Tips & Technology
For Bosch business partners

Current topics for successful workshops No. 71/2013

Special topic

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Gas system test

In addition to alternative drive concepts, various approaches to the use of alternative fuels are also being considered. The term "alternative" does not relate to specific properties or advantages of a fuel, it is merely an indication that a substance is an alternative to conventional gasoline or diesel fuel. Alternative fuels include regenerative fuels obtained from biomass or with the aid of wind and solar power as well as fuels based on fossil energy resources.

Compressed natural gas and liquefied petroleum gas are two examples of alternative fossil fuels, in other words fuels based on organic carbon compounds.

Compressed natural gas (CNG)

Natural gas includes all gaseous hydrocarbon compounds which are found in the earth's crust and are combustible. The composition of natural gas varies. The main constituent of natural gas is methane (CH_4), in chemical terms therefore an organic compound made up of the elements carbon (C) and hydrogen (H). Natural gas is lighter than air and rises.

H-gas and L-gas

The general designations "High Caloric" and "Low Caloric" for natural gas were introduced to facilitate categorization of the methane content.

Categorization is based on the methane content of natural gas*:

- H-gas Methane content between 87 and 99.1 % by vol. — 1 kg of H-gas corresponds to approx. 1.5 ltr of premium gasoline
- L-gas Methane content between 79.8 and 87 % by vol. — 1 kg of L-gas corresponds to approx. 1.2 ltr of premium gasoline

*Source: http://www.gibgas.de/Fakten/Mobilität/H und L-Gas

L-gas has a lower methane content than H-gas. This means that the consumption rate is higher with L-gas than with H-gas, however L-gas tends to be available at a much lower price than H-gas. As compared to gasoline, even L-gas provides more power and is less expensive: the energy content of approx. 1.2 liters of premium gasoline corresponds to that of 1 kg of group L natural gas.

At filling stations, the following symbols are used to indicate the type of gas.
L-gas is on offer primarily in northern Germany.

Liquefied petroleum gas (LPG)

International designations:
- *Autogas*
- *LPG* = "Liquefied Petroleum Gas"
- *GPL* = French "Gaz de Pétrole Liquéfié", also known as GPL-C (GPL-Carburant)
- GLP = Italian "Gas Liquido Propano", Spanish "Gases Licuados del Petróleo" (GLP Automoción)
- *Motorgas*, *Bilgas*, *Gasauto*, *INA PLIN*, *Probugas*

More than 60 % of the liquefied petroleum gas used in the world is obtained from natural gas fields. The hydrocarbon fractions (propane, butane, propene, butene,...) are extracted from the "wet natural gas" to enable the natural gas (methane) to be transported through pipelines. This means that LPG is just as much a "natural product" as natural gas. The rest of the liquefied petroleum gas on offer is obtained in the course of petrochemical processes in refineries (in gasoline and diesel production for example).

LPG is a mixture of propane (C_3H_8), propene (C_3H_6), butane (C_4H_{10}) and butene (C_4H_8) which turns to liquid at a pressure of roughly 8 bar, thus reducing its volume to 1/260th of the original volume. An approx. 1.6 - 11 % by vol. mixture of liquefied petroleum gas and air results in the formation of an explosive, readily flammable gas. Non-compressed LPG is heavier than air and can form a highly explosive "gas puddle" on the ground in the event of an accident.

In Germany it consists of roughly 95 % propane, the rest being made up of propene, butane, butene, etc. as per DIN 51622 = (95:5 mixture as also used in heating systems).

Many filling stations in Germany now also offer a mixture of propane and butane with a higher

butane content. (Note: According to EN589 any other mixture is possible). The warmer the climate where LPG is on sale, the higher the butane content. This means that a gas mixture made up of 45 % propane, propene and 55 % butane, butene can be sold in parts of France. These variable mixing ratios are necessary to prevent so-called "gelling" in the evaporator if exposed to very low temperatures.

Distinguishing features of CNG/LPG

		
CO_2 emissions per kg	1 kg methane (CH_4) = 2.743 kg CO_2	1 kg propane (C_3H_8) = 2.994 kg CO_2 1 kg butane (C_4H_{10}) = 3.028 kg CO_2
Measured values: CO_2 emissions (g/km) (as compared to gasoline operation) Gasoline: 205-222	165-175 = > 40-47 g Reduction by approx. 20 %	185-200 = > 20-22 g Reduction approx. 10 %
Explosive limits	4.0 and 16.0 % by vol.	Propane 2.1 and 9.5 % by vol. Butane 1.5 and 8.5 % by vol.
Knock resistance - Octane number	Methane: 120-130 (RON) / 120 (MON)	Butane: 103 (RON) / 89 (MON) Propane: 111 (RON) / 97 (MON)

Fuel tanks

Bivalent vehicles

Bivalent vehicles have two tanks and can run on both natural gas and gasoline. In other words, switching is possible at any time from gas to gasoline operation – convenient switching from

CNG/LPG to gasoline can be performed either automatically or by way of a button on the dashboard whilst driving.

The range of the vehicle is absolutely comparable to that of a conventional car, it is however usually much greater. Differences in performance with the various types of fuel are scarcely perceptible.

Monovalent vehicles

Monovalent vehicles run on one type of fuel only - either gasoline, diesel or ecological CNG. Monovalent CNG vehicles usually have an emergency tank for 14 liters of gasoline – which guarantees an additional standby range of around 150 kilometers if the need arises. This is the case if there is no CNG filling station in sight. The engines are specially geared to CNG operation. Engines optimized for gas/CNG have a higher compression ratio and are thus more efficient and more economical than bivalent versions.

