Veritas

Veritas GLEVERLOC®

The threaded pipe fitting for vehicles powered by CNG, LPG and H_2

Veritas connects! People, products, functions

Connecting, sealing and transporting –
these are the functions performed by Veritas products in motor vehicles.
However, there is a lot more to this than you may initially think.

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1. Overview of fuels

CNG

CNG = compressed natural gas. Due to its structural formula, up to 30% less CO_2 is released when burning natural gas compared with petrol or diesel. It is a gaseous fuel which, unlike the fuels we are familiar with, does not have to be atomised. This leads to clean combustion without soot particles (fuel that has not been completely burnt) with much lower nitrogen oxide emissions.

In addition to being extracted from fossil deposits with a known total capacity of around 180 trillion cubic metres (enough for a statistical range of 59 years), natural gas can also be synthesised. This can, for example, be performed using previously surplus energy from regenerative sources. This approach (power to gas) is being pursued by vehicle manufacturers in Germany. Vehicles powered in this way can achieve theoretical CO_2 emissions of just 30 g/km, as CO_2 is taken from the atmosphere in order to produce the natural gas. Another advantage lies in the more effective utilisation of renewable energies, as existing power capacity surpluses can be stored effectively as synthetic natural gas in the existing gas pipeline network.

Any internal combustion engine is fundamentally suitable for use with natural gas. Most of the modifications required are in the field of fuel injection. However, since natural gas has a 30% higher octane rating (120 octane) than premium grade petrol, significant efficiency increases can be achieved with specially constructed natural gas engines.

LPG

LPG = liquefied petrol gas. LPG is essentially a mixture of propane and butane. Similarly to CNG, LPG produces fewer particulate and nitrogen oxide emissions during combustion due to its molecular composition. Using a vehicle powered by LPG also allows an average of 16% CO_2 to be saved over petrol powered vehicles[1]. LPG is a by-product of crude oil mining and is generally burnt off directly on-site for economic reasons (in 2011, some 140 billion cubic metres of refinery gases were flared off[2]). LPG is also a by-product of petrol and diesel refining processes. LPG is easier to use in conventional internal combustion engines than natural gas, as the storage pressures of 10 bar to 15 bar do not require high-pressure tanks.

H_2

H_2= hydrogen, which does not occur in its pure molecular structure in the atmosphere. As an energy carrier, hydrogen is well suited to releasing the energy expended during production (water electrolysis) in a internal combustion engine or a fuel cell. In addition to the benefits offered by fuels such as CNG and LPG, fuel made from hydrogen does not contain any carbons. As such, no harmful gases are produced during combustion, so it is often referred to as a "clean source of energy".

1 Including start-up petrol, HTW Saarland study.

2 Source: Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe, BGR)

2. Requirements of the connection

All aforementioned fuels have one thing in common: They are in a gaseous state at room temperature and atmospheric pressure. This means that their combustion is much cleaner than with liquid fuels. Exhaust gas after-treatment is then far less complex and expensive than it would be with a diesel engine.

However, these "gaseous" fuels require more powerful connection technology than liquid fuels:

1. All connections need to be gas-tight, i.e. the permitted leakage rate must be an order of magnitude lower than has been the case to date.

2. For servicing reasons, it is necessary to design these connections as multi-component units, so that the entire line system does not have to be replaced when performing service work.

