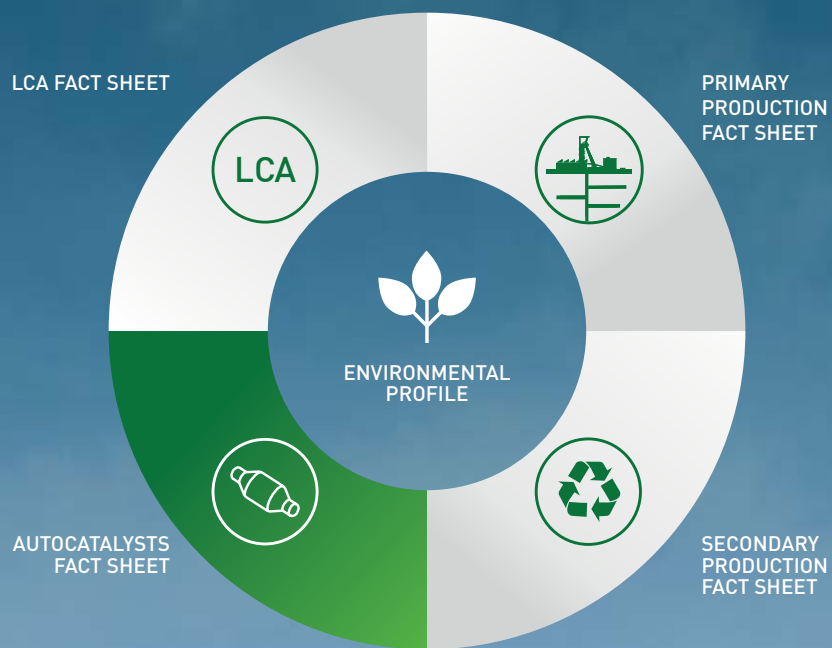


AUTOCATALYSTS AND PLATINUM GROUP METALS (PGMs)



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AUTOCATALYSTS AND PLATINUM GROUP METALS (PGMs)

Platinum Group Metals enable clean air and improve the quality of life

Arguably the most important pollution abatement device ever invented, the autocatalyst, or catalytic converter, based on platinum group metals is a key component of most of the world's vehicle powertrains. Without autocatalysts, air quality in and around most cities would be far worse than it is today.

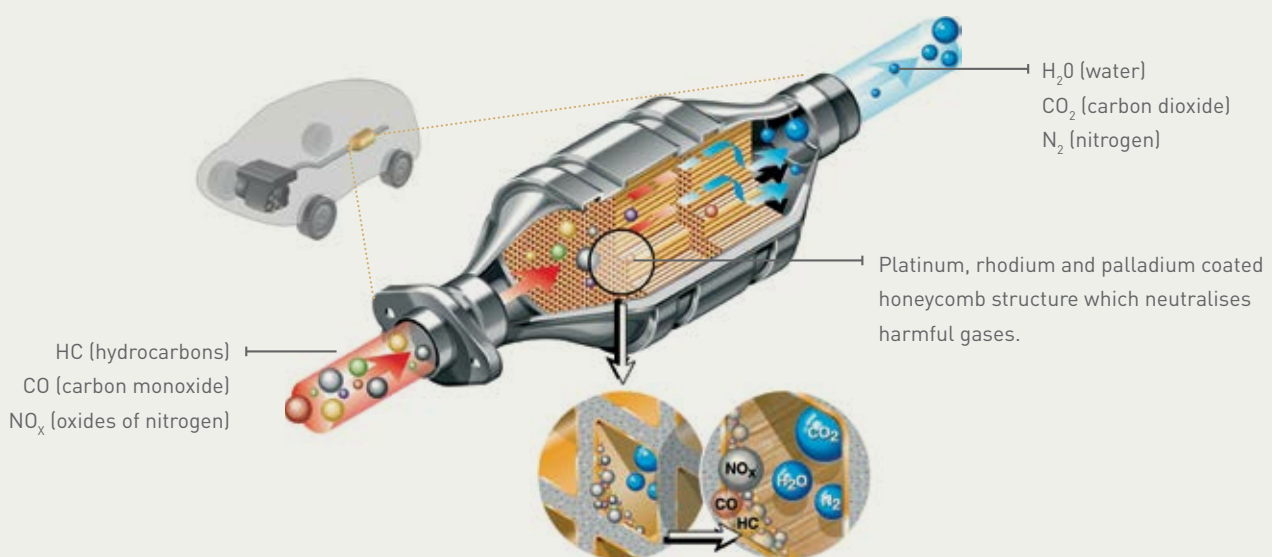
What is an autocatalyst?

