

SEWAGE OVER VIEW

- ❖ Introduction
- ❖ Classification of sewage
- ❖ Composition of sewage
- ❖ Characteristics of sewage
- ❖ Collection of sewage
- ❖ Treatment of sewage
- ❖ Disposal of sewage & Sludge

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INTRODUCTION

- Sewage is the liquid waste (Domestic) consisting faecal matter, urine and waste from bathrooms, kitchen and washing etc., it also contains 99% of water (Volumetric)
- In case of industrial sewage the main contents are organic and inorganic substances which are primarily depends on the nature of industry.
- In this session we concentrate on domestic sewage

AN OVERVIEW ON WATER POLLUTION AND SEWAGE

- Water is absolutely essential for the existence of life (animals and plants).
- It is wonderful chemical media in which all biological and biochemical process occur.
- Water dissolves various nutrients, distribute them to cells and removes waste products.
 - 60% of human body is composed of water
 - Without water the survival is difficult
 - Water is essential for bathing, washing live stock raising, industrial and agriculture usage.

DESOLVED OXIGEN IN WATER

- Oxygen is soluble in water
- Solubility of atmospheric oxygen in fresh water is around 7 – 15 mg/dl depending on temperature and pressure
- In case the temperature & dissolved salts increase in water the oxygen solubility decreases.

OXYGEN DISSOLVED IN WATER BY VARIOUS WAYS

- Direct entry from the atmosphere
- By aquatic plants (Algae), photosynthesis.
- By artificial means.
- Minimum dissolved oxygen level concentration in water is around 4 mg/dl required to support healthy aquatic life In absence of dissolved oxygen in water anaerobic micro organisms takeover, causing harmful effects.
- In polluted water both industrial and municipal waste the dissolved oxygen level is very low.
- The pollution in water can be measure by biological oxygen demand. i.e., BOD (5 Days)

SOURCE OF PATHOGENS IN WASTE WATER

- ❖ The prime source of pollution is due to human feces and urine.

Faecal Matter:

- It is a solid bodily waste discharge from the large intestine through anus during defecation
- Around 100 to 250 grms **excreted** by an adult daily
- The main constituents of feces are 75% water and 25% solids.
- 30% of solids containing dead bacteria.
- 30% contains indigestible food matter (cellulose)
- 10 to 20 % cholesterol, 10 to 20% inorganic substance (Calcium Phosphate and Iron Phosphate)
- 2 to 3% Proteins.
- Bile pigments and dead white cells
- The brown colour is due to action of bacteria on bilirubin (end product of hemoglobin)
- The odour of feces is caused by the chemical indole, skatole & H₂S produced by bacteria.

URINE

- It is a liquid or semi solid solution of metabolic waste often toxic, substances from excretory organs which are expelled from the body.
- In most mammals the formation of urine begins in the nephrons of the kindeys by filtration of blood plasma without proteins.
- As the fluid passes along the nephron tube, water and use full plasma such as amino acids, glucose and other nutrients re-obsorved into blood stream leaving concentrated solution called urine.

GERMS

- ❖ The Germs are in different form such as Bacteria, Viruses, Fungi and Protozoa
- ❖ The Germs are microscopic organisms
- **Bacteria:**
It is a single celled organism, get the nutrients from the environment (living being)
- **Virus:**
It is very tinny partial single celled organism. It lives inside of living cells.
- **Fungi:**
It is a multi cell plant like organism it is parasites on mainly get food from the plants, food and animals.
- **Protozoa:**
It is a single cell organism bigger than bacteria. It also gets its food from animal cells, plants and etc.,
It loves moisture hence most of the intestinal infections like malaria will be effected in animals and humans. It generally grows inside red blood cells.

DRINKING WATER STANDARDS

Parameter		Desirable – Tolerable		
▪ Physical				
Turbidity (NTU Units)	-	< 10		
Colour (Hazenscale)	-	<10		
Taste & Odour	-	Unobjectionable		
• Chemical				
pH	-	6.5	-	8.50
TDS mg/L	-	500	-	1500
Total Hardness Mg/L as CaCO ₃	-	200	-	300
Chlorides mg/L As Cl	-	200	-	250
Sulphates mg/L As So ⁴	-	150	-	200
Fluorides mg/L As (F)	-	0.60	-	1.20
Nitrates mg/L (No ₃	-	45		
Calcium mg/L As Ca	-	75		
Iron mg/L as Fe	-	0.10	-	0.30

BACTERIAL CHARACTERISTICS

- Water polluted by sewage contains one or more species of disease causing pathogenic bacteria.
- Pathogenic organisms cause water borne diseases and many non-pathogenic bacteria such as E-coli, a member of coli form group.
- Coli form bacteria also live in the intestinal tract of human beings.
- Coli form is not harmful group but it has more resistance than adverse condition.
- So if it is ensured to minimize the number of coli form the harmful species will be very less.
- Hence, coli form group serves as indicator of contamination of water with sewage and presence of pathogens.

