CHAPTER 4

Due to a variety of strains in a cycloalkane, the energy of various sized rings changes.

Heat of Combustion - The amount of heat (energy) released when a molecule burns completely with oxygen.

By comparing the heat of combustion of different sized cycloalkanes, their relative energies can be obtained. The fact that the size of the ring has an influence on the total energy of the molecule indicates that there is some degree of unstability associated with constraining the rings. This added energy (in addition to what would be expected from carbon and hydrogen combustion per mole) is what we refer to as Ring Strain.

Ring Strain - is due to a combination of angle strain, torsional strain, and steric strain - experimentally determined from the heat of combustion of cycloalkanes.

angle strain - the strain due to bond angles being forced to expand or contract from their ideal.

Cycloalkanes are not all flat!

Cyclopropane - has a high degree of angle strain - bond angles are 60 degrees and sp³ carbons want to be 109 degrees. For this reason, cyclopropane has the highest amount of ring strain of any cycloalkanes. Three carbon atoms define a plane. Cyclopropane is the only planar cycloalkane. The C-H bonds are all eclipsed.
♦ Cyclobutane - Almost as high in energy as cyclopropane, but slightly puckered to alleviate torsional strain - bonds are not quite eclipsed.

♦ Cyclopentane - even more puckered than cyclobutane - almost staggered

♦ Cyclohexane - no ring strain - all bonds staggered - all angles 109 degrees - chair conformation - notice the axial hydrogens point straight up and down and the equatorial hydrogens point out from the ring