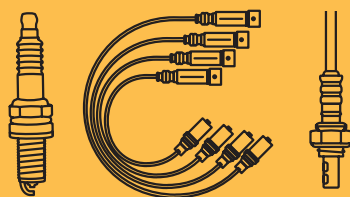




SPARK PLUGS · IGNITION CABLES · EXHAUST GAS SENSORS

Gas-powered engines: Ignition and exhaust technology



A market with a future: Gas-powered vehicles

Gas as a fuel: Ever more popular.

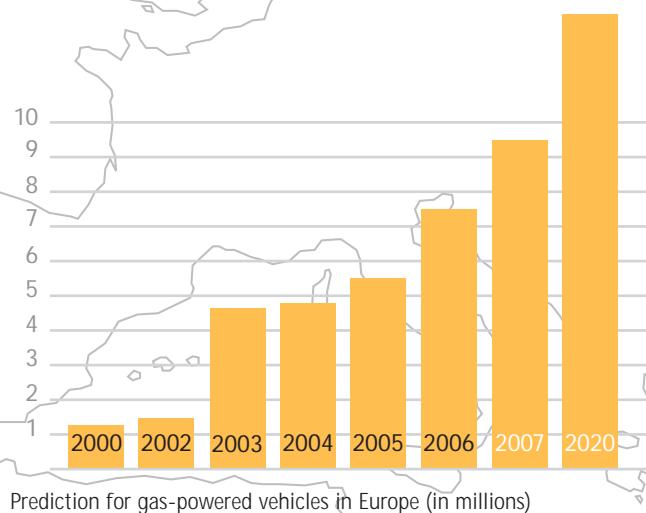
Increasing numbers of drivers are having their vehicle converted to gas operation. By the end of 2005, there were 5.5 million gas-powered cars on the roads of Europe. The total network of gas stations grew to 19,000 - and the trend is continuing sharply upwards.

An investment which pays off!

It makes no difference whether the owner decides on the liquid gas variant (liquefied petroleum gas, LPG) or on natural gas (compressed natural gas, CNG): The additional tank saves money and protects the environment. Pollutants which cause smog are reduced and the fuel is cheaper than petrol. The conversion therefore pays for itself in the long term.

A business area offering with much promise.

Many workshops are already specialising in this conversion. They must comply with DIN standards, as well as with guidelines for retro-fitting gas equipment. Furthermore – and above all – individual experience is important as is the exchange of information, because there are always questions which arise relating to conversion. For example, the correct spark plugs, but also the replacement of exhaust gas sensors and ignition cables. In the following pages you will read what needs to be taken into account in this area.



What spark plugs have to do during gas combustion

The igniting spark.

The basic facts are: the working principles of fuel ignition remain unchanged. Even in a dual fuel vehicle – powered by petrol or gas – the spark plug's job is to ignite the fuel mixture by means of a spark discharge.

The following is true: liquid gas is harder to ignite than petrol. In addition: liquid gas is more aggressive than petrol, so extremely durable materials are required to resist erosion. It is therefore recommended to use spark plugs which are equal to the special demands of combined operation.

The benefit of iridium:

As the leading supplier and developer of innovative spark plugs and exhaust gas sensors, NGK offers spark plugs which guarantee reliable ignition in converted engines. For many engines, there is a suitable spark plug in the NGK range. These spark plugs have laser welded centre electrodes using the precious metals iridium or platinum.

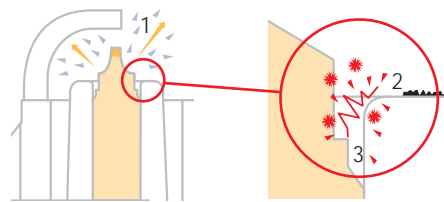
Spark plugs robust enough for dual fuel operation.

