REPLACING OXYGEN SENSORS FOR PREVENTIVE MAINTENANCE

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Troubleshooting driveability problems can be a challenge on late-model computer-controlled vehicles because there are so many possible causes to consider. Is it a conventional fuel, ignition or compression problem? A bad sensor? A computer glitch? A low-voltage problem?

The first thing to look for is a Diagnostic Trouble Code (DTC). If a code is found, it narrows down the list of possibilities to a specific circuit or component. But if no codes are found, then it's back to the basics: ignition checks, fuel pressure and delivery checks, and checking compression and engine vacuum.

On OBD II-equipped vehicles, adaptive strategies can sometimes prevent a fault code from being set as long as an outright failure of a sensor or other component has not occurred — provided that the system can compensate for any changes that have occurred to keep tailpipe emissions from exceeding 1.5 times the legal limit. In other words, you might have a vehicle with a bad coolant sensor that reads low. Normally, this would prevent the computer from going into closed loop. But in many instances, the OBD II system will still go into closed loop and no code will be set. To diagnose this kind of problem, you may have to use a scantool with real-time sensor readings, such as AutoTap, to look at individual sensor inputs to see if they make sense.

One item that's often overlooked in the diagnostic process that can cause a variety of driveability problems is a low battery or charging voltage. Electronics as well as electric fuel pumps must have the correct dosage of volts to function properly, so if the battery or charging system voltage is low it can cause a variety of driveability ills such as hard starting, hesitation, ignition misfire, etc. If voltage isn't up to specs, the fuel pump may not deliver enough pressure or volume to meet the demands of the engine. Likewise, low voltage can interfere with the operation of the injectors, sensors, actuators and ignition system.

OXYGEN SENSOR

Another component that often causes driveability problems is the oxygen (O2) sensor. This sensor is the master switch in the fuel control feedback loop. The O2 sensor monitors the amount of unburned oxygen in the exhaust and produces a voltage signal that varies from about 0.1 volts (lean) to 0.9 volts (rich). The computer uses the O2 sensor's signal to constantly fine-tune and flip-flop the fuel mixture so that the catalytic converter can do its job and clean the exhaust. On OBD II-equipped vehicles, a second O2 sensor after the catalytic converter is used to monitor converter efficiency.

If an O2 sensor circuit opens, shorts or goes out of range, it usually sets a fault code and illuminates the Service Engine Lamp. But many an O2 sensor that is badly degraded may continue to function well enough not to set a fault code — but not well enough to prevent an increase in emissions and fuel consumption. The absence of a fault code or warning lamp, therefore, doesn't mean the O2 sensor is doing its job.

The performance of the O2 sensor tends to diminish with age as contaminants accumulate on the sensor tip and gradually reduce its ability to produce voltage. This kind of deterioration can be caused by a variety of substances that find their way into the exhaust such as lead, silicone, sulfur, oil ash and even some fuel additives. The sensor can also be damaged by environmental factors such as water, splash from road salt, oil and dirt.

As the sensor ages and becomes sluggish, it may not allow the computer to flip-flop the fuel mixture fast enough to keep emissions within acceptable limits. If the sensor dies altogether, it will cause the feedback control system to go back into open loop with a fixed, rich fuel mixture. Fuel consumption and emissions go up, and the converter may suffer damage if it overheats.

One study conducted by Sierra Research a few years ago found that a high percentage of vehicles that fail emissions tests failed because of a bad oxygen sensor. Failure rates were highest on older vehicles with unheated O2 sensors (failure rates ranged from 60 percent to 72 percent). The next highest failure rate was among vehicles with first generation heated O2 sensors (19 percent to 27 percent), and the lowest failures were found on the newest vehicles with second generation heated O2 sensors (2 percent to 14 percent).

So it’s important to periodically check the sensor’s performance, as when doing routine maintenance (like changing the spark plugs) or diagnosing a vehicle for an emissions failure or converter failure.

