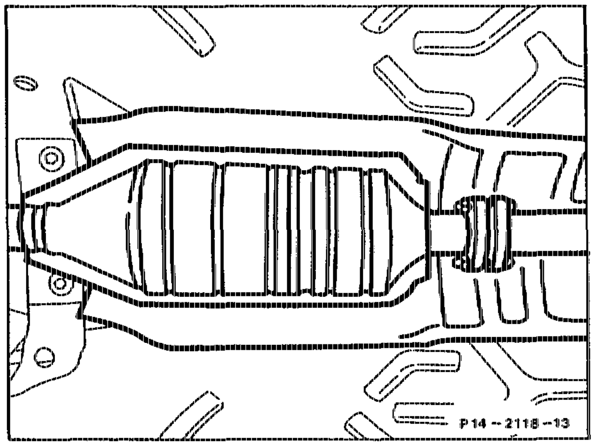
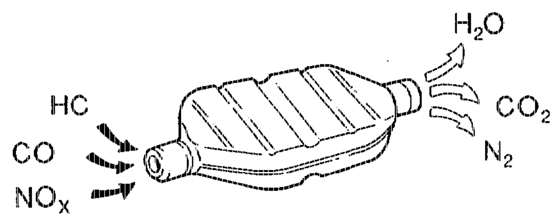
49–0005 Catalytic converter

The 3-way catalytic converters are designed as underfloor catalytic converters and are located in the exhaust system upstream of the center and tail silencer.



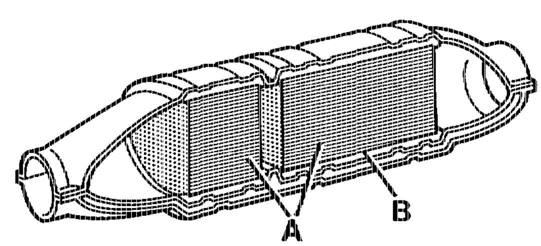
The task of the 3-way catalytic converter is to convert the three pollutants contained in the exhaust gas of gasoline engines, carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NO_X), into the harmless compounds of water (H_2O), carbon dioxide (CO_2) and nitrogen (N_2).



The catalyst contained within the catalytic converter is a term which comes from Greek and designates the element essential for catalytic conversion, which promotes the chemical reactions without itself being consumed. In the 3-way catalytic converter these are the noble metals platinum (Pt) and rhodium (Rh).

The catalytic converters consist essentially of three principle elements:

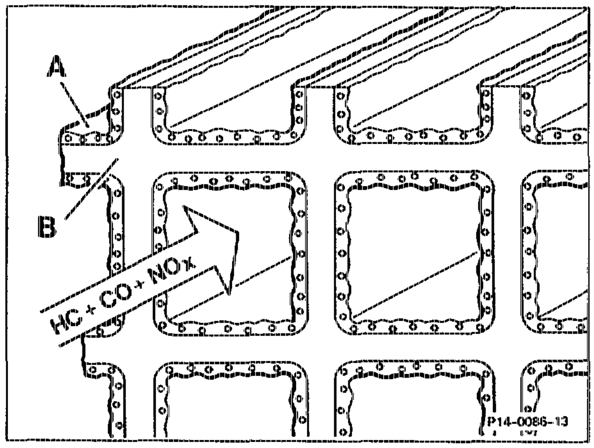
- Carrier body (monolith) made of high strength ceramic flexibly mounted on wire mesh



A Ceramic monolith
B Wire mesh

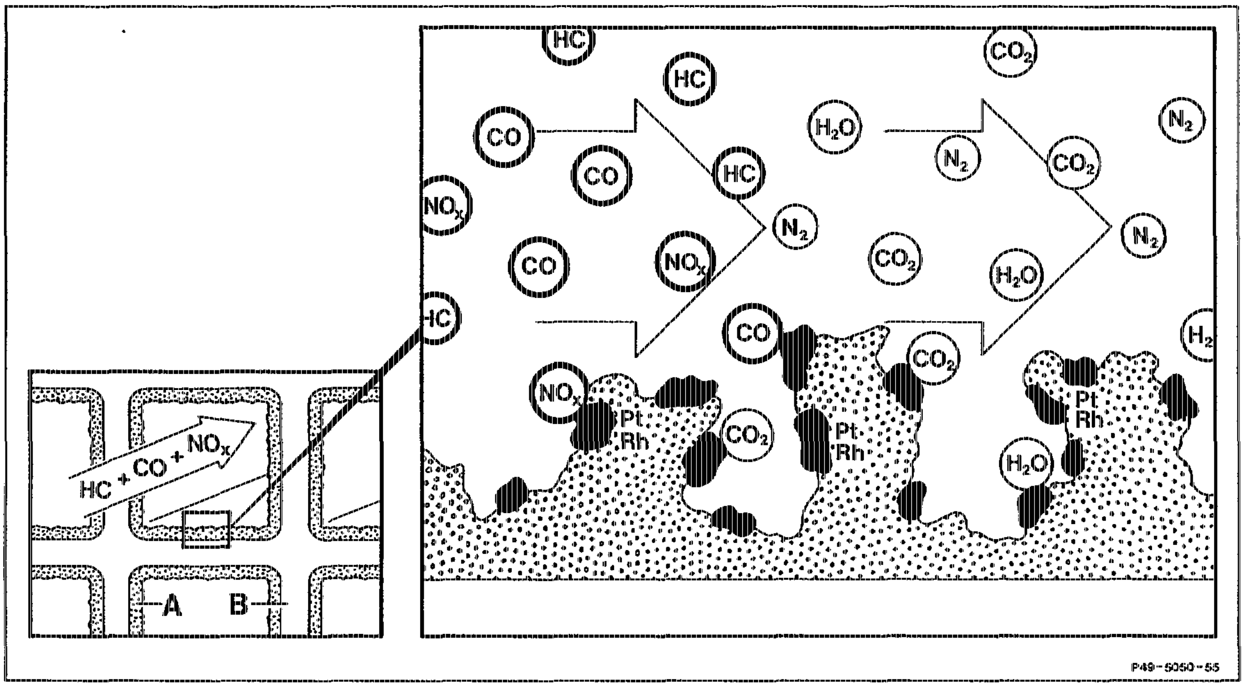
- An intermediate layer (washcoat) for enlarging the surface. As a result of the pore structure the surface on the monolith is increased approximately 7000 times.
- Catalytically active layer consisting of platinum (Pt) and rhodium (Rh).

