



The way of the future:
**Bosch technology for propane
gas and natural gas engines**



BOSCH

Invented for life

Technology with history and a future: Gas as a fuel is coming back

The prototype car: Gas-driven

Did you know that the gas-driven car has a longer history than its gasoline-driven cousin?

In 1862 Etienne Lenoir built the first gas-driven vehicle, providing the technological archetype for the later development of diesel and gasoline automobiles.

The idea of propelling a car with gas remained alive, and some work was done on the concept, but the auto industry focused on diesel and gasoline fuels – until recently.

Rapid development

Today, gas has once again become an important automotive fuel, and its use is growing rapidly. Numbers from Germany alone show this clearly:

- ▶ In 2004 there were 30.000 gas vehicles
- ▶ In 2006 it had gone up to 70.000
- ▶ In 2008 there are already 240.000 vehicles in Germany that run on gas.
- ▶ In 2015, according to prognoses, there will be over a million gas-driven cars in Germany.

Gas filling stations are spreading rapidly

as well, from just 600 in 2004, to over 1.000 in 2006, to around 3.800 today. Here again, the trend is for rapid growth.

Modern workshops are keeping up: Prepared for a new era



New opportunities: A clean environment with gas-fueled vehicles



New opportunities: Attractive business with gas fuel

The market of the future: Gas vehicles

The key facts: Gas-driven cars are injecting new life into the spark plug business. Gas combustion is harder on spark plugs, so they need to be changed considerably more often – every 15.000 kilometers for standard plugs or 30.000 kilometers for platinum plugs. Ignition cables need to be in top condition, and need to be checked and if necessary replaced at every spark plug change.

Gas-driven cars will become increasingly important for the aftermarket businesses. This is a sure thing. The growth of gas as a fuel has several reasons:

Gas vehicles are cost-efficient

- ▶ Gas costs less than diesel or gasoline. Right now propane gas is around 70 euro cents cheaper per liter than premium gasoline in Germany.
- ▶ In Germany, natural and propane gas get a tax break until December 31, 2018.
- ▶ Many regional gas suppliers offer premiums or rebates to customers who buy new vehicles with natural gas capability.

Gas vehicles are environmentally friendly

- ▶ Natural gas (CNG) cars emit about 25% less CO₂.
- ▶ Propane gas (LPG) cars emit about 18% less CO₂.
- ▶ Just the propane cars registered in Germany right now save 235.000 tons of CO₂ (source: TÜV Rheinland Group)

Gas vehicles are efficient

- ▶ The high-octane numbers of natural and propane gas allow better use of the knock limit, for more dynamic performance.

Gas vehicles are safe

- ▶ Gas tanks are less of a fire hazard than gasoline tanks.
- ▶ Under high heat or in a fire, gas escapes and burns off in a controlled manner.
- ▶ Gas tanks cannot explode.

Other benefits

- ▶ Almost all gasoline-engine cars can be easily converted to gas fuel.
- ▶ The conversion costs are quickly recouped by the lower cost of the fuel.
- ▶ Filling is just as simple as with gasoline.
- ▶ Today, in Germany there is a complete network of gas filling stations.

For your workshop, this means:

By extending your services to include gas engines, you can open up new market opportunities.

Two versions of the same principle:

Natural gas and propane gas



Natural gas expertise: Bosch supplies all important components

Different substances: CNG and LPG

Gas vehicles can take one of two different kinds of gas, natural gas or propane. The two cannot be mixed. Different nozzles at filling stations prevent motorists from fuelling with the wrong gas.



Natural gas

(Compressed Natural Gas, CNG)

- ▶ From own wells or as a by-product of oil wells
- ▶ The main component is the hydrocarbon methane, CH₄
- ▶ Octane number 130, stored at a pressure of about 200 bar, lighter than air
- ▶ Energy density : 1 kilogram natural gas equals about 1.5 liters gasoline
- ▶ Primarily used in original equipment gas vehicles



Propane gas

(Liquefied Petroleum Gas, LPG)

- ▶ By-product of crude oil refineries
- ▶ Mix of propane and butane
- ▶ Octane number 115, stored in liquid form at a pressure of around 8 bar, heavier than air
- ▶ Does not turn into a gas until it is in the engine
- ▶ Liquifies at low pressure
- ▶ Energy density: 1 liter LPG equals about 0.85 liters gasoline.
- ▶ Ideal for retrofitting

For gas and gasoline: Flexible-fuel vehicles

Flexible-fuel vehicles have two fuel tanks, and the driver can switch between gas and gasoline power with a dash board switch. As a rule these cars have higher range than single-fuel cars, and performance differences are barely noticeable.

