University Of Technology
Building and Construction Eng. Dept.
Final Exam–2014/2015

Branch :Sanitary & Envi. Eng. Class: Fourth
subject : Environment Protection Time: 3hours.
Examiner: Lec. Shaimaa T. Kadhum Date : 7/ 6/2015

NOTE: Answer four questions only

Q. 1 /A) An air stream with a flow rate of (10 m^3/s) is passed through a cyclone of standard proportions. The diameter of the cyclone is (4m), the viscosity of air is (2.1 x 10^{-5} Kg/m.s), and the number of effective turns within the cyclone is (5 turns).
a) Determine the removal efficiency for a particle with a density of (1.9 g/cm^3) and a diameter of (8μm)
b) Determine the collection efficiency based on the above if a bank of (70) cyclones with diameters of (25cm) are used instead of the single large unit.

(19%)

Q.1 /B) Show the changes in population of microorganism caused by waste discharge into a clean stream by drawing only.

(6%)

Q.2/ A) A fabric filter is to be constructed using bags of (0.4 m) in diameter and (6.8 m) long. The bag house receive (13 m^3/sec) of air, and the appropriate filtering velocity has been determined to be (2.5 m/min). Determine the number of bags required for a continuously cleaned operation.

(13%)

Q.2/ B) Write only six causes of water pollution

(12%)

Q.3/ A) A wastewater treatment plant disposes of its effluent in a surface stream. Characteristics of the stream and effluent are shown below:

Parameter	Flow (m^3/d)	BOD_5 at20^0c (mg/l)	DO (mg/l)	Temperature	K1 at 20^0c (d^{-1})	K2 at 20^0c (d^{-1})
wastewater	0.2	100	1	15^0c	0.09	-
stream	5	2	8	20.2^0c	-	0.13

Saturated level of oxygen is (9.17 mg/l)
a) What will be the dissolved oxygen concentration in the stream after 2 days?
b) What will be the lowest dissolved oxygen concentration as a result of the waste discharge?

(15%)

Q.3/ B) Define **(five)** of the following
(1) Groundwater contamination, (2) IAIA, (3) Non-biodegradable organics, (4) 4)Metaliminion, (5) Photochemical reaction, (6) Chlorofluorocarbons (CFCs),

(10%)

Q.4/ A) Determine the stratification category for a lake in summer and winter if length by width by depth is (1200m x 2500m x 80m), and

$\rho_{surface}$ at 40^0c= 992.2 Kg/m^3, and at 15^0c= 999.1 Kg/m^3

ρ_o = 1000 Kg/m^3

Q summer = 17280 m^3/d , and Q winter = 45000 m^3/d

(11%)

Q.4/ B) What are the stages that are necessary be involved in environmental impact assessment? (With explanation)

(14%)

Q.5/ A) If the efficiency for an electrostatic precipitator required to collect particles of (0.6 μm) diameter is 95%, flow equals to (125000 m^3/hr), and the analysis of a similar system shows that the drift velocity can be taken as ($w = 2.8 \times 10^5\, d_p$ m/s), what will be the plate area for the precipitator?

(15%)

Q.5/ B) Write the physical and chemical properties of the zones in Wipple model

(10%)

