3.37 (Class 17)

Review:

- Pure oxygen flames have 10x the heat intensity of the same flame burning in air (prop to Tf^2)
- Most flames used in welding are pre-mixed
  - Oxyacetylene torch, for safety fuel gas valve should only be opened about ¼ to ½ turn, standard is left hand thread
- The gas boundary layer greatly limits heat transfer to the surface
  - Flames in general only about at 10^3 W/cm^2
  - There are ways around this, with flame cutting have higher
- Fuels
  - Acetylene, 3100degC adiabatic flame temperature, temperature difference with steel molten weld pool (3100-1600)^2 = 225x10^4
  - MAPP, slightly lower adiabatic flame temperature 2870degC, (2870-1600)^2 = 161x10^4
  - If trying to melt steel there is a difference, can weld about 30% faster with acetylene
  - MAPP really is safer

Today:

Flame cutting

- "Burning of the steel"
- Oxidation of the iron
- With continuous casting, just pure oxygen hitting the iron surface

Torch for oxyacetylene (diagram on board)

- Flames approx ¼" long
- Primary and secondary combustion cone
- Hotter internal cone, cooler outer cone (air)
- Typically put inner cone tip just on surface of steel, wait until glows red, oxide surface of the steel starts to break up, trigger to release oxygen, the pure iron then becomes the fuel, in theory can then cut with just a straight oxygen torch, in practice the flame acts as a preheater and allows faster cutting.
- Like a controlled flare going off

Various metals and flame cutting

- Fe: Tmelt(oxide) = 1380degC vs. Tmelt(metal) = 1536degC
- Al: Tmelt(oxide) = 2000degC vs. Tmelt(metal) = 661degC
  - Aluminum can't be flame cut, pure metal melts before oxide
- Mg: Tmelt(oxide) = 2800degC vs. Tmelt(metal) = 650degC

- Cr: Tmelt(oxide) = 2800degC vs. Tmelt(metal) = 1875degC (sublimes)
    - Stainless steel cannot be flame cut
- Ti: Tmelt(oxide) = 1750degC vs. Tmelt(metal) = 1668degC
    - Is possible to flame-cut titanium
    - Tends to give off lots of smoke. Story: Staff member that would complain about smells coming out of the weld shop. Technician flame cutting titanium. Called the safety office. Lots of smoke but no toxicity to TiO_2.

Question on corrosion and iron oxides

- 3 types of iron oxides
    - Fe_2O_3
    - Fe_3O_4
    - FeO
- If oxygen in system, get corrosion, if no oxygen, no corrosion
- Commercial boiler systems, use deoxydents
- Shut down of nuclear reactor, pull vacuum or nitrogen blanket or put hydrazine in water to keep oxygen out (sister plant to 3-mile island had significant damage due to stress corrosion cracking on starting up after being shut down for a period of time)
- Story: Marbleized layer of calcium on copper pipes. Brand new subdivision having leak problems after only about 5 years. Plumbing inspector thought it was defective copper pipe. Turns out there was no calcium layer. Brand new plant. Langolier (sp?) index always negative, never get the limestone layer. Everyone else in town ok since already had limestone layer, but new subdivision did not. With certain water conditions can perforate copper pipe in less than 6 months.

Plasma cutting

- Nice smooth surface
- Corners can have some problems

Effective heat intensity

- No gas boundary layer, can get most all of the heat intensity
- Approaches 10^4 or 10^5 W/cm^2
- Limited by other things

Good paper in handouts on flame cutting

- Burn speed goes down as oxygen purity goes down
- Carbon content, carbon monoxide formation with high carbon steels, high carbon steels cut slower