1.85 WATER AND WASTEWATER TREATMENT ENGINEERING
HOMEWORK 5

Question 1 (4 points)

The water defined by the analysis given below is to be softened by excess-lime (and soda ash) treatment.

a. Sketch an meq/L bar graph (1 point).

b. Calculate the softening chemicals required (3 points).

c. Draw a bar graph for the softened water after recarbonation and filtration, assuming that 80% of the alkalinity is in the bicarbonate form (1 point).

CO_2	8.8 mg/L
Ca^{2+}	40.0 mg/L
Mg^{2+}	14.7 mg/L
Na^+	13.7 mg/L

ALK (HCO_3^-)	135 mg/L
SO_4^{2-}	29.0 mg/L
Cl^-	17.8 mg/L

Question 2 (2 points)

A small community has used an unchlorinated ground-water supply containing approximately 0.3 mg/L of iron and manganese for several years without any apparent iron and manganese problems. A health official suggested that the town install chlorination equipment to disinfect the water and provide a chlorine residual in the distribution system. After initiating chlorination, consumers complained about water staining washed clothes and bathroom fixtures. Explain what is occurring due to chlorination.

ANSWER: Chlorine is a strong oxidizer and is oxidizing the iron and the manganese. The oxidized iron and manganese is relatively insoluble and forms precipitates. These precipitates cause the stains on fixtures and laundry. Apparently, before chlorination, the iron and manganese remained dissolved or as fine colloids and passed through the system without causing problems.

Question 3 (2 points)

A wastewater containing phenol at a concentration of 0.4 mg/L is to be treated by granular activated carbon. Batch tests have been performed in the laboratory to determine the relative adsorption of phenol by GAC. Testing entails adding a mass of carbon to $V = 1$ liter of the 0.4 mg/L-solution, allowing the solution to reach equilibrium over 6 days, and then measuring the resulting equilibrium concentration of phenol. Results are shown in the table below. Develop a Freundlich isotherm to fit these data.

Mass of carbon, M (gm)	Initial conc., C_0 (mg/L)	Equilibrium conc C_e (mg/L)
0.52	0.400	0.322
2.32	0.400	0.117
3.46	0.400	0.051
3.84	0.400	0.039
4.50	0.400	0.023
5.40	0.400	0.012
6.67	0.400	0.0061
7.60	0.400	0.0042
8.82	0.400	0.0023

Question 4 (2 points)

An ion exchange resin is used to remove nitrate from a water supply with the ionic concentrations shown below. The total resin capacity is 1.5 equivalents per liter of resin.

Cations	meq/L	Anions	meq/L
Ca^{2+}	1.4	SO_4^{2-}	0.0
Mg^{2+}	0.8	Cl^-	3.0
Na^+	2.6	NO_3^-	1.8

    d. Do the anions and cations balance? (1 point).

    e. What volume of water can be treated with each liter of resin? (2 points)

    f. Qualitatively, how would your answer differ if the concentrations of Cl^- and SO_4^- were reversed? (1 point).