



# Clean Air Facts

## The Catalytic Converter: Technology for Clean Air

### Overview

The catalytic converter is the centerpiece of controlling emissions from mobile sources throughout the world. When strict vehicle emission standards were first set in the U.S. by the Clean Air Act Amendments of 1970, automakers did not possess the technology to significantly lower vehicle emissions. Catalytic converters for automobiles were developed to meet the standards set by the U.S. Congress.

Catalytic converters, or “catalysts,” were first installed on cars in the mid-1970s. Since then, catalysts equipped on passenger cars, from the first two-way oxidation catalysts to today’s advanced three-way catalysts, have cut pollution by more than 10 billion tons in the U.S. Catalytic converters have also been developed for use on trucks, buses, and motorcycles, as well as on construction equipment, lawn and garden equipment, and other nonroad engines.

Catalyst technology frequently has been hailed as one of the great automotive engineering achievements. Over the past 35 years, catalyst technology has continued to advance to meet increasingly tighter emissions standards and greater durability requirements. Today, the catalytic converter is an integral part of a vehicle’s high-tech, computerized engine system designed for optimal fuel economy, performance, and emission control.

### How a Catalytic Converter Works

- First-generation catalytic converters, called “two-way converters,” only controlled carbon monoxide (CO) and hydrocarbon (HC) emissions. In the early 1980s, catalysts were introduced that could control nitrogen oxides (NO<sub>x</sub>), in addition to controlling CO and HC. All gasoline cars sold in the U.S. today are equipped with this type of catalytic converter, called a “three-way converter.”

### Three-Way Converter

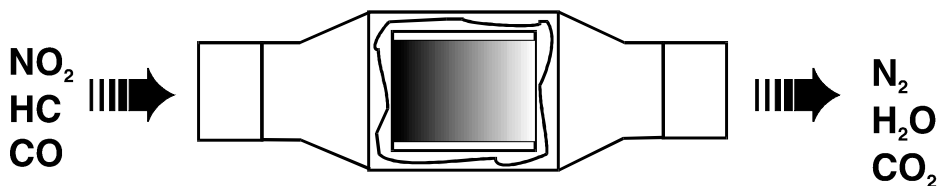


Figure 1. Diagram of a three-way catalytic converter.

- A catalytic converter has no moving parts. The technology behind the catalytic converter involves a very small amount of catalytic metal – platinum, rhodium, and/or palladium – applied to acres of surface area contained within a stainless steel canister. The active metals cause a chemical reaction – converting NO<sub>x</sub>, HC, and CO to N<sub>2</sub>, H<sub>2</sub>O, and CO<sub>2</sub> – without being changed or consumed.



**Figure 2. Cut-away of a three-way catalytic converter.**

- The catalyst technology used in mobile source applications today is part of an integrated emission control technology system that includes enhanced engine and fuel management strategies. Three-way catalysts can be used in applications where the engine operates in a stoichiometric condition (near perfect balance of available oxygen and unburned fuel). Emission control manufacturers continue to work on enhancing the design of the catalytic converter and optimizing its performance as part of a vehicle's high-tech, computerized engine system.
- Three-way catalysts are utilized on gasoline-powered passenger cars, light trucks, motorcycles, heavy trucks, and certain non-road applications, including forklifts, lawn and garden equipment, and marine engines.
- Catalytic converters are also used to reduce emissions from alternative fuel vehicles powered by natural gas, methanol, ethanol, and propane.

### Achievements of the Catalytic Converter

- Today's automobiles are meeting emission standards that require reductions of up to 99+ percent for HC, CO, and NO<sub>x</sub> compared to the uncontrolled levels of automobiles sold in the 1960s.
- In the 1970s and 1980s, many predicted that tight vehicle emissions standards would make automobiles prohibitively expensive, as well as decrease fuel economy, vehicle performance, and model selection. To the contrary, today's consumers can buy a wide variety of affordable, high-performance, lower-polluting vehicles.
- Fuel economy began a dramatic, continuous rise beginning with catalyst-equipped 1975 model year automobiles that were meeting much tighter emission requirements. This was largely because the use of the catalyst to control emissions allowed manufacturers to design engines for fuel efficiency.
- Because the catalyst is poisoned by lead, the use of catalytic converters helped bring about the elimination of gasoline containing lead, which has been found to be a serious health hazard.
- To date, more than 750 million vehicles equipped with catalytic converters have been sold worldwide (more than 500 million in the U.S.).

- *Car and Driver* magazine called the catalytic converter one of the century's 10 best automotive breakthroughs and the Society of Automotive Engineers selected the catalytic converter as one of the automobile industry's 10 greatest achievements over the past 100 years.

## Light-Duty Vehicle Emission Regulations

- On December 21, 1999, the U.S. EPA announced its Tier 2 program which established more stringent emission standards starting in 2004 for all passenger vehicles, including sport-utility vehicles (SUVs), minivans, vans, and pick-up trucks. The Tier 2 standards were completely phased in with the 2009 model year. In conjunction with the Tier 2 Program, EPA also announced lower standards for sulfur in gasoline, which ensure the effectiveness of catalytic converters to reduce automobile emissions.
- On November 1998, ARB amended California's Low Emission Vehicle (LEV) regulations. The new amendments, known as LEV II, affect passenger cars, light-duty trucks, and medium-duty vehicles. It started its phase-in in 2004 and was fully implemented in 2007. LEV II advances the state's clean air goals through improved emission reduction standards for automobiles.
- As part of California's LEV II program, vehicle manufacturers have introduced more than 40 models of vehicles that meet California's near-zero tailpipe emission standards – so-called Partial Zero Vehicles (PZEVs) or Super Ultra-Low Emission Vehicles (SULEVs). These vehicles use state-of-the-art emission control systems featuring advanced three-way catalytic converters (i.e., catalytic converters mounted near the exit of the engine exhaust manifold to reduce emissions within seconds after engine start) and advanced engine controls to reduce non-methane hydrocarbon (NMHC) and NOx emissions to below 30 mg/mile over the EPA light-duty vehicle Federal Test Procedure (FTP).
- EPA and ARB are working together to propose another round of tighter exhaust emission standards for light-duty vehicles (proposals are due by the end of 2011). These California LEV III and EPA Tier 3 standards are expected to require fleet average emission levels equivalent to today's SULEV/PZEV vehicles by 2025. EPA is expected to include further reductions in gasoline fuel sulfur levels to maintain ultra-high levels of catalytic converter performance over the vehicle's regulated useful life as part of their Tier 3 program. The LEV III and Tier 3 vehicle emission programs are expected to begin in the 2015-2017 timeframe.
- In countries where car ownership is rapidly increasing, such as in China, Brazil, India, and Russia, vehicle emission regulations have been put in place requiring the use of three-way catalysts on all new gasoline passenger cars.

For more information:

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