Case Study Teams

- Working in teams is one of the competencies for this class
  - We want you to learn about working in teams
  - Employers often value soft skills as much as technical skills
- Good practices:
  - Assign responsibilities
  - Meet often
  - Teach each other (good way to learn!)
  - Give feedback
  - Be punctual for meetings and on assignments

Team Member Feedback

(see handout)

A BYU chemical engineer is a leader in a global society because he/she:

- Is reliable and can be counted on to accomplish tasks in a manner that exceeds expectations.
- Takes initiative rather than waits for assignments.
- Develops a vision in his/her scope of responsibility.
- Identifies problems *and* solutions.
- Understands the personality traits of self and others and can work with others in accomplishing tasks.
- Is culturally sensitive and works effectively with people from diverse backgrounds.
- Takes time to evaluate personal performance as a team member and improves when needed.
- Gives honest feedback to others and helps them succeed in their responsibilities.
- Receives criticism and makes changes where appropriate.
- Follows as well as leads.
- Demonstrates a good attitude on life and is pleasant to work with.

Team Member Evaluation

(at the end of the Case Study)

1. Provide each member of your team with a written statement describing at least two strengths he or she possesses.
2. Provide each member of your team with a written statement describing at least two aspects of teamwork or leadership where improvements are needed.
3. Once you have the comments of your group members, create a document to turn into the instructor outlining each strength and weakness provided to you by your teammates. Then, select at least one of the weaknesses and develop a goal to improve in that area during the next group project experience.
   - Note that you will be graded at the end of the next ChE class (Fluid Dynamics) on your efforts to achieve the goal that you set in this class.
4. If you have any serious concerns about one of your teammates that you want to share with the instructor anonymously, please include the comments on your feedback document.
5. Email the completed feedback document (strengths, weaknesses, goals) to Dr. Fletcher.

Template

(see handout)

Please put your name in the subject line of the email!

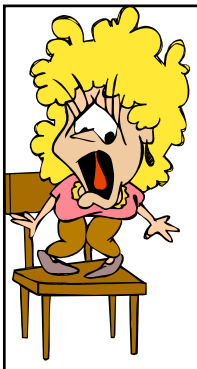
- Your name, and names of people on your team
- My leadership goals for working with my team on the Case Study
- Description of efforts to achieve the goal given above
- Strengths Identified by Teammates
- Areas for Improvement Identified by Teammates
- Specific Goals for the Next Lab Experience
- Anonymous Comments on Team Member Performance
  - Does every member of your team deserve full credit? (be honest)

Notes on Case Study

- You can assess what percentage of points each team member will receive
  - People who do not contribute should get less points
- You need to show how you got the answer
  - Hand-written pages of equations, diagrams, are OK if neat
- Hard copy required, not electronic copy
- **Due at 5 pm on Wednesday, April 19**
  - Better if turned in at the first of class
- **Review for Exam #3 on Monday (April 3)**
- I will not hold another formal class until April 19, but will be available especially during class time (10 am)
- HW hints
  - 14.6 is the hardest problem
  - I will talk about this problem on Wednesday, April 12 in class

Special Problem 11

- Write a problem for the exam, and provide a solution
- Good Exercise, but **not required** (due to Conference weekend)



Transient Balances

Chapter 11

Strategy

1. Find what is changing
2. Accum = In – Out + Gen – Cons
   - Material balances are on m_{tot}, m_i, n_{tot}, or n_i
3. Make sure units are consistent
   - Term inside derivative can not be per unit time
4. Separate (if possible) and integrate

Basic Equations

General conservation principle

$$\frac{\left[\begin{array}{c}\text{accumulation of } S\\ \text{within a system}\end{array}\right]}{\text{time period}} = \frac{\left[\begin{array}{c}\text{flow of } S\\ \text{into the system}\end{array}\right]}{\text{time period}} - \frac{\left[\begin{array}{c}\text{flow of } S\\ \text{out of the system}\end{array}\right]}{\text{time period}} + \frac{\left[\begin{array}{c}\text{amount of } S\\ \text{generated within}\\ \text{the system}\end{array}\right]}{\text{time period}} - \frac{\left[\begin{array}{c}\text{amount of } S\\ \text{consumed within}\\ \text{the system}\end{array}\right]}{\text{time period}}$$

where S can be:

m	Total mass
m_A	Mass of individual species
n_A	Moles of individual species
H	Enthalpy (open system) except for accumulation term
U	Internal energy (closed system)
mv	Momentum (mass times velocity)

Balances

Total mass

$$\frac{dm}{dt} = \frac{d(\rho V)}{dt} = \sum_{i=\text{inlet}} \dot{m}_i - \sum_{j=\text{outlet}} \dot{m}_j$$

Note: There are no balances for V or y_A or T!