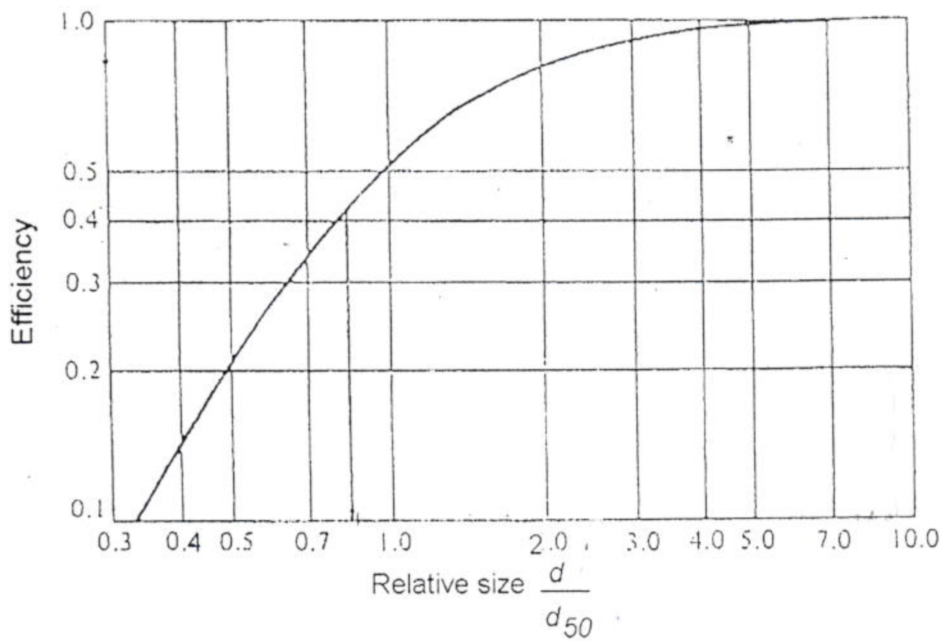
Useful informations:

$Y_t = L_o(1-e^{-k1t})$, $D = \frac{k1\, L_o}{k2-k1}(e^{-k1\, t} - e^{-k2\, t}) + D_o\, e^{-k2\, t}$

$D_c = \frac{k1}{k2} L_o e^{-k1\, tc}$, $t_c = \frac{1}{k2-k1} \ln\left[\frac{k2}{k1}\left(1 - D_o\frac{k2-k1}{k1 L_o}\right)\right]$, $k_T = k_{20}\theta^{T-20}$,

$E = 1 - \exp(-\frac{w}{Q} A)$, $FD = \frac{v}{\sqrt{\frac{\Delta\rho\, Dg}{\rho_o}}}$, Area=πDH, $FD = \frac{V}{\sqrt{(\frac{\Delta\rho\, Dg}{\rho_o})}}$, $E = 1-\exp(-\frac{v}{Q} A)$

, $b = \frac{1}{4}D$, $h = \frac{1}{2}D$, $d_{50} = \sqrt{(\frac{9\mu b}{2\pi\, Ne\, vi\, \rho p})}$



حلول نموذج (1) + أسئلة حماية بيئة 7/6/2015

Q1 A)

x) Cyclone of standard proportions

$$b = \frac{D}{4} = \frac{4\,m}{4} = 1\,m$$

$$h = \frac{D}{2} = \frac{4\,m}{2} = 2\,m$$

area of inlet = $1 \times 2 = 2\,m^2$

$$V_i = \frac{Q}{A} = \frac{10\,m^3/s}{2\,m^2} = 5\,m/s$$

$$d_{50} = \left(\frac{9\,\mu\,b}{2\pi\,N_e\,V_i\,\rho_p} \right)$$

$$= \left(\frac{9 \times 2.1 \times 10^{-5} \times 1}{2\pi \times 5 \times 5 \times \left(1.9\,g/cm^3 \times \frac{1\,kg}{1000\,g} \times \frac{(100)^3\,cm^3}{m^3}\right)} \right)$$

$$= 2.51 \times 10^{-5}\,m$$

$$= 25\,\mu m$$

$$\frac{d}{d_{50}} = \frac{8\,\mu m}{25\,\mu m} = 0.32$$

From Fig. the efficiency for the 8 μm Particle is found to be about 95%.

b)

$$b = \frac{D}{4} = \frac{0.25\,m}{4} = 0.06\ m$$

$$h = \frac{D}{2} = \frac{0.25\,m}{2} = 0.12\ m$$

Area of inlet $= 0.06\,m \times 0.12\,m = 7.2 \times 10^{-3}\ m^2$

Area of all inlets $= 70 \times 7.2 \times 10^{-3}\ m^2 = 0.5\ m^2$

Inlet velocity $= \frac{10\ m^3/s}{0.5\ m^2} = 20\ m/s$

$$d_{50} = \left(\frac{9 \times 2.1\times10^{-5} \times 0.06}{2\pi \times 5 \times 20\,m/s \times 1900\ kg/m^3} \right)^{\frac{1}{2}}$$

$$= 3.08 \times 10^{-6}\ m$$

$$= 3.08\ \mu m$$

$$\frac{d}{d_{50}} = \frac{8\ \mu m}{3.08\ \mu m} = 2.59$$

∴ From fig., the efficiency for the 8 μm particle is about 90%.

