EVE 290
Introduction to Environmental Engineering
Fall 2010

Exam #2 Review

Text coverage: Chapters 9-10

Ch. 9 – Water Quality

1. Important water quality parameters
    a. Dissolved oxygen (DO) = f(temp., atm. pressure, [dissolved solids])
        i. Max. [DO] = DO_{sat}
        ii. When [DO] is "too low," aquatic life is threatened/killed
    b. Biochemical oxygen demand (BOD)
        i. Aerobic(stable products) vs. anaerobic (objectionable products)
        ii. $BOD_5 = (DO_i - DO_f)(D)$; "unseeded"
        iii. $D = v_{total}/v_{sample}$ = expected BOD/ΔDO
        iv. $BOD_5 = [(I-F) - (I'-F')(x/y)](D)$; "seeded"
        v. Inside the bottle: (rate of DO accumulation) = - (rate of DO consumption)
            1. $d[DO]/dt = -k[DO] \rightarrow [DO] = [DO]_o exp(-kt)$
            2. $[BOD] = U[1 - exp(-kt)]$; U = ultimate oxygen demand
        vi. Nitrogenous (NBOD) vs carbonaceous (CBOD)
    c. Solids
        i. Dissolved solids (DS) vs suspended solids (SS)
        ii. Volatile solids (VS) vs fixed solids (FS)
        iii. Volatile suspended solids (VSS) vs. fixed suspended solids (FSS)
    d. Nitrogen
    e. Pathogens (viruses, bacteria, protozoa)
    f. Coliforms – indicator organisms
2. Water quality assessment and standards
    a. Drinking water standards
    b. Effluent standards
    c. Surface water quality standards
3. Relevant homework: HW12, HW13, Hw14

Ch. 10 – Water Supply and Treatment

1. Water availability
    a. Precipitation
    b. Runoff
    c. Evapotranspiration
2. Groundwater
    a. Aquifer

i. Confined – potential artesian well
ii. Unconfined

b. Porosity = V_{voids}/V_{total}
c. Specific yield
d. v' = actual velocity of water through soil = superficial velocity/porosity
e. Coefficient of permeability
f. Darcy's Law: $Q = kA(dh/dL) = \pi k(h_1^2 - h_2^2)/\ln(r_1/r_2)$, if well is cylindrical
    i. Extraction well vs. observation well(s)
    ii. "head" - analogous to potential energy
    iii. Drawdown
    iv. Cone of depression
g. Hardness – multivalent cations
    i. $TH \approx [Ca^{2+}] + [Mg^{2+}]$
    ii. EW = (AW or MW)/valence
    iii. C[meq/L] = C[mg/L]/EW
    iv. C[mg/L as $CaCO_3$] = 50*C[meq/L]
h. Alkalinity (ALK) – water's buffering capacity
    i. ALK[meq/L] = $(HCO_3^-) + (CO_3^{2-}) + (OH^-) - (H^+)$
i. Components of total hardness
    i. Carbonate hardness (CH)
    ii. Noncarbonated hardness (NCH)
    iii. CH = min(ALK, TH)
    iv. NCH = TH – CH, if ALK < TH
    v. NCH = 0 if ALK ≥ TH
j. Drinking water treatment systems (surface sources)
    i. Coagulation – particle destabilization via chemical edition
    ii. Flocculation – transport of particles so they "stick"
    iii. Sedimentation – settling of large particles
        1. u_t^* = surface settling rate = Q/LW
        2. fractional removal = u_t/u_t^*
    iv. Filtration – removal of small particles by transport and attachement
        1. Filtration rate = Q/A_s
        2. Vol. of backwash water = (backwash rate)$(A_s)(t)$
    v. Disinfection – remaining pathogens killed
        1. Parameter of interest: "CT"
        2. Most common disinfectant: Cl_2 (inexpensive; residual provided)
        3. Others: O_3, NaClO, ClO_2
k. Relevant homework: HW15, HW16, HW17, HW18
l. See also: Examples 10.19, 10.20, 10.21