Student Innovator of the Year Competition

Dear Professor,

The Student Innovator of the Year (SIOY) competition is on!

Each year students from across campus have an opportunity to receive $400 of funding to prototype and develop a project/idea that they have and then compete for part of $50,000 in prize money. All students and their ideas/projects across the spectrum of disciplines are welcome to compete.

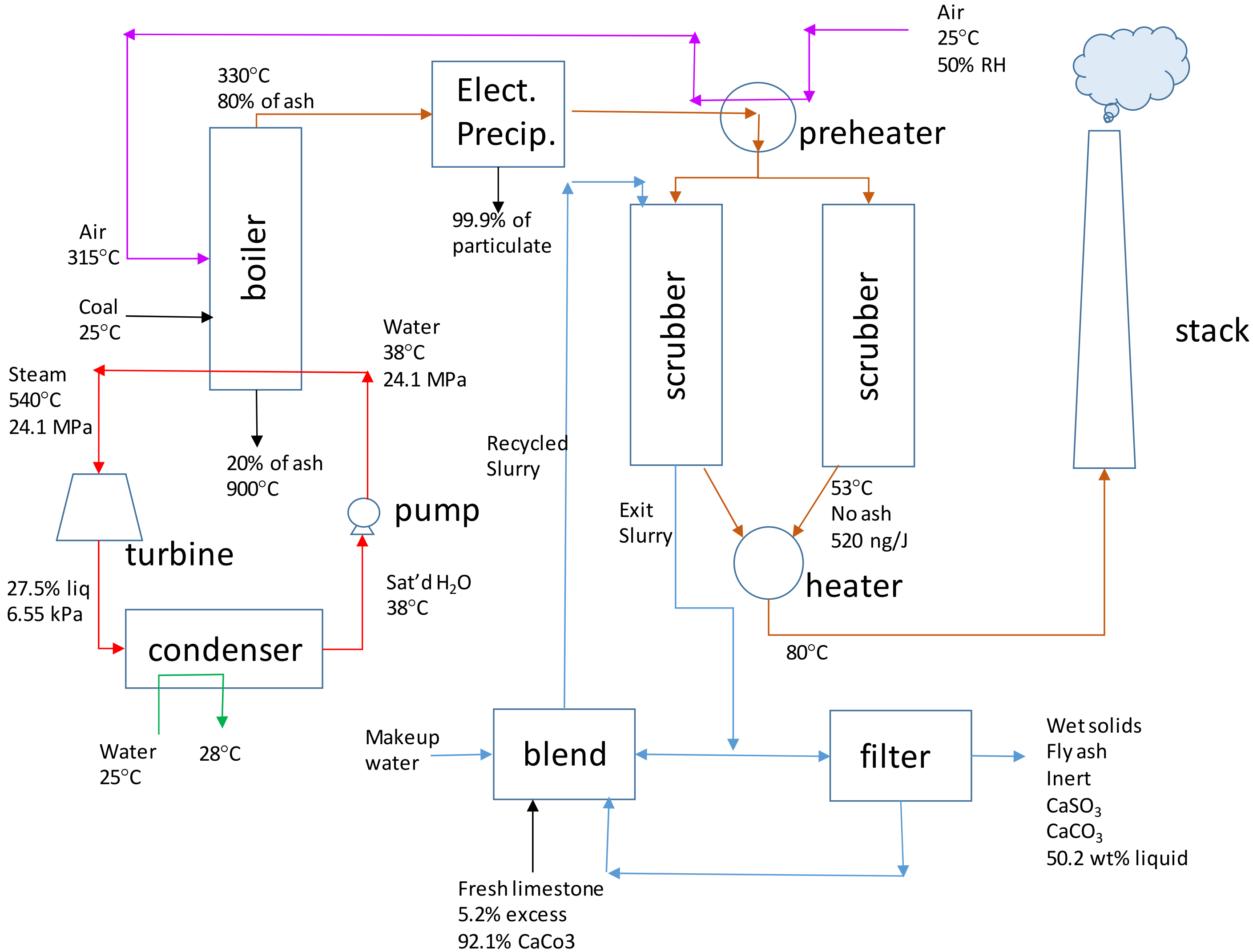
Would you be able to show this one minute video to the students in your class this week, or allow us to do a 30-second announcement about the competition so we can encourage some innovation from our student body whilst they may be home more than usual dreaming up big things?