Species A mole balance

$$\frac{dn_A}{dt} = \frac{d(y_A N)}{dt} = \sum_{i=\text{inlet}} y_{Ai}\dot{n}_i - \sum_{j=\text{outlet}} y_{Aj}\dot{n}_j + r_A V$$

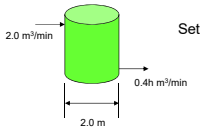
Total energy balance

$$\frac{dE}{dt} = \frac{d(U+K+P)}{dt} = \sum_{i=\text{inlet}} \dot{m}_i\left[h_i + \frac{z_i g_i}{g_c} + \frac{V_i^2}{2g_c}\right] - \sum_{j=\text{outlet}} \dot{m}_j\left[h_j + \frac{z_j g_j}{g_c} + \frac{V_j^2}{2g_c}\right] + Q - W_s$$

Simplified energy balance in terms of temperature

$$\rho C_v V\frac{dT}{dt} = \sum_{i\text{inlet}} \dot{m}_i \overline{C}_p(T_i - T_{ref}) - \sum_{j\text{outlet}} \dot{m}_j \overline{C}_p(T_j - T_{ref}) + \dot{Q} - W_s$$

A storage tank that is 2.0 m in diameter is being filled at the rate of 2.0 m^3/min. When the height of the liquid is 2 m in the tank, the bottom of the tank springs a leak. The rate of leaking is proportional to the head of fluid so that it is leaking at a rate of 0.4*h* m^3/min, where *h* is in m. Plot the height of the liquid as a function of time. What is the steady state height of the fluid in the tank?



Set up balance

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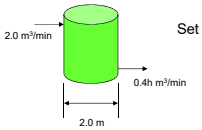


Set up balance

$$\frac{dm}{dt} = \dot{m}_{in} - \dot{m}_{out}$$

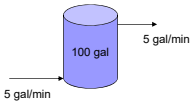
$$\rho\frac{dV}{dt} = \rho\dot{V}_{in} - \rho\dot{V}_{out}$$

$$V = \pi r^2 h$$

$$\dot{V}_{out} = 0.4h$$

$$\pi r^2\frac{dh}{dt} = 2 - 0.4h$$

A tank holds 100 gal of a salt-water solution in which 4.0 lbm of salt are dissolved. Water runs into the tank at the rate of 5 gal/min and salt solution overflows at the same rate. If the mixing in the tank is adequate to keep the concentration of salt in the tank spatially uniform at any time, how much salt is in the tank at the end of 50 min? Assume that the density of the salt solution is essentially the same as that of pure water.



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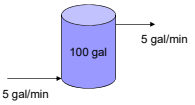

Set up balance

$$\frac{dx_s m}{dt} = (x_s \dot{m})_{in} - (x_s \dot{m})_{out}$$

$$m\frac{dx_s}{dt} = -(x_s \dot{m})_{out}$$

(a) A kettle containing 3.00 L of water at a temperature of 18°C is placed on an electric stove and begins to boil in four minutes. What is the average rate at which heat is added to the water during this period?

Set up balance

(b) Suppose that it takes 30 s for the stove heating element to reach full power. What is the time-dependent temperature of the water in the kettle?

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Set up balance

$$\frac{dU}{dt} = \dot{H}_{in} - \dot{H}_{out} + \dot{Q} - \dot{W}_s$$

$$m\frac{d\hat{U}}{dt} = \dot{Q}$$

$$\rho V C_v \frac{dT}{dt} = \dot{Q}$$

(b) Suppose that it takes 30 s for the stove heating element to reach full power. What is the time-dependent temperature of the water in the kettle?

$$\int_{T_0}^{T} \rho V C_v dT = \int_{0}^{30\,s} \dot{Q}_1 dt + \int_{30s}^{t} \dot{Q}_2 dt$$

How does the volumetric flow rate change with time in an oil funnel with an angle of 30° from vertical in the cone? The volumetric flow rate out is a function of the discharge coefficient, the square root of the pressure drop (see equation).

Set up balance

$$\dot{V}_{out} = c_v \sqrt{\frac{\Delta P}{S.G.}}$$

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$$\dot{V}_{out} = c_v \sqrt{\frac{\Delta P}{S.G.}}$$

Set up balance

$$\frac{dm}{dt} = \dot{m}_{in} - \dot{m}_{out}$$

$$\rho\frac{dV}{dt} = -\rho\dot{V}_{out}$$

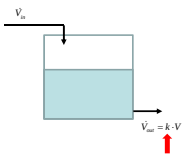
$$V = \frac{\pi r^2 h}{3} \qquad tan\theta = \frac{r}{h}$$

$$V = \pi(h\,tan\theta)^2 h/3$$

$$\frac{\pi(tan\theta)^2\,dh^3}{3\,dt} = c_v\sqrt{\frac{\Delta P}{S.G.}}$$

$$\Delta P = \rho g h$$

HW Hints on 11.6



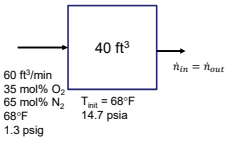
a) Find k when completely filled (300 L, 60 L/min)
   - Then using that k, find new V at steady-state with 20 L/min

b) Start completely filled
   - Flow changed to 20 L/min
   - Find time-dependent eqn

c) Set deriv term = 0 and find steady-state
   - Estimate shape of curve

d) Separate and integrate
   - Find time to reach within 1% of steady-state volume

Problem 11.12



$N_{in\ vessel} = PV/RT$

$$\frac{d(y_{O2}N_{vessel})}{dt} = y_{O2,in}\dot{n}_{in} - y_{O2,out}\dot{n}_{out}$$

$$\dot{n}_{in} = \frac{P_{in}\dot{V}}{RT_{in}}$$

$$N_{vessel}\frac{d(y_{O2})}{dt} = (0.035 - y_{O2})\dot{n}_{in}$$