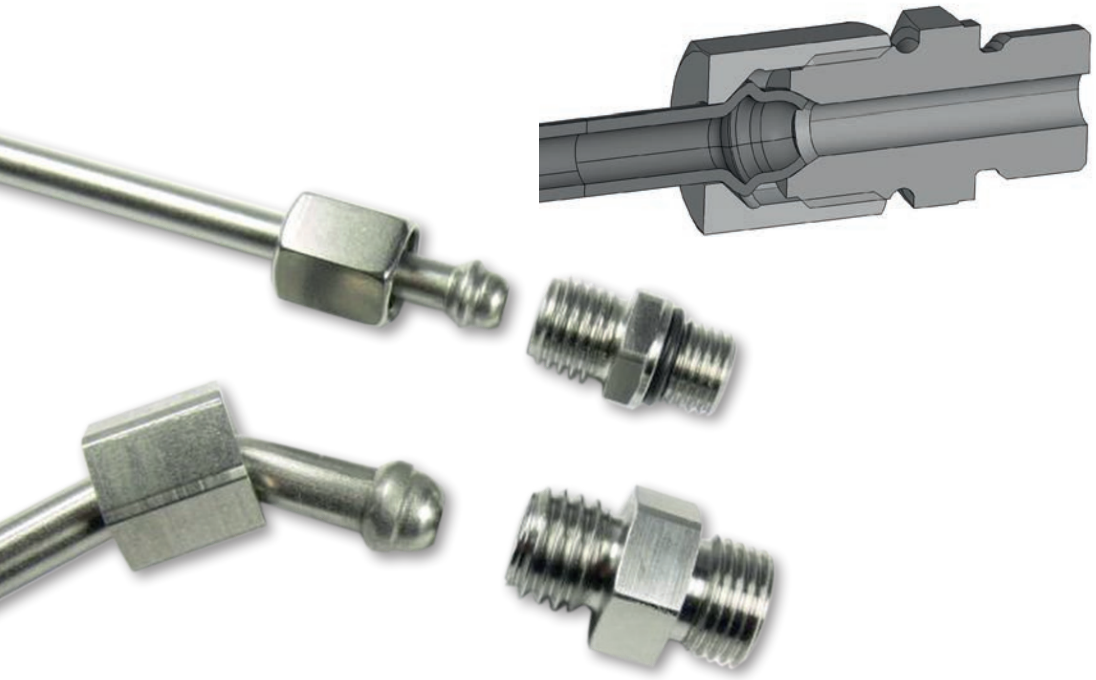
3. Connections of this type must not work loose in the event of a crash, as this would lead to combustible gases which are stored at extremely high pressure escaping uncontrollably.

With GLEVERLOC®, Veritas has developed a line and connection system that supports the sustainable development of individual mobility with a view to the fuels of the future.

Veritas GLEVERLOC®

3. GLEVERLOC® threaded pipe fitting

GLEVERLOC® is a threaded pipe fitting that is ideally suited for use with gaseous media. Manufacture of the sealing cone is particularly resource-friendly, as it is produced by forming a stainless steel pipe. No other clamping or cutting rings are required. A cap nut is all that is required to ensure a tight fit.



The Veritas ball seal allows axial offset between the pipe and the coupling without compromising the sealing function.

The fuel lines are pipe or hose lines for vehicles powered by gaseous alternative fuels such as CNG, LPG, or H_2. Low-pressure, medium-pressure or high-pressure lines are used, depending on the application. The medium-pressure lines with approval for use up to 30 bar consist of a hose section with adapted stainless steel threaded pipe fittings on the two ends. As they are used for pressures of up to 260 bar (CNG) or up to 700 bar (H_2), the high-pressure lines are made entirely of stainless steel pipe. Due to the systems used, multiple pressure ratings are applied in a vehicle. By guaranteeing extremely low leakage rates of 1*10-6 mbar l/s (He/N_2), the GLEVERLOC® threaded pipe fitting is a solution that is both affordable and reliable.

Main features of GLEVERLOC®

- robust
- long service life
- crash-safe
- can be used multiple times
- tolerance compensating
- economical

The lines are subject to approval as per the EU Directive. Veritas performs the requisite testing in-house and obtains approvals with an accredited partner.

Lines with GLEVERLOC® fulfil the requirements of ECE R 110 for compressed natural gas vehicles (CNG) and ECE R 67 for LPG vehicles.

4. Emissions legislation for passenger vehicles

For several years, there have essentially been four pieces of legislation, various versions of which are applied in all emerging and industrial nations.

CARB legislation > California, similar limits apply in New York, Massachusetts, Connecticut, Vermont, Rhode Island, Maine and New Jersey

EPA legislation > Rest of USA

EU legislation

Japanese legislation

The following table shows the binding laws and their entry into force worldwide.

