The Basics of Positive Crankcase Ventilation (PCV)

by Larry Carley copyright AA1Car.com

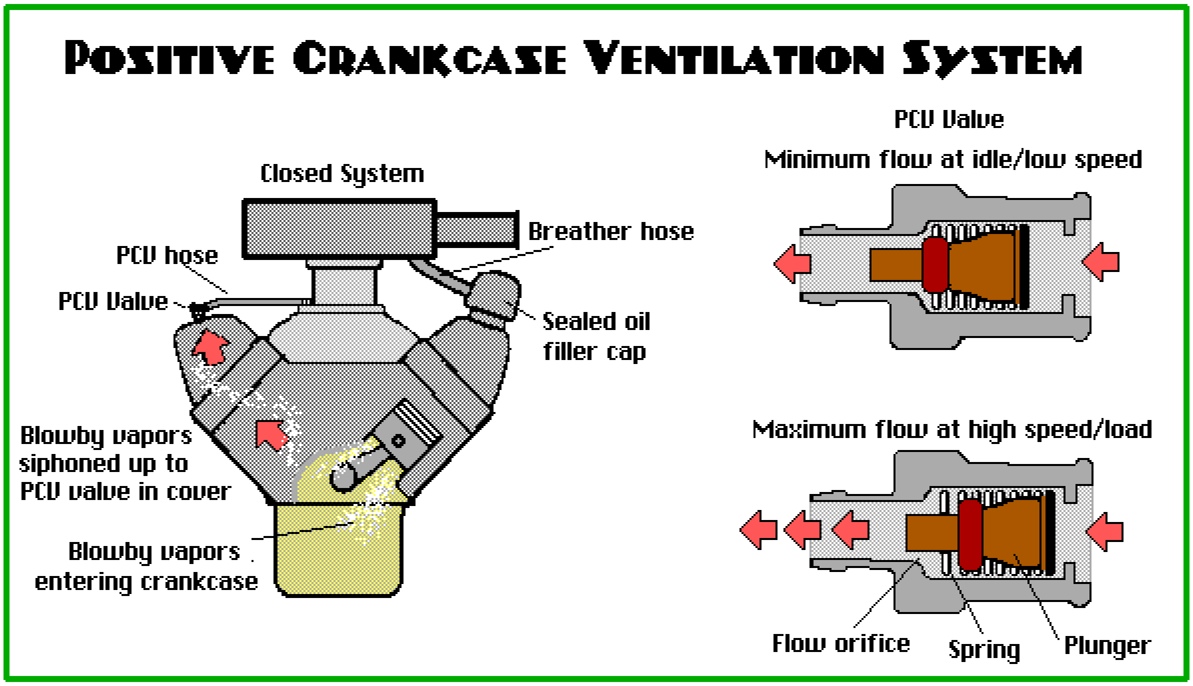
The Positive Crankcase Ventilation (PCV) system reduces blowby emissions from the engine. About 20% of the total hydrocarbon (HC) emissions produced by a vehicle are blowby emissions from gases that get past the piston rings and enter the crankcase. The higher the mileage on the engine and the greater the wear on the piston rings and cylinders, the greater the blowby into the crankcase.

Before PCV was invented, blowby vapors were simply vented to the atmosphere through a "road draft tube" that ran from a vent hole in a valve cover or valley cover down toward the ground.

In 1961, the first PCV systems appeared on California cars. The PCV system used intake vacuum to siphon blowby vapors back into the intake manifold. This allowed the HC to be re-burned and eliminated blowby vapors as a source of pollution.

The system proved to be so effective that "open" PCV systems were added to most cars nationwide in 1963. An open PCV system draws air in through a mesh filter inside the oil filler cap or a breather on a valve cover. The flow of fresh air through the crankcase helped pull moisture out of the oil to extended oil life and reduce sludge. The only drawback to these early open PCV systems was that blowby vapors could still backup at high engine speed and loads, and escape into the atmosphere through the oil filler cap or valve cover breather.

In 1968, "closed" PCV systems were added to most cars. The breather inlet was relocated inside the air cleaner housing so if pressure backed up it would overflow into the air cleaner and be sucked down the carburetor. No vapors would escape into the atmosphere.