Business

Professional Program Application

- Due Sunday!
- How many of you have this completed?
- Professor do not have enough time to do this all today

Case Study Problem #1



Recycled Slurry
50 °C
15.2 kg liq/kg inlet gas
1:9 solid/liquid
Sat'd $CaCO_3$ & $CaSO_3$

Exit Slurry
Sat'd $CaCO_3$ & $CaSO_3$
S.G. = 0.988
Solids:
- $CaCO_3$
- $CaSO_3$
- Fly ash
- Inerts

Solubilities
0.002 kg $CaCO_3$ / 100 kg H_2O
0.003 kg $CaSO_3$ / 100 kg H_2O

Review Prob 27.2

Given Q, find ξ

$$Q = \left(\sum n_i \hat{H}_i\right)_{out} - \left(\sum n_i \hat{H}_i\right)_{in}$$

$$n_i = n_{i,0} + \nu_i \xi$$

Mixed units (lb_m, lb-moles, J, g-moles)

Goals Today

1. Questions on Energy Balances
2. Look at HW problems

Review of Enthalpy

Term	Units	Explanation
H		
$\dot{H}$		
$\widehat{H}$		
$\Delta H_f{}^0$		
ΔH_{rxn}		
ΔH_c		
ΔH_{vap}		
ΔH_m		

Review of Enthalpy

Term	Units	Explanation
H	J	
$\dot{H}$	J/s	
$\widehat{H}$	J/mol or kJ/kg	
$\Delta H_f{}^0$	kJ/mol	
ΔH_{rxn}	kJ/mol	
ΔH_c	kJ/mol	
ΔH_{vap}	kJ/mol	
ΔH_m	kJ/mol	

Review of Enthalpy

Term	Units	Explanation
H	J	Total enthalpy (H = U + PV)
$\dot{H}$	J/s	Enthalpy per time
$\hat{H}$	J/mol or kJ/kg	Specific enthalpy (i.e., enthalpy per unit mass or mole)
$\Delta H_f{}^0$	kJ/mol	Standard heat of formation (^{0} means at 1 atm, 25°C)
ΔH_{rxn}	kJ/mol	Heat of reaction
ΔH_c	kJ/mol	Heat of combustion (in book, this corresponds to the high heating value with liquid H_2O as a product) (^{0} means reactants and products at 1 atm, 25°C)
ΔH_{vap}	kJ/mol	Heat of vaporization (liquid ⇒ vapor) (Value in Table B.1 at boiling temperature, 1 atm)
ΔH_m	kJ/mol	Heat of melting (Value in Table B.1 at melting temperature, 1 atm)

Review of Energy Balances

$$\Delta U + \Delta E_k + \Delta E_p = Q + W$$

$$\Delta \dot{H} + \Delta \dot{E}_K + \Delta \dot{E}_P = \dot{Q} + \dot{W}_s$$

$$\Delta \dot{H} = \left(\sum \dot{m}_j \widehat{H}_j\right)_{out} - \left(\sum \dot{m}_j \widehat{H}_j\right)_{in}$$

$$\widehat{H}_i = \Delta \widehat{H}^o_{f,i} + \int_{25°C}^{T_2} C_{P,i}\, dT$$

Path Method

In-Out Table Method

$$\frac{\Delta P}{\rho} + \frac{\Delta(u^2)}{2} + g\Delta z + \widehat{F} = +\frac{W_s}{\dot{m}}$$

$$C_p = C_v + R$$

$$\mathrm{d}\widehat{H} = C_P dT + \widehat{V} dP$$

Questions?

Problem 9.25 (3rd Ed.)

A gas mixture containing 85 mole% methane and the balance oxygen is to be charged into an evacuated well-insulated 10-liter reaction vessel at 25°C and 200 kPa. An electrical coil in the reactor, which delivers heat at a rate of 100 watts, will be turned on for 85 seconds and then turned off. Formaldehyde will be produced in the reaction

$$CH_4 + O_2 \rightarrow HCHO + H_2O$$

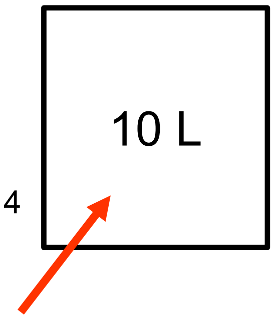
The reaction products will be cooled and discharged from the reactor.

Calculate the maximum pressure that the reactor is likely to have to withstand, assuming that there are no side reactions. If you were ordering the reactor, why would you specify an even greater pressure in your order? (Give several reasons.)

Problem 9.25 (3rd Ed.)

$$CH_4 + O_2 \rightarrow HCHO + H_2O$$

Before:
25°C
200 kPa
85% CH_4
15% O_2



Q=100 W for 85 s

Before:
T=?
P=?

