BEAR RIVER CONVERTERS NEWSLETTER

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Cerium Oxide

What is it, and what does it do?

In previous articles, we have discussed issues regarding the check engine light. However, we have not discussed the subject in any great detail as to what is happening or what the actual function of this material is. This issue is going to clarify some points, as well as provide valuable information about the future of catalytic converters.

A Brief History of Emission Controls

When catalyst technologies were introduced, the only gases people were concerned with were carbon monoxide and hydrocarbons. These gases would readily oxidize in an oxygen rich environment. However, the lean burning designs tend to produce high NOX outputs, which revealed a new problem. Nitrous Oxides form when high combustion temperatures cause atmospheric nitrogen to react with oxygen. This reaction not only produces an acidic gas that burns the eyes and produces harmful smog, it also reduces the amount of oxygen available to effectively consume CO and HC. There is no fuel to air ratio possible at which CO, HC, and NOX can all be broken down efficiently. Nitrous oxides will only break down in an environment that is low in oxygen, while CO and HC can only be broken down in an environment rich in oxygen. At the time the simplest solution was tune the engine slightly rich and to use a catalyst efficient at NOX reduction in a rich environment and inject air into a separate catalyst that was efficient at oxidation in a lean environment. This solution would reduce the tailpipe emissions of all three gases, but increased the fuel consumption of the vehicles. On the hottest burning engines, an additional method that was found to be effective was Exhaust Gas Recirculation (EGR) , which quickly became popular. It utilizes a valve that opens to draw spent exhaust gases into the engine intake to dilute the mixture without significantly changing the fuel to air ratio. This dramatically reduces the combustion temperature, which in turn reduces the NOX production. This method is much more effective than air injection alone, but introduces mechanical failures of the EGR components.

Oxygen Cycling Theory of Operation

In the mid to late eighties, a new method was invented which used rare earth metals such as Cerium Oxide to temporarily store excess oxygen. The materials will absorb oxygen when there is an abundance, such as when nitrous oxides are being broken down into atmospheric nitrogen and oxygen, and then release the oxygen when it is in short supply, such as when CO and HCs are combining with oxygen to form CO2 and H2O. By alternating the engine between slightly rich and slightly lean, the catalyst can be kept operating at peak efficiency, and the fuel air ratio still averages to be stoichiometric. This method has proven to be a very effective way to reduce total tailpipe emissions, while still maintaining fuel economy and introducing no additional moving parts. The method can be improved in some cases by combining it with EGR. This method is used in all 3 way catalysts that meet OBD-II requirements.

Oxygen Storage and OBD-II

It was found that catalyst efficiency could be monitored by monitoring the oxygen content of the gases coming out of the catalyst. In a working catalyst, the oxygen will be stored and released and combine with the appropriate pollutants. If everything functions as it should and the fuel to air ratio is kept with a certain operating window, the oxygen levels at the outlet side of the converter should be relatively low and stable. One sign of a failed catalyst is that the oxygen levels at the output will begin to fluctuated as the engine cycling between rich and lean. This means that the oxygen is not being stored and/or the converter is not efficiently consuming the oxygen to convert the gases into harmless compounds. When the vehicle's computer detects this condition, it often indicates a bad catalyst and a code is set. This does not necessarily mean that the converter is bad, but rather that the oxygen flow is unstable, possibly caused by a faulty converter. To get accurate readings it is important that OEM sensors be used and that no leaks or unmetered oxygen gets into the exhaust system

The Future of Catalyst Technology

The next wave of catalyst technology is NOX Storage. This allows automakers to return to the lean burning engine, which is the most efficient for fuel consumption. This new technology is already being used in the latest diesel engines (which are naturally very lean), and some new lean burning gasoline models. By storing the NOX, one can efficiently oxidize the CO and HCs. At regular intervals, the vehicles computer will switch into a burn off mode, where the vehicle briefly runs rich, consuming the NOX that was stored earlier. During this time, the HC and CO continue to burn efficiently, because the method is combined with Oxygen Cycling and oxygen that gets released from the NOX as it breaks down is also used. Technologies such as this are allowing automakers to dramatically improve the fuel economy of their cars and still meet the strictest of emissions regulations.

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