Service Training

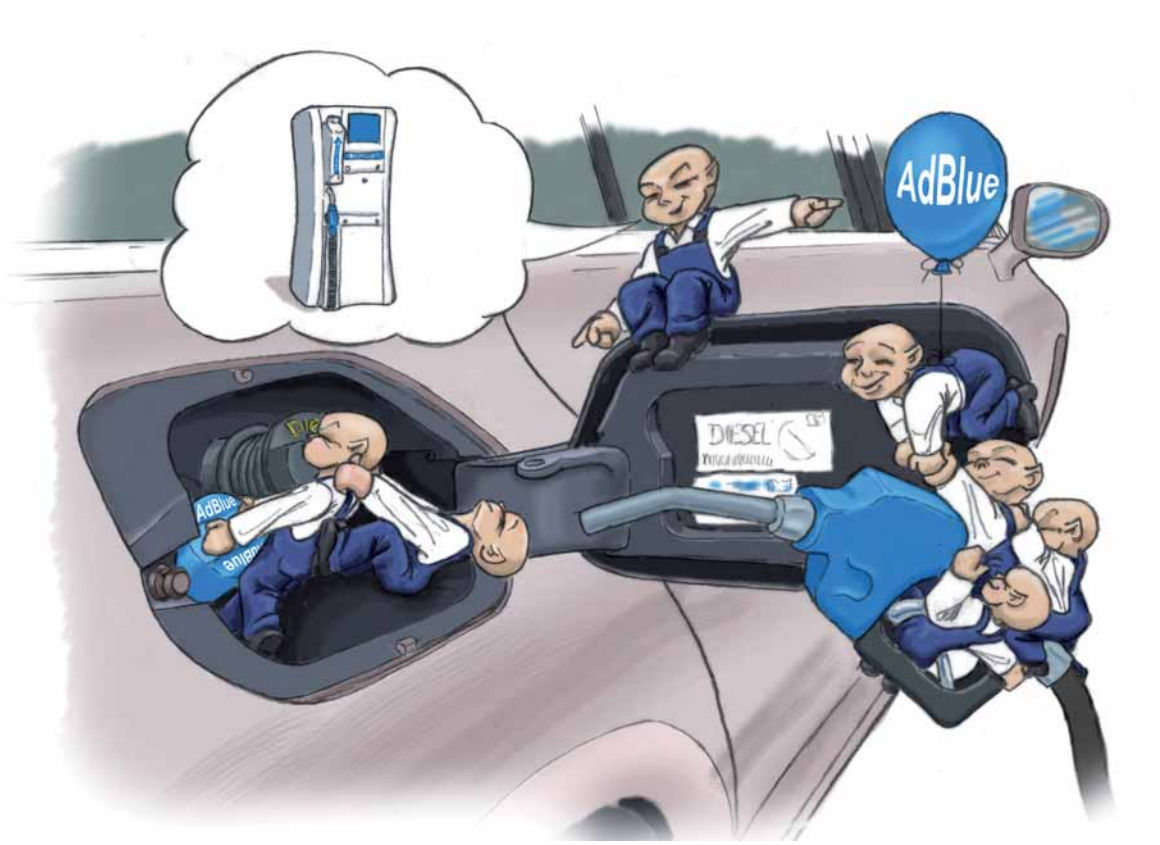
Self-study Programme 540

SCR Exhaust Gas Treatment in the Passat 2015

Design and Function

Across the globe, lawmakers and authorities are progressively lowering the limits for nitrogen oxide levels in motor vehicle exhaust gases. One key technology in reducing nitrogen oxide emissions is the “selective catalytic reduction” exhaust gas treatment system (SCR system). Volkswagen started using this exhaust gas treatment system in cars as early as 2009 with the “Passat BlueTDI”. At the time, this model already fulfilled the strict nitrogen oxide limits set by the EU6 emission standard, which came into force in Europe in September 2014. The SCR system has been enhanced and optimised to adapt the exhaust gas treatment system to the requirements of the new EA288 diesel engine family and to also meet future challenges in reducing emissions.

This Self-study Programme will provide you with information about the new features of the SCR system using the Passat 2015 as an example.



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The Self-study Programme shows the design and function of new developments.
The contents will not be updated.

For current testing, adjustment and repair instructions, refer to the relevant service literature.

Important note

Contents

Introduction

Nitrogen oxides and the EU6 emission standard

"Nitrogen oxides" is a collective term for chemical compounds containing nitrogen (N) and oxygen (O_2). They include, for example, nitrogen monoxide (NO) and nitrogen dioxide (NO_2). These compounds are formed when high pressure, high temperatures and excessive oxygen are present during combustion in the engine. Nitrogen oxides are partly responsible for the so-called acid rain that causes damage to forests.

