

# What's All the Fuss About OBD-II Converters?



By William Hale

## What is OBD-II?

In the late 1960s the state of California started requiring emission controls on vehicles to combat smog in the Los Angeles area. In 1970 the federal Environmental Protection Agency (EPA) was established, and a series of emissions-reduction standards followed for the rest of the country. Over time these standards have required greater reductions in emissions, and manufacturers have turned to electronic fuel-control and ignition systems.

Sensors were added to monitor engine performance, and control modules made adjustments to the engine to maintain emissions performance. Initially, vehicle manufacturers developed their own systems, but in the late 1980s the Society of Automotive Engineers (SAE) developed a standard connector plug and test signals for the on-board diagnostics (OBD) programs. These standards were further expanded into what became known as OBD-II and were adopted by EPA and California Air Resources Board (CARB) for all vehicles sold after Jan. 1, 1996. Some 1994- and 1995-model-year vehicles sold in California also were built with OBD-II technology.

OBD-II-equipped vehicles often have one or two sensors in the exhaust stream to measure engine

and catalytic-converter performance. An oxygen sensor, typically a lambda sensor, placed in front of the converter (upstream) measures the concentration of oxygen present in the exhaust-gas flow. This provides an indication of whether the engine is running rich or lean.

Now a little background on what the catalytic converter does. The primary harmful components that the catalytic converter improves are nitrogen oxides (NO and NO<sub>2</sub>, together called NO<sub>x</sub>), hydrocarbons (HC) and carbon monoxide (CO). NO<sub>x</sub> contributes to smog and acid rain and can cause irritation to the lungs. HCs contribute to ground-level ozone, a major component of smog. CO is poisonous to humans and is colorless and odorless. A typical three-way converter (TWC) will convert these harmful gases to harmless or at least less-harmful gases in the following reactions:

- NO<sub>x</sub> is reduced to N<sub>2</sub> and O<sub>2</sub>, both common constituents in air
- HC and CO are oxidized to H<sub>2</sub>O (water vapor) and CO<sub>2</sub>

The air/fuel ratio of the gas going into the converter where these reactions take place must be kept very close to the stoichiometric ratio (14.7:1 or lambda equal to 1.0) or else the purification rate of the exhaust gases will be poor, as

shown in Figure 1.

As mentioned, the oxygen sensor ahead of the converter provides a measure of the air/fuel ratio of gases going into the converter. The engine control module (ECM) will make adjustments to fuel injection, ignition timing and other engine-control features to keep this air/fuel ratio at the optimum for emissions reduction.

A second oxygen sensor is placed after the converter (downstream) to measure the oxygen content after the catalyst. By comparing the signals from the two oxygen sensors the ECM can determine the performance of the catalyst. If the ECM cannot adjust the engine performance to meet the conversion expectation of the downstream oxygen sensor, the malfunction indicator light (MIL) illuminates on the vehicle instrument panel.

## Why do OBD-II converters fail?

Catalytic converters are designed to last the useful life of the vehicle. If they do not, it is usually the result of one of the following reasons:

1. Overly rich air/fuel ratio can cause the converter to overheat and melt the substrate – look for causes in improper fuel mixture, improper timing, faulty spark

plugs or wires, defective fuel injector or failed oxygen sensor.

2. Carbon deposits on substrate fouling the catalyst function – oil or antifreeze in the exhaust stream can cause carbon deposits to coat the substrate and prevent the catalyst from doing its job in converting harmful emissions. Look for worn piston rings or valve seals, or failed gaskets, as the cause.

3. Leaded fuels – never put leaded gasoline in a vehicle with a catalytic converter. It will poison the catalyst and render it useless.

4. Catalyst breakage – look for dents in the converter or broken hangers that cause the converter to hang closer to the road and sustain damage.