Typical PCV system.

HOW PCV WORKS

The major component in the PCV system is the PCV valve, a simple spring-loaded valve with a sliding pintle inside. The pintle is tapered like a bullet so it will increase or decrease airflow depending on its position inside the valve housing. The movement of the pintle up and down changes the orifice opening to regulate the volume of air passing through the PCV valve.

The PCV valve is typically located in a valve cover or the intake valley, and usually fits into a rubber grommet. The location of the valve allows it to pull vapors from inside the engine without sucking oil from the crankcase (baffles inside the valve cover or valley cover deflect and help separate droplets of oil from the blowby vapors).

A hose connects the top of the PCV valve to a vacuum port on the throttle body, carburetor or intake manifold. This allows the vapors to be siphoned directly into the engine without gumming up the throttle body or carburetor.

Because the PCV system pulls air and blowby gases into the intake manifold, it has the same effect on the air/fuel mixture as a vacuum leak. This is compensated for by the calibration of the carburetor or fuel injection system. Consequently, the PCV system has no net effect on fuel economy, emissions or engine performance -- provided everything is working correctly.

WARNING: Removing or disconnecting the PCV system in an attempt to improve engine performance gains nothing, and is illegal. EPA rules prohibit tampering with any emission control device. Disabling or disconnecting the PCV system can also allow moisture to accumulate in the crankcase, which will reduce oil life and promote the formation of engine-damaging sludge.

HOW PCV FLOW CHANGES WITH ENGINE SPEED & LOAD

The flow rate of a PCV valve is calibrated for a specific engine application. For the system to function normally, therefore, the PCV valve must adjust the flow rate as operating conditions change.

When the engine is off, the spring inside the valve pushes the pintle shut to seal the crankcase and prevent the escape of any residual vapors into the atmosphere.

When the engine starts, vacuum in the intake manifold pulls on the pintle and sucks the PCV valve open. The pintle is pulled up against the spring and moves to its highest position. But the tapered shape of the pintle does not allow maximum flow in this position. Instead, it restricts flow so the engine will idle smoothly.

The same thing happens during deceleration when intake vacuum is high. The pintle is pulled all the way up to reduce flow and minimize the effect of blowby on decel emissions.

When the engine is cruising under light load and at part throttle, there is less intake vacuum and less pull on the pintle. This allows the pintle to slide down to a mid-range position and allow more airflow.

Under high load or hard acceleration conditions, intake vacuum drops even more, allowing the spring inside the PCV valve to push the pintle valve even lower to its maximum flow position. If blowby pressure builds up faster than the PCV system can handle it, the excess pressure flows back through the breather hose to the air cleaner and is sucked back into the engine and burned.

In the event of an engine backfire, the sudden rise in pressure inside the intake manifold blows back through the PCV hose and slams the pintle shut. This prevents the flame from traveling back through PCV valve and possibly igniting fuel vapors inside the crankcase.

PCV MAINTENANCE

Because the PCV system is relatively simple and requires minimal maintenance, it is often overlooked. The common replacement interval for many PCV valves is 50,000 miles, yet many engines have never had the PCV valve replaced. Many late model owners' manuals do not even have a recommended replacement interval listed for the PCV valve. The manual may only suggest "inspecting" the system periodically.

On many 2002 and newer vehicles with OBD II, the OBD II system monitors the PCV system and checks the flow rate once during each drive cycle. But on older OBD II and OBD I systems, the PCV system is NOT monitored. So a problem with the PCV system on a pre-2002 vehicle probably won't turn on the MIL (malfunction indicator lamp) or set a diagnostic trouble code (DTC).

PCV valves can last a long time, but they may eventually wear out or clog -- especially if the vehicle owner neglects regular oil changes, and sludge builds up in the crankcase. The same sludge and oil varnish that gums up the engine can also plug up the PCV valve.

