Detonation

Engines are most susceptible to detonation at high power settings, particularly if combined with improper leaning. Excessive temperature can cause the fuel/air mixture within the engine cylinders to detonate explosively. This causes a sharp, excessive pressure rise accompanied by a distinct metallic knock which, unlike automobiles, is seldom heard in an airplane. In addition, there also is a significant temperature increase in the combustion gases. This temperature rise causes the fuel/air mixture to expand, less fuel to burn, and engine power to decrease. Another reason for the power loss is the piston's inability to accelerate rapidly enough to convert the unusually high-pressure spike into power.

Perhaps the most serious aspect of detonation is its insidiousness. Cracked pistons, burned valves, and catastrophic engine failures show up only in the most severe cases. Light to medium detonation may not be noticeable at all in the cockpit but will still lead to piston, ring, and cylinder-head damage over time.

Causes of detonation are typically too low an octane fuel, excessively hot CHT, hot fuel-air mixture, excessively lean mixture, and high intake manifold pressure. Provided you have the correct fuel, detonation usually can be stopped by enriching the mixture, making shallower climbs to increase cooling airflow, selecting full-open cowl flaps, and reducing power. If none of these measures solve the problem, you should terminate the flight and seek the help of a mechanic.

Preignition

Often confused with detonation, preignition results when the fuel/air mixture is ignited prior to spark plug discharge. The symptoms are similar to (though not as severe as) detonation and include engine roughness, backfiring, high CHT, and a loss of power. Preignition may be caused by a hot spot in the cylinder, often a result of a carbon buildup on the cylinder head or spark plugs. It is also possible for a hot spot to develop if valve edges are ground too fine. In that case, the thinness causes the valve edge to glow, which, in turn, ignites the fuel/air mixture prematurely. As with detonation, significant damage may result, such as cracked pistons or valves, so it is important to reduce CHT as quickly as possible. This is done by enriching the mixture, reducing power, and maximizing cooling airflow with higher climb airspeeds and wide-open cowl flaps.

Engine Cooling

Abnormally high cylinder head temperatures in flight may be the result of a number of problems. First on the list of culprits would be an excessively lean mixture, which would be corrected by enriching the mixture. This tends to happen at high power settings during takeoff and initial climb. Similarly, any operations at higher-than-recommended power settings should be avoided. Operations during excessively high ambient temperatures also may lead to unusually high CHT. Some aircraft POHs list a maximum ambient temperature, but typically this is higher than the average pilot will ever encounter. Missing or misaligned engine baffles, air leaking out of the cowling, and airflow blockage all

Lombardo, David A.(Author). Aircraft Systems.
Blacklick, OH, USA: McGraw-Hill Professional Book Group, 1998. p 109.
http://site.ebrary.com/lib/modarres/Doc?id=5001849&page=125