Smog is also attributed to nitrogen oxides among other things. Cutting nitrogen oxide emissions from diesel engines was a key issue in the transition from the EU5 to the EU6 emission standard. The EU6 emission standard came into force in Europe in September 2014. It has set the limit for nitrogen oxides in exhaust gas at 0.08 g/km. The content is therefore over 50% lower compared with the EU5 emission standard.

Concepts for reducing nitrogen oxides

In order to comply with the strict emission standard limits, we can employ numerous technologies that prevent the formation of nitrogen oxides during the combustion process. The level of nitrogen oxides that is present in the exhaust gas after combustion can be reduced further with an exhaust gas treatment system. At Volkswagen, this includes the use of an NO_x storage catalytic converter or the selective catalytic reduction system (SCR system).

Which system is used depends on the vehicle concept, the vehicle weight and the associated assessment of the inertia class in the type approval tests. The inertia class is used to set the resistive force that the vehicle has to overcome on the dynamometer during the type approval.

The following technical measures ensure that as few nitrogen oxides as possible are produced during combustion before an exhaust gas treatment system makes its contribution to reducing nitrogen oxides:

- Configuring the inlet and exhaust ports in the cylinder head for optimum flow
- High injection pressures to ensure a good mixture formation
- Optimising the combustion chamber design with the piston recess geometry
- Low compression ratio
- Exhaust gas recirculation to reduce the amount of oxygen in the combustion chamber and thus lower the peak combustion temperature

Exhaust gas treatment with an NO_x storage catalytic converter

If the exhaust gas is treated with an NO_x storage catalytic converter, the oxidising catalytic converter in the emission control module will have an additional coating. This allows the nitrogen oxides from the exhaust gas to be stored during lean operation.

The engine is run with a rich mixture at regular intervals to regenerate the NO_x storage catalytic converter. The nitrogen oxides stored in the NO_x storage catalytic converter are converted into carbon dioxide and nitrogen.

The function of the NO_x storage catalytic converter is described in Self-study Programme no. 526 “The EA288 Diesel Engine Family with EU6 Compliance”.

Exhaust gas treatment with an SCR system

One effective way of reducing nitrogen oxide emissions is using an SCR system to treat the exhaust gas. The abbreviation SCR stands for Selective Catalytic Reduction. This system specifically reduces the nitrogen oxides in the exhaust gas. The nitrogen oxides (NO_x) contained in the exhaust gas react with ammonia (NH_3) to form nitrogen (N_2) and water (H_2O). This chemical process takes place in a reduction catalytic converter.

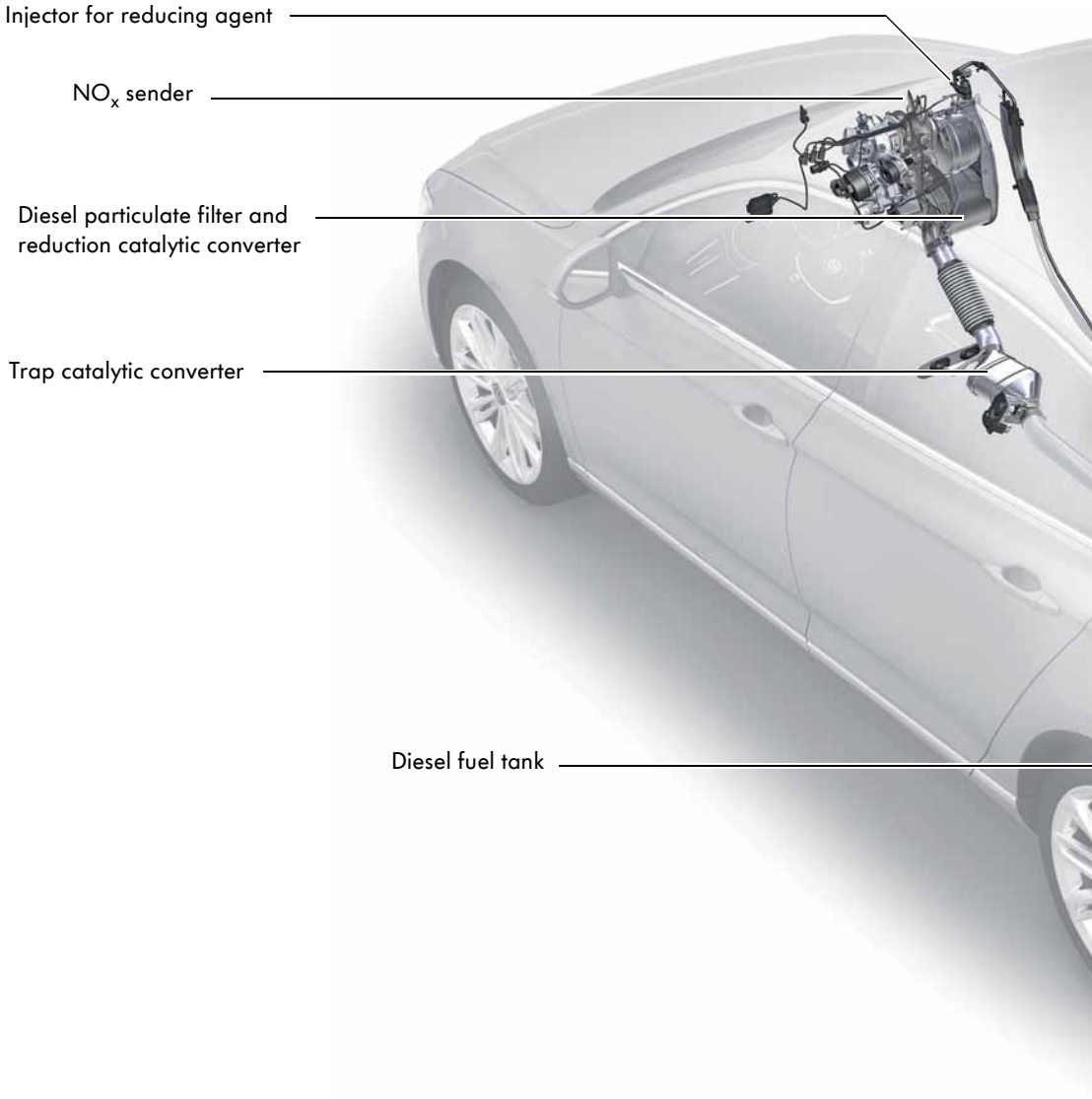
The ammonia required for the reduction process is supplied by a urea solution, the AdBlue® reducing agent. The reaction is assisted by the heat contained in the exhaust gas. The AdBlue® reducing agent is carried in an extra tank in the vehicle and is constantly injected into the flow of exhaust gas in front of the reduction catalytic converter.

