QUESTION 1

Wastewater treatment:

Wastewater treatment involves collecting the wastewater in a centralized or decentralized location (Wastewater Treatment Plant) and subjecting the wastewater to various treatment processes. Wastewater treatment consists of applying known technology to improve or upgrade the quality of a wastewater.

Importance of Wastewater treatment:

- The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed off without causing danger to human health or unacceptable damage to the natural environment.
- With the current emphasis on environmental health, water and soil pollution issues, there is an increasing awareness of the need to dispose off generated wastewaters safely and beneficially.
- Wastewater if properly treated is an important resource and can be used for various purposes including irrigation, lawn watering, car washing, flushing toilets and landscaping etc.
- Wastewater treatment can also generate biogas as final product which is a potential source of energy.

Why rectangular tanks are preferred over circular tanks:

Rectangular tanks are favored when space is a constraint because they may be constructed with a common wall and piping arrangement is more economical than for circular tanks. Circular tanks are generally proven unsatisfactory because of sludge build up in the corners, and fouling of the more complex sludge collection mechanism.

The shape of the rectangular clarifiers provides a longer path for the wastewater flow and the suspended solids to travel, and subsequently longer detention time which warrants less short circuiting and more sludge settling compared to the centre-feed/peripheral overflow circular clarifiers. In addition, flow distribution among several clarifiers is usually more even and often requires less head loss for rectangular clarifiers.

QUESTION 2

Difference between Aerobic and Anaerobic Wastewater Treatment:

Aerobic wastewater treatment	Anaerobic wastewater treatment
Aerobic wastewater treatment is a biological wastewater treatment process which uses an oxygen rich environment.	Anaerobic wastewater treatment is a process where anaerobic organisms break down organic material in oxygen absent environment.
Bacteria involved the aerobic wastewater treatment are aerobes.	Bacteria involved the anaerobic wastewater treatment are anaerobes.
Air is circulated in aerobic wastewater treatment tanks.	Air is not circulated in anaerobic wastewater treatment tanks.
Aerobic wastewater treatment does not produce methane and carbon dioxide.	Anaerobic wastewater treatment produces methane and carbon dioxide.
Aerobic wastewater treatment requires energy. Hence, they are less energy efficient.	Anaerobic wastewater treatment is an energy efficient process.
Activated sludge method, trickling filter, rotating biological reactors, and oxidation ditch are examples of aerobic wastewater treatment.	Anaerobic lagoons, septic tanks, and anaerobic digesters are examples of anaerobic wastewater treatment.

Activated Sludge Process:

- Microorganisms responsible for treatment are maintained in liquid suspension by appropriate mixing methods.
- Main constituents of ASP are Aeration tank in which oxygen is provided for the micro-organisms to grow. This aeration also helps to keep micro-organisms in suspension.
- Aeration tank is followed by Clarifier / Settler in which the micro- organisms form flocs and settled down at the bottom.

- Formation of floc particles, ranging in size from 50 to 200 µm, removed by gravity settling, leaving relatively clear liquid as treated effluent.
- A part of settled bio flocs are recycled back to the aeration tank to maintain certain amount of micro-organisms in the system for efficient operation of the system. This is known as Recycled Activated Sludge (RAS).
- Remaining settled bio flocs are removed from the system and are termed as Wasted Activated Sludge (WAS).

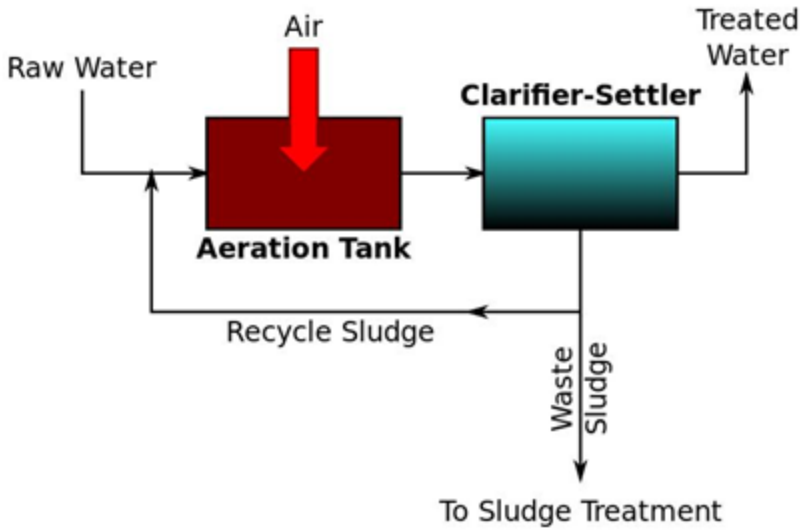

Figure 01: Activated Sludge Method

- In aeration tank, contact time is provided for mixing and aerating influent wastewater with microbial suspension, generally referred to mixed liquor suspended solids (MLSS).
- Typically 99% of suspended solids and up to 90 % of dissolved organics are removed by Activated sludge process.
- The main drawback associated with APS is its high electricity consumption particularly for aeration.

QUESTION 3

Assimilative capacity of receiving water bodies:

Assimilative capacity of receiving water bodies refers to the ability of a body of water to cleanse itself; its capacity to receive wastewaters without deleterious effects and without causing damage to aquatic life or humans who consume the water. It is level to which water body or nature control the toxicity without affecting the aquatic life.

