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Водоснабжение и водоотведение на английском языке

Методические указания к практическим занятиям

Факультет экологии

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Введение

Целью методических указаний является научить студентов переводить и понимать иностранную литературу по специальности «Водоснабжение и водоотведение», для выполнения литературно-патентного обзора в ходе дипломного проектирования.

Методические указания состоят из 6 разделов, и охватывают следующие темы: вода, загрязнение питьевой воды, процессы при очистке воды, очистка питьевой воды, сточная вода, очистка сточной воды, очистка осадка сточных вод.

Каждый раздел включает основной текст, лексические и грамматические упражнения, а также диаграммы и схемы для лучшего усвоения материала.

В пособии используются адаптированные тексты, взятые из англо-американских изданий и компьютерных энциклопедий.

Unit 1

1. Read the text.

Water

Of the 326 million cubic miles of water on Earth, only about 3% of it is fresh water; and 3/4 of that is frozen. Only 1/2 of 1% of all water is underground; about 1/50th of 1% of all water is found in lakes and streams. The average human is about 70% water. You can only survive 5 or less days without water.

Water is generally classified into two groups: Surface Water and Ground Water. Surface water is water found in a river, lake or other surface impoundment. This water is usually not very high in mineral content, and many times is called "soft water" even though it usually is not. Surface water is exposed to many different contaminants, such as animal wastes, pesticides, insecticides, industrial wastes, algae and many other organic materials. Even surface water found in a pristine mountain stream possibly contains Giardia or Coliform Bacteria from the feces of wild animals, and should be boiled or disinfected by some means prior to drinking.

Ground Water is that which is trapped beneath the ground. Rain that soaks into the ground, rivers that disappear beneath the earth, melting snow are but a few of the sources that recharge the supply of underground water. Because of the many sources of recharge, ground water may contain any or all of the contaminants found in surface water as well as the dissolved minerals it picks up during it's long stay underground. Waters that contains dissolved minerals, such as calcium and magnesium above certain levels are considered "hard water". Because water is considered a "solvent", over time it can break down the ionic bonds that hold most substances together, it tends to dissolve and 'gather up' small amounts of whatever it comes in contact with. For instance, in areas of the world where rock such as limestone, gypsum, fluorspar, magnetite, pyrite and magnesite are common, well water is usually very high in calcium content, and therefore considered "hard"[2.

Water pollution is the contamination of natural water bodies by chemical, physical, radioactive, or pathogenic microbial substances. Adverse alteration of water quality presently produces large scale illness and deaths, accounting for approximately 50 million deaths per year worldwide, most of these deaths occurring in Africa and Asia. In China, for example, about 75 percent of the population (or 1.1 billion people) are without access to unpolluted drinking water, according to China's own standards. Widespread consequences of water pollution upon ecosystems include species mortality, biodiversity reduction and loss of ecosystem services. Some consider that water pollution may occur from natural causes such as sedimentation from severe rainfall events; however, natural causes, including volcanic eruptions and algae blooms from natural causes constitute a minute amount of the instances of world water pollution. The most problematic of water pollutants are microbes that induce disease, since their sources may be construed as natural, but a preponderance of these instances result from human intervention in the environment or human overpopulation phenomena.

2. Translate into English.

1. В природе воды бывает двух типов – поверхностная и грунтовая.
2. Поверхностные воды содержат минеральные вещества, и загрязнены экскрементами животных, пестицидами, простоками, водорослями и другими органическими загрязнениями.
3. Перед употреблением в пищу, поверхностные воды необходимо прокипятить и продезинфицировать.
4. Грунтовые воды могут быть загрязнены теми же загрязнениями, которые содержатся в поверхностных водах, а также различными минералами примесями из грунта.
5. Вода называется жесткой при высоком содержании кальция и магния.

3. Make sentences.

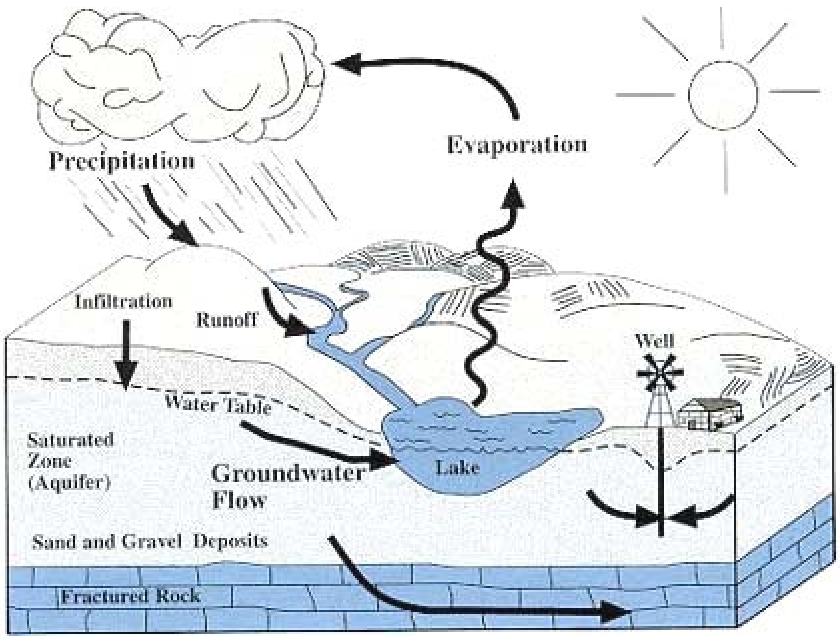
Water quality

The complexity of water quality as a subject is reflected in many types of measurements of water and wastewater quality. These measurements include:

<u>Water quality target</u>	Definition
1. <u>Conductivity</u>	a. amount of oxygen that would be consumed if all the organics in one liter of water were oxidized by bacteria.
2. <u>Dissolved Oxygen</u> (DO)	b. determined by the measurement of optical density (absorptivity) on a spectrophotometer of various wavelengths of the passing light.
3. <u>pH</u>	c. a major light-absorbing substance, responsible for much of the color in water bodies.
4. <u>Color of water</u>	d. a measure of the ability of water to pass an electrical current.

5. Turbidity	e. particles that are larger than 2 microns found in the water column.
6. Total suspended solids (TSS)	f. the concentration of oxygen dissolved in water, expressed in mg/l.
7. Chemical oxygen demand (COD)	g. a measure of the molar concentration of hydrogen ions in the water
8. Biochemical oxygen demand (BOD)	h. the most common microbiological contaminants of natural waters, live in the digestive tracks of warm-blooded animals, including humans, and are excreted in the feces.
9. Fecal coliform bacteria	i. measure of water clarity how much the material suspended in water decreases the passage of light through the water
10. Dissolved organics	j. the amount of oxygen which is needed for the oxidation of all organic substances in water in mg/l or g/m3.

4. Describe the scheme in English.



Unit 2

Water purification methods

1. Read and find the appropriate words in English. Remember the tense and endings of the verbs.

Coagulation and flocculation

Natural and *сточные воды* containing small particulates. They are *во взвешенном состоянии* in water forming a *коллоиды*. These particles carry the same *заряд*, and *препятствовать отталкиванию* them from combining into larger particulates *осаждаться*. Thus, some chemical and physical techniques are applied to help them settle. The *феномен* is known as *коагуляция*. A well known method is the *добавление электролита*. Charged particulates combine with *ионы* *нейтрализация* the charges. The *нейтральные частицы* combine to form larger particles, and finally settle down.

Another method is to use *материал с большой малекулярной массой* to *притягивать* or *улавливать* the particulates and settle down together. Such a process is called *хлопьеобразование*. Starch and *многозарядные ионы* are often used.

Historically, dirty water is cleaned by treating with *алюминий* and *известь*. These electrolytes cause the pH of the water to *изменяться в связи* to the following reactions:

The slightly basic water causes $Al(OH)_3$, $Fe(OH)_3$ and $Fe(OH)_2$ to *выпадать в осадок*, bringing the small particulates with them and the water becomes clear.

Суспензии оксида железа particulates and *гуминовое органическое вещество* in water gives water the yellow *грязные оттенок*. Both iron oxide particulates and organic matter can be removed from coagulation and flocculation. The *описание* given here is *простейшее*, and many more techniques have been applied in the treatment of water. Coagulation is a

attract or trap,
suspended,
repulsion prevents,
to settle,
phenomenon,
coagulation,
addition of electrolyte,
ions neutralizing,
neutral particulates,
high-molecular-weight material,
wastewater,
magnesium,
flocculation,
starch and multiply charged ions,
oversimplified,
alum, colloid
charges,
precipitate,
suspension of iron oxide, humic organic matter,
muddy appearance,
description, salts,
sulfates
special polymers
sodium, chloride,
calcium, lime,
potassium

major application of lime in the treatment of wastewater.

Other *соли* such as iron сульфаты $Fe_2(SO_4)_3$ and $FeSO_4$, chromium sulfate $Cr_2(SO_4)_3$, and some *специальные полимеры* are also useful. Other ions such as *натрий*, *соли хлора*, *кальций*, *магний*, and *калий* also affect the coagulation process.

Clarification and sedimentation

The term *осветление*, or *осаждение*, is normally used to describe the *осаждение хлопьев* produced by the coagulation and flocculation process. It works best with *относительно плотные частицы* (*ил* and minerals), while *флотация* works better for lighter particles (*водоросли*, color). A *отстойник* should be big enough so that it takes a long time to get through. *Впуск* and *выпуск* are designed so the water moves slowly in the tank. *Длина* and *ширина* channels are *установлено* to let the water to snake its way through the tank. The settled particles, *шлам*, must occasionally be removed from the tanks. The water is next ready to be *фильтровать*. Sedimentation is used in pre-treatment and *очистка сточных вод*.

Inlets, filtered, narrow, sludge, sedimentation, settling of the flocs, silt,algae, settling tank, outlets, long, installed, relatively dense particles, wastewater treatment, clarification, flotation,

Filtration

Filtration is the process of *удаление твердых частиц* from a *жидкость* by *пропускание* it through a *пористая среда*. *Крупный, средний*, and *мелкий* porous media have been used *в зависимости от требований*. The *фильтрующий материал* are *искусственные мембраны*, *сетки, песчаные фильтры*, and high technological filter systems. The choice of filters depends on the required filtering *скорость* and the *требования очистки воды.* The flow required for filtration *может быть достигнут* using *сила тяжести* or *давление*. In pressure filtration, one side of the filter medium is at higher pressure than that of the other so that the filter plane has a pressure drop.