Q2. A)

$$Q = 13 \frac{m^3}{s} \times \frac{60\ s}{min} = 780 \frac{m^3}{min}$$

Cloth area required

$$A = \frac{Q}{V} = \frac{780\ m^3/min}{2.5\ m/min} = 312\ m^2$$

The area of one baghouse is :-

$$\pi D H = \pi \times 0.4 \times 6.8 = 8.54\ m^2$$

The total number of bags is

$$\frac{312}{8.54} = 36.5 \quad \therefore \text{ use } \underline{37}$$

Q 3 A)

(a) $Q_{mix} = Q_w + Q_s = 0.2 + 5 = 5.2 \ m^3/s$

$$DO)_{mix} = \frac{(DO)_w Q_w + (DO)_s Q_s}{Q_{mix}} = \frac{1 \times 0.2 + 8 \times 5}{5.2} = 7.73 \ mg/l$$

$$T_{mix} = \frac{T_w Q_w + T_s Q_s}{Q_{mix}} = \frac{15(0.2) + 20.2(5)}{5.2} = 20^\circ C$$

$$BOD)_{mix} = \frac{100(0.2) + 2(5)}{5.2} = 5.277 \ mg/l$$

$$L_o = y_u = \frac{(BOD)_{mix}}{(1 - e^{-k_1 t})} = \frac{5.77}{1 - e^{-0.09 \times 5}} = 8.94 \ mg/l$$

Deficit $= C_s - C = 9.17 - 7.73 = 1.44 \ mg/l$

at $t = 2$ days

$$D = \frac{0.09\,(8.94)}{0.13 - 0.09}\left[e^{-0.09(2)} - e^{-0.13(2)}\right] + 1.44 \times e^{-0.13(2)}$$

$= 3.03 \ mg/l$

(b)
$$t_c = \frac{1}{0.13 - 0.09} \ln\left[\frac{0.13}{0.09}\left(1 - 1.44 \frac{0.13 - 0.09}{0.09 \times 8.94}\right)\right]$$

$= 3.19$ day

$$D_c = \frac{k_1}{k_2} L_o \, e^{-k_1 t_c}$$

$$= \frac{0.09}{0.13} \times 8.9 \times e^{-0.09 \times 3.19} = 3.2 \ mg/l$$

$D_{o\,min} = C_s - C_c = 9.17 - 3.2 = 5.97 \ mg/l$

Q 2. B)

Causes of Water Pollution

Let us now study the causes of water pollution.

1. Industrial waste: Industries produce huge amount of waste which contains toxic chemicals and pollutants which can cause air pollution and damage to us and our environment. They contain pollutants such as lead, mercury, sulphur, asbestos, nitrates and many other harmful chemicals. Many industries do not have proper waste management system and drain the waste in the fresh water which goes into rivers, canals and later in to sea. The toxic chemicals have the capability to change the color of water, increase the amount of minerals, also known as Eutrophication, change the temperature of water and pose serious hazard to water organisms.

2. Sewage and waste water: The sewage and waste water that is produced by each household is chemically treated and released in to sea with fresh water. The sewage water carries harmful bacteria and chemicals that can cause serious health problems. Pathogens are known as a common water pollutant; The sewers of cities house several pathogens and thereby diseases. Microorganisms in water are known to be causes of some very deadly diseases and become the breeding grounds for other creatures that act like carriers. These carriers inflict these diseases via various forms of contact onto an individual. A very common example of this process would be Malaria.

3. Mining activities: Mining is the process of crushing the rock and extracting coal and other minerals from underground. These elements when extracted in the raw form contains harmful chemicals and can increase the amount of toxic elements when mixed up with water which may result in health problems. Mining activities emit several metal waste and sulphides from the rocks and is harmful for the water.