SEWAGE

- ❖ It is liquid a waste arising mainly from domestic (residential, institute and commercial) and industrial sources.

▪ CLASIFICACION OF SEWAGE

- **Sewage in classified mainly into two types**

1. Domestic Sewage

2. Industrial Sewage

- Domestic sewage consisting of all household wastes including human and animal excrete.
- Industrial sewage depending on the nature of products produced in the industry.
- In general the sewage consisted the following:
 1. Soda waste (highly alkaline)
 2. Acid-mine drainage (highly acidic)
 3. Toxics – Presence of heavy metals, antibiotics and pesticides.
- Treatment of industrial sewage is very much complicated in comprise of domestic sewage.

COMPOSITION OF SEWAGE

A. Chemical Composition

- The composition of sewage depends on the source from which it comes.
- Around 97 to 99% sewage composed of water while the rest (1 – 3%) is solids.
- Sewage consisting organic, inorganic and living organisms.
- Sewage also consists Organic compounds such as 1) Carbohydrates, 2) Fats, 3) Proteins, 4) Amino acids and 5) Urea.
- It also consists inorganic compounds such as 1) Sand, 2) Mud, 3) Mineral ash, 4) Mineral salt, 5) Lead, 6) Mercury and 7) Arsenic and 8) Cyanides of Nitrogen, Phosphorus, Chlorides, Grease and Volatile organic compounds.
- Besides the sewage contains living organisms such as 1) Bacteria, 2) Viruses, 3) Algae, 4) Fungi and 5) Protozoa.
- In general the sewage of towns / cities in our country contains the following organic and inorganic matter:

1. BOD	-	350 ppm
2. Nitrogen (N ₂)	-	52 ppm
3. Potassium (K)	-	45 ppm
4. Phosphorus	-	16 ppm
- Also contains salts of several heavy metals like Zn, Cr, Ni and Pb

COMPOSITION OF SEWAGE

B. Microbial Composition

- Microbial population may vary from several lakhs to millions.
- The Pathogens occurring in sewage are mainly intestinal and soil inhabiting

❖ **BOD & COD**

- There are two parameters to characterize of waste water

❖ **BOD**

The amount of Oxygen used by Micro Organisms to breakdown organic substances.

The Aerobic & Anaerobic bacteria, East and Plankton are contained in the waster water. Degree of contamination measured in mg O₂ / Ltr.

The standard measure test is performed at 20^o for 5 days called as BOD₅.

The period 5 days are chosen as there is the average time it takes the British river water to reach sea.

Greater Pollution means Higher BOD

Pure water	:	2 – 20 mg/l
Slightly Polluted	:	20 – 100 mg/l
Moderate	:	100 – 500 mg/l
Highly polluted	:	500 – 3000 mg/l
Extreamly Polluted	:	3000 – 15000 mg/l

COMPOSITION OF SEWAGE

❖ COD

- It is the amount of Oxygen required to breakdown organic substances chemically and convert them CO_2 and H_2O . The taken to conduct this test is 3 Hours. COD in Industrial water may be around 50 – 2000 mg/l.

CHARACTERISTICS OF SEWAGE

- BOD & Oxygen consumption values are extremely high.
- Organic matter in sewage undergoes anaerobic or partial decomposition resulting production of unpleasant gases like CH_3 , CO and H_2S .
- Due to production of CH_3 , CO and H_2S which reacts with water produce acids.
- Production of acid make the sewage more acidic which is unfit for supporting life activity.
- Heavy metals which generally present in abnormal concentration pollute the ground water.
- All the characteristics of sewage:
 - a) Anoxic condition
 - b) High acidity
 - c) Highly concentration of heavy metals and
 - d) Reduction in photosynthetic rate cause the death of oxygen dependent aerobic micro organisms, plants and animals.

COLLECTION OF SEWAGE

❖ **A. Sewers:**

➤ The individual pipes used to collect and transport waste water are called sewers.