Replaced, passing, porous medium, coarse, medium, requirement gravity, fine, depending on the requirement, removing solids, fluid, reversing the flow , can be achieved, filter media, artificial membranes, nets, sand filter, speed, cleanness pressure, clogged, The process of removing the *заиленной* portion of the filter bed by *обратный поток* through the bed and washing out the solid is called back washing. During this process, the solid must be removed out of the system, but otherwise the filters must be *заменять* or taken out of service to be cleaned.

Reverse osmosis

Обратный осмос is a *процесс разделения* which employs pressure to force water through a *полупроницаемая мембрана* (a membrane which will only *допустимая вода* to pass) that retains the salts on one side and allows the pure water to pass to the other side. The water with the *солесодержание* is *отделаться* while the purified water is *собираеться* in a tank. The pore size of the reverse osmosis membrane is 0.0001 *микрон* or 0.000 0001 mm, which makes reverse osmosis the finest form of water filtration known to man.

discarded, semi-permeable membrane, separation process, allow water, salt concentration, micron, **reverse osmosis**,

Ozone treatment

The *формирование кислорода* into ozone *происходить* with the use of *электричество*. This process is *происходить* by an *электрически разряженное поле* as in the *генераторы озона CD-типа*. In general, an *озонирования* includes *пропускать через*, clean air through a *высокое напряжение* electric discharge, *коронарный разряд*, which creates and ozone concentration of *приблизительно* 1% or 10,000 mg/L

The *неочищенная вода* is then passed through a *диффузор* which creates a *вакуум* and pulls the ozone gas into the water or the air is then *образуются пузыри* through the water being treated. Since the ozone will react with metals to create insoluble metal oxides, post filtration is required

raw water,occurs, electricity, electric discharge field, ozonation system, high voltage, corona discharge, approximately, passing dry, CD-type ozone generators, venturi throat, vacuum, carried out, bubbled up, formation of oxygen, UV (Ultra Violet) treatment

Typical *дезинфекция ультрафиолетом* systems involve the *поток воды* through a *емкость* containing a *ультрафиолетовая лампа*. As the water passes through this vessel, microorganisms are *подвергаться* to intense ultraviolet light energy which *приводить к изменению* to *генетических малекул* needed for *воспроизводственная функция*. This damage prevents the microorganism from *размножение* or *воспроизводство* in a human or animal host. Because the microorganism cannot multiply, no infection can occur. Disinfection of water is achieved when UV light causes *подавление активности микробов*. Ultraviolet (UV) light is electromagnetic radiation traveling in *длина волны* in all directions from its *источник излучения* (bulb). It is found in the spectral range of light between *рентгеновские лучи* and *видимый свет*; UV light occurs with a wavelength ranging from 200 to 390 nanometers. The most effective wavelength *частота*, from the point-of-view of microbiological disinfection, is 254 nm as this is where the optimum energy intensity is found.

frequency,
flow of water,
microbial inactivation,
UV lamp, x-rays,
exposed,
causes damage,
genetic molecules,
reproductive functions,
multiplying, UV disinfection,
replicating
wavelengths,
emitting source,
visible light, vessel,

Water chlorination

Дизинфекция, a chemical process whose objective is to control *болезнетворные микроорганизмы* by killing or *дезактивировать* them, is *несомненно* the most important step in drinking water treatment. By far, the most common method of disinfection is *хлорирование*. Chlorine is added to filtered water to destroy *вредные микроорганизмы*. An additional amount, known as a *остаточный хлор* is *применяеться* to protect treated water from re-contamination as it travels throughout the *система подачи воды.*

distribution system,
disease-causing,
inactivating,
chlorine residual,
disinfection,
unquestionably,
harmful microorganisms,
microorganisms,
applied,

2. Test on your understanding water treatment process

1. ___________________ are purification methods which works by using chemicals that effectively "glue" small suspended particles together so that they settle out of the water or stick to sand or other granules in a granular media filter. (2 answers)
    a. filtration
    b. coagulation
    c. disinfection
    d. flocculation
    e. screening
    f. sedimentation

2. The coagulation chemicals are added in a tank (often called ______________ or _____), which typically has rotating paddles. (2 answers)
    a. flocculation tank\basin
    b. rapid mix tank\chamber
    c. sedimentation basin\tank
    d. filter
    e. sludge blanket\thickening tank
    f. flash mixer

3. One of the more common coagulants used is_______.
    a. Ozon
    b. Iron (II) sulfate
    c. Activated carbon
    d. Aluminum sulphate
    e. Fluoride

4. The principle involved is to allow as many particles to contact other particles as possible generating large and robust floc particles. Where does this process happen?
    a. sedimentation basin\tank
    b. flocculation tank\basin
    c. rapid mix chamber\tank
    d. clearwell

5. This could be called a clarifier or settling basin\tank.
    a. filter
    b. flocculation basin\tank
    c. sedimentation tank\basin
    d. flash mixer

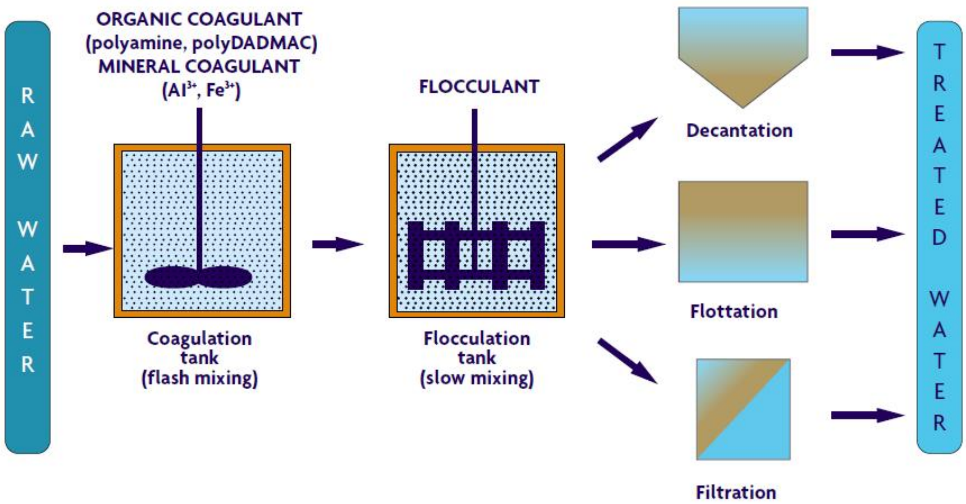
6. It is a large tank with slow flow, allowing floc to settle to the bottom.
   a. flocculation basin\tank
   b. sedimentation basin\tank
   c) mix chamber\tank
   d) filter

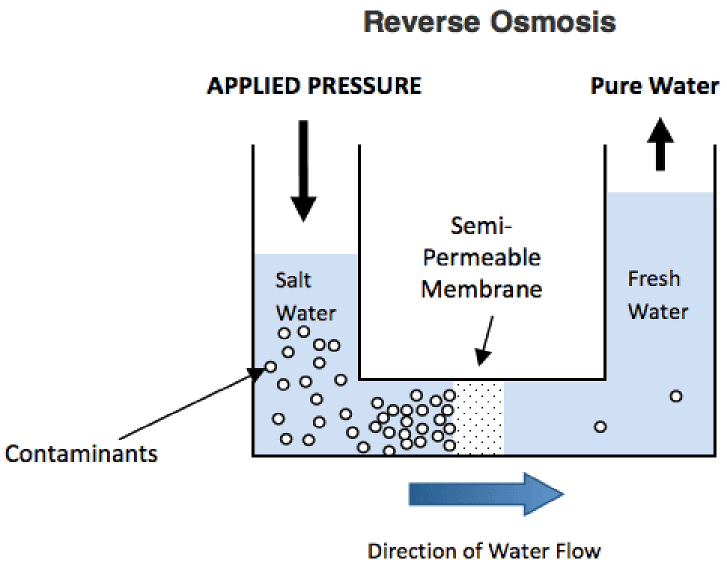
7. As particles settle to the bottom of the basin a layer of sludge is formed on the floor of the tank. Where does this process happen?
   a. sedimentation basin\tank
   b. filter
   c) clear well
   d) flocculation basin\tank

8. Why do use filtration?
   a. to remove debris
   b. to remove SS
   c) to remove taste and odour
   d) to soften water hardness

3. Describe the scheme in English. [6]

Coagulation-flocculation





Unit 3

1. **Read the text.**

Stages in water treatment

There are three principal stages in water purification:

Primary treatment - collecting and screening including pumping from rivers and initial storage;

Secondary treatment - removal of fine solids and the majority of contaminants using filters, coagulation, flocculation and membranes;

Tertiary treatment - polishing, pH adjustment, carbon treatment to remove taste and smells, disinfection, and temporary storage to allow the disinfecting agent to work.

Primary Treatment

Pumping and containment- The majority of water must be pumped from its source or directed into pipes or holding tanks. To avoid adding contaminants to the water, this physical infrastructure must be made from appropriate materials and constructed so that accidental contamination does not occur.

Screening - The first step in purifying surface water is to remove large debris such as sticks, leaves, trash and other large particles which may interfere with subsequent purification steps. Most deep Groundwater does not need screening before other purification steps.

Storage -Water from rivers may also be stored in bankside reservoirs for periods between a few days and many months to allow natural biological purification to take place. This is especially important if treatment is by slow sand filters. Storage reservoirs also provide a buffer against short periods of drought or to allow water supply to be maintained during transitory pollution incidents in the source river.

Pre-conditioning - many waters rich in hardness salts are treated with bsoda-ash to precipitate calcium carbonate out utilising the common ion effect

Pre-chlorination - in many plants the incoming water was chlorinated to minimise the gowth of fouling organisms on the pipe-work and tanks. Because of the potential adverse quality effects (see Chlorine below), This has largely been discontinued [3].

Secondary treatment

There are a wide range of techniques that can be used to remove the fine solids, micro-organisms and some dissolved inorganic and organic materials. The choice of method will depend on the quality of the water being treated, the cost of the treatment process and the quality standards expected of the processed water.

- pH adjustment,
- Coagulation and flocculation,
- Sedimentation,
- Filtration,
- Ultrafiltration membranes.

Tertiary treatment

Disinfection is normally the last step in purifying drinking water. Water is disinfected to destroy any pathogens which passed through the filters. Possible pathogens include viruses, bacteria, including Escherichia coli, Campylobacter and Shigella, and protozoans, including G. lamblia and other Cryptosporidia. In most developed countries, public water supplies are required to maintain a residual disinfecting agent throughout the distribution system, in which water may remain for days before reaching the consumer. Following the introduction of any chemical disinfecting agent, the water is usually held in temporary storage - often called a contact tank or clear well to allow the disinfecting action to complete.

