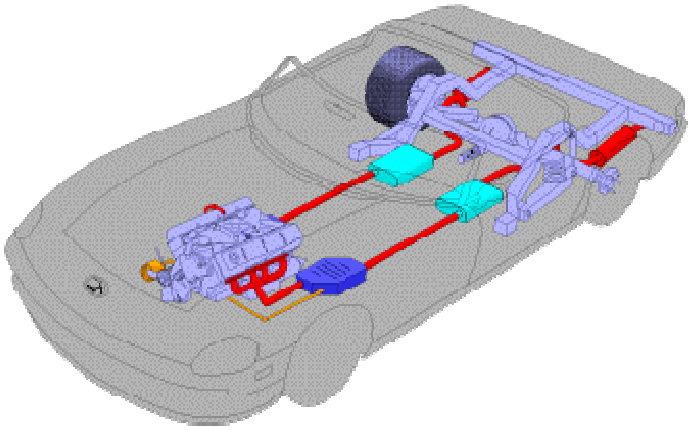
Exhaust/Emissions Systems Overview



Below is an overview of this system's operation

Emissions Testing

Many states require emissions tests on vehicles. This means that you drive to a facility where the test people take a sample of your emissions and run it through some analysis. The results are printed,and you pass or fail depending on the percentage of toxic emissions that turn up in your car's sample.

The only way to "study" or prepare for this test is to take good care of your car, including its emission system. If you use preventative maintenance, and keep your car tuned properly, you will pass. If you tamper with your emissions system, you will not pass. You can have your car checked independently before your emissions test if you want to resolve problems before going to the emissions test station.

One other good thing to do is to save your printouts from the test from year to year. If you compare them, you will be able to monitor your car (if its score is getting worse) and catch any problems before the emissions people catch you.

The Emission Control System

The purpose of the emission control system is just that; it controls the emissions and exhaust from your vehicle. The idea is to turn the harmful gases your car manufactures into harmless ones that don't ruin the environment, or us. Some of the problem gases are:

- hydrocarbons (unburned)
- carbon monoxide
- carbon dioxide
- nitrogen oxides
- sulfur dioxide
- phosphorus

- lead and other metals

To help control these substances, we (along with federal regulations) have made changes in our gasoline to eliminate them. Also, with a push from federal regulations, we have developed ways, varying from state to state, to test emissions, that have caused automotive manufacturers to develop better, safer emission systems.

Although emissions control systems vary between manufacturers and vehicles, they all have the same goal and use many of the same methods. The addition of computers to ignition systems allows the engine to monitor and adjust itself continuously, so it just isn't true that emission controls lower the amount of mileage we get fromfuel.

The best news is that emission controls have reduced carbon monoxide and hydrocarbon emissions by about ninety-six percent from pre-control vehicles. That's almost a hundred percent!

The Tailpipe

The tailpipe is a long metal tube attached to the muffler. It sticks out from under the body of your car, at the rear, in order to discharge the exhaust gases from the muffler of your engine into the air outside the car.

The Muffler

Exhaust gases leave the engine under extremely high pressure. If these gases escaped directly from the engine the noise would be tremendous. For this reason, the exhaust manifold sends the gases to a muffler where they go through metal plates, or tubes, with a series of holes. The pressure of the gases is reduced when they pass through the muffler, so they go out of the tail pipe quietly.

The muffler is made of metal and is located underneath the body ofthe car. It's connected between the tail pipe and the catalytic converter.

There are two types of muffler design. One type uses several baffled chambers to reduce noise. The other type sends the gases straight through perforated pipe wrapped in metal or fiberglass. This type of muffler is designed for the purpose of reducing back pressure and, consequently, makes slightly more noise.

Since a muffler cannot reduce the noise of the engine by itself, some exhaust systems also have a resonator. Resonators are like little mufflers, and are usually the "straight through" type. They are added at the end of the exhaust system to take care of any noise that has made it through the muffler.

The muffler quiets the noise of the exhaust by "muffling" the sound waves created by the opening and closing of the exhaust valves. When an exhaust valve opens, it discharges the burned gases at high pressures into the exhaust pipe, which is at low pressure. This type of action creates sound waves that travel through the flowing gas, moving much faster than the gas itself (up to 1400 m.p.h.), that the muffler must silence. It generally does this by converting the sound wave energy into heat

by passing the exhaust gas and its accompanying wave pattern, through perforated chambers of varied sizes. Passing into the perforations and reflectors within the chamber forces the sound waves to dissipate their energy.