- Iridium and platinum are extremely resistant to erosion.
- In gas operation too, they guarantee optimum ignition properties over a long lifetime.
- The use of these precious metals allows a centre electrode with a diameter of only 0.6 mm.
- The ignition voltage requirement is reduced.
- The small diameter of the centre electrode enhances the optimum spread of the flame core in all directions.



The iridium centre electrode with its iridium tip of only 0.6 mm.

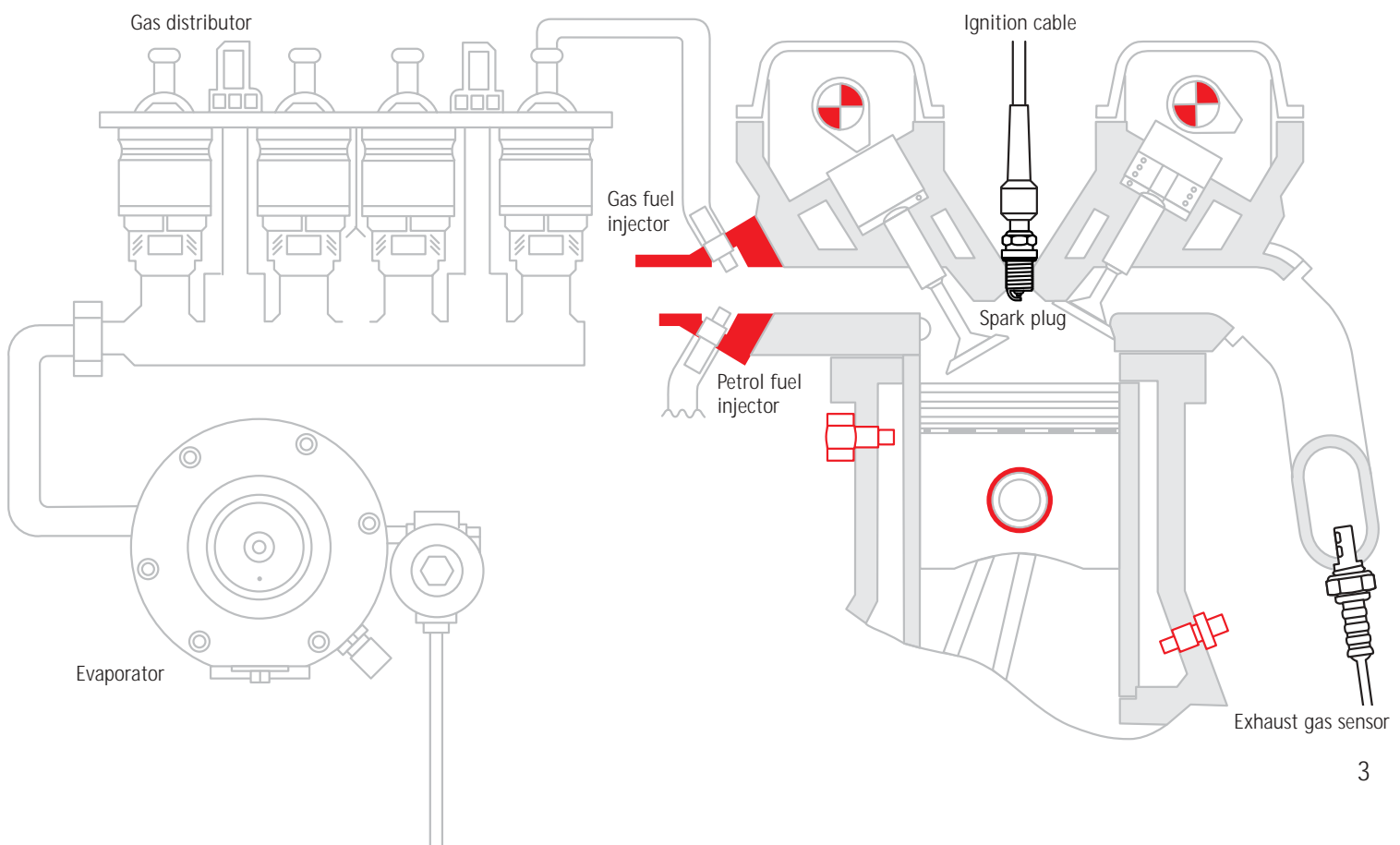
In brief: Iridium and platinum spark plugs enable reliable and environmentally friendly ignition – whether using petrol or gas.