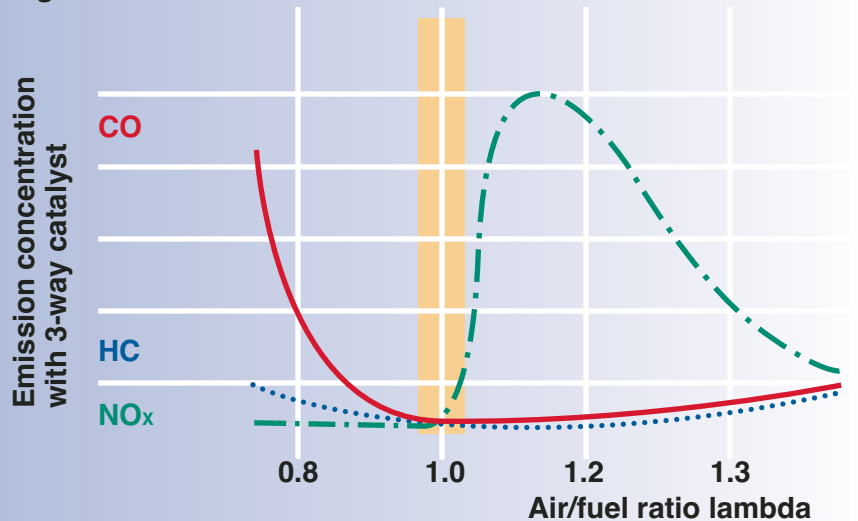
The MIL light is one indication of an exhaust-emissions malfunction, but many drivers find out their emissions controls are not working properly when they get an emissions test. Failing this test can be the result of a damaged catalytic converter but also can be caused by a defective oxygen sensor. If the air/fuel mixture is made too lean by this, for example, the catalyst may not be able to reduce the NO<sub>x</sub> emissions enough to pass the test.

### What's important in replacing them?

When the MIL light comes on or a vehicle fails to pass an emissions test the first recourse is often to replace the catalytic converter. This is often the culprit, but don't assume that the problem has gone away if the root cause has not been fixed. Replacing a converter that has been dented by an impact probably addresses the root of the problem as long as the new one is properly tucked up where the original one was.

But a melted or a carbon-fouled substrate indicates a maintenance problem with the vehicle. Address this with the customer or he/she may be disappointed when the problem returns.

Figure 1



Don't forget about the oxygen sensors. There are diagnostic tools for testing their function, but if you don't have access to one of these you also can check visually. The same contaminants that ruin catalytic-converter substrates will impair the lambda-probe function. A rich fuel mixture can cause a deposit to build up on the probe, reducing its ability to sense oxygen and causing it to report a lean mixture. The ECM then enriches the air/fuel mixture and the problem gets worse. Oil buildup on the probe can have the same effect. Antifreeze in the exhaust stream can cause failure of the probe and is indicated by a white or light gray color. Leaded gas will ruin the lambda probe after a couple of tanks of fuel and will discolor it to a light rust color.

And certainly, make sure you replace the failed catalytic converter with one that is designed for the application. This means by size and configuration, but also one that is properly loaded with platinum-group metals (PGMs). Aftermarket catalytic converters are held to less-strict requirements than the factory-installed product because they don't have to last as long. It is believed that a less-expensive replacement converter is more likely to be installed in the

event of a failure, and so there is less likelihood of a failed converter's not being replaced at all.

A lot of technology goes into the catalytic-converter substrate coating to make the most-cost-effective aftermarket product. It is a complex interplay at the surface of the substrate, where the chemical reactions take place to convert the harmful gases to less-harmful ones. The PGM content, which is very expensive by the ounce, is certainly not the only factor in making this conversion successful but it is an important one. The regulations do not tell manufacturers how much metal to put in their converters. It is ultimately the performance that counts. That's why EPA has advised manufacturers that for aftermarket OBD-II converters (excluding California) the converters must be "good enough that the catalyst monitor will not detect a problem for the required 25,000 mile performance period."\*

\*Excerpt from letter from Steve Albrink, Environmental Protection Agency, Aug. 2, 2000 **UD**

William Hale is business-unit manager for ACS Limited, manufacturer of RiteCat™ catalytic converters. 888-918-5047, [www.ritecat.com](http://www.ritecat.com)