liquid wastes collected in a sewer system and conveyed to a treatment plant for processing. In view of their sources of generation it may be defined as a combination of the liquid or water carrying wastes removed from residences, institutions, commercial and industrial establishments together with ground water, surface water and storm.

- Wastewater is any water that has been affected directly or indirectly by human use. Wastewater is "used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water ".

- Wastewater normally contains 99.9 percent water and 0.1 percent solids. The main concern about wastewater treatment is simply to reduce all or most part of this 0.1 percent of Solids.

- Major sources of wastewater are residential areas, commercial activities, industries and educational institutions etc.

## TYPES OF WASTEWATER FROM HOUSEHOLD

| TYPES OF WASTEWATER | SOURCE OF WASTEWATER |
|---|---|
| I. Grey Water | Washing water from the kitchen, Bath, Laundry. |
| II. Black Water | Water From Flush Toilet. |
| III. Yellow Water | Urine from separated toilets and urinals. |
| IV. Brown Water | Black water without urine or yellow water. |
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## Question NO.2:

**Briefly describe the relationship of wastewater generation with water supply of a locality?**

**Answer:**

1. In situations where waste water flows rate data are limited or unavailable waste water flow rate estimate have to be developed from water consumption records in other information.
2. About 60-85% of supplied water per capita becomes waste water.
3. Supply waste water generated is dependent on supplied water as the supplied water increases, the waste water will be more.

## Locality Of water:

1. A drainage Basin.
2. A raw water collection point (above or below ground) where the water accumulates, such as a lake, a river, or groundwater from an underground aquifer. Raw water may be transferred using uncovered ground-level aqueducts, covered tunnels or underground water pipes to water purification facilities.
3. Water purification facilities. Treated water is transferred using water pipes (usually underground).
4. Water storage facilities such as reservoirs, water tanks, or water towers. Smaller water systems may store the water in cisterns or pressure vessels. Tall buildings may also need to store water locally in pressure vessels in order for the water to reach the upper floors.
5. Additional water pressurizing components such as pumping stations may need to be situated at the outlet of underground or above ground reservoirs or cisterns (if gravity flow is impractical).
6. A pipe network for distribution of water to the consumers (which may be private houses or industrial, commercial or institution establishments) and other usage points (such as fire hydrants).
7. Connections to the sewers (underground pipes, or aboveground ditches in some developing countries) are generally found downstream of the water consumers, but the sewer system is considered to be a separate system, rather than part of the water supply system.
8. Water supply networks are often run by public utilities of the water industry.

### Question NO.3:

**What is the importance of wastewater characterization?**

**Answer:**

## WASTEWATER CHARACTERISTICS

### IMPORTANCE:

An understanding of the nature of wastewater is essential in the design and operation of collection, treatment, and disposal facilities.

### CONSTITUENTS FOUND IN WASTEWATER:

Wastewater is characterized in terms of its Physical, Chemical and Biological composition.

### Importance of Improved Wastewater Characterization

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

## Question NO.4:

**Enlist Physical, chemical and Biological characteristics of wastewater?**

**Answer:**

### PHYSICAL CHARACTERISTICS

Physical Characteristics include solids, temperature, color, and odor.

1. SOLIDS:

   Wastewater is normally 99.9 percent water and 0.1 percent solids. The types of solids are total, suspended, settle able, dissolved, volatile and fixed solids.

   - Total Solids:

     Total solids content of a wastewater is defined as all the matter that remains as residue upon evaporation at 103 to 105 C.

   - Suspended and Dissolved Solids:

     The solids which are retained on a filter paper (of 1.2 micrometer pore size) are known as suspended solids and those that pass through it along with water are known as dissolved solids.

   - Settle able Solids:

     Settle able solids are those solids that will settle at the bottom of a cone shaped container in a 60 min period. Settle able solids, expressed as mL/L, are an approximate measure of the quantity of sludge that will be removed by primary sedimentation.

     Suspended solids are further classified on the basis of their volatility as “volatile suspended solids” and “fixed solids”. Volatile Suspended Solids represent the organic content of suspended solids. Fixed Solids represent the inorganic content of suspended solids.

2. Temperature:

   Temperature of wastewater is slightly higher than that of water supply. Depending upon the geographical locations, and the industrial operations, the temperature of wastewater varies greatly. The temperature of water is very important parameter because of its effect on chemical reactions, aquatic life, and the suitability of water for beneficial uses. Optimum temperatures for bacterial activity are in the range from about 25 to 30 C.

3. Color:

Fresh wastewater is usually a light brownish-gray in color. As anaerobic conditions develop, the color sequentially changes from gray to dark gray and ultimately to black. When the color of wastewater is black the wastewater is often described as SEPTIC. Some industrial wastewater may also add color to domestic wastewater.

4. Odor:

Odors in domestic wastewater are caused by gases produced by decomposition of organic matter or by substances added to the wastewater. Fresh wastewater has an odor which is less objectionable than the odor of wastewater that has undergone anaerobic decomposition. The most characteristic odor of stale or septic wastewater is that of hydrogen sulfide.

## CHEMICAL CHARACTERISTICS

These include; Organic matters, Inorganics, and Gases.

1 INORGANICS:

- pH:

  Defined as negative logarithm of hydrogen-ion concentration. pH range suitable for the existence of most biological life is quite narrow and critical. Very important parameter in control of WWTP.

- Alkalinity:

  Mostly due to bicarbonates of calcium and magnesium. Wastewater is slightly alkaline. Alkalinity in wastewater helps to resist change in pH. Important in chemical treatment.

- Nitrogen:

  Total Nitrogen is composed of; Organic Nitrogen , Ammonia Nitrogen (Free ammonia, albuminoid ammonia) , Nitrite, and Nitrate. N & P essential to the growth of protista and plants, and are known as nutrients. Nitrogen data is required to evaluate treatability of wastewater by biological processes. To control algal growth in receiving waters, removal of N in wastewater prior to its discharge is desirable.