No deposits in the annular gap.

- 1 Ignition sparks
- 2 Build-up of deposits
- 3 The deposits are burnt in the annular gap

How a gas-powered engine functions



Special spark plugs from NGK: Specifically developed for gas operation



Even spread of the
flame core

As well as the current iridium types, NGK now also offers special spark plugs for gas-powered vehicles. They are specifically manufactured for use in retro-fitted vehicles and have proven themselves in Japan for many years – for example in taxis, which are without exception gas-powered in that country.

It’s the plating that does it.

The spark plugs for use with gas are plated with a chrome alloy specifically developed by NGK for this purpose. It is able to resist the aggressive conditions of gas operation for longer than normal platings. At present for cars there is no other spark plug which can offer a similar plating.

Platinum and iridium: The dynamic duo.

In the same way as with standard iridium and platinum spark plugs, the special spark plugs for gas-powered cars also have a laser welded centre electrode using an iridium chip of only 0.6 mm diameter. In addition, the ground electrode is fitted with a platinum chip which further improves the durability and therefore the lifetime of the spark plug.

An overview of the special spark plugs:

- A particularly long life thanks to a special plating for the metal shell as well as electrodes of platinum and iridium.
- Reliable ignition and an even spread of the flame core.
- The best ignition properties also when operating with gas.
- Low ignition voltage requirement.
- In comparison with standard spark plugs, improved emission values also when operating with gas.

A word on installation.

There is no difference between installing a spark plug in a dual fuel engine and installing one in a normal engine. Before removing the old spark plug, the cylinder head should be cleaned. The new spark plug is then screwed in by hand and then tightened with a torque wrench to the correct torque setting.

In some cases it has proven effective when retro-fitting for gas operation to reduce the electrode gap slightly, 0.3 mm at the most, in comparison to the normal recommendation for petrol operation to facilitate the spark discharge.

Torque settings

	Spark plug with gasket					Spark plug with taper seat	
	18 mm	14 mm	12 mm	10 mm	8 mm	18 mm	14 mm
Cast iron head	34–45 Nm	25–35 Nm	15–20 Nm	10–15 Nm	–	20–30 Nm	15–25 Nm
Aluminium head	34–45 Nm	25–30 Nm	15–20 Nm	10–12 Nm	8–10 Nm	20–30 Nm	10–20 Nm



Iridium spark plug BPR6EIX-LPG



Zero tolerance: Ignition cables must function perfectly

Play safe.

In combined operation, the spark plug depends on optimum operating conditions to be able to ignite the gas. That means: The ignition voltage created must arrive without loss to the terminal nut of the spark plug. The ignition cable must therefore not display any wear, all connections must be perfectly seated and free of movement.

Some manufacturers of conversion kits even recommend that the ignition cables are changed in any case, just to be sure. Anyway they must be carefully inspected.

NGK: Always ready with a perfect solution.

In the NGK range, there is a perfectly matching cable set for every engine. From the length of the cable to the connections, every detail matches OE specification and therefore ensures trouble-free installation and removal, as well as highest quality in operation.



The exhaust gas sensor: The basis for clean running



Since as long ago as the early 1980s in cars with the spark ignition engine, catalytic converters have been in use. For these to be able to optimally convert the pollutants into environmentally acceptable gases, the engine requires at least one exhaust gas (lambda) sensor.

What does the Greek letter ' λ ' ('lambda') actually represent? In the world of Otto engines a value of $\lambda = 1$ represents the mixture of fuel and air at which the combustion is complete (stoichiometric mixture).