An autocatalyst is a cylinder of circular or elliptical cross section made from ceramic or metal formed into a fine honeycomb and coated with a solution of chemicals and a combination of platinum, rhodium and/or palladium. It is mounted inside a stainless steel canister (the whole assembly is called a catalytic converter) and installed in a vehicle's exhaust line where it converts pollutants from the combustion of fuel into harmless gases.

Autocatalysts based on PGMs were first introduced in the USA on 1975 model year automobiles and in Japan in the same year for pollution abatement. Many other countries with large vehicle markets have followed since then.

Over 98% of new cars sold worldwide each year are now fitted with these devices and the automobile industry accounted for 51% of total world PGM demand in 2010.

In a catalyst system for gasoline engines, as exhaust passes through the device, the autocatalyst converts gaseous hydrocarbons, carbon monoxide and oxides of nitrogen into water, carbon dioxide and nitrogen. A catalyst system for diesel engines additionally employs a particulate filter to clean the emissions. The filter traps solid hydrocarbons in the form of soot, and is usually coated with PGMs to help to burn off the accumulated soot and regenerate the filter.



The structure and function of an autocatalyst
IMAGE CREDIT: UMICORE



What is an autocatalyst? CONT.

Without PGMs, the desired conversion reactions in the catalytic converter would not take place, resulting in the vehicle not meeting the emissions regulations. Other materials have been tried, but have not met the long term activity and durability requirements of modern-day emission control systems.

The activity of PGMs enables the reactions to occur at low temperature conditions that exist during cold starting of a vehicle, when emissions are at their highest. Durability is important since catalytic converters need to perform over the life of the vehicle. It also means that when an automobile is scrapped the precious metal contained in the catalytic

converter is available for recycling, creating a valuable supplementary supply source to mining for the production of new autocatalysts.

In typical European (EURO 5) emissions systems, a gasoline catalyst system contains between 2 grams and 3 grams of PGMs and a diesel system contains between 7 grams and 8 grams. However, catalyst manufacturers continue to improve the technology to make more efficient use of the PGMs, even as emissions regulations become more severe.

Autocatalysts help to avoid over 1.3 tonnes of toxic and harmful polluting gases

The effect of the use of catalytic converters in vehicle systems on human health can be quantified by the World Health Organization's (WHO) metric, Disability-Adjusted Life Year or DALY. A DALY is used to quantify the burden of disease or morbidity on human life. Based on this method, an LCA study conducted by the IPA has shown that over 1.3 tonnes of toxic and harmful polluting gases are avoided by the catalyst systems in one EURO 5 gasoline and one EURO 5 diesel vehicle in use over 160,000km, representing

7.86 days of healthy life gained assumed as days of healthy life per person.

Carbon dioxide (CO₂) is the final product of all combustion processes and the major contributor to climate change. Autocatalysts, although they generate some CO₂, do not increase overall carbon emissions from cars. These emissions can only be limited by reducing the amount of fuel used.

