19.5: Bond Energy

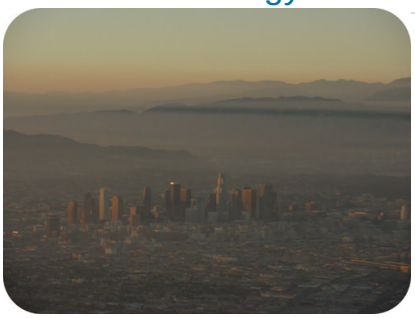

Figure 19.5.1(CC by 2.0; Warner Hocker (Flickr: TravelingOtter) via Flickr)

How does smog form?

We know that nitrogen makes up about 79% of the gases in the air, and that this gas is chemically very inert. However, we also know that a major contributor to the production of smog is a mixture of nitrogen compounds referred to as NO_x. Due to the high combustion temperatures in modern car engines (brought about by the need for better fuel efficiency), we make more NO_x that will react with other materials to create smog. So, our inert nitrogen gas can be converted to other compounds if enough energy is available to break the triple bonds in the N_2 molecule.

Bond Energy

The formation of a chemical bond results in a decrease in potential energy. Consequently, breaking a chemical bond requires an input of energy. **Bond energy** is the energy required to break a covalent bond between two atoms. A high bond energy means that a bond is strong and the molecule that contains that bond is likely to be stable and less reactive. More reactive compounds will contain bonds that have generally lower bond energies. Some bond energies are listed in the table below.

Table 19.5.1: Bond Energies

Bond	**Bond Energy** $(\mathrm{kJ/mol})$
$\mathrm{H-H}$	436
$\mathrm{C-H}$	414
$\mathrm{C-C}$	347
$\mathrm{C=C}$	620
$\mathrm{C\equiv C}$	812
$\mathrm{F-F}$	157
$\mathrm{Cl-Cl}$	243
$\mathrm{Br-Br}$	193
$\mathrm{I-I}$	151
$\mathrm{N\equiv N}$	941

The halogen elements all exist naturally as diatomic molecules (F_2, Cl_2, Br_2, and I_2). They are generally very reactive and thus have relatively low bond energies.

As can be seen by a comparison of the bond energies for the various carbon-carbon bonds, double bonds are substantially stronger than single bonds. Likewise, triple bonds are even stronger. The triple bond that exists between the nitrogen atoms in nitrogen gas (N_2) makes it very unreactive. All plants and animals require the element nitrogen, but it cannot be obtained from the direct absorption of nitrogen gas from the atmosphere because of its strong, unreactive triple bond. Instead, bacteria convert the nitrogen to a more usable form such as ammonium and nitrate ions, which are then absorbed by plants from the soil. Animals only obtain nitrogen by eating those plants.

Summary

- Bond energy is an indication of the amount of energy needed for a chemical reaction.
- The higher the bond energy, the less reactive the bond is.

Review

1. What does a high bond energy mean?
2. What kind of bonds do more reactive compounds have?
3. Which will react more readily: a C-H bond or a Cl-Cl bond?