Whenever possible, every engine should run with a stoichiometric mixture. If this ideal mixture is present, the 3-way catalytic converter works at its most efficient and can almost completely convert the nitrogen oxides (NOx), hydrocarbons (HC) and carbon monoxide which are created at combustion.

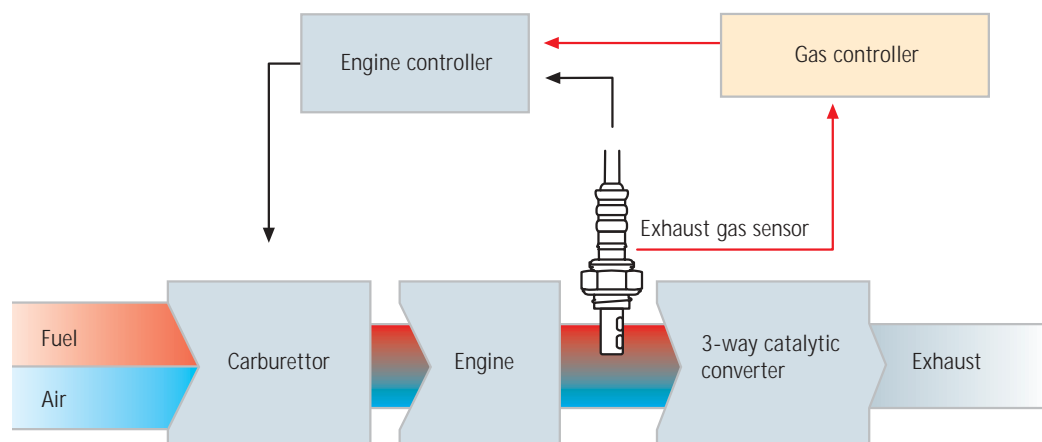
However, how can an engine or the engine control system know what mixture is currently present? This is where the exhaust gas sensor comes in – or to put it better: the exhaust gas sensors: For since the introduction of onboard diagnostics (OBD), there are two of them in the exhaust system of a

modern vehicle. The so-called control sensor upstream of the catalytic converter fulfils the task of creating the stoichiometric mixture. A further sensor (the monitor sensor) downstream of the catalytic converter is used for monitoring the whole system and the diagnostics. Both measure residual oxygen in the exhaust. The heart of this measurement is the ceramic element of the sensor, because it allows transfer of oxygen ions from about 300°C and therefore allows the measurement of the oxygen quantity.

For gas operation

For vehicles converted to gas operation, a conversion of the lambda signal is necessary. To ensure correct engine running, a special controller is used to adjust the lambda signal for gas operation. In general, the correct functioning of the exhaust gas sensor should be tested in advance, as old or sluggish sensors can cause problems later when the vehicle is running. The extreme thermal, chemical, and mechanical stresses can cause the exhaust gas sensor to fail.

How the exhaust gas sensor works:



Regular tests: Essential for gas operation.

First step: Visual check.

First the sensor is examined visually. Are there broken cables or damaged connectors, corroded contacts or other damage which can be seen? Then the sensor must be replaced.

Second step: Carry out measurements.

If no visible damage can be detected, the heating resistance is tested. It should not be more than $30\ \Omega$. The sensor signal and the reaction time are tested together using an oscilloscope. The sensor input is connected to the measuring unit by means of a connection device, but the sensor is not disconnected from the engine. At an engine speed of around 2000 rpm, a voltage range of between about 0.2 and 0.8 Volt should be displayed – in a reaction time of about 300 milliseconds. If the reaction time is longer, a replacement should be made.

Third step: Sensor replacement.

NGK has a suitable NTK brand sensor for nearly every car. NTK sensors are of identical construction to the sensor fitted as OE and are delivered ready to install. That means: connectors, cables, and technical properties are specifically selected for the given engine. There is no need for cutting to size or crimping. There is also a general operating certificate for each sensor.

