A-9-10

The four carbon-hydrogen bonds of methane are very strong and difficult to break. Once broken in the presence of oxygen (Figure 9-3), the resulting free radicals quickly react vigorously with oxygen in many different chemical reactions to ultimately form hot CO_2 and H_2O molecules. Thus, in order to obtain the energy from methane, one must expend a certain amount of energy first to break a fairly strong chemical bond. However, the energy gained from the methane and oxygen combustion is much greater than that initially expended in this bond-breaking reaction, so in order to initiate the reaction, energy must first be supplied to break the C–H bond.

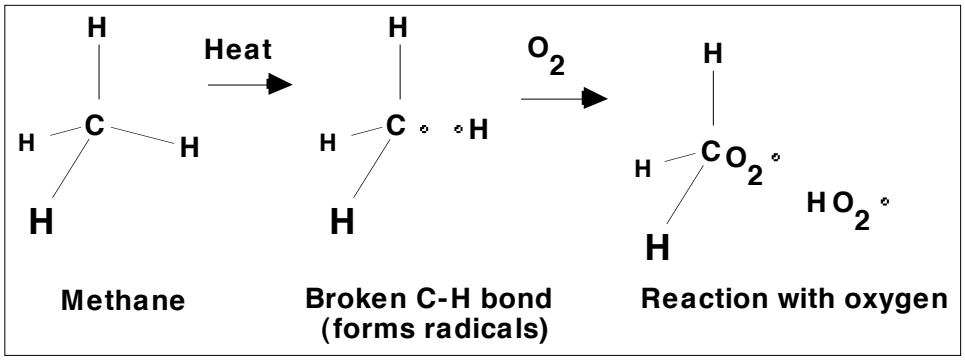

Figure 9-3 Representation of the early processes in the burning of methane in the presence of oxygen. Excess heat in a methane molecule breaks one of the C-H bonds forming two free radicals, each with an unpaired electron. Each of these free radicals then rapidly reacts with oxygen molecules to form oxygenated species that ultimately can be oxidized to form water and carbon dioxide.

However, if there is a shortage of oxygen during the combustion, the products will be those from limited oxidation, carbon **mon**oxide (CO) and water. It can be shown from thermodynamic analysis of the heats given off, that burning methane to the carbon monoxide gives off less energy per mole of methane than burning to carbon dioxide. Therefore, it is essential that methane be burned in excess oxygen to obtain the maximum energy from this fuel.