Name: _____ Student ID _____
Nickname: _____ Group: _____

Prince of Songkla University
Faculty of Engineering

Exam: Mid-Term, Semester I
Date: August 5, 2004
Subject: 230-391
Basic Chemical Engineering I

Academic Year: 2004 – 2005
Time: 1:30 – 4:30 PM
Room: R300

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Instructions: There are a total of 5 problems and 9 pages (not including this page). Place your name and the student ID number on every page. Students are allowed to use only a pen or pencil and a calculator. They can also bring in 1 sheet of A4 front side only, a Conversions Table, and a Dictionary. No exams are allowed to leave the room.

Points Distribution (For Grader Only)		
Problem	**Points Value**	**Score**
1	15	
2	20	
3	20	
4	20	
5	25	
Total	100	

Exam prepared by
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July 27, 2004

PLEASE CHECK TO MAKE SURE THAT
YOU HAVE ALL 6 PAGES OF THE EXAM BEFORE BEGINNING
(not including the cover sheet).
GOOD LUCK!

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1. Convert the following to the given units: **(15 Points)**

   (a) 200 W/(m^2 K) to Btu/(hr ft^2 °F) (5 points)

   (b) 20.75 (psia)(ft^3)/(lb-mol °R) to (L)(atm)/(gmol K) (5 points)

   (c) A bucket contains 10 lb of water. If the specific heat (C_p) of H_2O is 4.17 kJ/(kg °C), what is its enthalpy change (ΔH) if the temperature is increased from 40°C to 90°C. Give the answer in Btu. (5 points)

$$\Delta H = mC_p(T_2 - T_1)$$

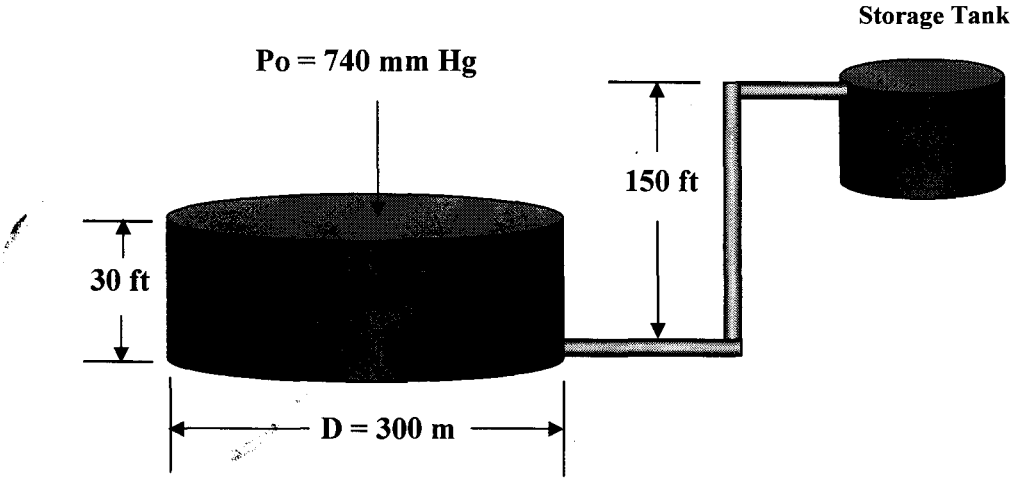
Constants:

$g = 32.2$ ft/s^2 = 9.81 m/s^2	$1 lb_m$ = 0.454 kg
g_c = 32.174 ft-lb_m/(lb_f-s^2)	1 ft = 0.3048 m
1 cp = 1 x 10^{-2} g/(cm-s)	1 m^3 = 264.172 gal
1 psia = 1 lb_f/in^2 = 6.89476 kPa	1 Pa = 1 N/m^2 = 1 kg/(m-s^2)
1 K = 1.8°R	1°C = 1.8°F
ρ_{H2O} = 62.4 lb_m/ft^3 = 1 g/cm^3	1 J/s = 1 W (Watt)