The Catalytic Converter

When your engine burns fuel, it produces gases that are bad for the environment. These noxious gases are hydrocarbons, carbon monoxide and nitrogen oxides. To prevent the engine from polluting the environment with these gases, we include a catalytic converter in our emission systems.

The catalytic converter is installed in the exhaust line, between the exhaust manifold and the muffler, and makes use of chemicals that act as a catalyst. A catalyst is a chemical that causes a reaction between other chemicals without being affected itself. In the case of the catalytic converter, the chemicals it contains cause a reaction in the pollutants in the exhaust. The pollutants are changed from harmful gases to harmless ones before they are let into the environment through the tail pipe.

Basically, the harmful gases enter the catalytic converter, a kind of stainless steel container. The converter is lined with chemicals such as aluminum oxide, platinum and palladium. These chemicals cause the carbon monoxide and hydrocarbons to change into water vapor and carbon dioxide. Some converters have a third lining of chemicals, platinum and rhodium, that reduce nitrogen oxides (three-way, dualbed converter).

The reason that leaded gas cannot be used in an engine with a catalytic converter is that the lead coats the chemicals in the converter. This makes them unable to do the job anymore, since the chemical lining can't come in contact with the pollutants. At first,this was a big disappointment, because lead acted as a lubricant and helped to reduce wear on some of the engine parts. Luckily for our engines and the environment (not to mention us), car manufacturers soon got around the problem by making tougher parts and coating them with special metal.

The EGR Valve

The Exhaust Gas Recirculation (EGR) valve is used to send some of the exhaust gas back into the cylinders to reduce combustion temperature. Why would we want to do this?

Nitrous oxides (nasty pollutants) form when the combustion temperature gets above 2,500 degrees F. This happens, because at such temperatures, the nitrogen in the air mixes with the oxygen to create nitrous oxides. Did you ever have two friends that were fine by themselves but just awful when they got together? Well, our good friend, the sun, is just like that. When it's sunny, the nitrous oxides from the exhaust get together with the hydrocarbons in the air to form our not-so-good friend, smog. That's when the EGR valve comesin handy.

By recirculating some of the exhaust gas back through the intake manifold to the cylinders, we can lower the combustion temperature. Lowering the combustion

temperature lowers the amount of nitrous oxide produced. Consequently, less of it comes out the tail pipe.

There are two types of EGR valves. One operates through the use of a vacuum, and the other operated through the use of pressure. Both types allow the exhaust gas in to lower the combustion temperature when it gets too high.

PCV Valve

The process of combustion forms several gases and vapors; many of them quite corrosive. Some of these gases get past the piston rings and into the crankcase. If left in the crankcase, these substances would cause all kinds of bad things (rust, corrosion, and formation of sludge), so they have to be removed. Back in the old days, they used to be dumped out into the atmosphere through a tube. Once we realized what a problem pollution was in the sixties, the PCV (Positive Crankcase Ventilation) system was developed to take the place of the old "dump tube."

The PCV system uses a hose connected between the engine and the intake manifold to draw these gases out of the engine's crankcase and back into the cylinders to burn with the regular fuel. The only problem to solve is how to keep these gases from going willy-nilly into the manifold and upsetting the required air-fuel ratio. The solution to this problem is the PCV valve.

The PCV valve controls the release of crankcase gases and vapors to the intake manifold. The valve is kept closed by spring action when the engine is at rest. When the engine is running normally, the low vacuum it creates allows the valve to open and release crankcase vapors and gases into the intake manifold for burning. If the engine is idling or you are slowing down, the vacuum level rises and pulls the valve plunger into the valve opening. This partially blocks off the opening so that only a small amount of vapors and gases can be drawn into the intake manifold.

One really comforting feature of the PCV valve is its behavior in the event of a backfire. If your car backfires in the manifold, the pressure makes the spring close the valve completely. With the valve closed, there is no chance that the flame can move into the crankcase and cause an explosion.

The Air Pump

The air pump sends (or pumps) compressed air into the exhaust manifold and in some cases to the catalytic converter. The oxygen in the pressurized air helps to burn quite a bit of any unburned hydrocarbons (fuel) and therby converts the poisonous carbon monoxide into good old carbon dioxide.