All O_2 reacts

Closed system energy balance

$$\Delta U + \cancel{\Delta E_k} + \cancel{\Delta E_p} = Q + \cancel{W}$$

$$\Delta U_f^0 = \Delta H_f^0 - RT, where\ T = 298\ K$$

$$\hat{U} = \Delta U_f^0 + \int_{25°C}^{T} C_v dT = \Delta U_f^0 + \int_{25°C}^{T} (C_p - R) dT$$

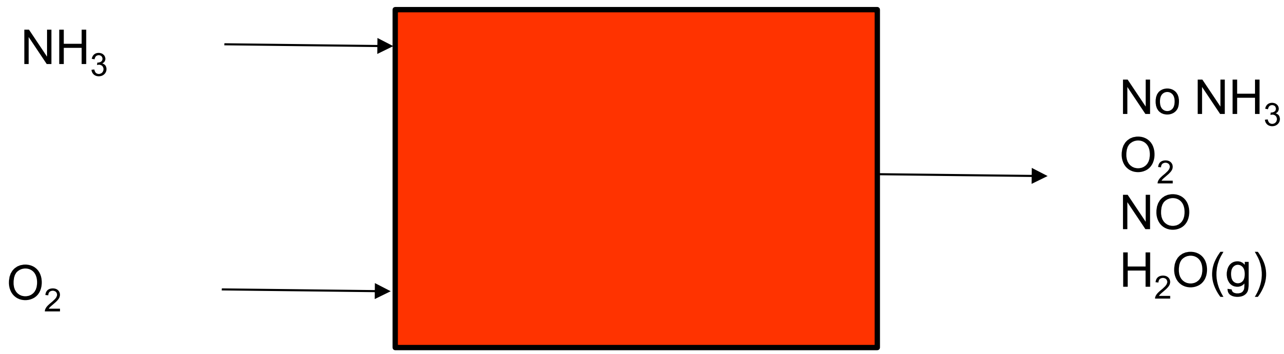
$$C_V = (a - R) + bT + cT^2 + dT^3 = a^* + bT + cT^2 + dT^3$$

Strategy:
1. Find $n_{initial}$
2. Find $n_{i,final}$ for each species
3. Guess T_{final}
4. Calculate Q from energy balance
5. $Q_{heater} = Q_{energy\ balance}$?
6. Find P_{final} = nRT/V

See Spreadsheet

Preview Prob 28.1

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O(g)$



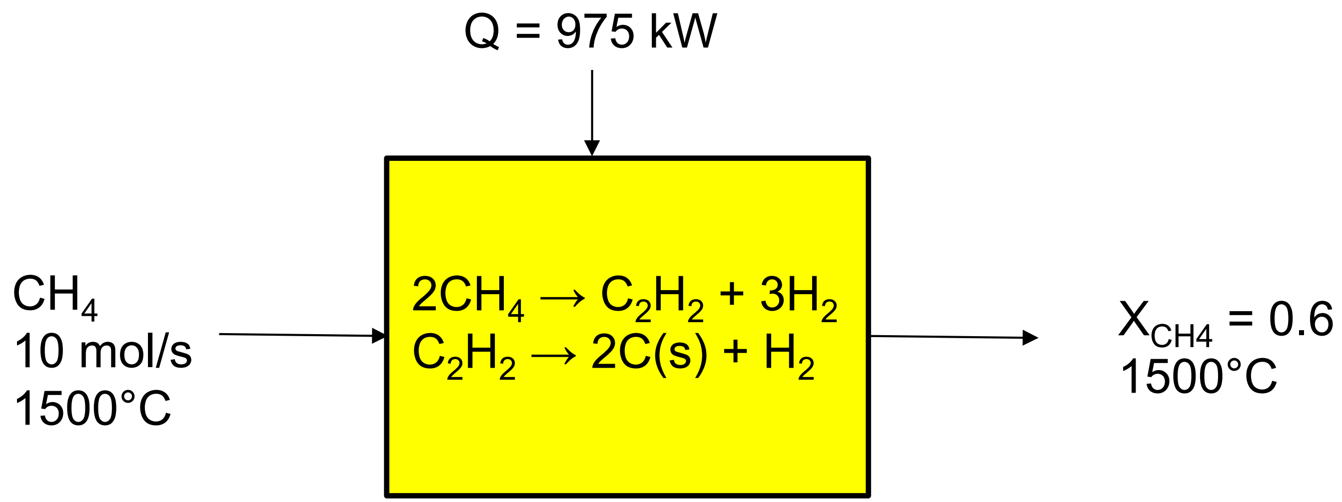
Find ξ from NH_3 balance

Find n_i's from $n_i = n_{i,0} + \nu_i \xi$

Given Q=0, find T_{out} using solver

$$Q = 0 = \left(\sum n_i \hat{H}_i\right)_{out} - \left(\sum n_i \hat{H}_i\right)_{in}$$

Preview Prob 28.2



Constant C_p's given

Find ξ_1 from CH_4 balance

Find n_i equations from $n_i = n_{i,0} + \nu_{i,1}\xi_1 + \nu_{i,2}\xi_2$

Given Q=ΔH, find ξ_2 using solver

$$Q = \left(\sum n_i \hat{H}_i\right)_{out} - \left(\sum n_i \hat{H}_i\right)_{in}$$