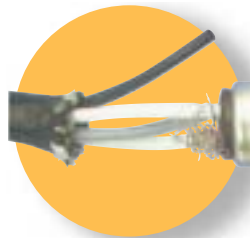


Diagnostics for exhaust gas sensors



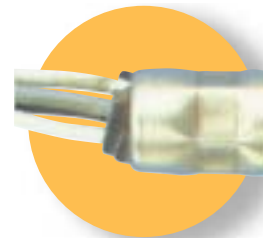
Cable and connector melted due to contact with the exhaust system

Solution: Replace the sensor and route the cable so that it does not touch the exhaust unit



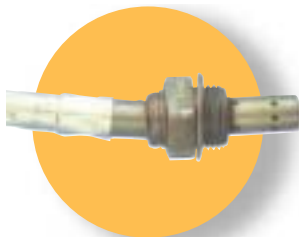
Frayed and broken cables

Solution: Replace the sensor and ensure some slack in the cable



Cable insulation has come away, water can get into the sensor

Solution: Replace the sensor and ensure some slack in the cable



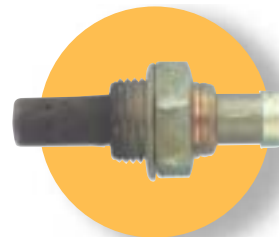
Sensor tube is snapped off

Solution: Replace the sensor



Water in the plug, contacts rusted fast

Solution: Replace the sensor. Check the electrical connections and the seal on the connector.



Soot deposits close the openings in the protective tube, e.g. because the mixture is too rich or high oil consumption due to engine and valve wear or leakages in the exhaust system.

Solution: Error diagnosis and correction.

NGK spark plugs: The right solution for the gas powered engine

- Three steps to installation:
1. Determine existing spark plug
 2. Find the alternative spark plug in the table*
 3. If necessary, reduce the electrode gap by 0.3 mm maximum

Cross-reference list: Which standard spark plug can be replaced by an iridium type?				
Original spark plug				IX-Type
BCP5ES BCPR5EY-11	BCPR5ES	BCPR5ES-11	BCPR5EY	BCPR5EIX-11
BCPR6E-11 BCP6ET	BCPR6E BCPR6E-11	BCPR6ES	BCP6ES	BCPR6EIX-11
BCPR7ES BCPR7ES-11	BCP7ET	BCP7ES	BCPR7ET	BCPR7EIX
BKR5EK BKR5EY	BKR5EZ BKR5E-11	BKR5E BKR5ES-11	BKR5ES BKR5EY-11	BKR5EIX
BKR6EKC BKR6EY	BKR6E BKR6E-11	BKR6ES BKR6ES-11	BKR6EZ	BKR6EIX-LPG
BKR7E				BKR7EIX
BP5ESZ BP5EY	BPR5ES BPR5EY-11	BP5ES BPR5ES-11	BPR5EY	BPR5EIX
BP6ES BPR6ES-11	BP6E BPR6EY-11	BPR6ES	BPR6EY	BPR6EIX-LPG
BP6HS	BPR6HS			BPR6HIX
BP7ES	BPR7ES			BPR7EIX
DCPR7E-N	DCPR7E			DCPR7EIX
ZFR5F	ZFR5F-11			ZFR5FIX-11
ZFR6F-11				ZFR6FIX-11

*** Please note:**

For LPG units based on the venturi system, spark plugs one heat range higher must be used (e.g. BKR5E => BKR6EIX-LPG).

For vehicles already factory fitted with high quality NGK platinum or iridium spark plugs, no other type needs to be used. If necessary adjust the electrode gap.



NGK SPARK PLUG EUROPE GMBH
Harkortstr. 41
40880 Ratingen
Germany
Tel. ++49(0)2102/974-000
Fax ++49(0)2102/974-149
www.ngk.de