4. Marine dumping: The garbage produce by each household in the form of paper, aluminum, rubber, glass, plastic, food if collected and deposited into the sea in some countries. These items take from 2 weeks to 200 years to decompose. When such items enters the sea, they not only cause water pollution but also harm animals in the sea.

5. Accidental Oil leakage: Oil spill pose a huge concern as large amount of oil enters into the sea and does not dissolve with water; there by opens problem for local marine wildlife such as fish, birds and sea otters. For e.g.: a ship carrying large quantity of oil may spill oil if met with an accident and can cause varying damage to species in the ocean depending on the quantity of oil spill, size of ocean, toxicity of pollutant.

6. Burning of fossil fuels: Fossil fuels like coal and oil when burnt produce substantial amount of ash in the atmosphere. The particles which contain toxic chemicals when mixed with water vapor result in acid rain. Also, carbon dioxide is released from burning of fossil fuels which result in global warming.

7. Chemical fertilizers and pesticides: Chemical fertilizers and pesticides are used by farmers to protect crops from insects and bacterias. They are useful for the plants growth. However, when these chemicals are mixed up with water produce harmful for plants and animals. Also, when it rains, the chemicals mixes up with rainwater and flow down into rivers and canals which pose serious damages for aquatic animals.

8. Leakage from sewer lines: A small leakage from the sewer lines can contaminate the underground water and make it unfit for the people to drink. Also, when not repaired on time, the leaking water can come on to the surface and become a breeding ground for insects and mosquitoes.

9. Global warming: An increase in earth's temperature due to greenhouse effect results in global warming. It increases the water temperature and result in death of aquatic animals and marine species which later results in water pollution.

10. Radioactive waste: Nuclear energy is produced using nuclear fission or fusion. The element that is used in production of nuclear energy is Uranium which is highly toxic chemical. The nuclear waste that is produced by radioactive material needs to be disposed off to prevent any nuclear accident. Nuclear waste can have serious

environmental hazards if not disposed off properly. Few major accidents have already taken place in Russia and Japan.

11. Urban development: As population has grown, so has the demand for housing, food and cloth. As more cities and towns are developed, they have resulted in increase use of fertilizers to produce more food, soil erosion due to deforestation, increase in construction activities, inadequate sewer collection and treatment, landfills as more garbage is produced, increase in chemicals from industries to produce more materials.

12. Leakage from the landfills: Landfills are nothing but huge pile of garbage that produces awful smell and can be seen across the city. When it rains, the landfills may leak and the leaking landfills can pollute the underground water with large variety of contaminants.

13. Animal waste: The waste produce produce by animals is washed away into the rivers when it rains. It gets mixed up with other harmful chemicals and causes various water borne diseases like cholera, diarrhea, jaundice, dysentery and typhoid.

14. Underground storage leakage: Transportation of coal and other petroleum products through underground pipes is well known. Accidentals leakage may happen anytime and may cause damage to environment and result in soil erosion.

Water pollutants also include both organic and inorganic factors. Organic factors include volatile organic compounds, fuels, waste from trees, plants etc. Inorganic factors include ammonia, chemical waste from factories, discarded cosmetics etc. The water that travels via fields is usually contaminated with all forms of waste inclusive of fertilizers that it swept along the way. This infected water makes its way to our water bodies and sometimes to the seas endangering the flora, fauna and humans that use it along its path.

The current scenario has led to a consciousness about water preservation and efforts are being made on several levels to redeem our water resources. Industries and factory set up's are restricted from contaminating the water bodies and are advised to treat their contaminated waste through filtration methods. People are investing in rain water harvesting projects to collect rainwater and preserve it in wells below ground level.

Q3 . B)

(1) groundwater contamination :- is an undesirable change in groundwater quality resulting from human activities.

(2) IAIA :- (The International Association of Impact Assessment) ~~an environmental impact assessment~~

(3) non-biodegradable organics :- Organic materials are resistant to biological degradation. like Tannic and lignic acids, cellulose, and Phenols are often found in natural water system.