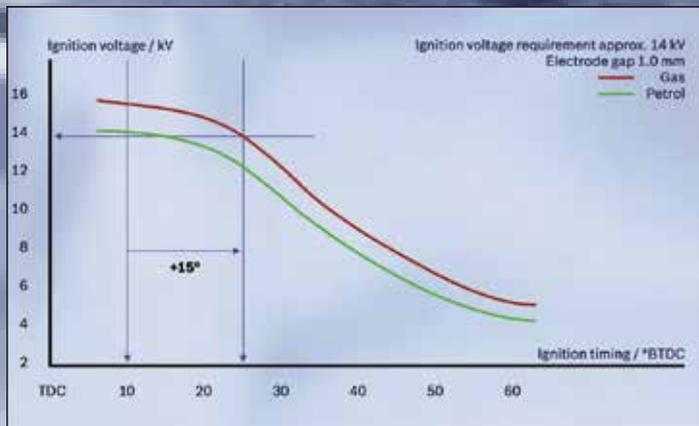
Important: To ensure proper functioning of the gasoline injection valves, every 2.000 kilometers the car should drive at least 150 continuous kilometers gasoline-only.

Optimized for natural gas: Single-fuel vehicles

Single-fuel gas vehicles are gas-only, but have a small emergency tank that holds about 14 liters of gasoline, to keep them going another 100 kilometers or so if gas isn't available. Being purpose-designed for natural gas, the engines are more efficient than flexible-fuel engines.

A solid partner for gas: Bosch is one of the leading OEM suppliers for natural-gas vehicles, with virtually all of the important components, like natural gas injectors, control units, pressure and temperature sensors, tank shut-off valves, and pressure control modules.

Show what you can do: GSP and GAP certificates



Certified expertise: License to convert to gas

Conventional inspections and service can be done by any workshop – as long as they don't work on the gas components.

Gas conversions can be done by licensed individuals. Such individuals get a "certified gas workshop" seal. There are two types of inspection:

GSP – Gas system installation inspection

The gas system installation inspection must be done by the shop after installation of a retrofit system.

GAP – Gas system inspection

Along with the main vehicle inspection, as well as after any unusual events such as fire, accident, or replacement of components.

Small difference: Higher spark voltage needed

It's all about voltage: Different sparks for different fuels

Whether flexible-fuel or single-fuel, whether gasoline or gas, all spark-ignition engines work in the same basic way. Thus, today almost any gasoline engine can be easily and economically converted. However, a few things do change:

Higher voltage requirements

Gas engines need higher spark voltage than gasoline engines. Where a gasoline engine might need 14 kV, the same engine but with gas fuel would need 16 kV.

Combustion chamber temperature

When gasoline enters the combustion chamber, there is evaporative cooling. This cools the spark plug and other components ("charge cooling"). Since gas is not a liquid, it burns dry, so there is no charge cooling effect. That means the combustion chamber and spark plug electrode are hotter.

These two factors accelerate spark plug wear, so plugs need to be changed more often.



Bosch offers testing at the Plochingen Service-Training-Center.

Interested in getting a Bosch inspection certificate for your workshop?

For further information visit
www.werkstattportal.bosch.de

Always the right fit:

Bosch spark plugs for gas vehicles

As an automotive technology pioneer, Bosch feels a responsibility to provide for gas fuel vehicles. Accordingly, we have the right products for practically any vehicle.



Most likely to succeed: Bosch spark plugs for gas vehicles

Ideal for the purpose:

Bosch spark plugs for purpose-built gas vehicles

A clear choice:

The quality of the spark plugs is fundamental to the reliability, efficiency, and life of an engine. Bosch works with leading car makers in the development of gas-fuel vehicles. As OEM, Bosch has therefore developed spark plugs that are ideal for series-built gas engines.



Convert to quality:

Bosch spark plugs for retrofit gas vehicles

Your expertise counts:

Manufacturers of gas conversion kits usually can't give definite information on the right spark plug. This is where your expertise comes in:

Sometimes the higher voltage needed for gas is automatically provided by a special gas engine control unit, if an early ignition adjustment is integrated.

But usually, the rule is:

- Choose a spark plug with an electrode gap of 0.7 mm, or adjust the gap accordingly

You can find the right spark plugs, marked especially for gas operation, in ESI[tronic] or in the Bosch spark plug catalog. Or ask your wholesaler.

Here is a selection of popular car models:

You'll find the exact specifications in the Bosch spark plug catalog.