Platinum accelerates the oxidation of hydrocarbons and carbon monoxide, rhodium the reduction of the oxides of nitrogen.
The portion of noble metal contained in a catalyst is some 2–3 grammes.



A Intermediate layer (washcoat) with platinum (Pt) and rhodium (Rh)
B Ceramic monolith

Function



The exhaust gases flow through the catalytic converter and come into contact there with the noble metals (Pt and Rh). This results in the following chemical reactions:

- carbon monoxide (CO) and hydrocarbons (HC) are converted by oxidation to water (H_2O),
- oxides of nitrogen (NO_X) are converted by reduction to nitrogen (N_2).

Chemical reactions:

$$2\,CO + O_2 \rightarrow 2\,CO_2$$
$$2\,C_2H_6 + 7\,O_2 \rightarrow 4\,CO_2 + 6\,H_2O$$
$$2\,NO + 2\,CO \rightarrow N_2 + 2\,CO_2$$

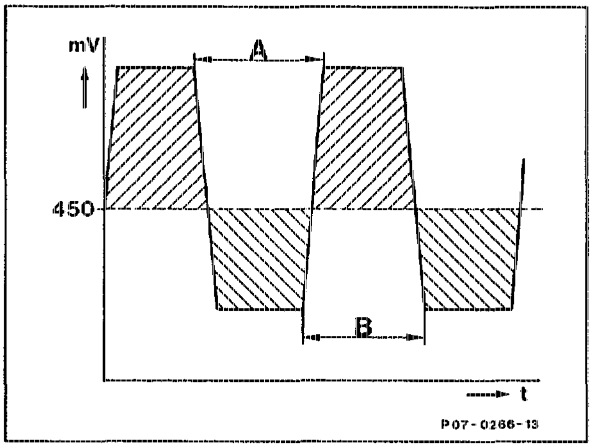
The high conversion rate of the pollutants is determined essentially by the temperature and the residual oxygen content in the exhaust.

Oxygen is required for the oxidation of CO and HC while the reduction of the oxides of nitrogen takes place in an oxygen-deficient atmosphere. The variation between oxygen-poor and oxygen-rich exhaust is achieved by altering the fuel-air mixture within narrow limits around $\lambda = 1$.

The ratio of the fuel/air mixture is designated with lambda (λ), in which the following mean:

$\lambda < 1$	rich mixture
$\lambda > 1$	lean mixture
$\lambda = 1$	complete combustion (stochiometric air/fuel ratio, 14.7 mass parts of air to 1 mass part of fuel)

This fluctuation of the oxygen portion in the exhaust is achieved by means of the oxygen sensor and the lambda control (see Group 14). It is only as a result of this oxygen fluctuation that it is possible to chemically convert the three exhaust elements in the catalytic converter.

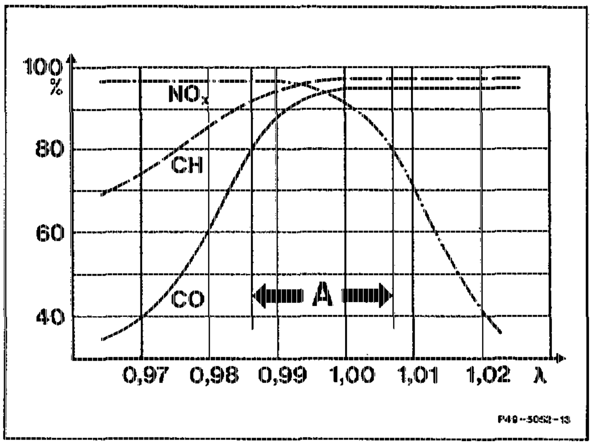


Voltage signals of oxygen sensor

A rich fuel/air mixture

B lean fuel/air mixture

The catalytic process, i. e. the chemical reaction begins in the catalytic converter from 250 °C. Excessively high temperatures cause a thermal overload.



Conversion rate of pollutants in catalytic converter

A λ control range (catalyst window)

Vehicles fitted with a catalytic converter and an oxygen sensor should only be operated with unleaded fuel. Lead additives (Pb) in the fuel form a deposit on the chemically reactive surface of the catalyst and of the oxygen sensor, rendering the system ineffective.