Combustion heat and head gasket destruction

by Gene Hailey

Heat is the root cause of the majority of head gasket failures. We are not just referring to cases of complete overheated conditions that are generated from a bad radiator, loss of coolant, stuck thermostat, collapsed lower hose or a dozen other things that are usually obvious to the average mechanic.

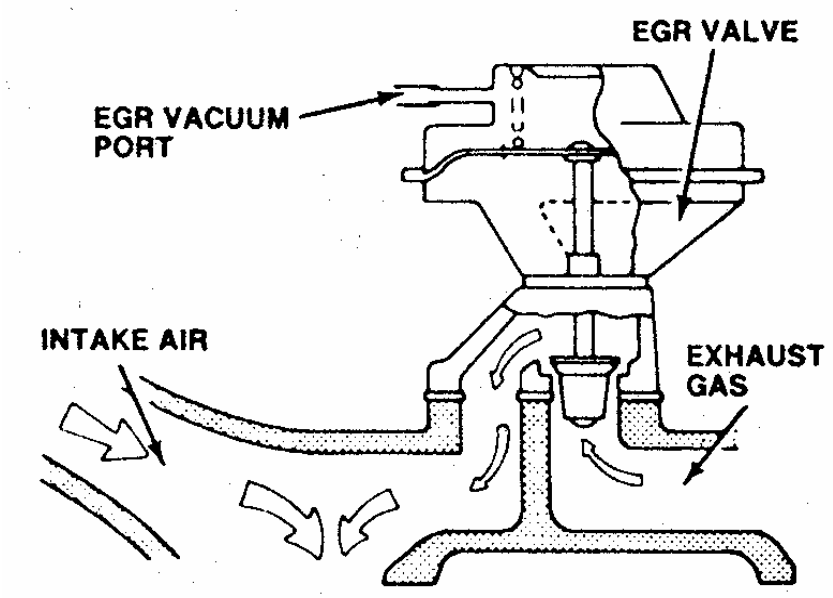
Too often, installers have a false sense of security that everything is OK because they have checked or replaced all of these items.

In many cases we have seen head gasket failure which was caused from excessively high combustion temperatures and the heat tabs do not indicate any overheating. The heat which destroys the head gaskets does not show up on the heat tab because it is localized and usually confined to the combustion chamber. This is especially true if the cooling system is in good condition.

The Exhaust Gas Recirculation (EGR) valve is one of the primary suspects in cases of localized hot spots in the combustion chamber. In some cases a malfunction of the EGR valve will cause poor driveability which will eventually damage the head gasket or cause damage to the pistons or valves.

An abnormally high flow of the inert gasses through the EGR valve at cruising speed will cause surging, power loss and of course effects driveability. The EGR valve that is working properly will not allow any passage during warm up from a cold start. This is usually accomplished by routing the vacuum line through a thermostatically controlled switch that allows the EGR valve to open only after the engine has reached normal operating temperature.

The majority of EGR valves are vacuum controlled which is really a variable regulated by engine condition, exhaust back pressure and of course engine loads and speeds. A sketch below shows a typical EGR valve operation.



Advanced methods use solenoids to open and close the EGR valve. The solenoids are toggled by signals from the microprocessor which acts accordingly to signals received from various sensors on the engine. The electronically managed EGR valves operate more precisely than the vacuum managed valves and they are also more expensive. Therefore before you condemn the EGR valve, perform an analysis to verify the EGR is receiving the signals. If not, a new one won't be of any help.

Should the EGR valve open during idle, the engine will often stall, again causing a driveablility problem. This coupled with the malfunction at cruising speed lets the driver know that something is not right and hopefully the problem can be corrected before the engine suffers damage.

For many years, automobiles were not equipped with EGR valves or any of the other various controls and sensors. The reason for the EGR valve is because we started running leaner mixtures in order to improve gas mileage and make the engines more efficient.

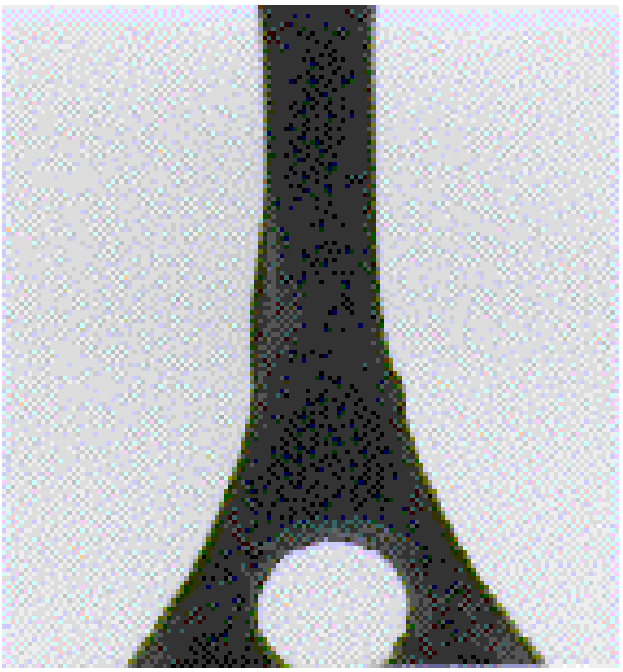
The early engines ran on the same stuff we breathe which is 78% nitrogen, 21% oxygen and the remaining 1% is a hodgepodge of other gasses.

The problem with the lean out is that when the mixture is heated above 2500° F a new substance called NOx is created which is oxides of nitrogen and not good for our atmosphere. The EGR valve was the fix for this problem. By routing some of the inert, burned gasses back into the combustion process, the combustion heat could be controlled to a level below 2500° F.

The real "sleeper" is when the EGR valve does NOT work at all - which is what usually happens when they fail. In fact, they are designed to close when the diaphragm ruptures. The lean burn mixture continues without the supplementation of the inert gasses which allow the combustion to become extremely hot, as much as 4500° F even with a satisfactory cooling system.

This situation does not necessarily cause any driveability problems, so it appears that everything is normal. A tail pipe test that shows high NOx emissions with all other exhaust gas levels in the normal range indicates there is no flow occurring through the EGR valve, unfortunately, this discovery would only be found on an emissions test.

How does all this affect the survival of the gasket? Engines with exhaust valves adjacent to each other such as the small block Chevys and engines with Siamese cylinders are highly prone to developing localized hot spots when the lean burn is uncontrolled. The increased crush of the gasket causes the steel to flatten out or widen and bulge over the edge of the cylinder. (see photo below)



This situation exposes the gasket to greater temperatures and eventually starts burning the steel fire ring of the gasket, once the burning starts, it burns completely across the gasket to the adjacent cylinder in a short time (photo below). The thickness reduction also allows the exhaust gasses to seep over the gasket which adds to the problem.

We do want to point out that a defective EGR valve is not the Lone Ranger in destroying head gaskets. It's only one of the causes but one of the most common. The ignition timing, clamp load and surface finish are equally as important. And, last but not least, is the entire cooling system.

A 25% loss of radiator capacity combined with a non-functioning EGR valve is a disaster waiting to happen.

A remanufactured engine is on the same playing field as a new engine in a new car only if the engine controls and cooling system are up to par. The cost of installing a remanufactured engine without making sure everything else is right is a terrible waste of time and money. Think about it!