

# ChEn 391

# Fluid Mechanics

Safety

# Spiritual Thought

D&C 130:20-21

20 There is a law, irrevocably decreed in heaven before the foundations of this world, upon which all blessings are predicated—

21 And when we obtain any blessing from God, it is by obedience to that law upon which it is predicated.

# OEP4 Clip



# OEP 4

## Open Ended Problem #4

### Escape From a Collapsing Dam

**GROUP WORK OKAY**, Due 10/5/16 at beginning of class

<https://www.youtube.com/watch?v=2g4bpb8fxcE>

The fearless Flynn Rider escapes (with significant help from Rapunzel) from the soldiers and thieves only to face the surging water from a collapsing dam. With much fanfare, finesse, and a few less-than-manly squeals, they dash to the nearby cave and into safety mere seconds before a falling rock column traps them inside. Ignoring the falling rock formation (for now) could they have realistically escaped from the cascading water from the dam breaking? (DO NOT ASSUME A WATER VELOCITY!!)

# OEP4 (Check)

7) Verify your answer... Does it look reasonable? Anything odd about the calculation?

a) How fast do they need to run in order to make it to the cave? Is this realistic?

b) Assuming the rock didn't block the cave entrance,

i) At what velocity would the water hit Flynn and Rapunzel?

ii) What is the force associated with this velocity?

iii) Was going into the cave a good idea, (assuming the rock didn't fall?)

c) Now assume that the rock formation DOES get hit by the water; how long does it take for the rock to fall against the cave?

d) based on your evaluation in part 7c, determine whether the rock can realistically block the cave from the water flow.

# Safety Culture

- Much of what you will (or should) do as a working engineer will be dictated by safety considerations.
- Safety is important for
  - **People**
  - Awareness
  - Avoid financial losses
- Companies that value safety, value you.

# Hazards

- Many types of hazards
  - Trips and falls
  - Confined spaces
  - Explosions: pressure and combustion
  - Chemical exposure
    - Liquids, gases, inhalation
  - Environmental exposure
    - Spills
    - Pollutant release

# Approach

- This is a broad area.
- Spend a whole career in safety
- Here:
  - Promote awareness
  - Provide examples
  - Apply safety considerations to our usual technical analyses.



# Example





- What happens?
  - Vacuum created by pumping liquid out of a tank.
  - Tank may be strong to internal pressure, but not to vacuum.
  - Collapses
- What consequences?
  - Financial
    - Equipment
    - Downtime = lost production
  - Fluid release

- Causes
  - Fluid movement in/out
  - Tank breathing due to weather changes
  - Fire exposure.
- Require a breather valve, or Pressure/Vacuum Relief valve or Conservation vent.
  - Relieves excess pressure/vacuum caused by thermal expansion/contraction



*From [http://web.singnet.com.sg/~corrom/Breather\\_Valve.htm](http://web.singnet.com.sg/~corrom/Breather_Valve.htm)*

# Example

- Plastic bag placed over tank vent.
- $F = P * A$ 
  - Bag withstood pressure forces due to small area, but the tank could not, and collapsed.
- Tank vents can get plugged: wax, bees, bags, valves, etc.



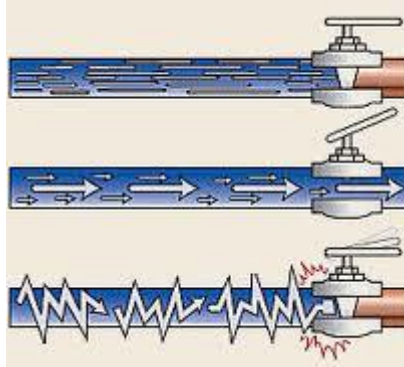
# Pressure Relief

- Pressure vessels, piping systems
- Prevent pressure increases above safe operation
- **Rupture Disks**
- **Relief valves:** spring loaded valve.
  - Checked, calibrated, maintained, no leaks, corrosion.
  - Often vent to flare
- Handle the max flow rate based on process flow conditions
  - Like maximum pump flow.
- Single phase, or two-phase?
- [www.aiche.org/diers](http://www.aiche.org/diers)



# Water Hammer

$$\frac{\delta P}{\delta t} = \rho a \frac{\delta v}{\delta t}$$



- On August 17, 2009 a massive hydroelectric dam on the Yenisei River, near Sayanogorsk in Khakassia, Russia experienced a catastrophic failure in the turbine room, which destroyed the turbine and engine room and flooded the structure. Six days later, when the structure had been pumped out, 76 people were known dead.



Before



After

<http://www.youtube.com/watch?v=pRe5GUpVYY8>