

## Oxygen Saturation

### Do exhaust leaks cause converter failures?

Today's cars are becoming increasingly sophisticated with more elaborate emission control systems and methods. However, these advancements come at a cost. As emission requirements become increasingly strict, the systems are configured to be less tolerant. In the previous article we discussed how excessive carbon build-up can destroy your new converter, however, exhaust leaks can also trigger false efficiency codes and even permanently damage the catalyst.

#### How Do OBD-II Converters Work?

Most OBD-I and older systems were configured with various methods for controlling catalyst efficiency. When the EPA and CARB required car manufacturers to control NOX emissions, this introduced new challenges for the industry. COs and HCs require an oxygen rich (slightly lean) environment to properly oxidize in the catalyst. This ensures optimum efficiency. NOX, however, can only be reduced efficiently in the relative absence of oxygen. Engines that run hot, or lean tend to produce high NOX outputs. So, to effectively reduce NOX and properly oxidize HCs and COs, engines require more sophisticated systems. The addition of an EGR system reduces engine temperature by diluting the air mixture with already burned exhaust gases. Air injection systems require that the vehicle be tuned slightly rich to create a low oxygen environment in the reduction bed, and air is injected to create an oxygen rich environment in the oxidation bed.

However, most OBD-II system do not use either method. Instead they rely on a new method known as "Oxygen Cycling". Oxygen cycling works by adding a rare earth metal (cerium) to the substrate to control the oxygen levels in the converter. By automatically cycling the engine between slightly rich and slightly lean, the system can create a balanced environment that efficiently reduces NOX, HC, and CO emissions all at the same time.

#### How Do Exhaust Leaks Interfere with this Operation?

Proper oxygen cycling requires precise control over how much oxygen is entering the exhaust system. Various sensors, including O2 sensors, Fuel Air Sensors (wideband O2 sensors), MAF sensors, MAP sensors, Intake Temp Sensors, etc, provide this information. These sensors allow the computer to calculate the air density, oxygen content, etc. However, the vehicle's computer cannot adjust for unmetered air that enters the exhaust system. Any excessive oxygen will quickly saturate the cerium in the catalyst and reduce its efficiency. If the leak is prior to the primary O2 sensor, the computer may interpret the excessive oxygen as a lean condition, and richen the fuel air mixture. This can cause the converter to overheat due to excessive fuel entering the exhaust. This will often be seen as heat damage to the substrate. If the leak occurs after the primary O2 sensor, the computer will not richen the mixture to compensate, thus the converter's NOX reduction is severely compromised. In addition, the excessive oxygen can cause the converter to run slightly hotter than normal for extended periods of time, gradually damaging the substrate and the ceramic fiber padding.

#### Wouldn't Backpressure Prevent Oxygen From Entering the Exhaust?

One would assume that this would be the case. However, much has changed throughout the years. On today's finely tuned cars, backpressure only occurs under certain conditions. The exhaust system, especially at the forward end, may be under some backpressure during acceleration, towing, idling, etc. However, during actual operation of the vehicle in ordinary situations, the exhaust system is actually under slight vacuum. These conditions include cruising, deceleration, moving at constant highway speeds, etc. The properties and characteristics of the exhaust system on a car running on a "dyno" are very different than a vehicle that is actually moving. Wind and the motion of the vehicle can create a strong venturi effect in the exhaust system that reduces or eliminates backpressure. Some highly tuned vehicles can experience as much as 5-lbs of vacuum in the exhaust system at highway speeds depending on the design of the system, the type of mufflers that are used, and the location of the exhaust tips. Under these circumstances, even the smallest leaks can result in unmetered oxygen entering the exhaust system.

#### Where are These Leaks Most Likely to Form?

The most likely locations are the exhaust manifold (cracks), flanges, flex couplings, slip joints, gaskets, and stress points. The exhaust system should always be thoroughly inspected to ensure that no leaks are present. Even the smallest leak can trigger a code. In many cases, such a leak alone caused the original converter to fail, or led to other conditions that in turn caused the converter to either plug or fail.