ANSWERS TO SAMPLE FINAL EXAM

1. WARM-UP EXERCISES
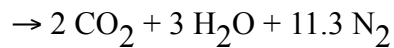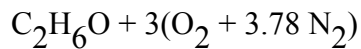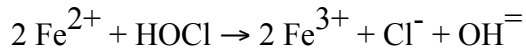
J = flux [=] $M\,L^{-2}\,T^{-1}$; D = diffusivity [=] $L^2\,T^{-1}$; C = concentration [=] $M\,L^{-3}$; x = distance [=] L

U = velocity [=] $L\,T^{-1}$; K = hydraulic conductivity [=] $L\,T^{-1}$; h = head [=] L; l = length through sand column [=] L

EMBED Equation.3
EMBED Equation.3
EMBED Equation.3

$$2\,Fe^{2+} + HOCl \rightarrow 2\,Fe^{3+} + Cl^- + OH^=$$

$$C_2H_6O + 3(O_2 + 3.78\,N_2)$$
$$\rightarrow 2\,CO_2 + 3\,H_2O + 11.3\,N_2$$

2. TRY THESE!

$pH \geq 8.3$

$P = 1.03$ atm

$C_{max} = 1.7\ g/m^3$

EMBED Equation.3

3. ON WATER QUALITY ENGINEERING

When there is insufficient alkalinity in the water to form $CaCO_3(s)$

$CO_2(g)$

Na^+

Disinfection and sedimentation

By scraping the schmutzdeck off the top and discarding

$HOCl$

Less prone to form disinfection byproducts

N, P

Nonaqueous phase liquid (e.g., gasoline)

C+P make small particles stick together so that they settle more rapidly

Reverse osmosis (only)

BOD is oxidized (or incorporated into cell mass) by biofilm growing on media

4. ON AIR QUALITY ENGINEERING

Reduce emissions of precursors: NO_x and VOC

SO_2, PM

Thermal NO_x: N from N_2, formed at high T; fuel NO_x: N from fuel, formation insensitive to T

Ash is nnoncombustible, from impurities in fuel. Diesel PM is carbonaceous, formed

by incomplete combustion. It is known as soot.

Reaction triggered by absorption of a photon, e.g. $NO_2 + h\nu \rightarrow NO + O\bullet$

(i) Avoid use; (ii) replace fireplace with airtight, low emitting wood-burning stove

(i) Fuel reformulation (oxygenate addition); (ii) catalytic converters on exhaust

(i) Fuel reformulation (reduce S content); (ii) diesel particle traps on exhaust

5. DRINKING WATER DISINFECTION

$k = 11.5 \text{ min}^{-1}$

99.999% (5-9's removal)

99.8%

6. ETS CONTROL BY AIR FILTRATION

$C^* = 29.1 \text{ µg m}^{-3}; \tau = 117 \text{ min}$

$C^* = 28.6 \text{ µg m}^{-3}; \tau = 73 \text{ min}$

CE 111: Environmental Engineering