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Civil Engineering Department

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CVG2132 – FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING

Homework 1: Professor: Rob Delatolla

Due Date: Sept. 30, 2011 (3:00pm) – Cubby « CVG 2132 », Mezzanine A (0.5) CBY

Remember to use units !!

Question 1: Before wastewater can be released back into the environment it must be treated so that contaminant concentrations are within acceptable parameters as to not negatively impact the receiving waters. Ammonia is listed as a deleterious substance and can be acutely toxic to fish at low concentrations and is therefore a regulated contaminant. The allowable limit for ammonia (also referred to as un-ionized ammonia) is 1.25 mg NH_3/L. If the wastewater has an ammonium (NH_4^+) concentration of 23 mg NH_4^+-N/L and a pH of 8.1, does it meet the discharge requirements? What if the limit was 1.25 mg NH_3-N/L?

> Note: pKa = 9.3 for NH_4^+ -> NH_3 + H^+, mg NH_3-N/L means milligrams of ammonia as nitrogen per liter (MW= 14 g/mol instead of 17 g/mol)

Question 2: A sample of water has a pH of 9.3 and a C_T value of 1.3 x 10^{-3} mol C/L. **a)** What are the concentrations of HCO_3^- and CO_3^{2-} in mol/L? **b)** What is the alkalinity as mg $CaCO_3$/L? If enough HCl was added to reduce the pH to 6.7, **c)** what is the concentration of HCO_3^- in mol/L? **d)** What is the new alkalinity as mg $CaCO_3$/L? Assume CO_2 is negligible and all carbon is inorganic (HCO_3^-, CO_3^{2-}, H_2CO_3).

> Recall pKa_2 = 10.3 for HCO_3^- -> H^+ + CO_3^{2-} , pKa_1 =6.3 H_2CO_3* -> H^+ + HCO_3^- .

Question 3: a) 1.4 mL of 2.5 M HCl was add to pure water to make a 4L solution. What is the pH? What is the concentration of Cl^- in ug/L, M and ppm? In addition how many atoms of Cl^- are present in the solution? **b)** If 4.5 mL of 2 M CH_3COOH (acetic acid a.k.a vinegar) was added to make a 2 L solution with a pH = pKa, what is the concentration of acetate in mg/L, ppb and M? How many molecules of acetate are present in the solution? pKa =4.75 CH_3COOH -> H^++CH_3COO^-.

Question 4: Two 100 mL samples were taken from a river. The first sample was dried, unfiltered, at 105˚C and weighed 1.6112 g. The second sample was filtered and the filter was dried at 105˚C for one hour, after which it weighed 2.1085 g. The same sample was then placed in a muffle furnace at 550˚C for 30 minutes, after which it weighed 2.103g. Note the weight of the holder is 1.6g and the weight of the filter is 0.5g.

Find the:

a) TS concentration in mg/L

b) VSS concentration in mg/L

c) TSS concentration in mg/L

d) FSS concentration in mg/L

e) TDS concentration in mg/L

Question 5: A potential water source was sampled and tested for suitability. The sample had a temperature of 15 ˚C and was characterized with the following parameters:

Constituent	**Concentration**	**Molecular Weight**
	g/m^3	*g/mol*
Ca^{2+}	100	40
Mg^{2+}	19.2	24
Na^{+}	23	23
Fe^{2+}	1.008	56
HCO_3^{-}	335.5	61
SO_4^{2-}	27.65	96
CO_3^{2-}	1.8	60
Cl^{-}	39.05	35.5
NO_3^{-}	24.8	62

Given these parameters determine if the water is suitable for use by finding the hardness (total, carbonate and noncarbonated), the alkalinity and the pH. In addition check the charge balance to see if the data provided is reliable.

Note: You need to show at least 1 sample calculation for each calculation type completed.

Assume $K = 10^{-10.3} = [H^+][CO_3^{2-}] / [HCO_3^-]$

Note: When pH is between 6-8 H^+ and OH^- effects can be ignored for alkalinity.