Physical Forces Helping Assimilative Capacity of Receiving Bodies:

1) **Dilution:** Dilution is the process of reducing the concentration of pollutants in receiving water, usually simply by mixing with more quantity of water.

2) **Dispersion:** Dispersion is the distribution of pollutants in relatively large area of water. Dilution and dispersion are inter-related.

3) **Sunlight:** Sunlight facilitates biological decomposition of pollutants and kills pathogens by ultraviolet radiation (UV).

Factors Effecting Assimilative Capacity:

1) **Temperature:** Temperature plays an important role in assimilative capacity of receiving water. Increase in temperature will increase the biological decomposition of organics and thus assimilative capacity will improve.
2) **Flow Velocity:** Flow velocity is also critical to assimilative capacity of receiving water bodies. Higher the flow velocity will encourage quick dilution and dispersion of pollutants.
3) **Dissolved Oxygen (DO):** Rate of biological decomposition is directly related to the amount of dissolved oxygen. DO is replenished by re-aeration. Re-aeration may be provided by maintaining sufficient flowing velocity.
4) **Depth of flowing water:** Assimilative capacity is indirectly related to the depth of receiving water bodies. Increase in depth causes to decrease dissolved oxygen in the water and thus it reduces the purification process. Also the effects of UV radiation from sunlight which helps to kill the pathogens, decreases with increase in depth.
5) **Types and concentration of pollutants:** Types and concentration of pollutants disposed off to the water greatly affect the assimilative capacity. Higher concentration of pollutants require much time for dilution and purification as compared to less pollutants present in the sewage.

QUESTION 4

Sludge refers to the residual, semi-solid material left from, municipal wastewater or industrial wastewater treatment processes.

Sustainable sludge handling may be defined as a socially acceptable, cost-effective method that meets the requirement of efficient recycling of resources while ensuring that harmful substances are not transferred to humans or the environment i.e. water, air or soil.

Sludge Handling Processes:

I. Primary operations
II. Thickening
III. Stabilization
IV. Dewatering
V. Heat drying

Primary Operations:

- **Grinding:** It includes particles size reduction**.**
- **Screening:** It includes removal of fibrous materials.
- **Degritting:** It includes removal of sand or other inorganic materials.
- **Blending:** It includes making the sludge homogenous.
- **Storage:** It ensures flow equalization in the system.

Sludge Thickening:

- Sludge thickening is undertaken to increase percentage of solid content in sludge by removing a portion of liquid fraction.
- Volume reduction of approximately 30 – 80 % can be reached with sludge thickening.
- Various methods of sludge thickening are:

a. Gravity thickening
b. Flotation thickening
c. Rotatory drum thickening

Sludge Stabilization:

- Sludge Stabilization is undertaken to reduce pathogens, eliminate offensive odors, and minimize production of usable gas (methane).

- Methods of stabilization are:

a) Alkaline Stabilization
b) Anaerobic Digestion

Dewatering:

- Dewatering is undertaken to reduce the moisture content of sludge.
- Compared to thermal (evaporative processes) for water reduction, mechanical dewatering is often selected due to its low energy requirement.
- Centrifugation is the method used for separating liquids of different densities, thickening slurries.

Heat Drying:

- It involves the application of heat to evaporate water and to reduce the moisture content of biosolids.
- Advantage of this method is to reduce product transportation costs, improve storage capability, and marketability.
- Direct drying involves the wastewater solids come into contact with hot gases, which cause evaporation of moisture. Dryers such as rotary dryers and fluidized bed dryers are used.

Advantages in wastewater engineering:

The goals of wastewater treatment plants are to develop more environmentally friendly processes to reduce the volume of sludge for disposal and to convert sludge into bioenergy. Energy recovery of the sludge generally includes the conversion of the sludge into biogas, syngas, and bio-oil which can be further converted into electricity, mechanical energy, and heat.

QUESTION 5

Environmental Impact Assessment (EIA):

Environmental legislation is the collection of laws and regulations pertaining to air quality, water quality, the endangered wildlife and other environmental factors.

- Although development aims to bring about a positive change, it can also lead to social conflicts and / or environmental concerns.
- The need to avoid / minimize adverse impacts and ensure long term benefits led to the concept of sustainability.
- Sustainability refers to an economic activity that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

Parameters considered while conducting EIA for newly proposed wastewater treatment plant:

There are eight guiding principles that govern the entire process of EIA as mentioned below:

1) Participation: An appropriate and timely access to the process for all interested parties.

2) Transparency: All assessment decisions and their basis should be open and accessible.

3) Certainty: The process and timing of the assessment should be agreed in advanced and followed by all participants.

4) Accountability: The decision-makers are responsible to all parties for their action and decisions under the assessment process.

5) Credibility: Assessment is undertaken with professionalism and objectivity.

6) Cost-effectiveness: The assessment process and its outcomes will ensure environmental protection at the least cost to the society.

7) Flexibility: The assessment process should be able to adapt to deal efficiently with any proposal and decision making situation.

8) Practicality: The information and outputs provided by the assessment process are readily usable in decision making and planning.