Vehicle	Model	Gasoline-engine spark plug		Platinum spark plug for gas engines	
		Type designation	Order number	Type designation	Order number
Audi	A6 2.4	FR 7 KPP 332	0 242 235 776	FR 6 KI 332 S	0 242 240 653
BMW	740i	FR 7 KPP 332	0 242 235 776	FR 6 KI 332 S	0 242 240 653
Ford	Mondeo 1.8	HR 7 KPP 33+	0 242 236 563	HR 6 KI 332 S	0 242 240 656
Ford	Galaxy 2.3	FR 7 KPP 33U+	0 242 236 544	FR 6 KI 332 S	0 242 240 653
Mercedes	E280	YR 7 MPP 33	0 242 135 509	YR 6 NI 332 S	0 242 140 515
Opel	Astra 1.6	FQR 8 LEU	0 242 229 699	FR 7 KI 332 S	0 242 236 571
Opel	Zafira 1.8	FLR 8 LDCU+	0 242 229 654	FR 7 KI 332 S	0 242 236 571
Peugeot	307 1.4	VR 8 SC+	0 242 129 510	VR 7 SI 332 S	0 242 135 517
Renault	Espace 2.0 16V	FR 7 DPP+	0 242 235 749	FR 6 KI 332 S	0 242 240 653
Volvo	V70 2.4	FGR 7 DQE+	0 242 235 748	FR 6 KI 332 S	0 242 240 653
VW	Sharan 1.8T	FR 7 KPP 33+	0 242 236 564	FR 6 KI 332 S	0 242 240 653

Precious metal for impressive performance: Bosch platinum spark plugs



Platinum spark plugs: Precious material, high quality, long life

Higher quality for higher demands: Going platinum

Platinum is the most precious metal in the world – about five times as expensive as gold. And not only is platinum much rarer and costlier than gold, it is also much harder. Of all the precious metals, it is the least conductive to heat and electricity, and has the lowest heat expansion. What's more, it is very corrosion-resistant.

The special Bosch platinum spark plugs have a very carefully manufactured center electrode with a platinum-iridium alloy. This makes them very wear-resistant and much less sensitive to chemical effects in the combustion chamber. They have a much longer life, making them ideal for gas engines.

Benefits at a glance:

- ▶ Optimum ignition characteristics and long life
- ▶ Higher sparking efficiency
- ▶ Very resistant to material erosion
- ▶ Center electrode just 0.6 mm thick
- ▶ Perfect flame front propagation to all sides

Important:

The replacement interval of Bosch platinum spark plugs is at least 30.000 kilometers instead of 15.000 like with normal plugs.

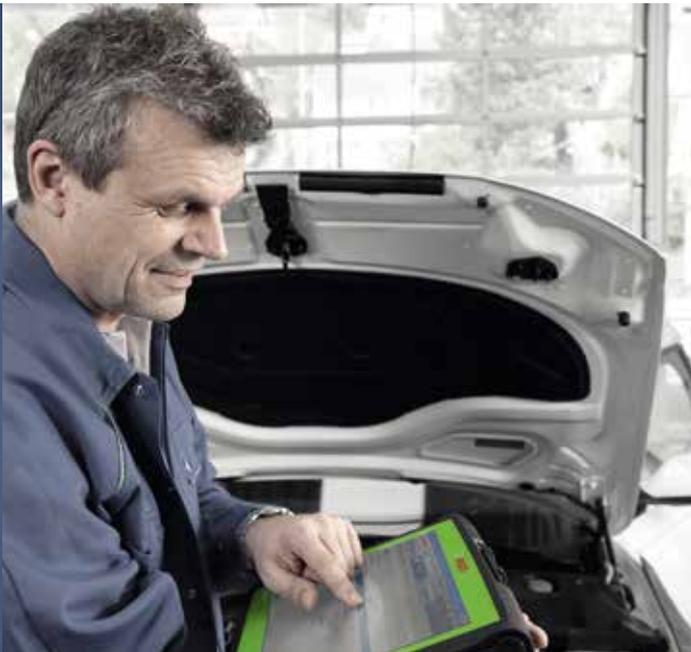
Platinum-iridium alloy

Platinum-iridium alloys are used in mechanical engineering, medicine and precision measurement.



No-problem changes:

Tips for replacing spark plugs



A handle on everything: Check the ignition, replace the spark plugs



Quality in the details: Spark plug cap by Bosch

Flexible-fuel: Special requirements for spark plugs

A spark plug that has to ignite a gasoline-air mixture as well as a gas-air mixture is subject to special requirements. It is particularly important that the ignition voltage reaches the plug

Removing and replacing spark plugs – a checklist

- ▶ Before removing the old plug, always clean the cylinder head.
- ▶ First screw in the new plug, then tighten to the correct torque with a torque wrench.
- ▶ Before putting on the spark plug cap, apply insulation paste (1 987 123 010) directly to the connector.

The spark plug connector is a potential trouble spot – check it

- ▶ Misfires due to faulty plug connector.
- ▶ Small cracks and resulting poor plug connector sealing can lead to high-voltage sparkover.
- ▶ Higher stress on the ignition coil due to contact resistance on plugs and ignition wires.
- ▶ If a spark plug cap is faulty, replace it.