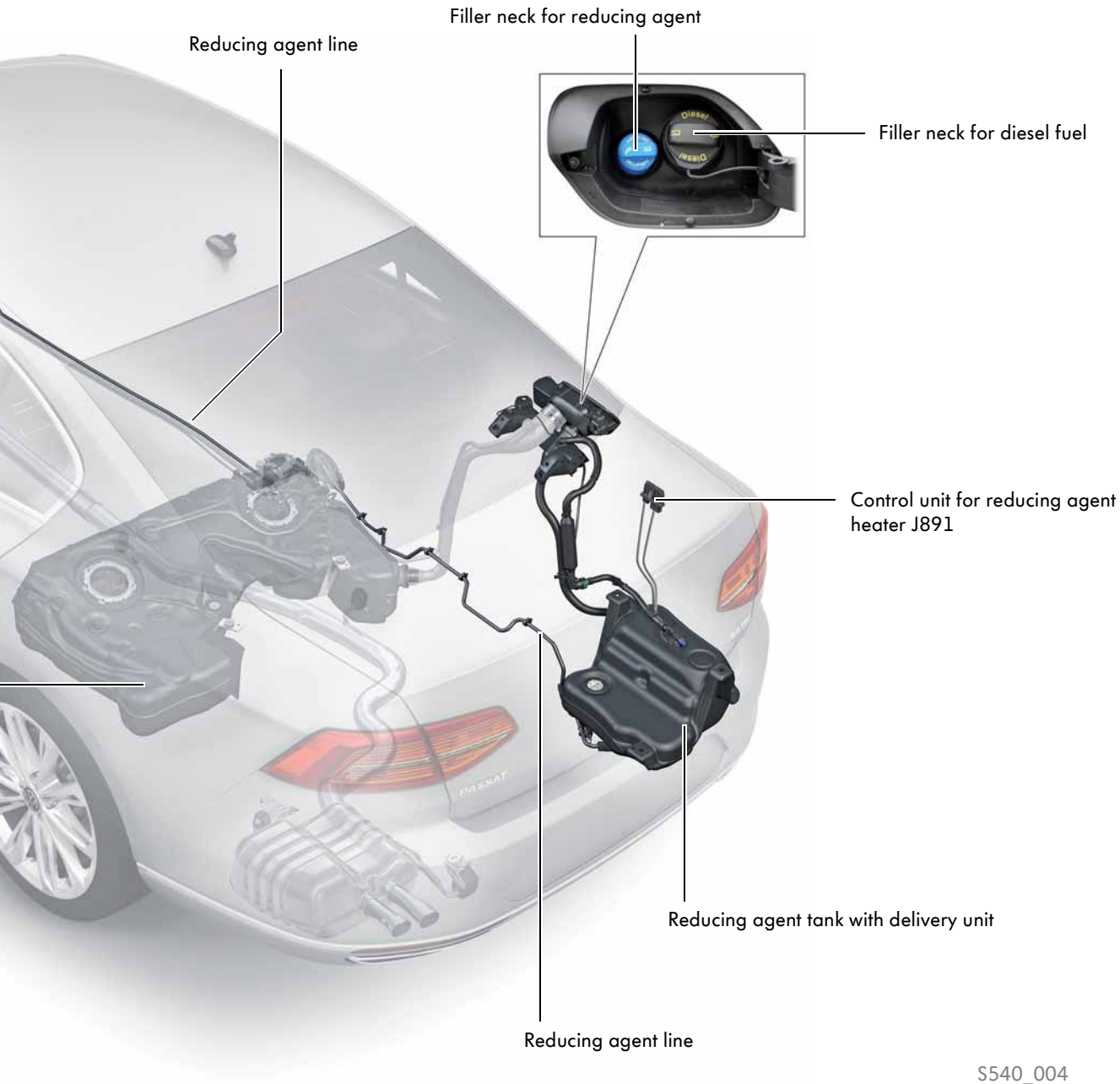
The design and function of the first SCR system to be used at Volkswagen Passenger Cars are described in Self-study Programme no 424 “Exhaust Gas Aftertreatment System Selective Catalytic Reduction”.

