

ChEn 374

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.

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

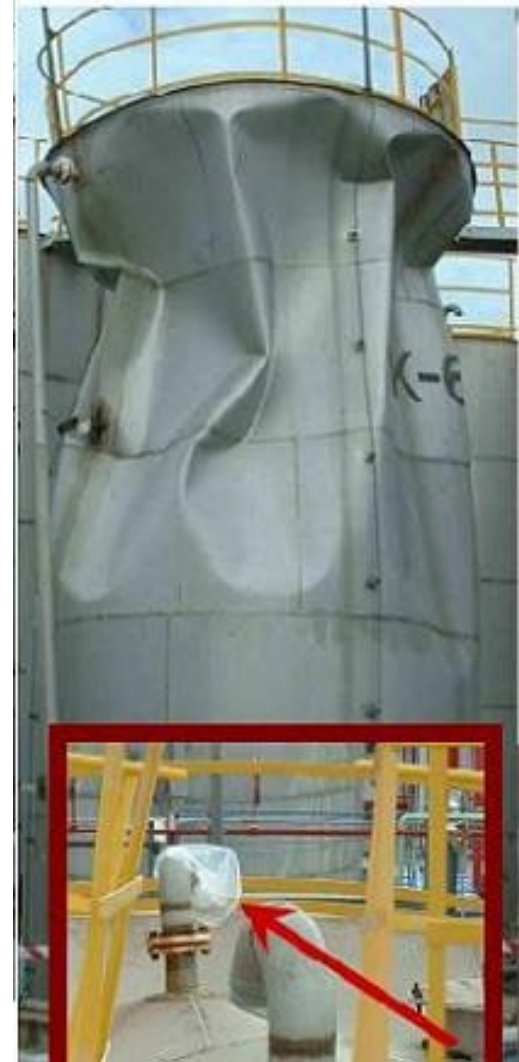
- Causes
 - Fluid movement in/out
 - Tank breathing due to weather changes
 - Fire exposure.
- Require a breather valve, or Pressure/Vacuum Relief valve or Conservation vent.
 - Relieves excess pressure/vacuum caused by thermal expansion/contraction



From http://web.singnet.com.sg/~corrom/Breather_Valve.htm

Example

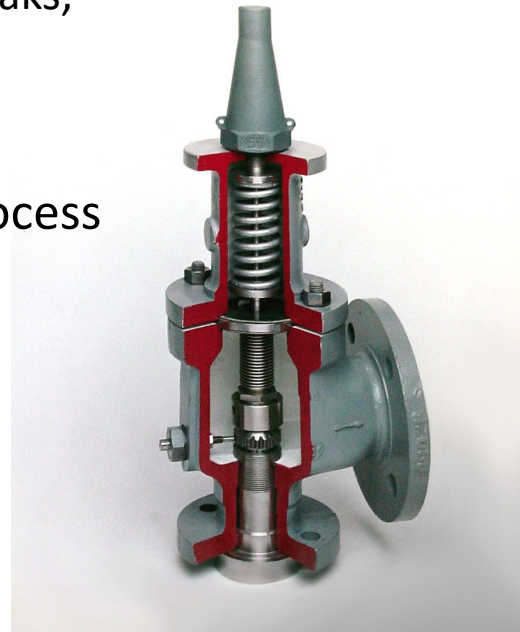
- Plastic bag placed over tank vent.
- $F = P * A$
 - Bag withstood pressure forces due to small area, but the tank could not, and collapsed.
- Tank vents can get plugged: wax, bees, bags, valves, etc.



From <http://www.isplonline.com/vacuumhazardalert.htm>

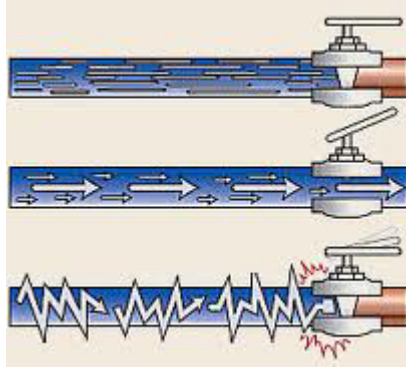
Pressure Relief

- 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



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.