Tab. 1: Emissions legislation

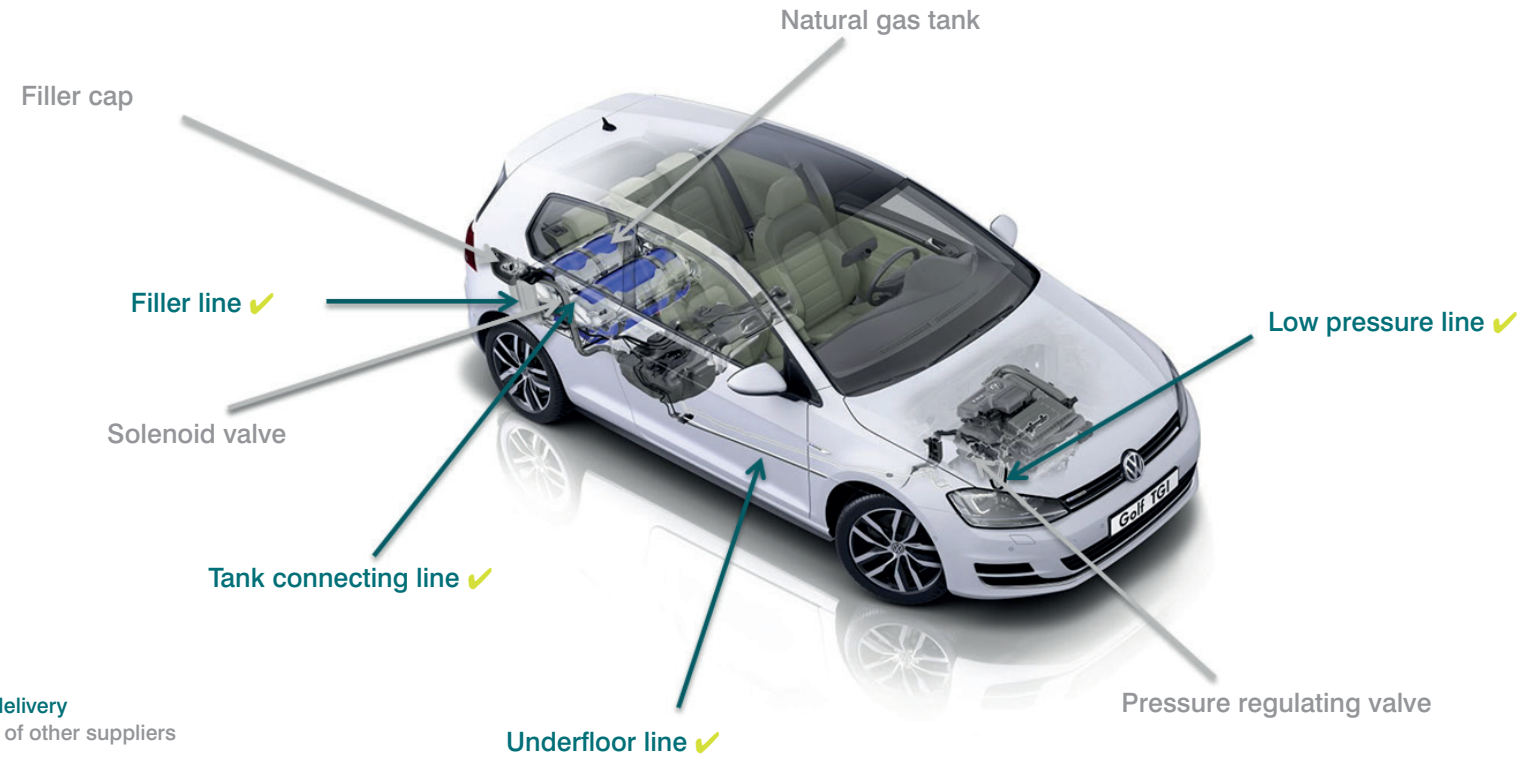
		2013	2014	2015	2016	2017	2018	2019	2020
Europe	Czech Republic	Euro 5				Euro 6			
	France	Euro 5				Euro 6			
	Germany	Euro 5				Euro 6			
	Hungary	Euro 5				Euro 6			
	Italy	Euro 5				Euro 6			
	Poland	Euro 5				Euro 6			
	Russia		Euro 4				Euro 5		
	Slovakia	Euro 5				Euro 6			
	Turkey		Euro 5				Euro 6		
	Great Britain	Euro 5				Euro 6			
China	Beijing					Euro 5			
	China		Euro 4				Euro 5		
	Taiwan					Euro 5			
Japan/Korea	Japan					Japan ´09			
	South Korea	Euro 5				Euro 6			
Middle East/ Africa	Iran					Euro 2			
	South Africa					Euro 4			
North America	Canada				Tier II, Bin 4			Tier II, Bin 2	
	Mexico - petrol	Euro 4				Euro 5			
	USA				Tier II, Bin 4			Tier II, Bin 2	
	USA California					LEV III			
South America	Argentina					Euro 5			
	Brazil - LCV diesel				Euro 5				Euro 6
	Brazil - petrol				Euro 5				Euro 6
South Asia	Australia					Euro 4			
	India - metropolitan region					Euro 4			
	India - rest					Euro 3			
	Indonesia					Euro 4			
	Malaysia					Euro 3			
	Thailand					Euro 4			