The SCR system

Overview

The following illustration shows the main components of the SCR system in the Passat 2015. The reducing agent tank is located at the rear right underneath the vehicle floor. The filler neck for filling the reducing agent tank is located next to the filler neck for the fuel tank. A delivery unit integrated into the reducing agent tank pumps the reducing agent from the tank to the injector for reducing agent. A coating in the diesel particulate filter, which is located in the emission control module, functions as a reduction catalytic converter. A trap catalytic converter prevents excess ammonia being released into the outside air. The engine control unit uses the NO_x sender to monitor the efficiency of the SCR system.




Filler neck for reducing agent
Reducing agent line
Filler neck for diesel fuel
Control unit for reducing agent heater J891
Reducing agent tank with delivery unit
Reducing agent line
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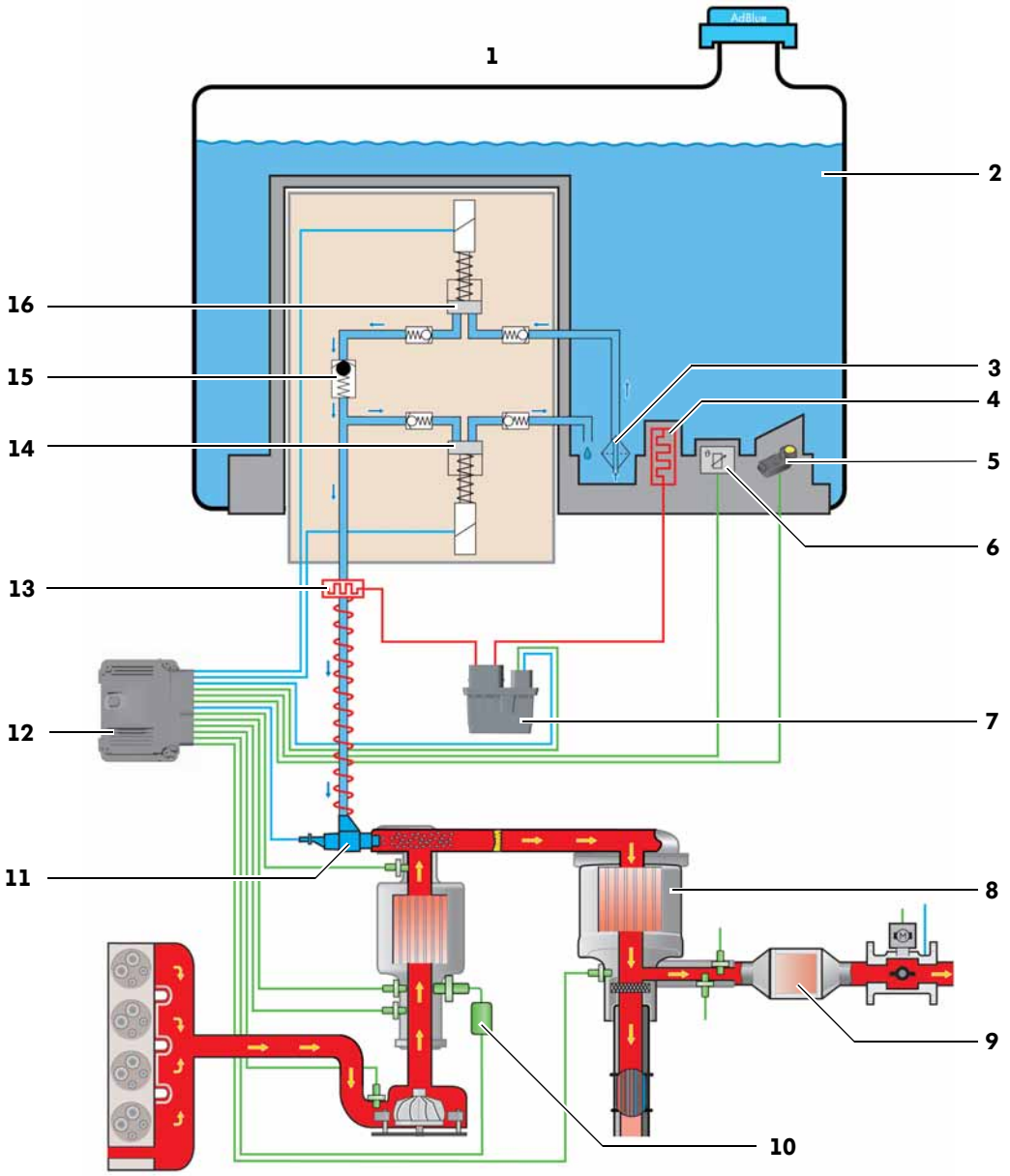
Schematic diagram of SCR system

