The Effects of Unleaded Gasoline on Engine Valves

With engines running primarily on unleaded gasoline, what will be the effect on valves and valve seats?

First of all we should discuss why there is reduction in the lead content of gasoline. The reason is that the Environmental Protection Agency has determined that there will be a significant decline in deaths due to high blood pressure, strokes, heart attacks and other related diseases if the lead content in gasoline is reduced to zero. However, this contention is greatly disputed.

During the year 1981, the content of tetraethyl lead was reduced to 1.1 grams per gallon of gasoline. On July 1, 1985, the lead content was reduced to 0.5 grams per gallon; and on January 1, 1986, it was reduced to the current level of 0.1 grams of tetraethyl lead per gallon of gasoline.

The lead content could go to zero as soon as January 1, 1988, or as late as 1995.

The amount of lead required to prevent engine problems depends on the engine load and rpm range. Lightly loaded engines will run with as little as 0.05 grams of lead per gallon of gasoline, where heavily loaded engines running at high rpm's may require a minimum of 0.2 grams per gallon of fuel.

What are the effects on engines with the removal of lead from gasoline? First the positive effects—cleaner combustion chambers, cleaner oil and less corrosion. Unfortunately, the negatives loom larger. When the protective lead deposit film is removed from valve faces and seats, engines that were not designed to run on non-leaded fuels can run into valve seat recession problems.

As the valve closes on the seat with no lubrication film present, there is a welding that takes place between the particles of the face and the seat. After the welding comes a tearing action, and this process is repeated thousands of times until a considerable amount of material is removed and failure occurs. This condition is aggravated by valve rotation, high speed and high temperatures.

What are the solutions to the seat recession problems? The Original Equipment engine manufacturers have arrived at a partial solution by induction hardening the seats in cast iron heads and installing alloyed iron seats in aluminum heads. Also, some have removed the valve rotators.

We say these may be only partial solutions because under long-term, high-temperature operation, the induction hardened seats may anneal or soften; and even with the rotators removed there is some auto-rotation and spring wind up, which causes a skidding motion as the valve hits the seat.

Before we look at possible solutions for the aftermarket, let's look at the scope of the potential problem:

In 1988, it is estimated that there will be the following number of vehicles running which were not designed for use with unleaded gasoline:

- 6 million pre-1971 cars
- 9 million post-1971 cars which were not equipped with hardened seats
- 12 million light, medium and heavy-duty trucks
- 2 million 4-cycle marine engines
- Plus thousands of 4-cycle outboard marine engines and thousands of motorcycles

We are looking at a potential of 35 to 40 million vehicles that are candidates for valve and seat failure should all the lead be removed from gasoline in 1988.

How should these engines that were not designed for unleaded fuel, and even the millions of engines that were designed for unleaded fuel, be repaired when they have valve and seat problems? The answer is to use high quality alloyed iron seats. Plain cast iron will not last under no-lead fuel operating conditions. Also, on heavy-duty applications the engine manufacturer may have recommended stellite valve facing. If there are stellite faced valves available for the engines, by all means use them.

In addition, extra care should be exercised in the valve reconditioning process. Such things as valve face to seat widths and concentricity, valve stem to guide clearance, valve stem heights, spring pressure and rocker arm to valve tip contact are extremely important. Follow the engine manufacturer's specifications.

Can valves be reconditioned and reused? If the engine and valves were designed for use with no-lead fuels, they may be reused providing there is sufficient margin and the other dimensions are within the manufacturer's tolerance. As stated previously, good shop practices must be followed.

If the engine was designed for leaded fuels, some changes may have to be made. A valve with a chrome-plated stem is recommended and a hardened seat should be installed. Stellite faced valves are also recommended if available for heavy-duty engines.

Will valve stem and guide wear be greater with unleaded gas? Most Original Equipment engine manufacturers are now using chrome-plated stems, which reduce wear. Although there is a modest price premium for chrome stem valves, they should be used when a leaded fuel engine is converted to no-lead.

Should valve stem seals be used? Absolutely. We recommend that a quality, positive type valve stem seal is used for both leaded fuel and non-leaded fuel engines.

What about other fuels such as propane and natural gas? So far we have been talking about unleaded gasoline and converting engines that were designed to run on leaded fuel to unleaded fuels. Natural gas and propane are called "dry" fuels, which have little or no lubricating qualities of their own. Therefore, the things we have said about the valves, seats and guides used with unleaded fuel will also apply to these fuels. Hardened seats are a must and valve rotation is not recommended.

There are some other concerns when using no-lead fuel: Does no-lead fuel burn hotter than leaded fuel? No, not because of the lack of lead itself. The combustion temperature will depend on characteristics such as compression ratios, ignition timing, engine load and fuel octane. If the octane is not sufficient, detonation can occur and temperatures can rise rapidly.

When converting from a leaded fuel engine to no-lead fuel, some reduction in compression ratios may be required to get the engine to run properly. This is why the compression height has been reduced .020" or so on many aftermarket pistons.

Does smog equipment have a detrimental effect on valves? If the equipment is in good working order, the answer is "no". However, if the equipment is malfunctioning, problems may result. For example:

The Catalytic Converter — If the converter becomes clogged, the exhaust back pressure builds up and the exhaust valve temperature rises. Valve burning may result.

The EGR Valve — If the EGR valve is not operating, the combustion temperatures rise and detonation occurs. This causes a rapid rise in valve temperature to the point where valve cupping or tuliping may occur.

The PCV Valve — If the PCV valve is stuck closed, air circulation through the engine is cut off and oil contamination and acid formation result. This can cause valve stem wear along with rapid wear on other engine parts.

Spark Advance — Engines running with too much initial advance or too much total advance may run into detonation problems which can destroy valves and other engine components.

In summary, and back to the original questions, "What are the effects of running with unleaded fuel on valves and seats?"

- — The effects on the intake valves is minimal; however, a chrome-plated stem is beneficial.
- — On the exhaust valve — again use a chrome-plated stem. In heavy-duty applications use a premium material and stellite faced valve where available.
- — On the intake valve seats — a cast iron seat may do for light loads and low temperatures. For heavy loads an alloy seat is preferred. To be safe and since the type of service is not always known, we recommend installing alloyed seats.
- — For the exhaust seats a hardened alloyed seat is highly recommended, and for heavily loaded engines they are a must.
- — Finally, follow good machine shop practices and the engine manufacturer's specifications.

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