1. Chlorine
2. Chlorine dioxide
3. Ozone
4. UV radiation

2. Answer the following question according to the text.

1. What are the principal stages in water purification?
2. What process take place at the Primary Treatment?
3. What process take place at the Secondary Treatment?
4. What process take place at the Tertiary Treatment?

3. Read and find the appropriate words in English.

Water leaves the river through *водозабор*. It then passes through a mechanically raked *стержневая решетка* before entering the *насосная станция первого подъема*, where it is strained through fine *механическое барабанное сито* before being pumped to the *резервуар*. Water from the Low Lift Pumping Station enters the first compartment of the reservoir where 90% of the *твердые вещества* settle to the reservoir floor. Many of the bacteria and viruses die off before the water *спускаться самотеком* to the *водоочистная станция* where a *предварительное хлорирование* dose is *добавляться* to ensure the start of the *процесс обеззараживания*. A *коагулянт* is added at the *смеситель* to bind any small *частицы*. The *вода с дозой коагулянта* is now *задерживаться* a short period to enable the *процесс образования хлопьев* to start before the water passes to the *стадия осветления*. The 'clarified water' is then *разделяться* equally between *скорый безнапорный фильтр*. The filtered water is then passed through a *система мембранных фильтров*. Following filtration the 'filtered water' is further dosed with chlorine to ensure *достаточная дезинфекция*. It remains in contact with a high dose of chlorine for a minimum of six hours in a *контактный резервуар*. The final water is dosed with *реагент* to reduce the *остаточный хлор* to its set point before being pumped by *насосная станция второго подъема*.

bar-screen; reservoir; solids; Treatment Works; preliminary chlorine dose; added; adequate disinfection; disinfection process; coagulant; Flash Mixer; 'Clarification Stage'particles; 'dosed water'; retained for; 'binding process'; Low Lift Pumping Station;; divided, rapid gravity filters; Intakes; mesh rotating screens; chlorine residual; a membrane filtration system; sink; gravitates; covered contact tank; chemicals; High Lift Pumps.

4. Make sentences in the following way:

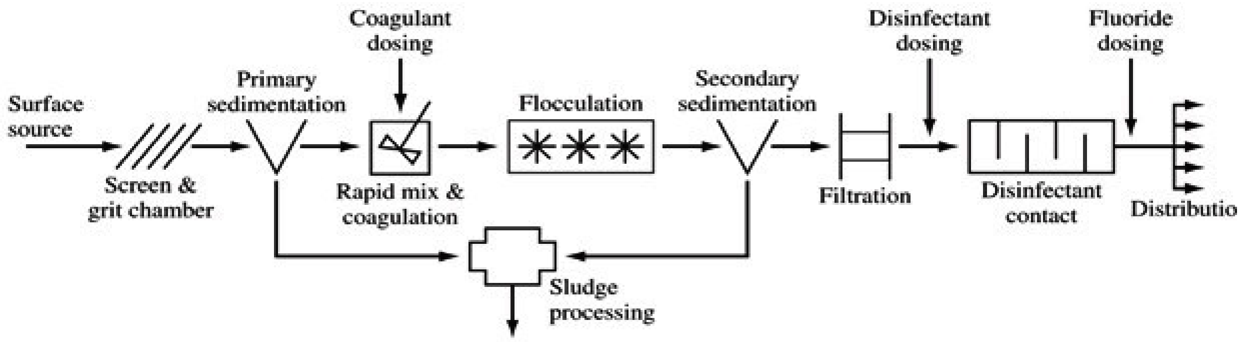
For example: The Boiling is used to inactivate or kill microorganisms. (using the Infinitive).

or During the Boiling inactivation of microorganisms happen. (using a noun instead of a verb).

or During the Boiling microorganisms are inactivated and killed. (using the Passive Voice)

Name of treatment stage	Name of process	Main verb (noun)	Process
Primary Treatment	Sedimentation	to pump (pumping)	large debris
Secondary treatment	Filtration	to remove (removal)	to settle out SS in rapid mix tank\flash mixer
Tertiary treatment	Pre-chlorination	to be stored in	large flocs in flocculation basin\tank
	Water conditioning	to chlorinate (chlorination)	flocs
	pH adjustment	to be added	bankside reservoirs
	Fluoridation	to use chemicals	to minimise the growth of fouling organisms on the pipe-work and tanks
	Coagulation	to generate	lime or soda ash
	Flocculation	to settle to the bottom of the clarifier (settling)	organic compounds including taste and odour
	Pumping	to remove (removal)	pathogens
	disinfection	to destroy (destruction)	tooth decay
		to prevent (prevention)	water from its sources
		to reduce (reduction)	hardness of water

5. **Describe the scheme in English.**



Unit 4

1. **Read the text.**

Wastewater

Sewage is the liquid waste from toilets, baths, showers, kitchens, etc. that is disposed of via sewers. In many areas sewage also includes some liquid waste from industry and commerce.

The waste from toilets is termed foul waste, the waste from items such as basins, baths, kitchens is termed sullage water, and the industrial and commercial waste is termed trade waste. Much sewage also includes some surface water from roofs or hard-standing areas. Municipal wastewater therefore includes residential, commercial, and industrial liquid waste discharges, and may include stormwater runoff.

The underground conduit for the collection of sewage is called sewer. A network of sewers and appurtenances for the collection and conveyance of sewage generated from each of the properties to sewage pumping station for pumping to sewage treatment and disposal is called **Sewage System**.

There are two types of sewerage system:

1. Separate sewerage system
2. Combined sewerage system.

Separate sewerage system

In separate system of sewerage there are two collection systems or pipe network:

1. for collecting domestic sewage as sanitary sewerage system,
2. for collecting storm water as storm water drainage system.

The sanitary sewerage systems for domestic sewage are designed for peak sewage flow expected at ultimate stage at the end design period. The storm water drainage systems are designed to carry the maximum storm runoff expected during the critical duration of rainfall.

The advantages of separate sewerage system are:

1. The capacity of the water treatment plant will be smaller since only domestic sewage alone is to be treated.
2. Operational problems are less.

The disadvantage of separate sewerage system is:

1. Storm water may always find its way into the domestic sewerage system either through wrong house sewer connections or through manholes and overload the sewage treatment plant.

Combined sewerage system

In Combined system of sewerage both sewage discharge and the storm runoff are collected and conveyed through a common collection system. The ratio of the maximum storm runoff to sewage flow works out to be 20 to 30. Hence during non-monsoon period only 1/20th or 1/30th of the design flow, only the sewage flow is passing through the combined system with very small velocity, resulting in clogging of the systems. Combined sewers are, therefore not recommended for Indian conditions since the rainfall occurs for a period of 3 months or less and there are poor water supplies. In India, only separate sewerage system are adopted.

The advantages of Combined sewerage system are:

1. Only one system is provided and therefore there will not be any confusion in giving connection,
2. Less expensive to install the system.

The disadvantage of Combined sewerage system is:

1. During non-rainy days the flow will be very meager causing, salivation requiring frequent cleaning.

As rainfall runs over the surface of roofs and the ground, it may pick up various contaminants including soil particles (sediment), heavy metals, organic compounds, animal waste, and oil and grease. Some jurisdictions require stormwater to receive some level of treatment before being discharged to the environment. Examples of treatment processes used for stormwater include sedimentation basins, wetlands, and vortex separators (to remove coarse solids).

The site where the process is conducted is called a sewage treatment plant. The flow scheme of a sewage treatment plant is generally the same for all countries:

Mechanical treatment;

- ✓ Influx (Influent)

- ✓ Removal of large objects
- ✓ Removal of sand and grit
- ✓ Pre-precipitation

Biological treatment;

- ✓ Oxidation bed (oxidizing bed) or Aerated systems
- ✓ Post precipitation
- ✓ Effluent
- ✓

Chemical treatment (this step is usually combined with settling and other processes to remove solids, such as filtration. The combination is referred to physical-chemical treatment.).

2. Find the English equivalents to the underlined Russian ones in the text:

a. Сточная вода is the liquid waste from toilets, baths, showers, kitchens, etc. that is disposed of via сточные трубы (коллекторы, канализационные трубы).

b. Городские сточные воды therefore includes жилые дома, офисы, and промышленные предприятия liquid waste discharges, and may include поверхностный сток

c. A сеть канализационных труб conveyance of sewage to sewage насосной станции for pumping to очистные сооружения канализации is called канализационная система.

d. In раздельной системе of sewerage are two системы отведения стоков for collecting domestic sewage as система бытовой канализации and for collecting storm water as система ливневой канализации.

e. Соотношение of the maximum ливневого стока to сточным водам works out to be 20 to 30.

f. As rainfall runs over the поверхность крыш and земля, it may pick up various contaminants including твердые частицы (минералы), тяжелые металлы, органические соединения, экскременты животных, масла and жиры.

g. Технологическая схема of a очистных сооружений канализации is generally the same for all countries.

3. Answer the questions:

1. What is the difference is between the following terms: foul waste, sullage water and trade waste?
2. What is the difference is between the following terms: Separate sewerage system and Combined sewerage system?
3. What steps does mechanical (biological and chemical) treatment include?

4. Describe the scheme in English.

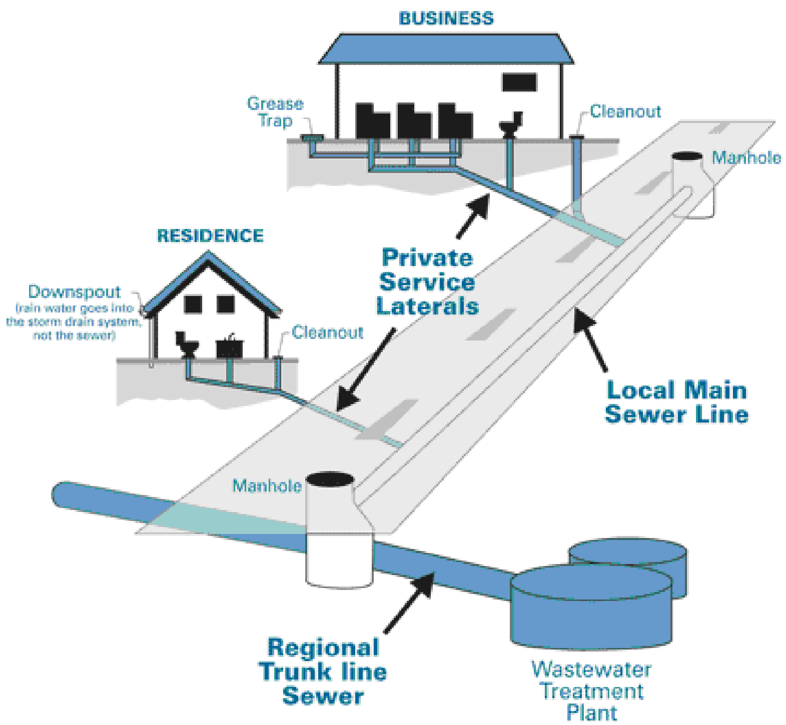


Diagram of a sanitary sewer system

Unit 5

1. **Read the text.**

Wastewater treatment

Sewage (or domestic wastewater) treatment incorporates physical, chemical and biological processes which treat and remove physical, chemical and biological contaminants from water following human use. The objective of the treatment is to produce both a clean waste stream suitable for discharge or reuse back into the environment, and a solid waste or sludge also suitable for proper disposal or reuse.