5. Application in vehicles

To comply with the legally prescribed emission values (Tab. 1, p. 7), manufacturers are bringing more and more vehicle models designed for alternative fuels to the market. Outside the discussion regarding purely electric drive systems, vehicles powered by CNG, LPG and H_2 are already in series production and making a genuine contribution to reducing emissions.

Veritas developed the GLEVERLOC® product line to actively support and promote this kind of environmentally friendly mobility.

The image below shows the specific assemblies and their position in the vehicle.

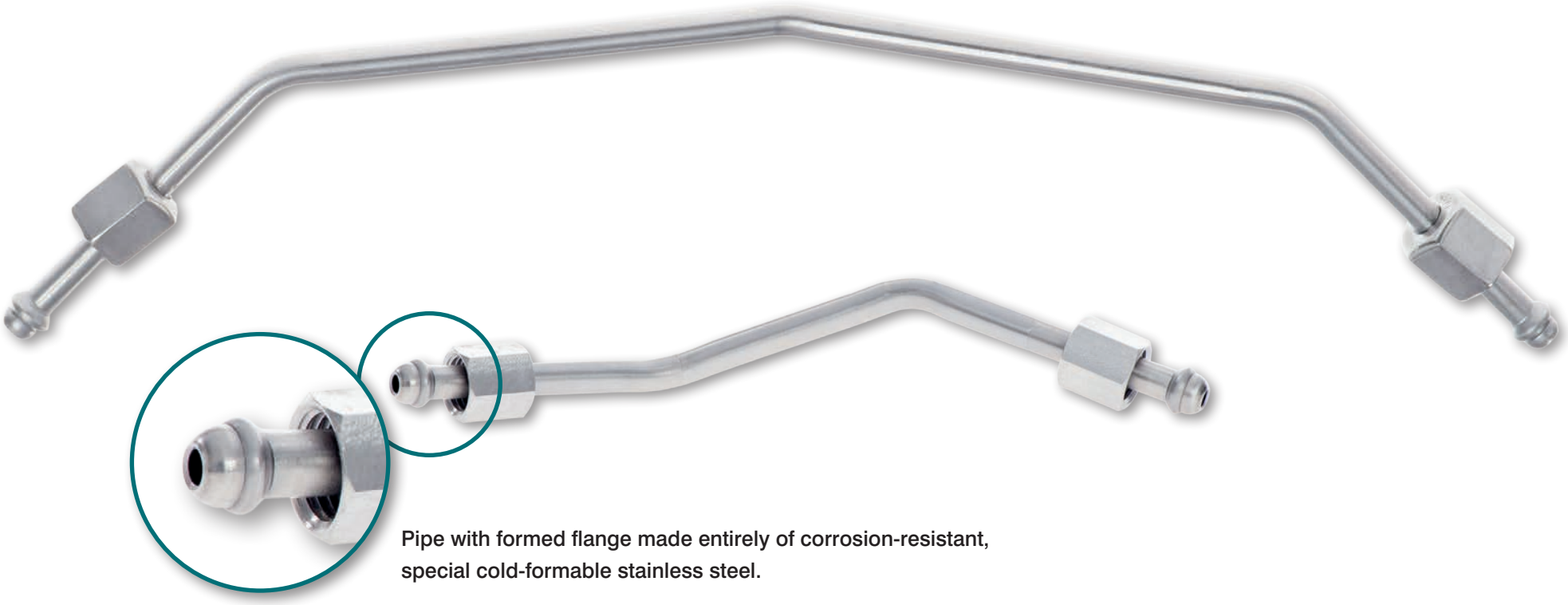


Veritas scope of delivery
Scope of delivery of other suppliers

Image: Volkswagen AG

6. Typical lines and materials

High-pressure line



Pipe with formed flange made entirely of corrosion-resistant, special cold-formable stainless steel.

Low-pressure and medium-pressure line

The flare connections on both sides correspond to those of the high-pressure line. The image shows the application with the Veritas G-Liner®.

Product Performance and Data Sheet

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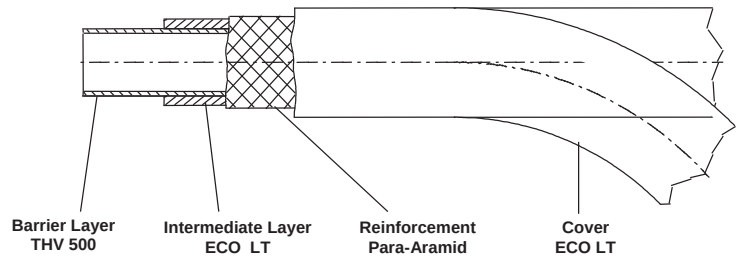
Product: **Veritas-G-Liner®**

Ultra Low Permeation Gas-Line Hose,



TECHNICAL PERFORMANCE

Dimensions	Burst Pressure	Operating Pressure
7.3 x 3.0 mm	>150 bar	0 – 30 bar
7.3 x 3.5 mm	>150 bar	0 – 30 bar

Temperatures:

Service:	< 125°C
Peak:	150°C
Cold Impact:	- 50°C

Medium:	CNG and LPG
Conductivity:	non conductive, optional conductiv
Licensure	ECE R110

Issue:	0	1	2	3	4	5
Date:	11.07.02	26.08.09				

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Veritas G-Liner elastomer hose®

When selecting materials for elastomer hoses, it is important to pay attention to the requirements, particularly those relating to permeability.

The Veritas G-Liner® – a patented Veritas hose with corresponding barrier layer – facilitates a minimum permeation rate which fulfils the requirements of EU standard ECE R 110.

7. Simulation and testing

Due to their requirements for gas tightness, "high system pressures" and low leakage rates, lines for alternative fuels must pass specific physical tests. These can be prescribed in parallel with series production or only during the development phase.

In addition to this, it is important to incorporate findings early on during development regarding the behaviour of the pipes in actual use. Tools for computer-based flow calculations, as well as tools for numeric simulation of component stress factors are used here. This makes it possible to gain information, for example regarding the flow characteristics or component strengths, before the actual line is even produced.

To give you an idea of what is being referred to here, the following pages list several tools for system design, simulation and testing, as well as the extensive testing equipment of Veritas AG required to perform the aforementioned fuel line tests.

Computational fluid dynamics (CFD)

Pressure loss calculations during refuelling, shown here as an example.

The formation of the sealing cone means that cross-sectional changes in the line system are unavoidable. This can lead to losses of pressure and flow. It is important to detect these during the development process and then reduce them as far as possible.

The images show a networked model, as required for flow simulation.