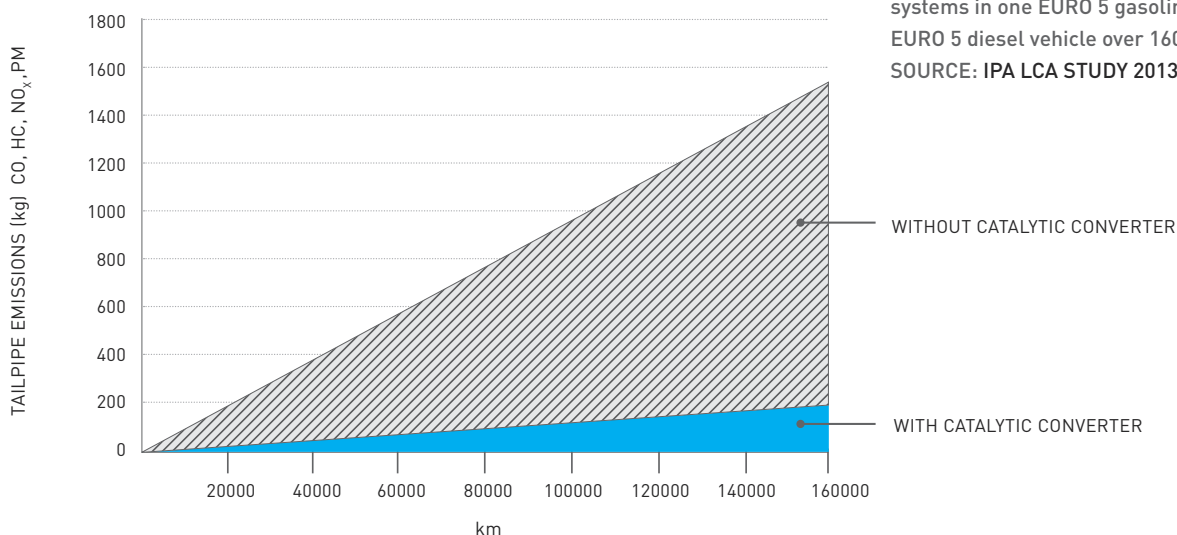


FIGURE 1
Over 1.3 tonnes of toxic and harmful polluting gases are avoided by the catalytic converter systems in one EURO 5 gasoline and one EURO 5 diesel vehicle over 160,000km
SOURCE: IPA LCA STUDY 2013

Avoided harmful emissions

CO

CARBON MONOXIDE

Carbon monoxide is a poisonous gas that displaces oxygen from the blood. At high concentrations it is fatal; at lower concentrations, it can exacerbate heart problems.

HC

HYDROCARBONS

Hydrocarbons help to form photochemical smog in the atmosphere. Some HCs, such as benzene, are known carcinogens.

NO_x

OXIDES OF NITROGEN

Oxides of nitrogen react with hydrocarbons in sunlight, forming ozone and photochemical smog. NO_x can increase respiratory illnesses and is a contributor to acid rain. Ozone causes breathing difficulties and damages plants.

PM

PARTICULATE MATTER

PM consists mainly of soot particles with volatile hydrocarbons and some sulfate and metallic residues from the fuel and engine lubricant. There is evidence that fine and ultra-fine particles are linked to increased rates of premature death from causes such as cardiovascular and lung diseases.