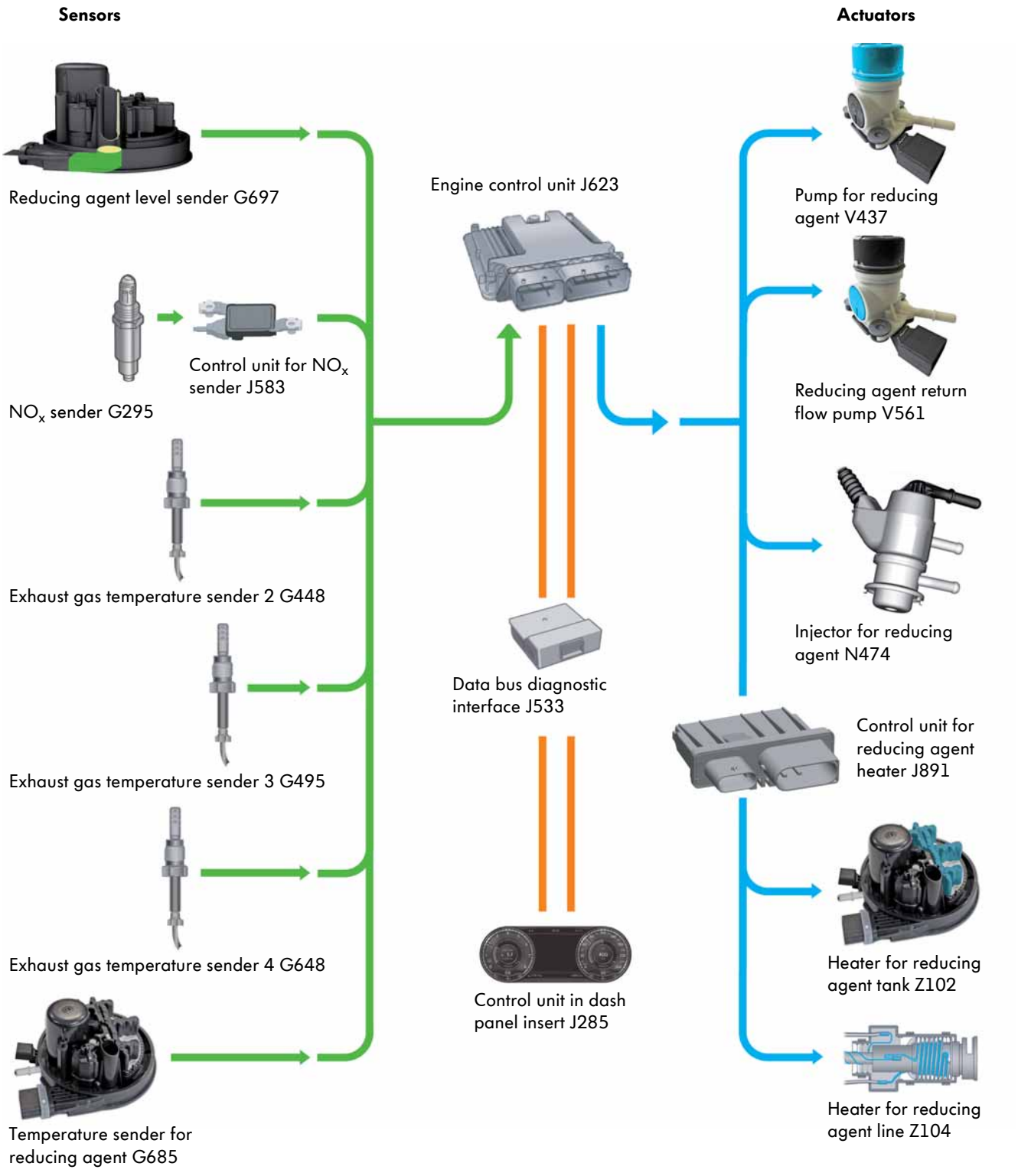


Key

1 Reducing agent tank
2 Reducing agent
3 Filter
4 Heater for reducing agent tank (heater circuit 1) Z102
5 Reducing agent level sender G697
6 Temperature sender for reducing agent G685
7 Control unit for reducing agent heater J891
8 Diesel particulate filter (reduction catalytic converter)
9 Trap catalytic converter
10 NO_x sender G295 with control unit for NO_x sender J583
11 Injector for reducing agent N474
12 Engine control unit J623
13 Heater for reducing agent line (heater circuit 2) Z104
14 Reducing agent return flow pump V561
15 Pulsation damper
16 Pump for reducing agent V437