PCV PROBLEMS

The most common problem that afflicts PCV systems is a plugged up PCV valve. An accumulation of fuel and oil varnish deposits and/or sludge inside the valve can restrict or even block the flow of vapors through the valve. A restricted or plugged PCV valve cannot pull moisture and blowby vapors out of the crankcase. This can cause engine-damaging sludge to form, and a backup of pressure that may force oil to leak past gaskets and seals. The loss of airflow through the valve can also cause the air/fuel mixture to run richer than normal, increasing fuel consumption and emissions. The same thing can happen if the pintle inside the PCV valve sticks shut.

If the pintle inside the PCV valve sticks open, or the spring breaks, the PCV valve may flow too much air and lean out the idle mixture. This may cause a rough idle, hard starting and/or lean misfire (which increases emissions and wastes fuel). The same thing can happen if the hose that connects the valve to the throttle body, carburetor or intake manifold pulls loose, cracks, or leaks. A loose or leaky hose allows "un-metered" air to enter the engine and upset the fuel mixture, especially at idle where the idle mixture is most sensitive to vacuum leaks.

On late model vehicles with computer engine controls, the engine management system will detect any changes in the air/fuel mixture and compensate by increasing or decreasing short term and long term fuel trim (STFT and LTFT). Small corrections cause no problems, but large corrections (more than 10 to 15 points negative or positive) will typically set a lean or rich DTC and turn on the MIL.

Problems can also occur if someone installs the wrong PCV valve for the application. As we said earlier, the flow rate of the PCV valve is calibrated for a specific engine application. Two valves that appear to be identical on the outside (same diameter and hose fittings) may have different pintle valves and springs inside, giving them very different flow rates. A PCV valve that flows too much air will lean the air/fuel mixture, while one that flows too little will richen the mixture and increase the risk of sludge buildup in the crankcase.

Watch out for cheap replacement PCV valves. They may not flow the same as the OEM PCV valve. Quality brand name replacement PCV valves are calibrated exactly the same as the original valves, and are designed to provide long-lasting, trouble-free performance.

The PCV valve is usually located on the valve cover or cylinder head. Pull the valve out (leave the hose connected) and feel for vacuum while the engine is idling. No vacuum indicates a plugged PCV valve.

PCV VALVE CHECKS

There are a number of ways to check a PCV valve:

1. Remove the valve and shake it. If it rattles, it means the pintle inside is not stuck and the valve should flow air. But there's no way to know if the spring is weak or broken, or if a buildup of varnish and deposits inside the valve is restricting flow.

2. Check for vacuum by holding your finger over the end of the valve while the engine is idling. This test tells you if vacuum is reaching the valve, but not if the valve is flowing properly. If you don't feel vacuum, it means the valve or hose is plugged and needs to be replaced.

3. Use a flow tester to check the performance of the valve. This method is the best because it tests both vacuum and air flow.

The volume of air that is pulled from the crankcase by the PCV system is important because it takes a certain amount of airflow to remove the blowby vapors and moisture. Tis prevents moisture contamination of the oil and the formation of sludge in the crankcase. However, too much airflow can upset the air/fuel mixture in the engine. It can also increase oil consumption.

***To check airflow through the PCV valve**, you can do any of the following:*

Pinch or block off the vacuum hose to the PCV valve with the engine idling at operating temperature. The engine idle rpm should typically drop about 50 to 80 rpm before the idle speed corrects itself (or you can disconnect the idle speed control motor so it won't affect idle speed during this test). If there is no change in idle speed, check the PCV valve, hose and breather tube for a restriction or blockage. A greater change would indicate too much airflow through the PCV valve. Check the part number on the PCV valve to see if it is the correct one for the engine. The wrong valve may flow too much air. If there is no part number, replace the valve with a new one (which meets OEM specifications) and test again.

Measure the amount of vacuum in the crankcase. With the engine at normal operating temperature, block off the PCV breather tube or vent to the engine (usually the hose that runs from the air cleaner housing to the valve cover on the engine). Pull out the dipstick and connect a vacuum-pressure gauge to the dipstick tube. A typical PCV system should be pulling about 1 to 3 inches of vacuum in the crankcase at idle. If you see a significantly higher vacuum reading, the intake manifold gasket is probably leaking and pulling vacuum on the crankcase (replace the leaky intake manifold gasket). If you see no vacuum, or find a buildup of pressure in the crankcase, the PCV system is plugged or is not pulling enough air through the crankcase to get rid of the blowby vapors.