- Sulfur:

  Sulfates present in wastewater are reduced by microorganisms under anaerobic condition to sulfide. Sulfides combine with hydrogen to form hydrogen sulfide (H2S). Accumulated H2S can be oxidized biologically to H2SO4 which causes sewer corrosion.

- Heavy Metals:
  Indicate inclusion of industrial wastes in sewage. Results in adverse health impacts, Interferes with biological treatment.

2 GASES:

Dissolved Oxygen:

Its presence is necessary to avoid anaerobic conditions and for aerobic biological treatment of waste.

- Hydrogen Sulfide:
  Causes sewer corrosion.

3 Organic Matter: Organic constituents are carbohydrates, proteins, and fats. Total quantity of organic matter is measured by biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total organic carbon (TOC). Theoretical estimation can be made as ThOD.

- Biochemical Oxygen Demand (BOD):
  "It is the amount of oxygen required by bacteria to oxidize organic matter to stable end products such as CO2 and water.

## BACTERIOLOGICAL CHARACTERISTICS

Enormous quantities of microorganisms are present in domestic sewage. They include;

- Bacteria
- Worms
- Viruses
- Protozoa etc.

Bacterial counts in raw sewage may range from 500,000 / ml to 5,000,000 / ml. Concerns in wastewater reuse of agricultural irrigation.

## BACTERIOLOGICAL CHARACTERISTICS

1. Bacteria:-

Bacteria are spherical, rod, spiral and filamentous shape. Some important bacteria are

- Pseudomonas:-
  Reduce NO3 to N2 , So it is very important in biological nitrate removal in treatment works.

- Bdellovibrio:
  Destroy pathogens in biological treatment.

- Acinetobacter:
  Store large amounts of under aerobic conditions and release it under an anaerobic condition so, they are useful in phosphate removal.

- Nitrobacter:
  Transform NO2 - to NO3 5.

- Coliform bacteria:- The most common type is E-Coli or Echerichia Coli, (indicator for the presence of pathogens).

2. Fungi:
   Important in decomposing organic matter to simple forms.

3. Algae:
   Useful in oxidation ponds for treatment of wastewater. Cause taste and problems when decayed. Cause eutrophication phenomena.

4. Protozoa:
   Feed on bacteria so they help in the purification of treated waste water. Some of them are pathogenic.

5. Viruses: Viruses are a major hazard to public health. They cause lots of dangerous diseases.

## Question NO.5:

**What are the advantages and disadvantages of combine and separate sewerage system? Which sewerage system will you recommend for a new proposed township? Support your answer with justification?**

**Answer:**

1) **Sewerage**:

Sewerage is a system for the collection and conveyance / carriage of municipal wastewater to the wastewater treatment plant or to the point of disposal. Sewerage system comprised of various sewers.

### Types of Sewerage System

There are three systems of sewerage adopted in practice:

- Combined system
- Separate system
- Partially separate system

I. Combined Sewerage System:

When both sanitary sewage and storm water are carried in a single sewer, it is called a combined sewerage system. When the flow in a combined sewerage system consists of only domestic sewage without storm water, flow is called 'DRY WEATHER FLOW'.

Advantages:

1) The cleaning of sewers is easy as they are of large in size.
2) The maintenance cost is less.
3) The storm water reduces the strength of sewage by dilution.
4) The self-cleaning velocity is easily achieved.
5) This system requires only one set of the sewer. Thus it becomes economical.
6) In towns with narrow streets, this system is preferred.

Disadvantages:

1) The load on the treatment plant becomes high.
2) The storm water is unnecessarily polluted.
3) The sewers are large in diameter.
4) This system proves to be uneconomical when pumping is required for the lifting of sewage.
5) During a heavy storm, the combined sewer may be overflown which may create trouble for the people.
6) Initial cost is high because of large dimensions of sewers.
7) Because of large size of sewer, their handling and transportation is difficult.

8) Due to the inclusion of storm water, the load on the treatment plant increases and ultimately increases treatment costs.
9) During heavy rain the sewer may be overflow and may thus create unhygienic conditions.

II. Separate Sewerage System:

In this system two separate sets of sewers are installed, one for collection and conveyance of sanitary sewage and other for storm water. As storm water is carried separately, it does not contaminate nature and normally disposed to natural water coarse / streams without any treatment. Whereas the sanitary sewage is taken to treatment plant separately, so there is less load on treatment plant thus reducing treatment costs.

Advantages:

1) The load on the treatment unit becomes less.
2) The storm water is not unnecessarily polluted.
3) The sewers are small in size.
4) The storm water can be discharged into natural streams without any treatment.
5) This system proves to be economical when pumping is required for the lifting of sewage.
6) Since the sanitary sewage and storm water flows in separate pipes, the quantity of sewage to be treated is less.
7) As the sewers are smaller in section, they can be easily ventilated.
8) Rain water can be discharged in to the streams or can be reused / recycled without any treatment.

Disadvantages:

1) The cleaning of sewers is difficult as they are of small in size.
2) The maintenance cost is high.
3) The self-cleaning velocity is not easily achieved.
4) They are likely to get chocked / blocked.
5) Initial cost is high, when two separate sets are used.
6) Maintenance cost of system is also high.

**Sewerage system will you recommend for a new proposed township**

I recommend the COMBINED SEWERAGE SYSTEM in proposed township because of the following reasons

- More Efficient.
- Maintenance cost is less.
- In towns with narrow streets, it's preferable.
- Cleaning of sewers is easy.
- Most economical.

In most of the township across Pakistan and all over the world combined sewerage system is being used.