Sewage is generated by residences, institutions, and commercial and industrial establishments. It can be treated onsite at the point of which it is generated (e.g., septic tanks or onsite package plants), or collected and conveyed via a network of pipes and pump stations to a municipal treatment plant (see Sewerage and pipes and infrastructure). Efforts to collect, treat and discharge domestic wastewater are typically subject to local, state and federal regulations and standards (regulation and controls). Industrial sources of wastewater often require specialized treatment processes.

Typically, sewage treatment is achieved by the initial physical separation of solids from the raw wastewater stream followed by the progressive conversion of dissolved biological matter into a solid biological mass using indigenous, water-borne bacteria. Once the biological mass is separated or removed, the treated water may undergo additional disinfection via chemical or physical processes. This 'final effluent' can then be discharged or re-introduced back into a natural surface water body (stream, river or bay) or other environment (wetlands, golf courses, greenways, etc.). The segregated biological solids undergo additional treatment and neutralization prior to proper disposal or re-use.

Treatment stages

Primary treatment

Primary treatment is to reduce oils, grease, fats, sand, grit, and coarse (settleable) solids. This step is done entirely with machinery, hence the name mechanical treatment.

Influx (influent) and removal of large objects

In the mechanical treatment, the influx (*приток*) of sewage water is strained *удалять* all large objects that are *содержаться* in the sewer system, such as *тряпки*, *палки*, *гигиенические средства* (sanitary napkins), cans, fruit, etc. This is most commonly done using a manual or automated mechanically *решетки*. This type of waste is removed because it can damage the *чувствительное оборудование* in the sewage treatment plant.

raked screen, to remove, sticks, deposited, sensitive equipment, Influent, sanitary towels, rags.

Sand and grit removal and Screening

This stage typically includes a *песковой канал* where the *скорость* of the incoming wastewater is *тщательно контролируется* to allow sand grit and stones *оседать* but still maintain the majority of the *органические материалы* within the flow. This equipment is called a *песколовка*. Sand grit and stones need to be removed early in the process to *во избежание повреждений* to насосы and other equipment in the remaining treatment stages. Sometimes there is a sand washer followed by a conveyor that transports the sand to a container for *утилизация*. The contents from the sand catcher may *подаваться* into the *мусоросжигательная печь* in a sludge processing plant but in many cases the sand and grit is sent to a *иловая* площадка.

carefully controlled, to settle, detritor or sand catcher, velocity, avoid damage, pumps, disposal, fed, land-fill, organic material, sand or grit channel

Sedimentation

Almost all plants have a *стадия осветления (отстаиваня)* where the sewage is allowed to pass through large *круглые* or *прямоугольные резервуары*. The tanks are large enough that *фекальные твердые вещества* can settle and *плавучие вещества* such as grease and plastics can rise to the surface and be *снять с поверхности.* The main purpose of the primary stage is to produce a generally *однородная жидкость* capable of being treated biologically and a sludge that can be separately treated or processed. Primary settlement tanks are usually equipped with mechanically *движущийся скребковый механизм* that continually drive the collected sludge towards a hopper in the base of the tank from where it can *перекачивать* to further *стадия обработки осадка.*

homogeneous liquid,
circular or rectangular tanks,
floating material,
skimmed off, be pumped, sludge treatment stages,
faecal solids,
sedimentation stage,
driven scrapers,

Secondary treatment

Secondary treatment is designed to substantially degrade the biological content of the sewage such as are derived from human waste, food waste, soaps and detergent. The majority of municipal and industrial plants treat the settled sewage liquor using aerobic biological processes. For this to be effective, the biota require both oxygen and a substrate on which to live. There are number of ways in which this is done. In all these methods, the bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc particles. Secondary treatment systems are classified as fixed film or suspended growth. In fixed film systems - such as rock filters - the biomass grows on media and the sewage passes over its surface. In suspended growth systems - such as activated sludge - the biomass is well mixed with the sewage. Typically, fixed film systems require smaller footprints than for an equivalent suspended growth system; however, suspended growth systems are more able to cope with shocks in biological loading and provide higher removal rates for BOD and suspended solids than fixed film systems.

Roughing filters

Фильтр предварительной (грубой) очистки are *предназначен* to treat *очень высокая* or *переменная нагрузка по органическим веществам*, typically industrial, to allow them to then be treated by conventional secondary treatment processes. They are typically tall, circular filters filled with open *синтетическая фильтрующая загрузка* to which sewage is applied at a *достаточно высокая скорость*. The design of the filters allows *высокая гидравлическая нагрузка* and a *интенсивный поток воздуха*. On larger installations, air is *подается* through the media using *воздуходувку*. The *получившаяся жидкость* is usually within the normal range for *традиционных* treatment processes.

intended, particularly strong, resultant liquor, synthetic filter media, relatively high rate, high flow-through of air ,forced, blowers, variable organic loads, roughing filters, high hydraulic loading, conventional.

Activated sludge

Активный ил plants use a variety of mechanisms and processes to use dissolved oxygen to generate a *биологические хлопья* that substantially removes organic material. It also traps particulate material and can, under ideal conditions, *преобразовать азот* to *нитриты* and *нитраты* and ultimately to *азот газообразный*.

nitrite, biological floc, convert ammonia, nitrate, nitrogen gas, activated sludge,

Filter Beds (Oxidising beds)

In older plants and plants receiving more variable loads, *капельный биологический фильтр* are used where the *осветленная сточная жидкость* is spread onto the surface of a deep bed made up of *кокс (карбонизированный уголь)*, *известковый щебень* or *специально приготовленные пластиковые загрузки*. Such media must have high surface areas to support the *биопленка* that form. The liquor is distributed through *перфорированный вращающийся ороситель биофльтра* radiating from a *центральный привод*. The distributed liquor trickles through this bed and is collected in *дренажного устройства для удаления профильтровавшейся воды.* These drains also provide a source of air which percolates up through the bed, keeping it aerobic.

settled sewage liquor, protozoa, fungi,limestone chips, specially fabricated plastic media, biofilm, perforated rotating arms, central pivot, drains at the base, coke (carbonised coal), trickling filter beds.

Moving Bed Biological Reactor

Биореактор с плавающей загрузкой involve the addition of *инертная среда* into existing activated sludge basins to provide active sites for *присоединение биомассы*. This conversion results in a strictly attached *систему роста*. Advantages of attached growth systems include 1) maintain a high *плотность популяций биомассы* 2) increase the efficiency of the system without the need for increasing the *перемешивание жидкости* suspended solids (MLSS) concentration and 3) eliminate the cost of operating the *трубопровод рециркуляционного активного ила.*

return activated sludge line, biomass attachment, inert media, density of biomass population, growth system, mixed liquor, Moving Bed Biological Reactor,

Aeration Tanks

The *аэротенк* provide a location where biological treatment of the waste water takes place. In these tanks, microorganisms and waste water in various stages of *разложение* are mixed, aerated, and maintained in suspension. The contents of the aeration tanks, which require a delicate balance of food and oxygen, are commonly referred to as the mixed liquor suspended solids (MLSS) or activated sludge. The activated sludge *преобразовывать органические вещества* into oxidized products and *а осаждение хлопьев* which is settled out in the *вторичные отстойники*. Raw sewage can be introduced in various locations and be aerated and mixed for varying lengths of time and intensity.

decomposition, settleable floc, converts organic substances, aeration tanks, secondary clarifiers.

Membrane Biological Reactors

Мембранный биореактор (MBR) includes a *полунепроницаемая мембрана барьер* either submerged or in *сочетание* with an activated sludge process. This technology guarantees removal of all suspended and some *растворенные загрязнения*. The *ограничение системы MBR* is directly proportional to nutrient reduction efficiency of the activated sludge process. The cost of building and operating a MBR is usually higher than conventional wastewater treatment.

limitation of MBR systems, dissolved pollutants,semi-permeable membrane barrier system, conjunction, Membrane Biological Reactors

Secondary sedimentation

The final step in the secondary treatment stage is to settle out the biological floc or filter material and produce sewage water containing very low levels of organic material and suspended matter.

Tertiary treatment

Tertiary treatment provides a final stage to raise the effluent quality to the standard required before it is discharged to the receiving environment (sea, river, lake, ground, etc.) More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called Effluent polishing.

Lagooning

Биопруд provides settlement and further biological improvement through storage in large *сделанный руками человека пруд* or *природный пруд.* These lagoons are highly aerobic and colonization by *природные микрофиты*, especially reeds, is often encouraged. Small filter *кормление беспозвоночных* such as *дафния* and *виды коловраток* greatly assist in treatment by removing fine particulates.	Daphnia, species of Rotifera, Lagooning, man-made ponds, feeding invertebrates, native macrophytesm, lagoons.