***NOTE:** If the engine has a leaky oil pan, valve cover or intake manifold gasket leak, or leaky crankshaft seals, it will not be able to develop much vacuum in the crankcase because it is pulling in outside air (which is also unfiltered and can further contaminate the oil).*

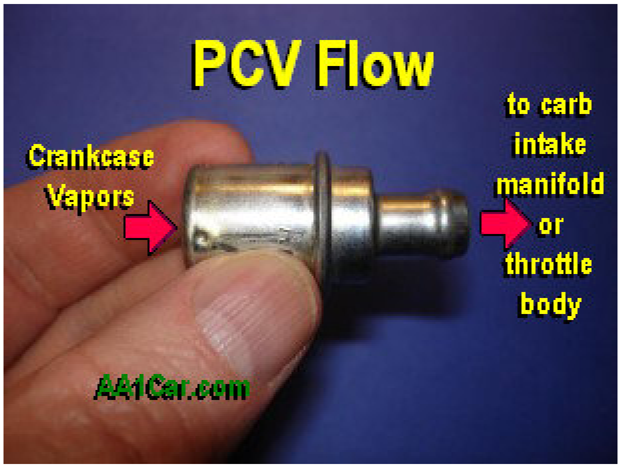
To find a crankcase air leak, you can lightly pressurize (no more than 1 to 3 psi) the crankcase with shop air via the dipstick tube or oil filler cap or breather after blocking all the other vents. Do not use any more air pressure than this or you may create leaks where there were no leaks before. Then use a spray bottle to squirt soapy water around the gasket seams and seals. If you see bubbles, you have found an air leak (replace the gasket or seal as needed).

A smoke machine also works great for finding crankcase leaks as well as vacuum leaks. A smoke machine generates a smoke-like vapor by heating mineral oil. The mist can then fed into the intake manifold to check for intake manifold vacuum leaks, or into the crankcase to check for internal engine air leaks. Any leaks will allow the smoke to escape and you will see the smoke on the outside of the engine.

PCV REPLACEMENT TIPS

When replacing a PCV valve, make sure the replacement valve is the same as the original. External appearances can be misleading because valves that look the same on the outside may be calibrated differently inside. If the replacement valve does not have the same flow characteristics as the original, it may upset emissions and cause driveability problems.

The PCV hose that connects the PCV valve to the engine should also be replaced when the valve is changed. Use hose that is approved for PCV use only.



PCV valves are directional. Install the valve so crankcase vapors flow from the valve cover or cylinder head into the hose that goes to the intake manifold, carburetor or throttle body.

Some Engines Do Not Have a PCV Valve

Can't find your PCV valve? Some engines do not have a PCV valve, but use a crankcase ventilation system with a fixed orifice oil/vapor breather/separator. This part functions similar to a PCV valve, but there is no movable pintle or spring inside. The breather/separator is simply a small box with some baffles inside and a calibrated hole that allows intake vacuum to pull the blowby vapors back into the intake manifold.

Like a PCV valve, the breather/separator can plug up with varnish and sludge, causing driveability and emissions problems. It may be possible to clean out the part with solvent or carburetor cleaner to restore normal airflow. But if the part can't be cleaned, you will have to replace it with a new breather/separator.

More Emissions Articles:

Exhaust Gas Recirculation (EGR)

EVAP Evaporative Emission Control System

Understanding OBD II Driveability & Emissions Problems

Fixing Emission Failures

All About Onboard Diagnostics II (OBD II)

Basic Emission Control Systems Overview

Exhaust Emissions Diagnosis

Troubleshooting a P0420 Catalyst Code

Catalytic Converters

Driveability Diagnosis: Misfires

Spark Knock (Detonation)

Finding & Fixing Vacuum Leaks

Understanding Oxygen (O2) Sensors

Wide Ratio Air Fuel (WRAF) Sensors

Sensing Emission Problems (O2 Sensors)

Emissions testing update

Click Here To Read More Automotive Technical Articles

Be sure to visit our other websites:

AA1Car Automotive Diagnostic & Repair Help

OBD2HELP

Random-Misfire

ScanToolHelp

TROUBLE-CODES