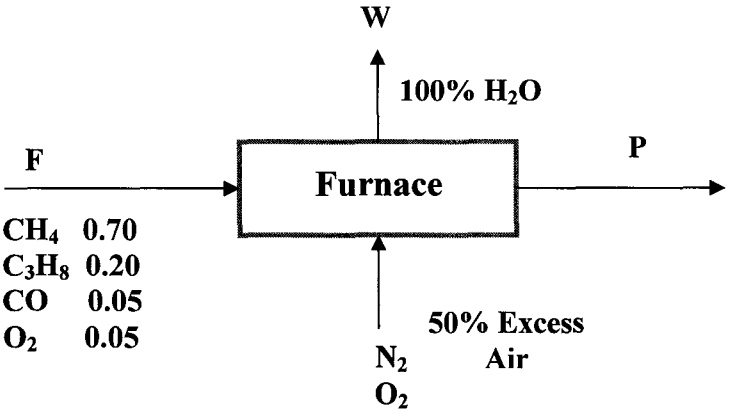
Equations: Pressure = Force/Area
Static Pressure: $P = \rho gh + Po$

2. A centrifugal pump is to be used to pump water from the bottom of the PSU reservoir to a storage tank 150 feet above the surface of the reservoir. The pumping rate is 0.4 gal/min, and the water temperature is 20°C. The diameter of the reservoir is 300 m. (Neglect pipe friction kinetic energy effects, or factors involving the pump efficiency.) **(20 Points)**

   (a) What is the pressure in psig that the pump must develop in order to deliver a flow rate of 0.4 gal/min of water to the storage tank? (10 points)
   (b) What is the total force exerted on the bottom of reservoir in Newton? (10 points) (Hint: Determine the total pressure at the bottom of the reservoir in Pa units.)

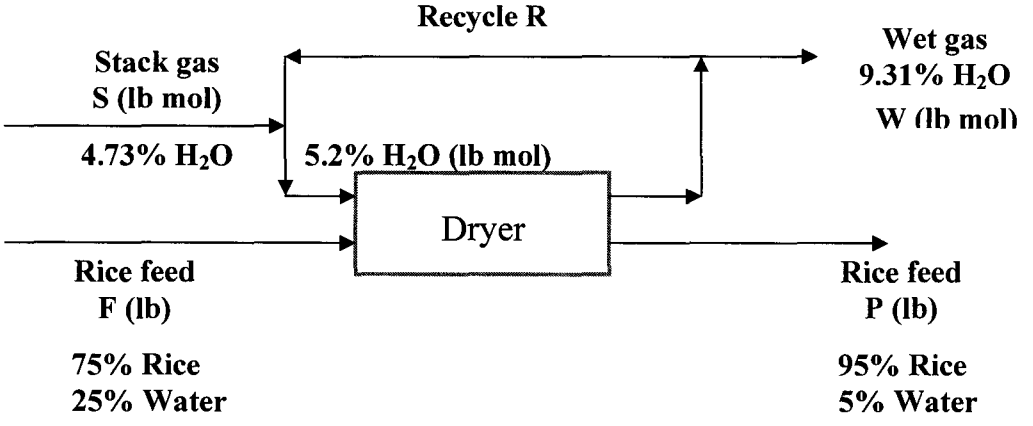


3. A mixture of 70% CH_4, 20% C_3H_8, 5% CO and 5% O_2 is burned in a furnace with 50% excess air. If no CO leaves the furnace, determine the following information: **(20 points)**



(a) The moles of air entering the furnace (10 points)
(b) The moles of water produced (5 points)
(c) The Orsat Analysis of the flue gas (5 points)

4. To save energy, stack gas from a furnace is used to dry rice. The flow sheet and known data are shown below. What is the amount of recycle gas (in lb mol) per 100 lb of P if the concentration of water in the gas stream entering the dryer is 5.20%? (Hint: Do a mass balance for Rice and Water. Then, do mole balances for water and gas.) **(20 points)**



5. The process shown in the figure below is the dehydrogenation of propane (C_3H_8) to propylene (C_3H_6) according to the reaction.

$$C_3H_8 \rightarrow C_3H_6 + H_2$$

The conversion of propane to propylene based on the total propane feed into the reactor at F_2 is 60%. The product flow rate F_5 is 50 kg mol/hr. Calculate all the six flow rates F_1 to F_6 in kg mol/hr. **(25 points)**