Constructed wetlands

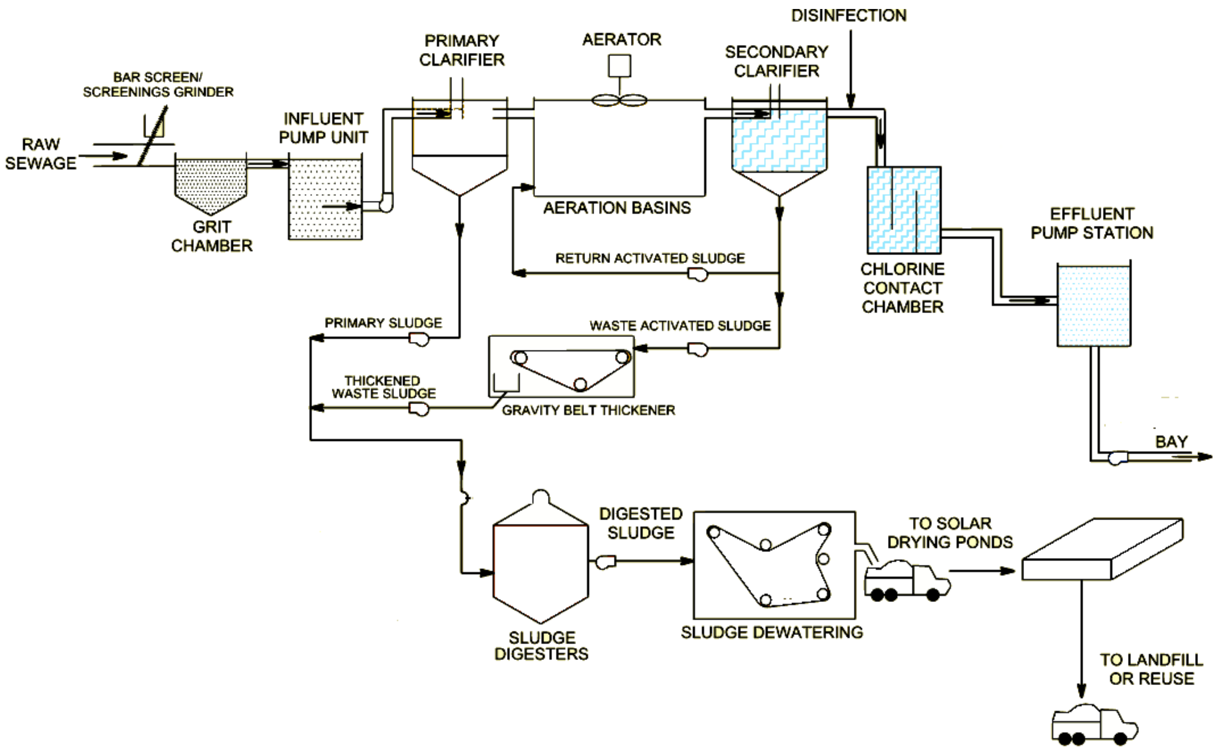
Поля орошения (фильтрации) include engineered *заросли тростника* and a range of *похожих методов*, all of which provide a high degree of aerobic biological improvement and can often be used instead of secondary treatment for small communities, also see *фиторемидиация.*	Constructed wetlands, similar methodologies, phytoremediation, reedbeds.

Disinfection

The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of living organisms in the water to be *возвращаться обратно в окружающую среду*. The effectiveness of disinfection depends on the quality of the water being treated (e.g., turbidity, pH, etc.), the type of disinfection being used, the disinfectant dosage (concentration and time), and other environmental variables. *Мутная вода* will be treated less successfully since solid matter can shield organisms, especially from Ultraviolet light or if contact times are low. Generally, short contact times, low doses and high flows all militate against effective disinfection. Common methods of disinfection include ozone, chlorine, or UV light.

discharged back into the environment,
turbid water,
persistence,

2. Describe the scheme in English.



3 Match the words

1. **activated sludge** 2. **aeration** 3. **BOD** 4. **biosolids** 5. **decomposition** 6. **domestic wastewater** 7. **effluent** 8. **grit chamber** 9. **influent** 10. **lagoons (oxidation ponds or stabilization ponds** 11. **primary treatment** 12. **secondary treatment** 13. **sedimentation** 14. **settling tank (sedimentation tank or clarifier)** 15. **sludge** 16. **tertiary treatment** 17. **total suspended solids TSS** 18. **trickling filter process** 19. **turbidity:**	a. exposing to circulating air; adds oxygen to the wastewater and allows other gases trapped in the wastewater to escape (the first step in secondary treatment via activated sludge process) b. sludge particles produced by the growth of microorganisms in aerated tanks as a part of the activated sludge process to treat wastewater c. wastewater that comes primarily from individuals, and does not generally include industrial or agricultural wastewater d. a parameter used to measure the amount of oxygen that will be consumed by microorganisms during the biological reaction of oxygen with organic material e. sludge that is intended for beneficial use. They must meet certain governmentspecified criteria depending on its use (e.g., fertilizer or soil amendment) f. treated wastewater, flowing from a lagoon, tank, treatment process, or treatment plant g. wastewater flowing into a treatment plant h. a chamber or tank used in primary treatment where wastewater slows down and heavy, large solids (grit) settle out and are removed i. the process used in both primary and secondary wastewater treatment, that takes place when gravity pulls particles to the bottom of a tank (also called settling) j. a tank in which solids settle out of water by gravity during wastewater or drinking water treatment processes k. a wastewater treatment method that uses ponds to treat wastewater l. the first stage of wastewater treatment that removes settleable or floating solids only m. a type of wastewater treatment used to convert dissolved and suspended pollutants into a form that can be removed, producing a relatively highly treated effluent n. any level of treatment beyond secondary treatment, which could include filtration, nutrient removal and removal of toxic chemicals or metals o. the process of breaking down into constituent parts or elements p. the cloudy or muddy appearance of a naturally clear liquid caused by the suspension of particulate matter q. any solid, semisolid, or liquid waste that settles to the bottom of sedimentation tanks or septic tanks r. a laboratory measurement of the quantity of suspended solids present in wastewater s. a biological treatment process that uses coarse media contained in a tank that serves as a surface on which microbiological growth occurs

4. **Describe in details each of 5 processes using the following words.**

1. **Preliminary treatment**

transported via
the sewer system
to be sent through a bar screen
to include
to be used to
to remove large solid objects
wastewater flow
to enter the grit tank
to settle to the bottom
debris is disposed at a sanitary landfill

2. **Primary treatment**

second step
physical separation of solids and greases from the wastewater
to flow into settling tank
to allow solid particles to settle to the bottom of the tank
oil and grease float to the top

3. **Secondary treatment**

a biological treatment process
to remove dissolved organic matter from wastewater
the settling tank
to flow by gravity
aeration tank
to be mixed with solids, that contain micro-organisms
to use oxygen to consume the remaining organic matter
air bubbles provide the mixing and oxygen
to be sent to the final clarifier
the solids settle out to the bottom
to be sent to the solids handling process

4. **Final treatment**

to be disinfected by chlorine and ultraviolet disinfection
to kill harmful micro-organisms to release into receiving water

5. **Solids processing**

The primary solids from the primary settling tank
the secondary solids from the clarifier
to be sent to the digester
micro-organisms use the organic materia as a food source
to convert to by-products such as methane gas and water
a 90% reduction in pathogens
production of a wet soil-like material called "biosolids" that contain 95-97% water
filter presses or centrifuges
to be used to squeeze water from the biosolids
is sent to landfill, incinerator
to be used as a fertilizer or soil amendment

Unit 6

1. Read the text.

Sludge treatment

The coarse primary solids and secondary biosolids accumulated in a wastewater treatment process must be treated and disposed of in a safe and effective manner. This material is often inadvertently contaminated with toxic organic and inorganic compounds (e.g. heavy metals). The purpose of digestion is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion, aerobic digestion, and composting.

Anaerobic digestion

Анаэробное сбраживание is a bacterial process that is carried out in the *отсутствие кислорода*. The process can either be *термофильное браживание* in which sludge is *подвергается брожению* in tanks heated to about 38°C or *мезофильное сбраживание* where sludge is maintained in large tanks for weeks to allow *естественная минерализация* of the sludge. Thermophilic digestion generates biogas with a high proportion of *метан* that may be used to both heat the tank and run engines or microturbines for other on-site processes. In large treatment plants sufficient energy can be generated in this way to produce more electricity than the machines require. The *образование метана* is a key advantage of the *анаэробный процесс*. Its key disadvantage is the long time required for the process (up to 30 days) and the high *капитальные вложения*.

capital cost, natural mineralisation, absence of oxygen, fermented, mesophilic digestion, thermophilic digestion, methane, methane generation, anaerobic process, anaerobic digestion

Aerobic digestion

Аэробное сбраживание is a bacterial process occurring in the presence of oxygen. Under *аэробные условия,* bacteria *стремительно потреблять* organic matter and convert it into *углекислый газ*. Once there is a lack of organic matter, bacteria die and are used as food by other bactieria. This stage of the process is known as *эндогенное дыхание*. *Растворение твердых веществ* occurs in this phase. Because the aerobic digestion occurs much faster than anaerobic digestion, the capital costs of aerobic digestion are lower. However, the operating costs are characteristically much greater for aerobic digestion because of energy costs for aeration needed to add oxygen to the process.

solids reduction, aerobic conditions , carbon dioxide, endogenous respiration, aerobic digestion, rapidly consume,

Sludge thickening

Уплотнение осадка is the process used to increase the solids content of sludge by the *разделение* and removal of a portion of the *жидкая фаза*. *Гравитационное уплотнение* makes use of the force of gravity as the main agent in the settling and thickening process. The thickening of sludge plays an important role in reducing capital costs relating to the provision of sludge handling equipment and the operational costs of the handling and treatment of the sludge. Three accepted methods used for pre-digestion sludge thickening: Gravity thickening, *флотационное илоуплотнение* and *центрифугирование*.

separation, dissolved air flotation thickening, centrifugation, liquid phase, gravity thickening, thickening.

Composting

Компостирование is also an aerobic process that involves mixing the wastewater solids with sources of carbon such as *опилки*, *солома* or *древесные щепки*. In the presence of oxygen, bacteria digest both the wastewater solids and the added carbon source and, in doing so, produce a large amount of heat.

wood chips
straw,
composting,
sawdust,

Both anaerobic and aerobic digestion processes can result in the destruction of disease-causing microorganisms and parasites to a sufficient level to allow the resulting digested solids to be safely applied to land used as a soil amendment material (with similar benefits to peat) or used for agriculture as a fertilizer provided that levels of toxic constituents are sufficiently low.

Thermal depolymerization

Термическая деполимеризация uses hydrous *пиролиз* to convert reduced complex organics to oil. The *предварительно измельченный*, *при удалении песка* sludge is heated to 250C and compressed to 40 MPa. The hydrogen in the water inserts itself between chemical bonds in natural polymers such as fats, proteins and cellulose. The oxygen of the water combines with carbon, hydrogen and metals. The result is oil, light combustible gases such as methane, propane and butane, water with *растворенные соли*, carbon dioxide, and a small *остаточный инертный нерастворимый материал* that resembles powdered rock and char. All organisms and many organic toxins are destroyed. Inorganic salts such as nitrates and phosphates remain in the water after treatment at sufficiently high levels that further treatment is required.

soluble salts,
pyrolysis,
premacerated,
grit-reduced,
residue of inert insoluble material,
thermal depolymerization

The choice of a wastewater solid treatment method depends on the amount of solids generated and other site-specific conditions. However, in general, composting is most often applied to smaller-scale applications followed by aerobic digestion and then lastly anaerobic digestion for the larger-scale municipal applications.

