



**Figure 14-7.** Preignition can cause detonation and damage to the engine.

### **Octane and Performance Number Rating**

Octane ratings and performance numbers are given to fuels to describe their resistance to detonation. Fuels with high critical pressure and high octane or performance numbers have the greatest resistance. A referencing system is used to rate the fuel. A mixture of two hydrocarbons, iso-octane ( $C_8H_{18}$ ) and heptane ( $C_7H_{16}$ ), is used. Various ratios of the two hydrocarbons in a mixture result in proportional antidentalation properties. The more iso-octane there is in the mixture, the higher its resistance is to detonation.

When a fuel has the same critical pressure as a reference mixture of these two hydrocarbons, it is said to have an octane rating that is the same as the percentage of the iso-octane in this reference mixture. An 80-octane fuel has the same resistance to detonation as an 80 percent iso-octane, 20 percent heptane mixture; a 90-octane fuel has the same resistance to detonation as a 90 percent iso-octane, 10 percent heptane mixture; and a 100-octane fuel has the same resistance to detonation as 100 percent pure iso-octane. So, by comparing a fuel's tendency to detonate to reference mixtures of iso-octane and heptane, octane ratings from 80 to 100 can be established. The highest-octane fuel possible with this system of measurement is 100-octane fuel.

To increase antidentalation characteristics of fuel, substances can be added. Tetraethyl lead (TEL) is the most common additive that increases the critical pressure and temperature of a fuel. However, additional additives, such as ethylene dibromide and tricresyl phosphate, must be also be added so that the TEL does not leave solid deposits in the combustion chamber.

The amount of TEL added to a fuel can be increased to raise the antidentalation characteristics from 80 to the 100-octane

level and higher. References to octane characteristics above 100 percent iso-octane are made by referencing the antidentalation properties of the fuel to a mixture of pure iso-octane and specific quantities of TEL. The specific mixtures of iso-octane and TEL are assigned arbitrary octane numbers above 100. In addition to increasing the antidentalation characteristics of a fuel, TEL also lubricates the engine valves.

Performance numbers are also used to characterize the antidentalation characteristics of fuel. A performance number consists of two numbers (e.g., 80/87, 100/130, 115/145) in which higher numbers indicate a higher resistance to detonation. The first number indicates the octane rating of the fuel in a lean fuel-air mixture, and the second number indicates the octane rating of the fuel in a rich mixture.

Due to the small size of the worldwide aviation gasoline market, a single 100 octane low-lead fuel (100LL) is desired as the only AVGAS for all aircraft with reciprocating engines. This presents problems in engines originally designed to run on 80/87 fuel; the low lead 100-octane fuel still contains more lead than the 80-octane fuel. Spark plug fouling has been common and lower times between overhaul have occurred. Other engines designed for 91/96 fuel or 100/130 fuel operate satisfactorily on 100LL, which contains 2 milliliters of TEL per gallon (enough to lubricate the valves and control detonation). For environmental purposes, AVGAS with no TEL is sought for the aviation fleet of the future.

### **Fuel Identification**

Aircraft and engine manufacturers designate approved fuels for each aircraft and engine. Consult manufacturer data and use only those fuel specified therein.

The existence of more than one fuel makes it imperative that fuel be positively identified and never introduced into a fuel system that is not designed for it. The use of dyes in fuel helps aviators monitor fuel type. 100LL AVGAS is the AVGAS most readily available and used in the United States. It is dyed blue. Some 100 octane or 100/130 fuel may still be available, but it is dyed green.

80/87 AVGAS is no longer available. It was dyed red. Many supplemental type certificates have been issued to engine and engine/airframe combinations that permit the use of automobile gasoline in engines originally designed for red AVGAS. A relatively new AVGAS fuel, 82UL (unleaded), has been introduced for use by this group of relatively low compression engines. It is dyed purple.

115/145 AVGAS is a fuel designed for large, high performance reciprocating engines from the World War II