System overview

System overview of sensors and actuators in the SCR system for the Passat 2015

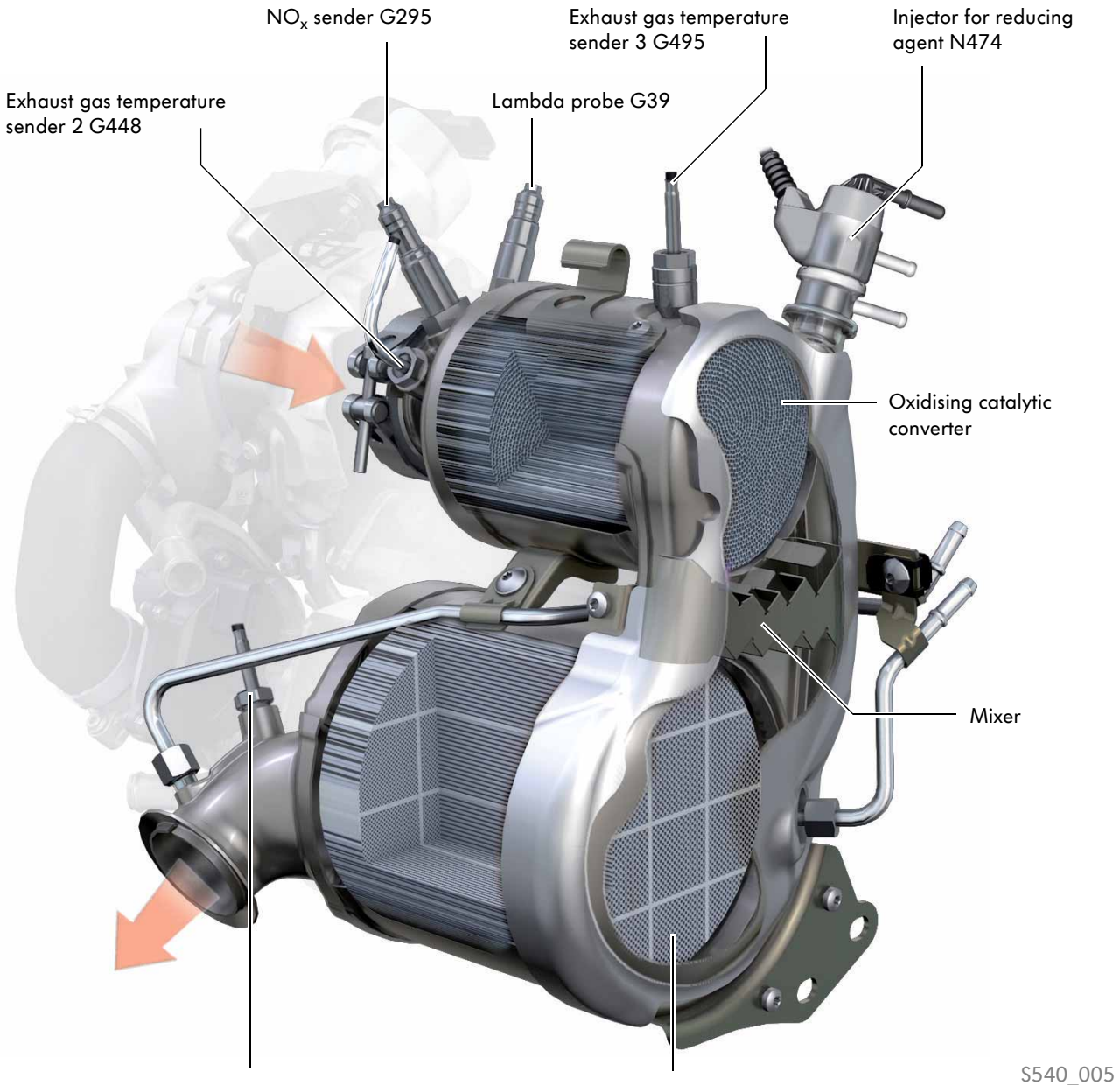


System components

Emission control module

The emission control module consists of an oxidising catalytic converter and a diesel particulate filter. The diesel particulate filter has a copper-zeolite coating so that it can act as a reduction catalytic converter. The reduction catalytic converter is therefore integrated into the diesel particulate filter.

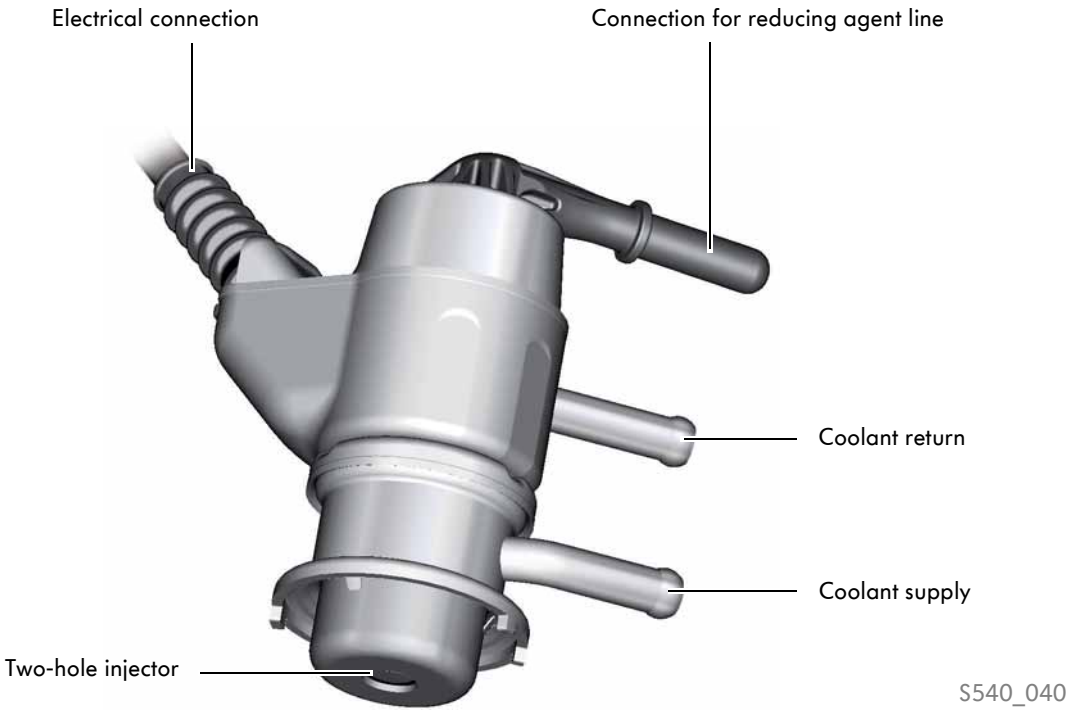
The close-coupled location has the advantage that the reduction catalytic converter quickly reaches its operating temperature after a cold start. Furthermore the operating temperature is maintained longer even during low-load engine operation.



Injector for reducing agent N474

The injector for reducing agent N474 is a solenoid valve. It is secured with a clamp to the inlet funnel on the emission control module and has the task of injecting reducing agent into the exhaust gas stream behind the oxidising catalytic converter. It is activated by the engine control unit with a pulse-width-modulated signal for this purpose. A calculation model in the engine control unit is used to determine the required quantity of reducing agent. The model is based on the theoretical nitrogen oxide content in the exhaust gas mass flow. The signals from the temperature sensors and the pressure sensors as well as the masses of the intake air, the recirculated exhaust gases and the injected fuel are evaluated to calculate the nitrogen oxide content in the exhaust gas.

The injector has a cooling jacket due to the close-coupled installation position and the resulting high thermal loading. This cooling jacket protects the electrical connection for the injector in addition to the mechanical components against overheating. The injector for reducing agent N474 has been incorporated into the low-temperature coolant circuit in the engine cooling system.