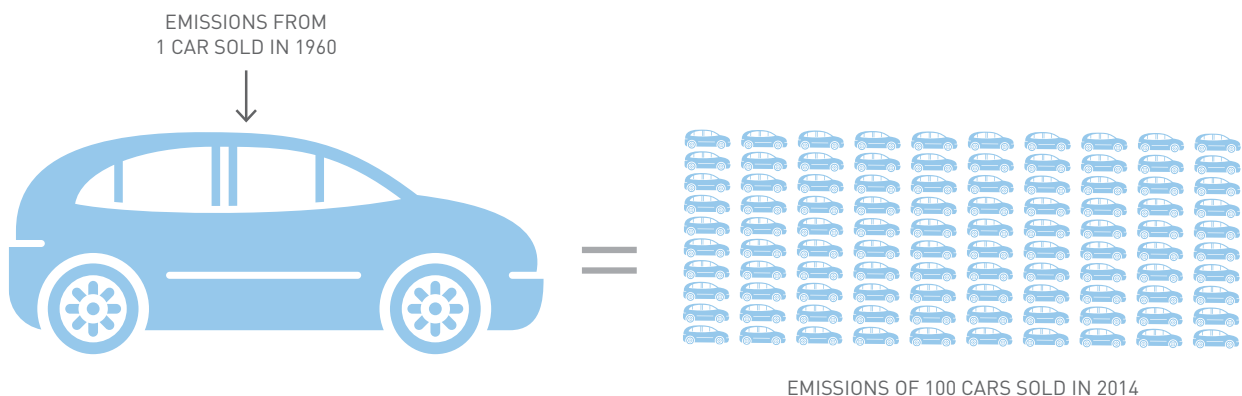


Latest WHO mortality data indicates that outdoor air pollution in both cities and rural areas was estimated to cause 3.7 million premature deaths worldwide in 2012. The WHO estimates that 80% of outdoor-air pollution-related premature deaths were due to ischaemic heart disease and strokes, while 14% of deaths were due to chronic obstructive pulmonary disease or acute lower respiratory infections; and 6% of deaths were due to lung cancer.¹

PGMs support emissions regulations

Due to the catalytic properties of PGMs it has been possible for legislators to mitigate the effects of exhaust pollution from increasing numbers of vehicles on our roads. Emissions regulations have been progressively tightened to the extent that just one car sold in the 1960s would have produced as many harmful exhaust emissions as one hundred of today's automobiles equipped with catalytic converters.

This tightening will continue in the future. For example, EURO 6 regulations for light duty diesel vehicles, which start in 2015, require more than a 50% reduction in NO_x emissions over the current EURO 5 regulations. For gasoline engines, the California LEV III (SULEV III) regulations, which also start in 2015, require more than a 70% reduction in CO emissions compared to the US Federal Tier 2 Bin 5 regulations.



Additional benefits of catalytic converters

The increasing use of catalytic converters required the introduction of more sophisticated engine control technologies. These have allowed automobile manufacturers to design engines for higher fuel efficiency, promoting a continuous rise in fuel economy which will continue to be important as manufacturers strive to meet more demanding fuel economy and CO₂ regulations.

Sulphur in gasoline and diesel fuel has a major negative impact on catalyst performance and also contributes to the mass of particulate matter (PM). The effect of sulphur on catalyst performance becomes more critical as lower tailpipe emissions are targeted and the loss of

catalyst efficiency caused by sulphur in the fuel has a greater impact at the very low emissions levels required in the most advanced emissions regulations. For this reason European legislation has limited on-road and non-road fuel sulphur content to 10ppm (max.). In the US, the limit is 15ppm (max.) for diesel and will be 10ppm for gasoline when EPA Tier 3 regulations take effect from 2017.

In addition, because the catalyst is poisoned by lead, the introduction of catalytic converters on vehicles helped bring about the elimination of lead-containing gasoline additives, which were found to be a serious health hazard.

Over 98% of new cars sold worldwide each year are fitted with catalytic converters and autocatalysts account for 51% of total world PGM demand.

Catalytic converters reduce outdoor air pollution in both cities and rural areas which was estimated by the WHO to cause 3.7 million premature deaths worldwide in 2012.

Over 1.3 tonnes of toxic and harmful polluting gases are avoided by the catalytic converter systems in one EURO 5 gasoline and one EURO 5 diesel vehicle in use over 160,000km, representing 7.86 days of healthy life gained.

For more information on autocatalysts and emissions regulations, please visit:

Association for Emissions Control by Catalyst
www.aecc.eu

Manufacturers of Emission Controls Association
www.meca.org

PLATINUM GROUP METALS
THE POWER TO IMPROVE LIVES



ABOUT THE IPA

The IPA is a non-profit organisation representing 80% of the mining, production and fabrication companies in the global platinum group metals (PGM) industry, comprising platinum, palladium, iridium, rhodium, osmium and ruthenium.

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