Sludge disposal

When a liquid sludge is produced, further treatment may be required to make it suitable for final *утилизация*. Typically, sludges are thickened (dewatered) to reduce the volumes transported off-site for disposal. Processes for reducing water content include lagooning in drying beds to produce a cake that can be applied to land or incinerated; pressing, where sludge is mechanically filtered, often through *тканевый фильтр* to produce a firm cake; and centrifugation where the sludge is thickened by centrifugally separating the solid and liquid. Sludges can be disposed of by liquid injection to land or by disposal in a landfill. There are concerns about *сжигание осадка* because of air pollutants in the *выбросы в атмосферу*, along with the high cost of supplemental fuel, making this a less attractive and less commonly constructed means of sludge treatment and disposal. There is no process which completely *исключать* the requirements for disposal of biosolids.

emissions,
cloth screens,
sludge incineration,
eliminates,
disposal

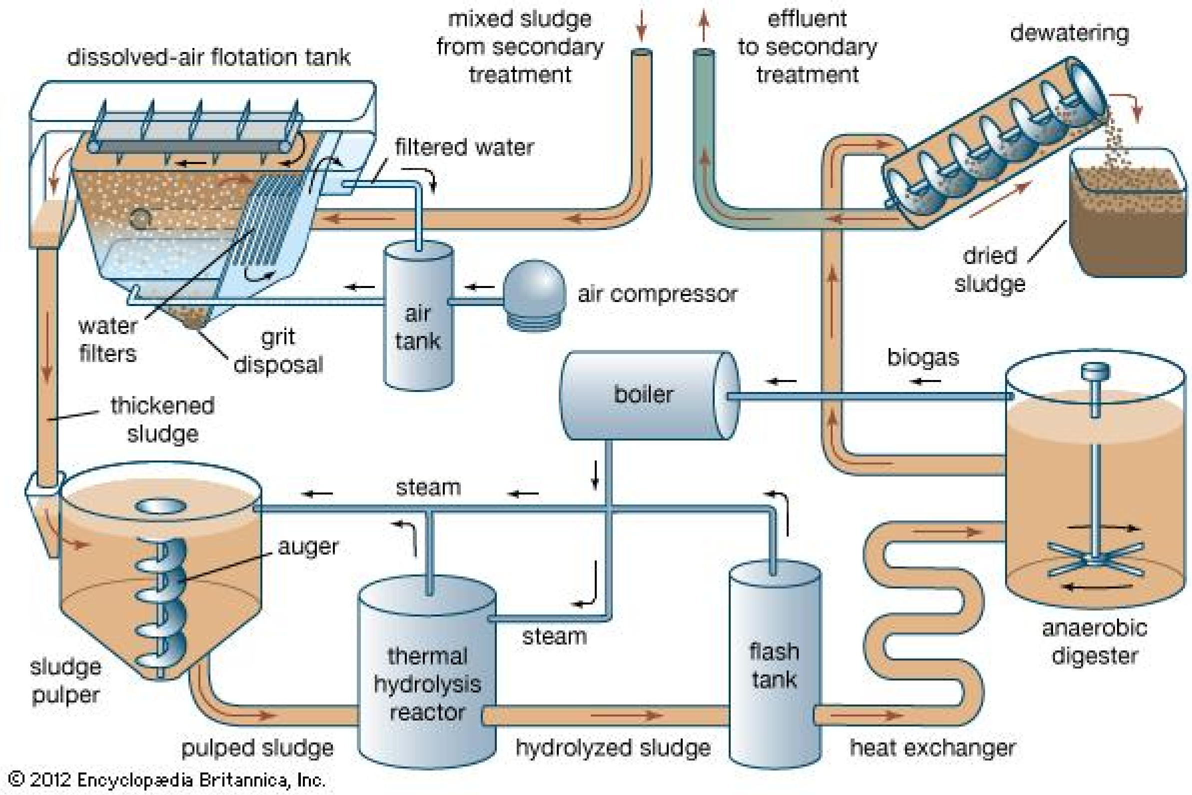
2. Translate into English.

1. Осадок из первичных отстойников и избыточный активный ил из вторичных отстойников, часто загрязненные токсичными органическими и неорганическими соединениями, должны быть обработаны и утилизировать безопасным и эффективным способом.
2. Наиболее распространенными вариантами обработки осадка являются анаэробное и аэробное сбраживание и компостирование.
3. Для анаэробного сбраживания обычно используют два температурных режима: термофильный при температуре 38°C и мезофильный.
4. При аэробном сбраживании бактерии потребляют органические вещества и превращают их в углекислый газ.

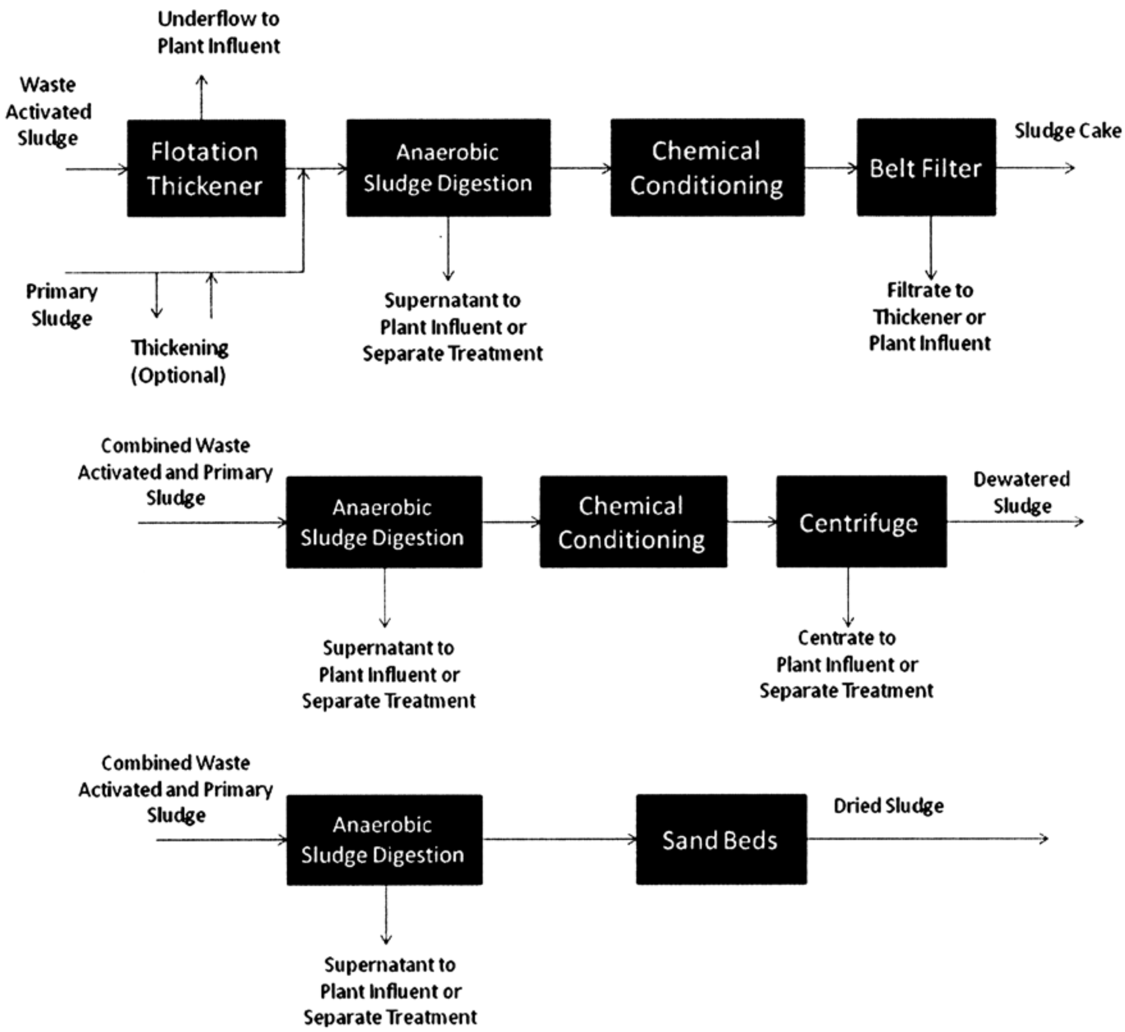
5. Уплотнение осадка это процесс, используемый для повышения содержания сухого вещества ила, отделяя жидкую фазу.
6. При компостировании происходит смешивание осадка сточных вод с источниками углерода, такими как опилки, солома или древесная стружка.
7. При термической деполимеризации используется пиролиз для разложения сложных органических соединений.

3. Describe the scheme in English.

a. The main scheme of sludge treatment**[6]**



b. Alternative treatment of sewage sludge



Понятийный словарь

A

Absorptivity – абсорбционная способность,
Addition – добавление, привнесение,
Alum – алюминий,
Algae – водоросли,
Artificial membrane – мембрана из искусственного волокна,
Ammonia – азот,
Activated sludge – активный ил,
Aeration tank - аэротенк,
Anaerobic digestion – анаэробное сбраживание

B

Biochemical oxygen demand (BOD) – биохимическая потребность в кислороде,
Bar-screen – решетка,
Biofilm – биопленка (тонкий слой микроорганизмов),
Biosolids – твердые вещества биологического происхождения**.**

C

Conductivity – электропроводность,
Chemical oxygen demand (COD) – химическая потребность в кислороде,
Coagulation – коагуляция,
chloride – хлорид,
Clarification – осветление,
chemicals – реагенты,
Conditioning – кондиционирование,
Combined sewerage system – комбинированная канализационная система**,**
Cleanout – ревизия (канализационной сети),
Constructed wetlands – поле фильтрации,
Carbon dioxide – углекислый газ,
Composting – компостирование.

D

Dissolved Oxygen (DO) – растворенный кислород,
Disinfection – обеззараживание,
Decomposition – распад, разложение,
Domestic wastewater – хозяйственно-бытовые сточные воды,
Disposal – удаление, устранение.

E

Evaporation – испарение,
Effluent – выпуск сточных вод,
endogenous respiration – эндогенное дыхание.

F

Feces – фекалии,
Flocculation – хлопьеобразование,
Floc – хлопья,
Flotation – флотация,
flocculation tank\basin – камера хлопьеобразование,
Fluoridation – фторирование,
filter media – фильтрующая загрузка,
fermented – вызывать брожение, ферментировать,
flotation thickening – флотационный илоуплотнитель.

H

Hydrogen – водород,
Hardness – твердый прочный,
High Lift Pumps – насосная станция второго подъема.