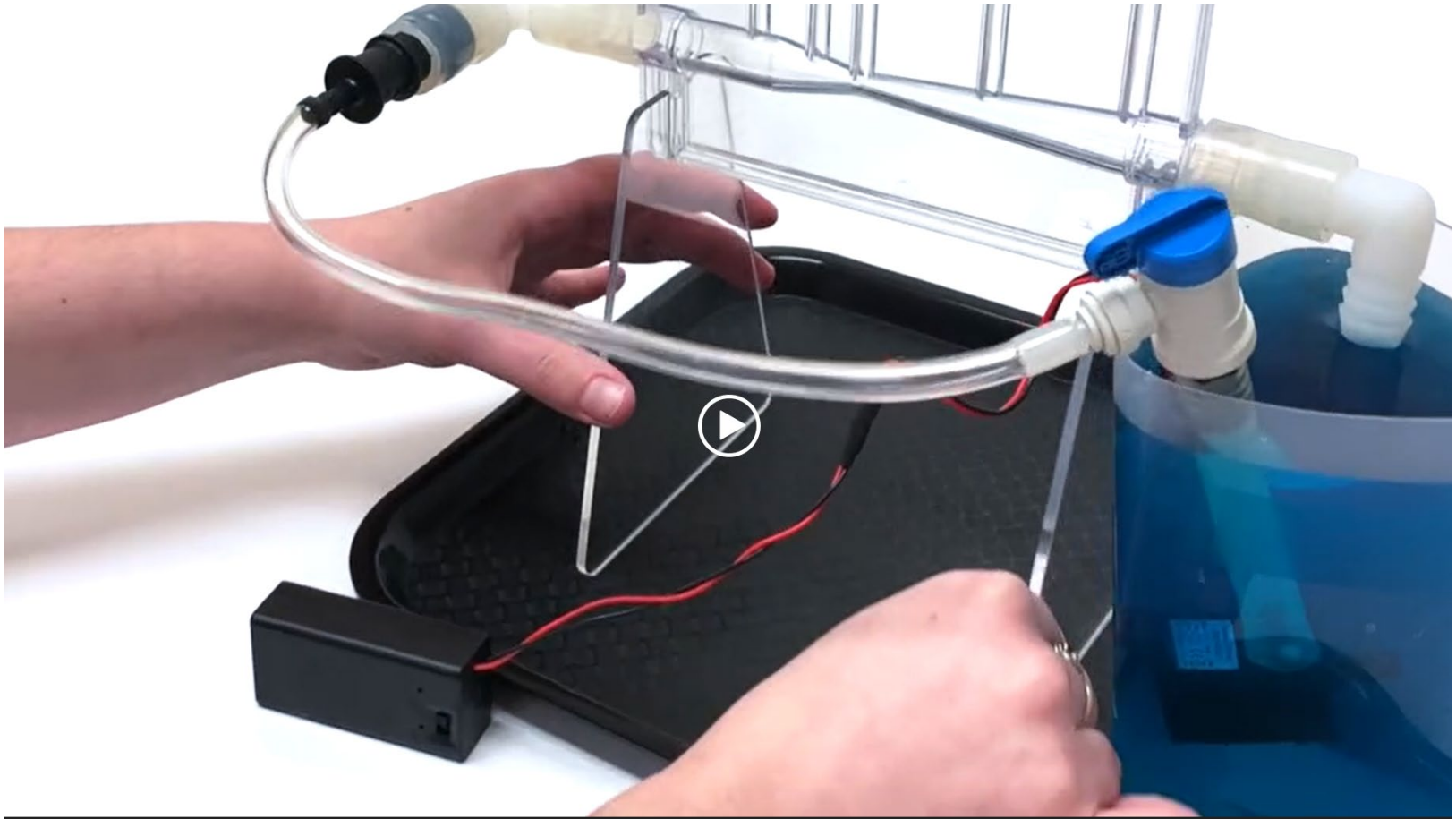
Before



After

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

LCDLM Module



<https://labs.wsu.edu/educ-ate/tutorial-videos/>.