❖ **B. Sewerage System:**

➤ It is the net worth of sewers used to collect waste water from a community is sewerage collection system.

❖ **Sewage collection is done by:**

- 1) Conservancy system
- 2) Water Carriage system

❖ **Conservancy System:**

It is also called dry system. In this system the faecal matter (Night soil) is collected in pails and removed to convenient site away from habituated area.

The night soil collected is buried underground to control the odor nuisance.

❖ **Water Carriage System:**

The human waste is removed along with sewage through underground sewers and finally take to treatment system for final treatment.

WASTE WATER QUANTITY ESTIMATION

- ❖ **DWF** :
- Dry weather flow
- It is the sanitary sewage in absence of storm water
- Usually 80% of water supply may be expected to reach the sewer.
- Maximum daily flow is 2 times average flow.
- Minimum daily flow is $2/3^{\text{rd}}$ of average flow.
- Design period - Prospective - 10 years.
Ultimate - 15 years.
- Population forecasting - 8 methods are there out of which
 - 1) Incremental increase
 - 2) Decreasing rate of gravity
 - 3) Arithmetic increase are reasonable

WASTE WATER QUANTITY ESTIMATION

❖ SEWER DESIGN

- Sewage contains suspension particles and the behavior of particles to settle down at the bottom. In case when flow is low to avoid silting of sewers, it should be laid to required gradient for generating self cleaning velocity.
- The sewer pipes carry sewage as gravity conduits and are therefore laid at continuous gradient.

❖ Velocity

- a) Minimum - 0.60 m/s of average flow
- b) Maximum - Not more than 3.0 m/s

❖ Sewer appurtenances

- a) Man holes
- b) Lamp holes
- c) Street inlets (Increase combined system)
- d) Catch basins etc.,
- e) Flushing manholes.

TREATMENT OF SEWAGE

- Finally the effluent is to be disinfected to destroy the remaining pathogens which are harmful to the public health.
- The degree to which waster water must be treated to stream to standards and effluent standards
- Stream standards, to prevent deterioration of existing water quality parameters such as
 - Dissolved Oxygen
 - Coli forms
 - Turbidity
 - Acidity
 - Toxic substances
- The factors controlled under these standards usually include
 1. BOD, 2. Suspended solids, 3. Acidity and 4. Coli forms

TREATMENT OF SEWAGE

Sludge Treatment and Disposal Sewage Sludge:

Sewage Sludge is the residue accumulate in the treatment plant. It is composed of both Organic and Inorganic compounds, large quantity of plant nutrients, organic chemicals as well as pathogens. Hence, it is extremely important to properly treat in order to minimize its environmental repercussions. The residue is further classified as primary and secondary sludge.

Primary Sludge:

It is generated during Chemical precipitation, sedimentation and other primary process.

Secondary Sludge:

It is the activated waste Biomass resulting from Biological treatment.

Necessity for the sludge treatment and Disposal:

The sludge consists Biodegradable volatile Solids causing odour. Hence, it is reduced by stabilization.

The sludge contains high water content makes it difficult to handle.

Transportation cost will be high

Storage / dumping area will be more.

TREATMENT OF SEWAGE

❖ **Sludge Disposal:**

- 1) Sludge thickening,
- 2) Sludge digestion,
- 3) De-watering.

1) Sludge thickening:

There are 2 methods are being followed

- i. Gravity thickener
- ii. Dissolved air flotation

2) Sludge Digestion:

It is a biological process in which the Organic solids in the sludge decomposed into stable substance. It helps in reducing the total mass of solids while destroying any pathogens present. CO_2 Methane are produced.

3) De-watering:

After digestion, the remaining sludge is dewatered before final disposal. The sludge is containing 70% of water and the water contained is reduced with 1) Drying beds, 2) Centrifuge, 3) Rotary drum, 4) Belt filter press and 5) Vacuum filters.

The de-water sludge is buried under ground in a sanitary land fill or can be used as fertilizer depending its chemical composition. In case the sludge is too toxic incineration is the better option.

TREATMENT OF SEWAGE

Any reaction causes loss of electrons occurs by an atom.

There are three types of oxidation.

1. Bio-Chemical oxidation
2. Chemical oxidation
3. Nitrification

- **Bio-chemical oxidation (BO):**

BO of dissolved and chloride organic compounds is commonly used for some agriculture and industrial waste waters – BO removes organic pollutants.

- **Chemical oxidation:**

Co generally removes some persistent organic compounds and left over concentrations after biochemical oxidation.