Gas system testing

GSIT (gas system installation test)

The gas system installation test is to be performed after installing the gas system and adapting it to the mixture formation system in the vehicle.

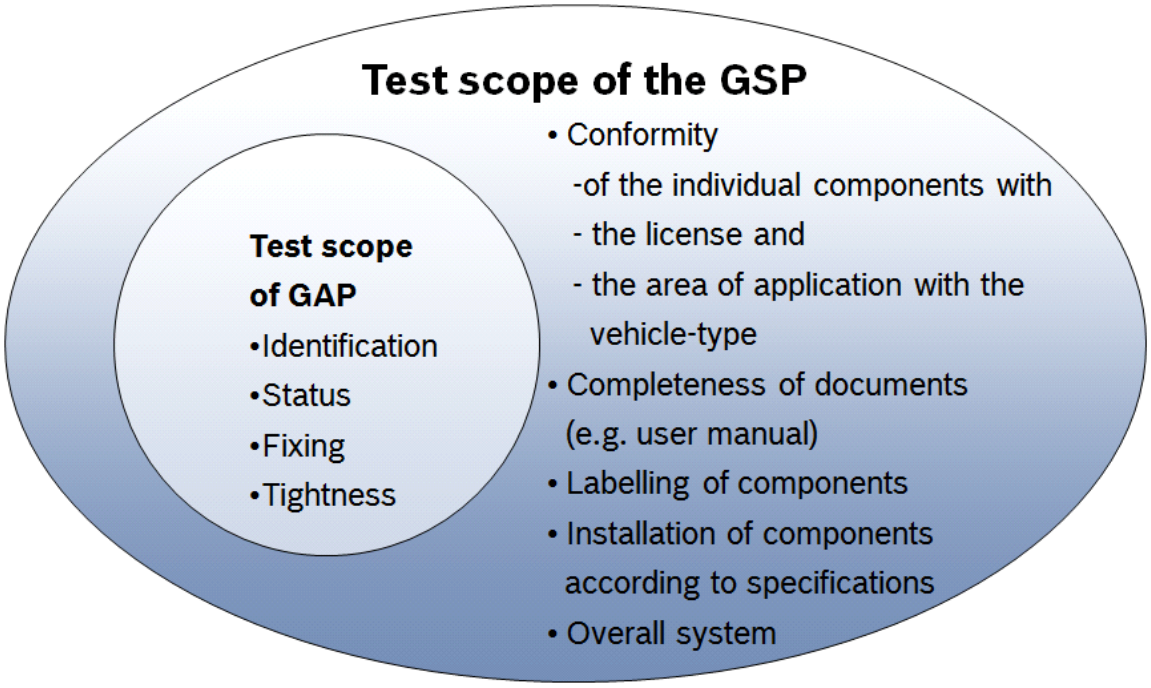
It can be conducted by authorized workshops and test agencies. Workshops are only allowed to carry out the GSIT if they were responsible for installing the system. A GSIT must be performed or GSIT verification furnished for individual expert reports as per § 21 StVZO (German Road Traffic Licensing Act). In the case of "ECE-approved" systems (ECE-R 115), the vehicle documents are amended by the registration authorities without the need for additional acceptance - on the basis of the "GSIT verification". The GSIT is only to be conducted by qualified personnel. Such personnel must furnish proof of GSIT training (acknowledgment procedure as for general inspection). GSIT workshop approval also incorporates GST authorization.

GST (other and recurring gas system testing)

The GST is to be performed at certain intervals (recurring) in conjunction with the general inspection (as a separate part of the general inspection, up to 12 months before the general inspection) and after particular events possibly affecting the safety of the gas system (e.g. repair work, collision or fire damage).

Scope of GST:
- Identification
- Condition
- Proper system attachment
- Freedom from leaks

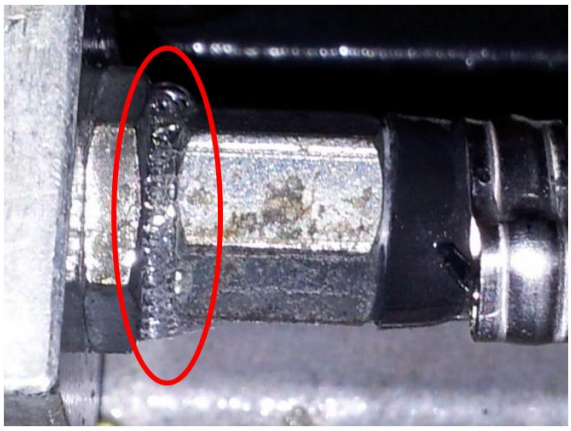
The GST can be conducted by authorized workshops and test agencies. All specialists and responsible personnel must furnish proof of GST training (acknowledgment procedure as for exhaust emission test/safety testing). Sole authorization as a GST workshop does not however include authorization to perform the gas system installation test (GSIT).



Gas system leak test

The system must be checked for leaks after particular events, fire, accident repair work and gas system maintenance. 2 options are available:

The first option is to spray the system with an approved GAS leak detector spray. After a waiting time of 10 minutes, there must not be any evidence of foam formation at the connections or pipes.



Within the red marking, foam formation can be seen at the gas pipe. This is an indication of leakage.

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The second leak test option involves the use of an HC leak detector to measure free hydrocarbons emerging from leaking pipes. The probe must be applied to all pipes and connections for this test.

Test prerequisite: The vehicle must have been running on gas to ensure that the entire system is filled with gas.

Use must be made of an H_2 leak detection tester for leak testing on hydrogen systems.

The display shows leakage at the connection.