I

Infiltration – просачивание,
Influent – поступление (приток).

G

Ground Water – грунтовая вода,
grit chamber – песколовка,
Gravity thickening – гравитационный илоуплотнитель.

L

Lime – известь,
Low Lift Pumping Station – насосная станция первого подъема,
Liquid – жидкость,
Lagooning – биологический пруд.

M

Measurement – измерение,
Mesh rotating screens – механическое барабанное сито,
Moving Bed Biological Reactor – биореактор с подвижной загрузкой,
mesophilic digestion – мезофильное сбраживание,
Methane – метан.

N

Nitrite – нитрит,
Nitrate – нитрат.

O

Oxygen – кислород,
ozonation system – система озонирования.

P

Pollution – загрязнение,
Particle – частица,
Precipitation – выпадение в осадок,
purification methods – методы очистки,
Primary treatment – первичная очистка,
Pumping – перекачивание насосами,
Pipe – труба,
Pre-conditioning – предварительное кондиционирование,
Pre-chlorination – предварительное хлорирование.

Q

Quality – качество.

R

Runoff – поверхностный сток,
Reverse osmosis – обратный осмос,
Raw water – неочищенная вода,
Rapid mix chamber\tank – смеситель,
Rapid gravity filter – скорый безнапорный фильтр,
Return activated sludge – рециркуляционный активный ил.

S

Surface Water – поверхностные воды,
spectrophotometer
substance – субстанция,
suspended

settle – отстаивать,
salt – соль,
sludge - осадок,
Sedimentation – осаждение,
settling tank – отстойник,
semi-permeable membrane – полунепроницаемая мембрана,
separation – разделение,
sedimentation basin\tank – отстойник,
Secondary treatment – вторичная очистка воды,
Storage – хранилище,
Solids – твердые вещества,
Sewage – канализация,
Separate sewerage system – раздельная система канализации.

T

Turbidity – мутность,
Total suspended solids (TSS) – общее число взвешенных веществ,
Tertiary treatment – доочистка воды,
thermophilic digestion – термофильное сбраживание,
Thermal depolymerization – термическая деполимеризация.

W

well – колодец,
wastewater – сточный воды,
wastewater treatment - очистка сточных вод.

Приложение

1. Read the text and state the main idea of it. Be sure to speak about stages In history of drinking water treatment.

History of drinking water treatment

In ancient Greek and Sanskrit (India) writings dating back to 2000 BC, water treatment methods were recommended. People back than knew that heating water might purify it, and they were also educated in sand and gravel filtration, boiling, and straining. The major motive for water purification was better tasting drinking water, because people could not yet distinguish between foul and clean water. Turbidity was the main driving force between the earliest water treatments. Not much was known about micro organisms, or chemical contaminants.

After 1500 BC, the Egyptians first discovered the principle of coagulation. They applied the chemical alum for suspended particle settlement. Pictures of this purification technique were found on the wall of the tomb of Amenophis II and Ramses II.

After 500 BC, Hippocrates discovered the healing powers of water. He invented the practice of sieving water, and obtained the first bag filter, which was called the ‘Hippocratic sleeve’. The main purpose of the bag was to trap sediments that caused bad tastes or odours. In 300-200 BC, Rome built its first aqueducts. Archimedes invented his water screw.

Aqueducts

The Assyrians built the first structure that could carry water from one place to another in the 7th century BC. It was 10 meters high and 300 meters long, and carried the water 80 kilometres across a valley to Nineveh. Later, the Romans started building many of these structures. They named them aqueducts. In Latin, aqua means ‘water’, and ducere means ‘to lead’. Roman aqueducts were very sophisticated pieces of engineering that were powered entirely by gravity, and carried water over extremely large distances. They were applied specifically to supply water to the big cities and industrial areas of the Roman Empire. In the city of Rome alone more than 400 km of aqueduct were present, and it took over 500 years to complete all eleven of them. Most of the aqueducts were underground structures, to protect them in times of was and to prevent pollution. Together, they supplied Rome with over one million cubic meters of water on a daily basis.

Today, aqueducts can still be found on some locations in France, Germany, Spain and Turkey. The United States have even taken up building aqueducts to supply the big cities with water again. Many of the techniques the Romans used in their aqueducts can be seen in modern-day sewers and water transport systems[1].

Archimedes' screw

Archimedes was a Greek engineer that lived between 287 and 212 BC, and was responsible for many different inventions. One of his findings was a device to transport water from lower water bodies to higher land. He called this invention the water screw. It is a large screw inside a hollow pipe that pumps up water to higher land. Originally, it was applied to irrigate cropland and to lift water from mines and ship bilges. Today, this invention is still applied to transport water from lower to higher land or water bodies. In The Netherlands for example, such structures can be found in the city of Zoetermeer (see picture), in the west close to The Hague. The water screw formed the basis for many modern-day industrial pumps.

During the Middle Ages (500-1500 AD), water supply was no longer as sophisticated as before. These centuries where also known as the Dark Ages, because of a lack of scientific innovations and experiments. After the fall of the Roman Empire enemy forces destroyed many aqueducts, and others were no longer applied. The future for water treatment was uncertain.

Than, in 1627 the water treatment history continued as Sir Francis Bacon started experimenting with seawater desalination. He attempted to remove salt particles by means of an unsophisticated form of sand filtration. It did not exactly work, but it did paved the way for further experimentation by other scientists.

Experimentation of two Dutch spectacle makers experimented with object magnification led to the discovery of the microscope by Antonie van Leeuwenhoek in the 1670s. He grinded and polished lenses and thereby achieved greater magnification. The invention enables scientists to watch tiny particles in water. In 1676, Van Leeuwenhoek first observed water micro organisms.

In the 1700s the first water filters for domestic application were applied. These were made of wool, sponge and charcoal. In 1804 the first actual municipal water treatment plant designed by Robert Thom, was built in Scotland. The water treatment was based on slow sand filtration, and horse and cart distributed the water. Some three years later, the first water pipes were installed. The suggestion was made that every person should have access to safe drinking water, but it would take somewhat longer before this was actually brought to practice in most countries.

In 1854 it was discovered that a cholera epidemic spread through water. The outbreak seemed less severe in areas where sand filters were installed. British scientist John Snow found that the direct cause of the outbreak was water pump contamination by sewage water. He applied chlorine to purify the water, and this paved the way for water disinfection. Since the water in the pump had tasted and smelled normal, the conclusion was finally drawn that good taste and smell alone do not guarantee safe drinking water. This discovery led to governments starting to install municipal water filters (sand filters and chlorination), and hence the first government regulation of public water.

In the 1890s America started building large sand filters to protect public health. These turned out to be a success. Instead of slow sand filtration, rapid sand filtration was now applied. Filter capacity was improved by cleaning it with powerful jet steam. Subsequently, Dr. Fuller found that rapid sand filtration worked much better when it was preceded by coagulation and sedimentation techniques. Meanwhile, such waterborne illnesses as cholera and typhoid became less and less common as water chlorination won terrain throughout the world.

But the victory obtained by the invention of chlorination did not last long. After some time the negative effects of this element were discovered. Chlorine vaporizes much faster than water, and it was linked to the aggravation and cause of respiratory disease. Water experts started looking for alternative water disinfectants. In 1902 calcium hypo chlorite and ferric chloride were mixed in a drinking water supply in Belgium, resulting in both coagulation and disinfection. In 1906 ozone was first applied as a disinfectant in France. Additionally, people started installing home water filters and shower filters to prevent negative effects of chlorine in water.

In 1903 water softening was invented as a technique for water desalination. Cations were removed from water by exchanging them by sodium or other cations, in ion exchangers.

Eventually, starting 1914 drinking water standards were implemented for drinking water supplies in public traffic, based on coliform growth. It would take until the 1940s before drinking water standards applied to municipal drinking water. In 1972, the Clean Water Act was passed in the United States. In 1974 the Safe Drinking Water Act (SDWA) was formulated. The general principle in the developed world now was that every person had the right to safe drinking water.

Starting in 1970, public health concerns shifted from waterborne illnesses caused by disease-causing micro organisms, to anthropogenic water pollution such as pesticide residues and industrial sludge and organic chemicals. Regulation now focused on industrial waste and industrial water contamination, and water treatment plants were adapted. Techniques such as aeration, flocculation, and active carbon adsorption were applied. In the 1980s, membrane development for reverse osmosis was added to the list. Risk assessments were enabled after 1990.

Water treatment experimentation today mainly focuses on disinfection by-products. An example is trihalomethane (THM) formation from chlorine disinfection. These organics were linked to cancer. Lead also became a concern after it was discovered to corrode from water pipes. The high pH level of disinfected water enabled corrosion. Today, other materials have replaced many lead water pipes.

2. Read the text and state the main idea of it. Be sure to speak about stages in history of drinking water disinfection

History of drinking water disinfection

The link between water quality and health has been known since the early ages. Clear water was considered clean water. Swamp areas were associated with fever.

Disinfection has been applied for centuries. Two basic rules dating back to 2000 B.C. state that water must be exposed to sunlight and filtered with charcoal and that impure water must be purified by boiling the water and than dipping a piece of copper in the water seven times, before filtering the water. Descriptions of ancient civilisations were found about boiling water and water storage in silver jugs. To realize water purification copper, silver and electrolysis were applied.

Disinfection has been applied for several decades. However, the mechanism has been known for only one hundred years. In 1680 Anthony van Leeuwenhoek developed the microscope. His discovery of microorganisms was considered a curiosity. It took scientists another two hundred years before they started using the microscope to distinguish microorganisms and other pathogens. The first multiple filter was developed in 1685 by the Italian physician Lu Antonio Porzo. The filter consisted of a settling unit and a sandfiltration unit. In 1746 the French scientist Joseph Amy received the first patent for a filter design, which was applied in households by 1750. The filters consisted of wool, sponges and charcoal.

For the past centuries humans have suffered from diseases such as cholera and the plague. The origin of these diseases was misinterpreted. It was said that the diseases were a devine punishment or were caused by impure air or the alignment of the planets.

In the nineteenth century the effect of disinfectants, such as chlorine, was discovered. Since 1900 disinfectants are largely applied by drinking water companies to prevent the distribution of diseases and to improve water quality.