~~(4) Metalimimion :- It is a large of water which rapidly changes separate the temperature with depth of Lake and epilimnion and the hypolimnion.~~

(4) Metaliminion :- It is a layer of water which rapidly changes temperature with depth of Lake and separate the epiliminion and the hypolimnion Layers.

(5) Photochemical reaction :- A chemical reaction in the atmosphere that is triggered by sunlight. Ozon is a Pollutant created from a photochemical reaction.

(6) Chloroflouro carbone :- These are gases which released from air conditioners, refrigerators, aerosol spray, harmful to the Ozon Layer, and emitted from Products are currently banned from use.

Q 4.A)

$$Q_{summer} = 17280 \, m^3/d \times \frac{1}{24 \times 60 \times 60} = 0.2 \, m^3/s$$

$$Q_{winter} = 45000 \, m^3/d \times \frac{1}{24 \times 60 \times 60} = 0.52 \, m^3/s$$

at summer

$$V = \frac{Q}{BD} = \frac{0.2}{2500 \times 80} = 1 \times 10^{-6} \, m/s$$

$$FD = \frac{1 \times 10^{-6}}{\sqrt{\left(\frac{1000 - 992.2}{1000}\right) \times 80 \times 9.81}} = 0.04 \times 10^{-5} < 0.01$$

∴ Lake is strongly stratified in summer

at winter

$$V = \frac{0.52}{2500 \times 80} = 0.26 \times 10^{-5} \, m/s$$

$$FD = \frac{0.26 \times 10^{-5}}{\sqrt{\left(\frac{1000 - 999.1}{1000}\right) \times 80 \times 9.81}} = 0.3 \times 10^{-5} < 0.01$$

∴ Lake is strongly stratified at winter.

protection

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Q4.B)

... involve the following stages:

1. **Screening** to determine which projects or developments require a full or partial impact assessment study;
2. **Scoping** to identify which potential impacts are relevant to assess (based on legislative requirements, international conventions, expert knowledge and public involvement), to identify alternative solutions that avoid, mitigate or compensate adverse impacts on biodiversity (including the option of not proceeding with the

development, finding alternative designs or sites which avoid the impacts, incorporating safeguards in the design of the project, or providing compensation for adverse impacts), and finally to derive terms of reference for the impact assessment;

3. **Assessment and evaluation of impacts and development of alternatives**, to predict and identify the likely environmental impacts of a proposed project or development, including the detailed elaboration of alternatives;
4. **Reporting the Environmental Impact Statement (EIS) or EIA report**, including an environmental management plan (EMP), and a non-technical summary for the general audience.
5. **Review of the Environmental Impact Statement (EIS)**, based on the terms of reference (scoping) and public (including authority) participation.
6. **Decision-making** on whether to approve the project or not, and under what conditions; and
7. **Monitoring, compliance, enforcement and environmental auditing**. Monitor whether the predicted impacts and proposed mitigation measures occur as defined in the EMP. Verify the compliance of proponent with the EMP, to ensure that unpredicted impacts or failed mitigation measures are identified and addressed in a timely fashion.

Q5. A)

$\omega = 2.8 \times 10^{5}\ m/s \times 6 \times 10^{-7}\ m = 0.16\ m/s$

$Q = 125000\ m^3/s = 34.72\ m^3/s$

$E = 1 - \exp\left(-\frac{\omega}{Q} A\right)$

$0.95 = 1 - \exp\left(-\frac{0.16}{34.72} A\right)$

$-2.99 = -0.004 A$

$\therefore A = \frac{2.99}{0.004} = 747.5\ m^2$

Q5.B)