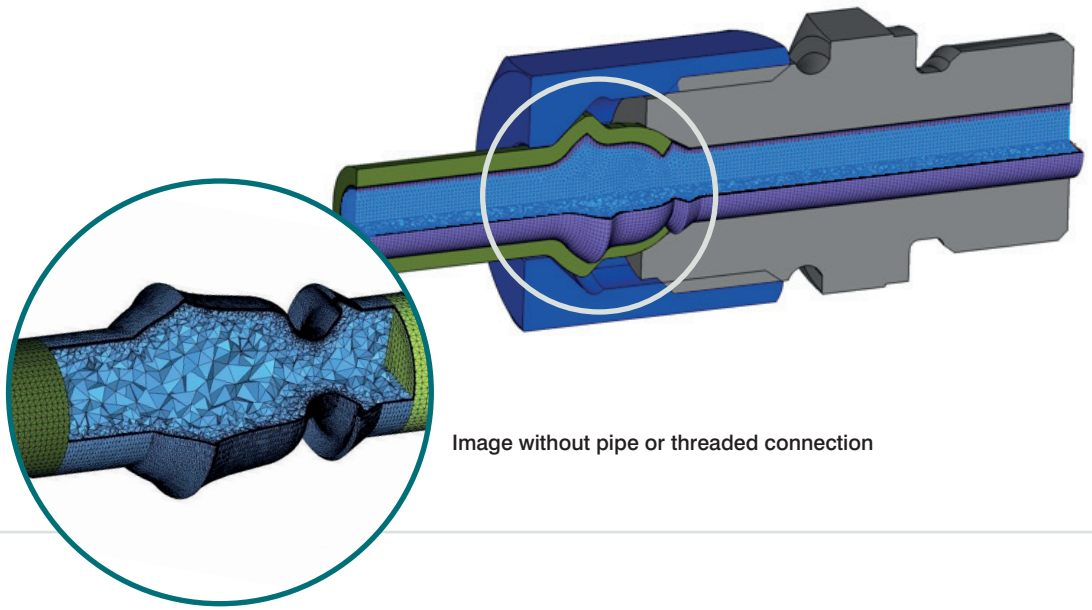
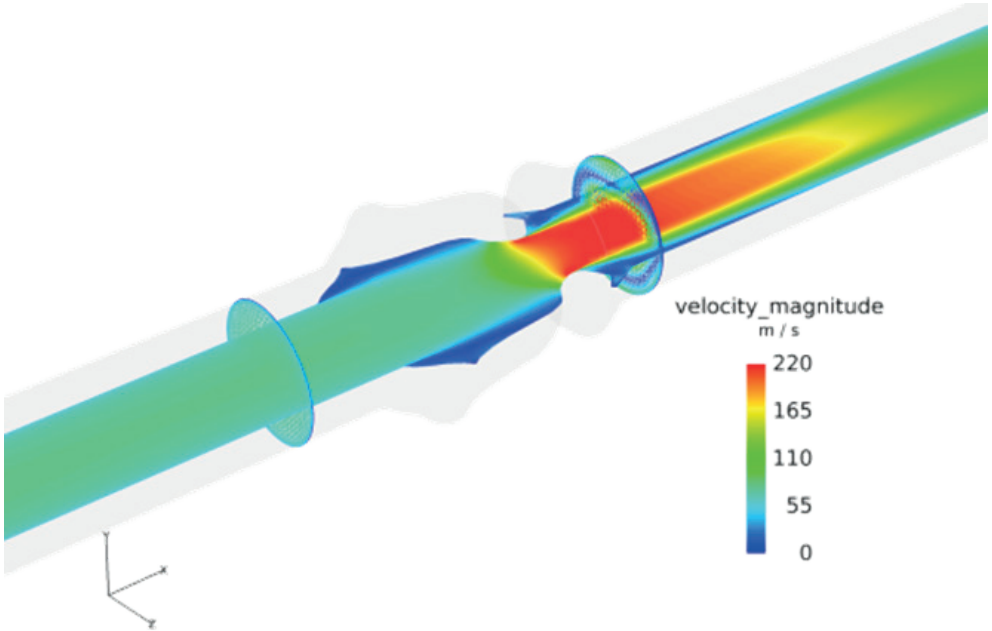
