GEMS 160  Feb 27, 2006

- Ch. 6 homework due by 5:00 pm
- Ch. 7 homework due by Friday, 5:00 pm
- Exam next Monday, Ch. 6, 7, part of 8??
- Chem in the news
  - Wed: Kelli Carrier, Joseph Kik
  - Fri: Leon Hendrix

Hydrocarbons and energy - Ch. 7

- Useful fuel for the gasoline engine
  - Large amount of energy/gram
  - Have a reasonable cost
  - Be easily vaporized (boiling point)
  - Burn smoothly and evenly
- Achieved through a mixture of hydrocarbons
  - Chain length and boiling point (volatility)
  - Branching and boiling point
  - Concept of structure, property and function

Octane - a measure of gasoline function

- What is needed to obtain the maximum amount of energy from gasoline?
  - A high compression ratio
  - 4.4 for 1925 autos
  - 10 or more in modern cars
- High compression ratio requires proper combustion of gasoline in the chamber
  - A well-timed, ”smooth” burn
  - No “knocking” - a pre-ignition or uneven burning
  - Octane is a measure of resistance to knocking, higher octane means less knocking

What contributes to high octane?

- Highly branched alkanes have good octane ratings
  - Straight-chain octane is -20
  - 2,2,4-trimethyl pentane is 100

Which of the following will have the highest octane rating?

- 1. 3-ethyl pentane
- 2. 1,2,5-trimethyl pentane
- 3. 2,4-dimethyl pentane
- 4. decane

What contributes to high octane?

- Highly branched alkanes have good octane ratings
  - Straight-chain Octane is -20
  - 2,2,4-trimethyl pentane is 100
- Why not have mostly branched alkanes if high octane is good?
  - Relation between branching and volatility?
  - If too volatile, there can be too little oxygen for combustion
  - Vapor lock (a gas bubble that blocks fuel flow)
  - Expense
- The answer to affordable octane
  - 1920’s - 70’s, tetraethyl lead
Based on your knowledge of naming compounds, tetraethyl lead is

17%: \( \text{PbC}_2\text{H}_5 \)
13%: \( \text{Pb(CH}_3)_4 \)
37%: \( \text{Pb(C}_2\text{H}_5)_3 \)
36%: \( \text{Pb(C}_4\text{H}_9)_4 \)

Function of catalytic converter

- 1970’s, catalytic converters, get the lead out
- Speeds up reactions, they can take place under milder conditions
- Reactions occur to form a greater amount of products
- Normal combustion of hydrocarbons is typically not complete
  - Some of the carbon ends up as CO instead of CO\(_2\)
  - Small amounts of various unburned hydrocarbons are produced
- Catalytic converter helps with complete conversion of the hydrocarbon fuel to CO\(_2\) and water.
- Catalytic converter actually increases greenhouse gas emissions while reducing other pollution problems.

Current octane answers

- Octane enhancers
  - Functional group called ethers (MTBE)
  - Provides branching
  - Adds oxygen to aid combustion, reduces CO formation
  - MTBE easily contaminates wells
- Petroleum processing
  - Distillation, gasoline from crude oil

Current octane answers

- Petroleum processing
  - Distillation, gasoline from crude oil
  - Cracking, small pieces of big molecules
  - Reforming, making branched isomers from straight chains

Which of the following would be collected in the hottest zone of the fractionating tower

82%: \( \text{C}_{24}\text{H}_{50} \)
5%: \( \text{C}_{18}\text{H}_{38} \)
5%: \( \text{C}_{12}\text{H}_{26} \)
36%: \( \text{C}_4\text{H}_{14} \)

Auto Pollution Solution

- Continued use of hydrocarbons
  - More fuel efficient vehicles
  - Cleaner burning fuels
  - Better pollution control devices
  - Non renewable resource
- Electric vehicles
  - Zero pollution at point of use
  - Performance
  - Source of electricity, not pollution free
  - (acid rain issues - next week in lab)
Auto Pollution Solution

- **Ethanol**
  - Renewable energy, fermentation of grain crops
  - Plants absorb CO$_2$ to offset greenhouse gas buildup
    - Photosynthesis
      - $12 \text{ CO}_2 + 11 \text{ H}_2\text{O} + \text{ solar energy} \rightarrow C_{2}\text{H}_{{6}}\text{O}_{{6}} + 12 \text{ O}_2$
    - Low energy content
    - Use as oxygenate in gasohol
    - Increased volatility of mixture, escaped hydrocarbons
- **Methanol**
  - Manufactured from various sources
  - Relatively corrosive
  - Low energy content
  - Toxic