Table 3-3 Whipple, Fair, and Whipple model for zones of stream self-purification

Zone	Physical characteristics	Chemical characteristics	Biological characteristics
Degradation (Zone 2 in Fig. 3-13)	The water is turbid; there are sludge deposits and floating debris	Oxygen is reduced to about 40% of saturation.	Fish and green algae are declining; littoral forms of green and blue-green algae are trailing from frequently wetted stones. These include *Stigeoclonium*, *Oscillatoria*, and *Ulothrix*. Bottom forms in sludge include reddish worms (Tubificidae) similar to earthworms, such as *Tubifex* and *Limnodrilus*. Water fungi are typically white, olive green, putty gray, rusty brown. *Sphaerotilus natans*, *Leptomitus*, and *Achlya* appear, as do ciliated protozoa or ciliata such as *Carchesium*, *Epistylis*, and *Vorticella*.
Active decomposition (Zone 3 in Fig. 3-13)	Water is grayish and darker than in degradation zone; scum may form; septic conditions may have set in	Oxygen level moves between 40% of saturation and zero; then as active decomposition diminishes, oxygen content rises. Methane, hydrogen, and sulfide are given off	Bacteria flora flourish; anaerobes displace aerobes, which reappear toward the lower end of the zone. Protozoa follow course of aerobic bacteria, first diminishing and then reappearing. Fungi follow a similar course, disappearing under true septic conditions and then reappearing. Organisms are threadlike and develop pink, cream, and grayish tints. Algae are present to a very slight extent at the lower end of the zone. *Tubifex* are present only at the upper and lower ends of the zone. *Psychoda* (sewage fly) larvae are present in all but the most septic stage. Rattail maggots (*Eristalis*) and mosquito larvae (*Culex*) are found. There is no fish life.

(continued)

Table 3-3 (continued)

Zone	Physical characteristics	Chemical characteristics	Biological characteristics
Recovery (Zone 4 in Fig. 3-13)	Water is clearer.	Dissolved oxygen content moves upward from 40% of saturation; nitrates are present.	Protozoa, rotifers, and crustaceans appear. Fungi are present to a limited degree. Algae appear in the following order: *Cyanophyceae*, *Chlorophyceae*, and diatoms. Large plants (sponges, bryozoans) appear. Bottom organisms include *Tubifex*, mussels, snails, and insect larvae. Carp, suckers, and more resistant forms of fish occur.
Clean water (Zones 1 and 5 in Fig. 3-13)	Natural stream conditions are restored.	Dissolved oxygen is close to saturation.	Mayflies (*Ephemeropteria*), stone flies (*Plecoptera*), caddis flies (Trichoptera), and gamefish are found.

Q1. B

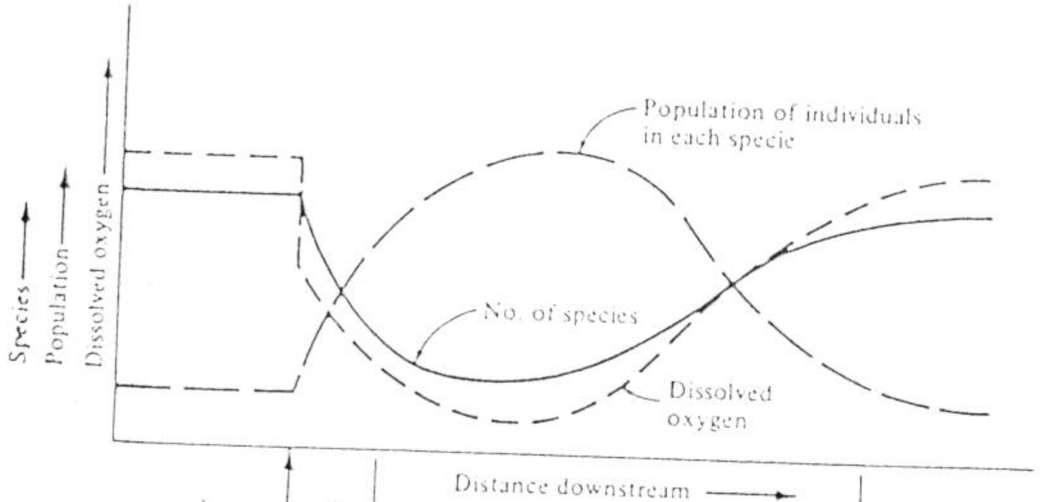

Figure 3-13 Changes in population of macroorganisms caused by waste discharge into a clean stream. (*From Kemmer.*) [3-10]