3. **Read the text and state the main idea of it.**

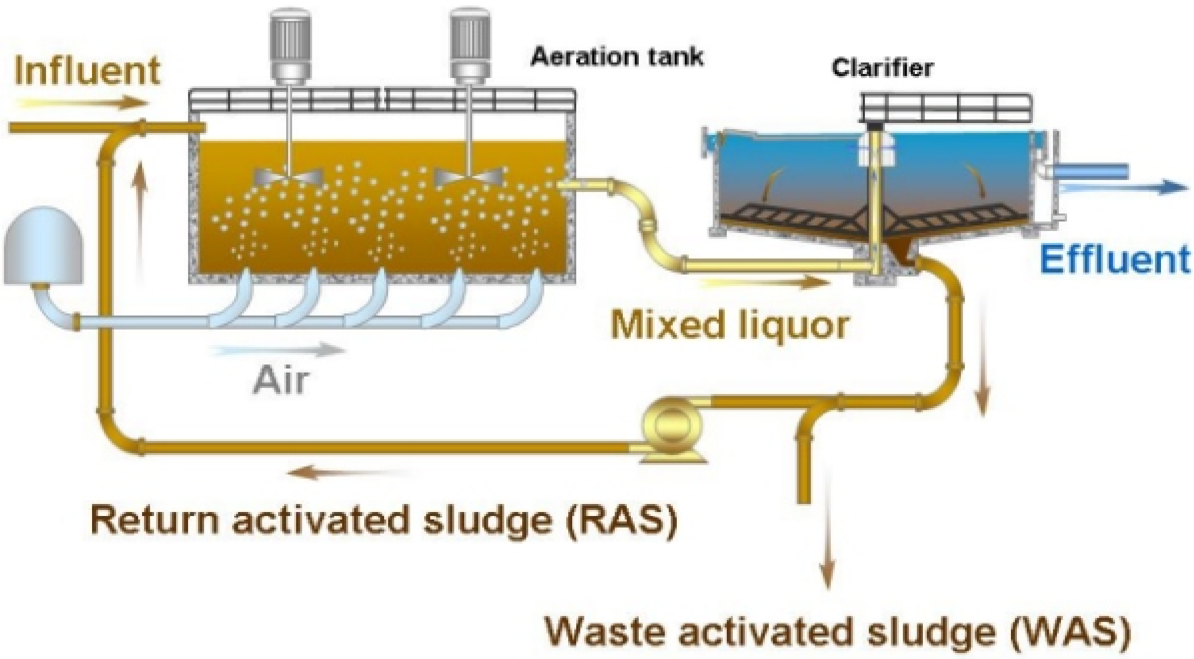
Water Treatment Membrane Type and Materials

The water treatments membrane can be defined essentially as a barrier, which separates two phases and restricts transport of various chemicals in a selective manner. A membrane can be homogeneous or heterogeneous, symmetric or asymmetric in structure, solid or liquid, can carry a positive or negative charge or be neutral or bipolar. Transport through a water treatments membrane can be effected by convection or by diffusion of individual molecules, induced by an electric field or concentration, pressure or temperature gradient. In the Water treatment Membrane filtration are categorized according to their pore sizes as micro-filtration, ultra filtration, nano filtration and reverse osmosis. Micro filtration uses the largest pore size, reverse osmosis the smallest. Reverse Osmosis water treatment membranes have pore diameters ranging from 5 to 15 A degree (0.5 nm to 1.5 nm). The extremely small size of Reverse Osmosis water treatments membrane pores allows only the smallest organic molecules and unchanged solutes to pass through the semi-permeable membrane along with the water. The water treatments membrane thickness for reverse osmosis may vary from as small as 100 micron to several millimeters. The first commercially available membranes, developed in the mid 1960s, were made of cellulose acetate (CA) manufactured in flat sheets. Modern Cellulose Acetate membranes are modifications of the cellulose acetate structure, including blends and different surface treatments, and are called cellulose or symmetric water treatments membrane.

Non-cellulose water treatments membranes, called thin-film composite membranes, have been developed since the 1970s. These include poly amide membranes with relatively thick asymmetric poly amide support structures and composite membranes with thin-film poly amide or other membrane materials on a porous support structure. Almost all water treatment Reverse Osmosis membranes are made of polymers, cellulose acetate and poly amide types rated at 96%-99+% salt rejection**[4]**.

4. Read the text and state the main idea of it.

Activated sludge



Activated sludge refers to a mass of microorganisms cultivated in the treatment process to break down organic matter into carbon dioxide, water, and other inorganic compounds. The activated sludge process has three basic components: 1) a reactor in which the microorganisms are kept in suspension, aerated, and in contact with the waste they are treating; 2) liquid-solid separation; and 3) a sludge recycling system for returning activated sludge back to the beginning of the process. There are many variants of activated sludge processes, including variations in the aeration method and the way the sludge is returned to the process**[5]**.

The process was discovered by the aeration of holding tanks for distributing raw sewage onto land. It was noticed that the nature of the sewage improved during aeration, which was applied mainly to prevent odours from forming. This improvement was even more marked when some of the sludge that was suspended and settled to the bottom during decanting, was re-suspended during aeration of the following batch of sewage. This led to the Fill and Draw method of treatment by which the sludge was allowed to settle to the bottom before decanting the effluent, filling the tank again with raw sewage, re-suspending the sludge by aeration and repeating the decanting process. It was noticed that under these conditions the sludge became more active and this process was referred to as activating the sludge. The basic layout of an activated sludge plant is illustrated in the sketch below. The aeration basin is followed by a clarifier, where the active sludge is separated from the liquid and returned (pumped) to the aeration basin, together with the raw influent. The aeration basin or reactor, the clarifier and return sludge pumping form integral parts of an activated sludge system.

The wastewater, containing numerous organic compounds, serves as a food source for micro-organisms in the mixture of activated sludge. Air is supplied for the respiration or breathing of these organisms and also for keeping the organisms in suspension and in contact with the food source. The organisms use the food to obtain energy, thereby growing to form new micro-organisms, carbon dioxide and water. The mass of organisms is constantly passed to the clarifier to be separated by settling and recycled by pumping back to the aeration basin (return activated sludge – RAS). The surplus sludge (waste activated sludge – WAS) formed by the additional growth of organisms must be removed from the system to keep the total mass of organisms constant **[5].**

5. **Read the text and state the main idea of it.**

Nutrient removal

Wastewater may also contain high levels of nutrients (nitrogen and phosphorus) that in certain forms may be toxic to fish and invertebrates at very low concentrations (e.g. ammonia) or that can create nuisance conditions in the receiving environment (e.g. weed or algal growth). Weeds and algae may seem to be an aesthetic issue, but algae can produce toxins, and their death and consumption by bacteria (decay) can deplete oxygen in the water and suffocate fish and other aquatic life. Where receiving rivers discharge to lakes or shallow seas, the added nutrients can cause severe eutrophication losing many sensitive clean water fish. The removal of nitrogen and/or phosphorus from wastewater can be achieved either biologically or by chemical precipitation.

Nitrogen removal is effected through the biological reduction of nitrogen from the ammonia to nitrate (nitrification involving nitrifying bacteria such as Nitrobacter and Nitrosomous), and then from nitrate to nitrogen gas (denitrification), which is released to the atmosphere. These conversions require carefully controlled conditions to encourage the appropriate biological communities to form. Sand filters, lagooning and reed beds can all be used to reduce nitrogen. Sometimes the conversion of toxic ammonia to nitrate alone is referred to as tertiary treatment.

Phosphorus removal can be effected biologically in a process called enhanced biological phosphorus removal. In this process specific bacteria, called Polyphosphate accumulating Organisms, are selectively enriched and accumulate large quantities of phosphorus within their cells. When the biomass enriched in these bacteria is separated from the treated water, the bacterial biosolids have a high fertilizer value. Phosphorus removal can also be achieved, usually by chemical precipitation with salts of iron (e.g. ferric chloride) or aluminum (e.g. alum). The resulting chemical sludge, however, is difficult to dispose of, and the use of chemicals in the treatment process is expensive. Although this makes operation difficult and often messy, chemical phosphorous removal requires significantly smaller equipment footprint than biological removal and is easier to operate.

6. **Read the text and state the main idea of it.**

Water Distribution Pipes

A water pipe is any pipe or tube designed to transport drinking water to consumers. If the water is treated before distribution or at the point of use (POU) depends on the context. In well planned and designed water distribution networks, water is generally treated before distribution and sometimes also chlorinated, in order to prevent recontamination on the way to the end user. The varieties of water pipes include large diameter main pipes, which supply entire towns, smaller branch lines that supply a street or group of buildings, or small diameter pipes located within individual buildings. Water pipes can range in size from giant mains of up to 3.65 m in diameter to small 12.7 mm pipes used to feed individual outlets within a building. Materials commonly used to construct water pipes include polyvinyl chloride (PVC), cast iron, copper, steel and in older systems concrete or fired clay. Joining individual water pipe lengths to make up extended runs is possible with flange, nipple, compression or soldered joints (SCOTT 2011)

Types of Pipes

Pipes come in several types and sizes. They can be divided into three main categories: metallic pipes, cement pipes and plastic pipes. Metallic pipes include steel pipes, galvanised iron pipes and cast iron pipes. Cement pipes include concrete cement pipes and asbestos cement pipes. Plastic pipes include plasticised polyvinyl chloride (PVC) pipes.

Steel Pipes

Steel pipes are comparatively expensive, but they are the strongest and most durable of all water supply pipes. They can withstand high water pressure, come in convenient (longer) lengths than most other pipes and thus incur lower installation/transportation costs. They can also be easily welded.

Galvanised Steel or Iron Pipes

Galvanised steel or iron is the traditional piping material in the plumbing industry for the*conveyance* of water and *wastewater*. Although still used throughout the world, its popularity is declining. The use of galvanised steel or iron as a conveyer for *drinking water* is problematic where water flow is slow or static for periods of time because it causes rust from internal corrosion. Galvanised steel or iron piping may also give an unpalatable taste and smell to the water conveyed under corrosive conditions.

Cast Iron Pipes

Cast iron pipes are quite stable and well suited for high water pressure. However, cast iron pipes are heavy, which makes them unsuitable for inaccessible places due to transportation problems. In addition, due to their weight they generally come in short lengths increasing costs for layout and jointing.

Concrete Cement and Asbestos Cement Pipes

Concrete cement pipes are expensive but non-corrosive by nature. Their advantage is that they are extremely strong and durable. However, being bulky and heavy, they are harder and more costly to handle, install and transport.

Plasticised Polyvinyl Chloride (PVC) Pipes

PVC pipes are non-corrosive, extremely light and thus easy to handle and transport. Still, they are strong and come in long lengths that lower installation/transportation costs (LEE *n*.y.). However, they are prone to physical damage if exposed overground and become brittle when exposed to *ultraviolet* light. In addition to the problems associated with the expansion and contraction of PVC, the material will soften and deform if exposed to *temperatures* over 65 °C.

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