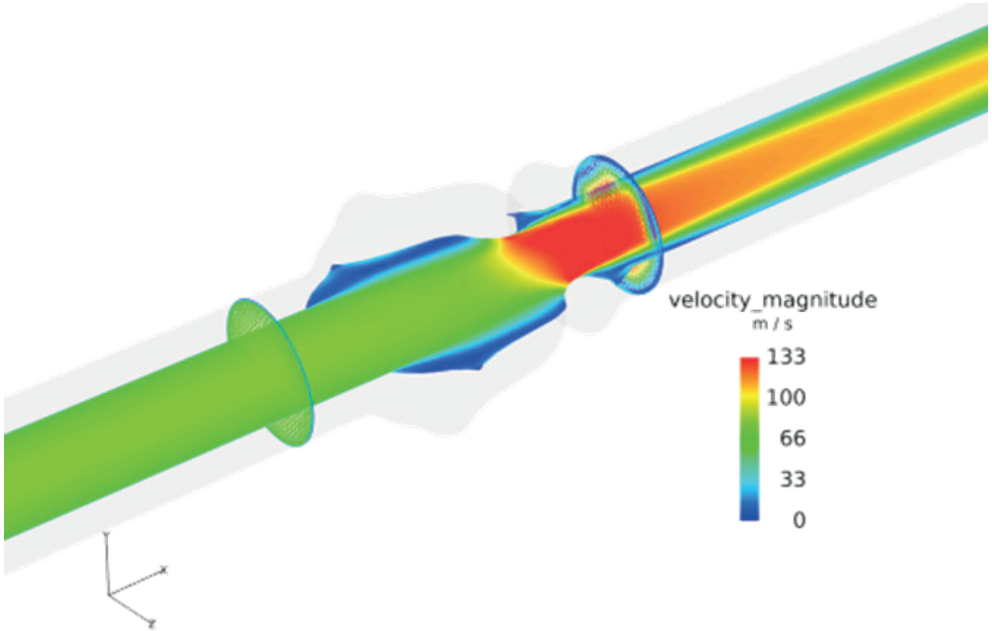