O2 SENSOR CHECKS

On OBDII vehicles (1996 and newer) you can use your AutoTap scantool's graphing feature to check O2 sensor performance. A good sensor should produce an oscillating waveform that flip-flops from near minimum (0.1 to 0.2v) to near maximum (0.8 to 0.9v). O2 sensors in throttle body injection systems flip-flop two to three times per second at 2,500 rpm, while multi-port injected applications are the fastest (five to seven times per second at 2,500 rpm).

When the mixture is made artificially rich, the sensor should respond almost immediately (within 100 to 300 milliseconds) and go to the maximum (0.9v) reading. Likewise, making the mixture artificially lean by opening a vacuum line should cause the sensor’s output to drop immediately to the minimum (0.1v) reading. If the sensor fails to respond or is sluggish, it needs to be replaced.

READING THE O2 SENSOR’S OUTPUT

Regardless of what factor or combination of factors caused it, a misfire allows unburned fuel to enter the exhaust. When the fuel hits the converter, it temporarily overwhelms it. This causes a momentary spike in hydrocarbon (HC) emissions until the converter starts to oxidize the unburned fuel. At the same time, the unburned oxygen that accompanies the fuel causes a momentary spike in the oxygen content of the exhaust. As it passes by the oxygen sensor, it causes a sudden dip in the sensor’s output voltage, which shows up as high frequency oscillations or "hash" on the sensor’s output signal. If you’re watching the O2 sensor’s output voltage when the misfire occurs, you’ll see the normal up and down signal pattern suddenly go berserk.

Misfire hash is hard to miss, but some hash in the O2 sensor signal is considered normal. As a rule, little oscillations or noise between 300 and 600 millivolts in amplitude is nothing to worry about. Bosch’s and General Motors’ O2 sensors tend to produce more of this kind of hash than Japanese O2 sensors because of their increased sensitivity to minute changes in exhaust oxygen levels.

Vacuum leaks that cause misfire can be pinpointed using a propane enrichment tool to check the intake manifold gaskets, throttle body and hose connections. If the misfire hash on the O2 sensor signal goes away when you feed propane to a particular point, you’ve found the leak.

Identifying a lean misfire caused by dirty injectors takes a more experienced eye. Most O2 sensors are sensitive enough to pick up a single misfire in an individual cylinder at low rpm. If the hash appears as one or two spikes in an otherwise normal pattern, the engine may have only one or two bad injectors. On the other hand, if the hash is severe (numerous spikes), all the injectors may need cleaning or replacing.

PREVENTING DRIVEABILITY PROBLEMS

Many driveability problems can be prevented by simply replacing aging O2 sensors for preventive maintenance. Though some import vehicle manufacturers recommend replacing O2 sensors at specific mileage intervals, others do not. Even so, replacing the sensor as regular preventive maintenance can providenumerous benefits.

Bosch recommends replacing unheated one- or two-wire O2 sensors on 1976 through early 1990s applications every 30,000 to 50,000 miles. Heated three and four-wire O2 sensors on mid-1980s through mid-1990s applications should be changed every 60,000 miles. And on 1996 and newer OBD II-equipped vehicles, the recommended replacement interval is 100,000 miles.

A good oxygen sensor is essential for good fuel economy, emissions and performance.

If a vehicle with a sluggish O2 sensor is only averaging 18 mpg, and is driven 12,000 miles a year, replacing the sensor can save $100 or more a year in fuel bills if the new sensor improves fuel economy 10 percent to 15 percent (which it often can). It’s not a big savings, but there are other benefits, too. As we said earlier, bad O2 sensors are a major cause of emission failures, as well as a leading cause of catalytic converter failures. Replacing an aging O2 sensor for preventive maintenance, therefore, is recommended not only to restore peak fuel efficiency and to minimize exhaust emissions, but to also prolong and protect the life of the converter, too.

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