A belt from the engine drives the air pump. It has little vanes (thin, flat, curved fins) that draw the air into the compression chamber. Here, the air is compressed and sent off to the exhaust manifold where it speeds up the emissions burning process. Stainless steel nozzles are used to shoot the air into the exhaust manifold, because they will not burn.

Some engines use a pulse air injection system. This system uses pulses of exhaust gas to operate an air pump that delivers air into the exhaust system.

The Exhaust Manifold and Header

The exhaust manifold, usually constructed of cast iron, is a pipe that conducts the exhaust gases from the combustion chambers to the exhaust pipe. It has smooth curves in it for improving the flow of exhaust.

The exhaust manifold is bolted to the cylinder head, and has entrances for the air that is injected into it. It is usually located under the intake manifold.

A header is a different type of manifold; it is made of separate equal-length tubes.

Manifold to Exhaust Pipe Gaskets

There are several types of gaskets that connect the exhaust pipe to the manifold.

One is a flat surface gasket. Another type uses a ball and socket with springs to maintain pressure. This type allows some flexibility without breakage of the seal or the manifold. A third type is the full ball connector type, which also allows a little flexibility.

Exhaust Pipe Hangers

Hangers hold the exhaust system in place. They give the system flexibility and reduce the noise level. The hanger system consists of rubber rings, tubes and clamps.

Catalysts

The materials within a catalytic converter vary between cars. Catalytic converters are designed to do different things, depending on the design of the converter.

Some catalytic converters use what is called an "oxidation" catalyst; this usually consists of ceramic beads coated with platinum to reduce hydrocarbons and carbon monoxide. Through the catalytic action, the hydrocarbons and carbon monoxide are "burned" to creat ewater vapor and carbon dioxide. This type of catalytic converter needs an input of oxygen, so oxygen is usually injected into the cylinder head, or directly into the exhaust header or manifold.

Newer catalytic converters have a two part design. The front half is a "three-way" catalyst, which burns various pollutants, and reduces hydrocarbons, carbon monoxide, and oxides of nitrogen into water, carbon dioxide and nitrogen. These converters require exact fuel air mixtures in order to maintain efficient exhaust reduction. The rear section of these converters is the normal oxidation catalyst that further reduces hydrocarbons and carbon monoxide. Air from the air pump is injected into the center of these converters. Here the air is allowed to mix with the exhaust before it passes into the oxidation catalyst, where it burns off its toxic chemicals and reduces emissions.

Exhaust Pipe

The exhaust pipe is the bent-up or convoluted pipes you will notice underneath your car. Some are shaped to go over the rear axle, allowing the rear axle to move up and down without bumping into the exhaust pipe; some are shaped to bend around under the floor of the car, connecting the catalytic converter with the muffler. Exhaust pipes are usually made out of stainless steel, since the high heat conditions involved with the muffler system will cause rust.

Reverse-flow Muffler

The reverse-flow muffler is oval-shaped and has multiple pipes. Four chambers and a double jacket are used to accomplish muffling of the exhaust noise. Exhaust gases are directed to the third chamber, forced forward to the first chamber, from where they travel the length of the muffler and are exhausted into the tail pipe.

Straight Through Muffler

The straight through muffler has a central tube, perforated with several openings which lead into an outside chamber packed with a sound absorbing (or insulating) material. As the exhaust gases expand from the perforated inner pipe into the outer chamber, they come in contact with the insulator and escape to the atmosphere under constant pressure. Because of this, the expanding chamber tends to equalize or spread the pressure peaks throughout the exhaust from each individual cylinder of the engine.

A V-8 engine requires two exhaust manifolds and either one or two mufflers and often accompanying resonators. If one muffler is used, the exhaust pipe from one manifold meets the other one in the form of a "Y".

Dual Exhaust System

The advantage of a dual exhaust system is that the engine exhausts more freely, thereby lowering the back pressure which is inherent in an exhaust system. With a dual exhaust system, a sizable increase in engine horsepower can be obtained because the "breathing" capacity of the engine is improved, leaving less exhaust gases in the engine at the end of each exhaust stroke. This, in turn, leaves more room for an extra intake of the air-fuel mixture.