Image without pipe or threaded connection

Loss of pressure during refuelling



Small opening diameter



Large opening diameter

Enlargement of opening diameter by 0.5 mm

- » Reduces flow speed by 40%
- » Reduces pressure loss by 75%

Tests

During the development phase, comprehensive tests are to be performed on the threaded pipe fittings to guarantee proper functionality throughout the entire life cycle. The tests represent the life cycle (time-lapsed). The test requirements are the result of legal regulations and customer requirements (works standards and requirements specifications). They typically include tests for pressure changes, vibrations (shaker), burst pressure and leakage.

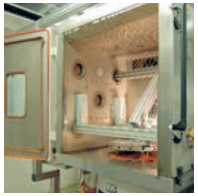
Overview of testing options at Veritas AG

High-pressure pulse testing system

For pressures of up to 4000 bar, max. testing frequency 15 Hz, 16 test connections

Burst pressure test bench

For pressures up to 1000 bar, test medium = water



Temperature change test bench with shaker

Temperature unit with electrodynamic shaker, chamber volume 1000 litres, chamber temperature -70 °C to +180 °C, for pressures up to 15 bar Vibration amplitude +/- 25.6 mm, frequency 5 Hz to 3000 Hz, max. acceleration 60 g

CT test bench

Computer tomograph for measuring parts and non-destructive component testing

Helium leak testing system

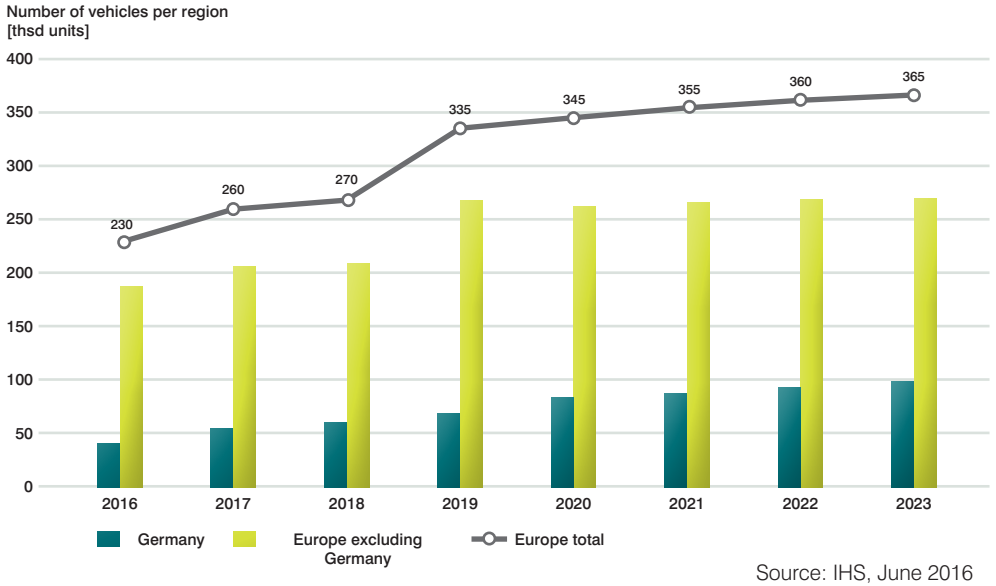
Detection limit 10 to the power of -7 mbar l/s

8. Outlook

The proportion of vehicles with CNG, LPG and H_2 drive systems is on the rise in the European market.

Production figures for vehicles powered by alternative fuels in Germany/Europe for 2016 onwards.

Here: CNG, LPG, H_2 (fuel cell) vehicles



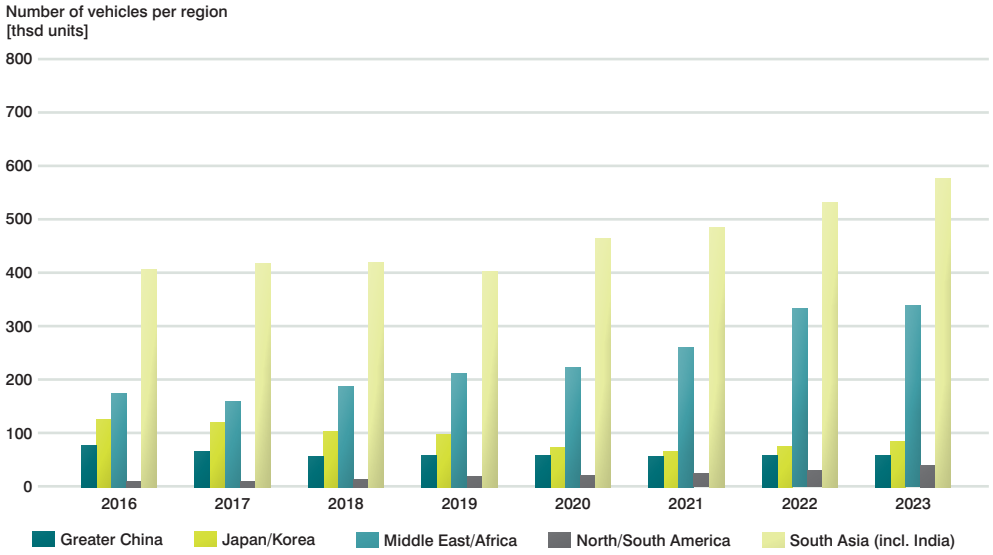
Source: IHS, June 2016

These vehicle types are already making an important contribution to reducing emissions on our roads. The technologies are in series production and available in virtually all vehicle segments. Although they are designed for different fuels, these vehicles can use the same Veritas line type with GLEVERLOC®.

Let us now take a look at market trends worldwide. Outside Europe, the proportion of vehicles with H_2 drive systems is fairly insignificant. The vast majority of alternative-fuel vehicles are powered by gas.

Worldwide production figures for vehicles powered by alternative fuels (excluding Europe) up to 2023.

Here: CNG, LPG, H_2 (fuel cell) vehicles



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