What to tell your customers

Some important factors depend on the spark plugs, including

- ▶ Ignition reliability
- ▶ Protection of engine and catalytic converter
- ▶ Fuel economy and emissions



Make good contacts:

Tips on ignition cables



Quality connections: Bosch ignition cables for all applications



NGI2 injector

The key to full engine power: The ignition system

Retrofitted cars that were originally designed for gasoline will need 100% ignition system performance for gas operation. Gas engines need higher ignition voltage. This means the ignition system has to work at its upper performance limits. For workshops this means that ignition components of retrofitted vehicles need special attention. Some tips:

Before testing:

The engine should be in good mechanical condition.

Step 1: Visual check

To ensure proper functioning of the ignition system, pay attention to the following:

- ▶ Ignition cables must be in good condition and be neither worn nor damaged:
 - No tears
 - No contamination, as for example salt
 - No bends or worn spots (due to pulling, pushing, or rubbing)
 - No high-voltage breakdown
- ▶ All connections must be perfect and tight.

Step 2: Functional testing

- ▶ The ignition system can be tested with an engine tester or oscilloscope.
- ▶ The measured ignition voltage should correspond to the target voltage given by the vehicle manufacturer.
- ▶ Is anything out of the ordinary? Then replace the corresponding ignition cable or component.

Please note:

Especially with older resistance ignition wires, the inside lead can break. The entire ignition cable set should be replaced. Bosch offers ignition cables for all applications.

Ideal for bi-fuel engines: NGI2 injectors

Bosch has specially developed NGI2 injectors for the injection of natural gas for vehicles that are optionally operated with gasoline or natural gas. They are part of the complete injection and engine management system, and are characterized by a long service life and small size.

What to tell your customers:

If the ignition system is not performing at its peak, there are consequences for the engine:

- ▶ Rough running, misfires
- ▶ Significant drop in performance
- ▶ Increased fuel consumption
- ▶ Danger of damage to the lambda sensor and catalytic converter

For pure success:

Tips on lambda sensors



A clean solution: Lambda sensor by Bosch



The KTS 8 series: Complete solution for control unit diagnosis and vehicle system analysis

Important engine component for gas and gasoline engines alike: The lambda sensor

The lambda sensor is indispensable for reliable engine functioning as well as low exhaust emissions. Lambda sensors work in extreme conditions. Since with gas the exhaust can be hotter than it is with gasoline or diesel, conditions are even more extreme and lambda sensors must be repeatedly inspected during exhaust gas inspections. Some tips for measuring and testing lambda sensors:

Before inspection:

The engine must be in good mechanical shape and the fuel and ignition system must be in good condition. The induction system should be sealed and not pulling in any extraneous air.

What to tell your customers:

Incorrectly functioning lambda sensors lead to:

- ▶ Increased fuel consumption (up to 15% higher)
- ▶ Higher pollution
- ▶ Higher CO₂ emissions
- ▶ Rough running
- ▶ Creeping performance loss

Step 1: Visual check

- ▶ If there are any wire or contact breaks, corrosion, or other visible damage, the lambda sensor will definitely have to be replaced.

Step 2: Functional testing

- ▶ Heating resistance should not exceed the target values given in the trouble-shooting instructions of the ESI[tronic] (often smaller than or equal to 30 ohms).
- ▶ Then use an oscilloscope to test the sensor signal and test the reaction time of step type sensors.
- ▶ Connect the sensor output to the test instrument.
- ▶ Do not disconnect the sensor from the engine.
- ▶ Engine speed should be between 1,800 and 2,100 rpm, and a voltage jump between 0.1 and 1 volt should be detectable within a reaction time of about 300 milliseconds.
- ▶ Wide band sensors should be tested using the vehicle's own diagnostics.
- ▶ Does the lambda sensor fall outside of these values? Does it show problems when testing via on-board diagnostics? Then it should be replaced.

Bosch lambda sensors: Benefits at a glance

- ▶ The right wire length
- ▶ The right plug
- ▶ Pre-greased threads
- ▶ Proven OEM quality

Bosch ignition components for gas engines:

All the advantages at a glance

Top quality

- ▶ All of our ignition components are OEM quality and are factory-installed on new gas vehicles.
- ▶ Our platinum spark plugs have a high-quality platinum-iridium alloy for even better efficiency and longer life.

Wide product range

- ▶ We have the right ignition components for virtually every vehicle make and model.
- ▶ Our comprehensive product range covers over 90% of the market.

System expertise

- ▶ The Bosch product range includes all components for gas engines, and they are perfect matches for each other.
- ▶ Bosch offers training and certification for gas system installation inspection and gas system inspection.

Your address for genuine Bosch quality:

For more information visit:
www.bosch.com



We reserve the right to make specification and product changes without notice.

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