Disinfection by using ozone, chlorine or hypochlorite in chemical oxidation kills pathogens.

- **Nitrification:**

It is an oxidation process. In this process the ammonia which gets oxidized into Nitrite (NO_2).

It is a bacteriological process and later Nitrite get oxidized into Nitrate (NO_3) under aerobic condition.

TREATMENT OF SEWAGE

Nitrification : Ammonium gets converted into nitrate.

De-Nitrification: Nitrate is reduced into Nitrogen Gas is called de-nitrification.

Nitrification & De-Nitrification is called Nitrogen cycle.

78% atmosphere contains Nitrogen which is essential Biological Molecule found in proteins & Nucleic Acid.

Nitrification : Useful for plants.

De-Nitrification: Removal of Ammonium from the waste water beneficial for aquatic habitats.

TREATMENT OF SEWAGE

❖ **BNR**

- Biological Nutrient Removal.

❖ **VLR system**

- VLR (Vertical Loop Reactor) system is one option.
- It is an anaerobic anoxic reactor process to achieve BNR through simultaneous nitrification / de-nitrification.

❖ **Advantages of VLR**

- Reduces ammonia and phosphorus to very low levels.
- No aeration required - Energy savings.
- Small foot prints

TREATMENT OF SEWAGE

There are 3 levels of waste water treatment

- 1) Primary treatment
- 2) Secondary treatment
- 3) Tertiary Treatment

1) Primary Treatment:

It is the physical process of screening, acumination, grit removal and sedimentation.

Primary treatment removed around 60% of TSS and 35% of BOD

2) Secondary treatment:

It is a biological process in which microbes consume the organic impurities as food and converting them into CO₂, Water and energy for their own growth and reproduction.

In Secondary treatment around 85% of TSS and BOD are removed. But dissolved impurities are not removed in this process.

3) Tertiary Treatment:

When the TS, BOD, Total dissolved nitrates and phosphate are to be reduced is more than 85% the tertiary treatment is necessary.

Tertiary treatment is necessary for removal of more than 85% of TSS and BOD and dissolved impurities such as nitrates and phosphate.

TREATMENT OF SEWAGE

❖ **EXPANDABLE OXIDATION DITCH**

➤ It is a multi channel oxidation ditch using aerated anoxic nutrient removal technology.

❖ **Advantages**

- 1) TN below - Below 3.0 mg / L
- 2) Phosphorous - below 1.0 mg / L
- 3) More than 90% TN and 75% phosphorous
- 4) Less odour
- 5) O & M is less

THE NATIONAL GREEN TRIBUNAL ORDERS ON 30TH APRIL 2019, THE EFFLUENT DISCHARGE STANDARDS FROM THE SEWAGE TREATMENT SYSTEM

S.NO	RECENT ORDER THE NORMS ARE	PREVIOUS NORMS
BOD	10 mg / L	30 mg / L
COD	50 mg / L	250 mg / L
pH	5.50 to 9.0	5.50 to 9.0
TSS	20 mg /L	100 mg / L
Fecal Cow form	230 / 100mL	---

TERTIARY TREATMENT METHODS

S.NO	Test method	Capable of removal
1	Filtration Air / stream stripping	Suspended solid particles dissolved ammonia volatile organic component
2	Adsorption	Colour, odour and VOC removal.
3	Biological process	Nitrogenous and phosphorous components
4	Membrane separation process MF, UF, NF & RO	Dissolved organic and inorganic compounds.
5	Ion – exchange process	Dissolved anions & cat ions
6	Precipitation	Heavy metals
7	Oxidation – Reduction	Organic and some in-organics
8	Disinfection	Micro organisms

CHEMICAL CONTAMINANTS

➤ **Waste water effluent**

- Reclaimed waste water usually clean enough to be used for irrigation.
- But it contains higher concentrations of dissolved solids.
- It also contains disinfectants by products such as trihalomethanes and halo acetic acids.

➤ **Bio solids (Sludge)**

- Waste water sludge contains fertilizer properties.
- At the sometime it may also contain heavy metals and synthetic organic compounds.

Hence, the effluent and Bio-solids can be applied only when the chemical contaminants are properly treated.

MICRO PLASTICS IN WASTE WATER TREATMENT

- So far no treatment method is specially designed to remove MPs.
- However there is 90% MPs in the sludge which are in fibre state.
- In final effluent only small MPs (100-100µm) were found.

THANKING YOU

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