Effects upon failure

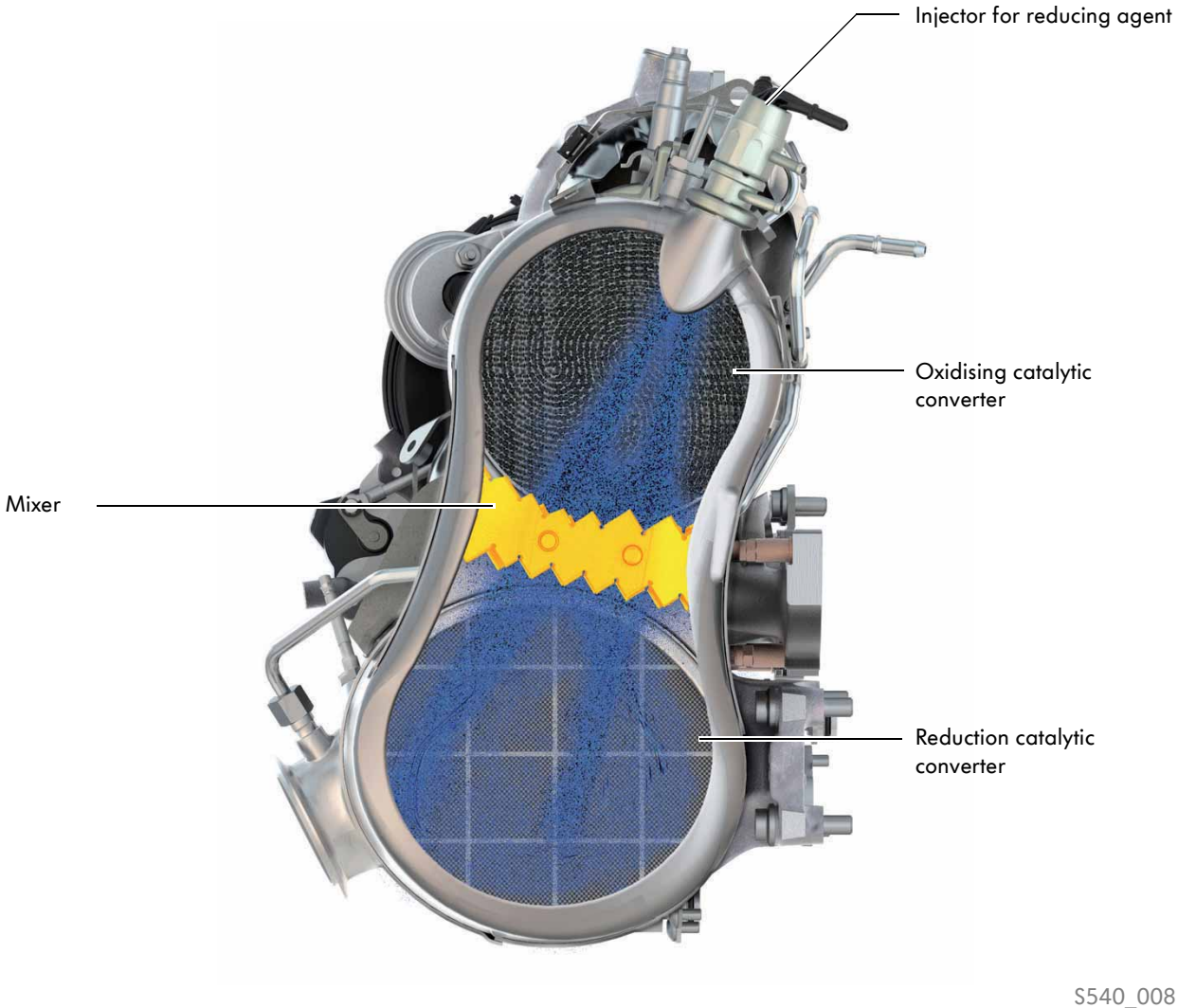
If the injector is defective, insufficient, too much or no reducing agent may be injected into the exhaust system. Compliance to the emissions values is no longer possible. Depending on the defect type, the exhaust emissions warning lamp K83 (MIL) and the AdBlue® warning display for SCR system errors will be switched on in the dash panel insert.

Exhaust gas treatment system

Mixer

The mixer is located in the emission control module between the oxidising catalytic converter and reduction catalytic converter. It ensures a homogeneous distribution of the reducing agent. The reducing agent is injected into the exhaust gas stream via two metering holes in the injector for reducing agent N474. The spray droplets are reduced in size when they hit the baffle plates in the mixer.

This leads to faster evaporation of the injected reducing agent, which then becomes gaseous. In addition, the exhaust gas mass flow is swirled due to the geometry of the mixer. This ensures even mixing of the injected reducing agent.



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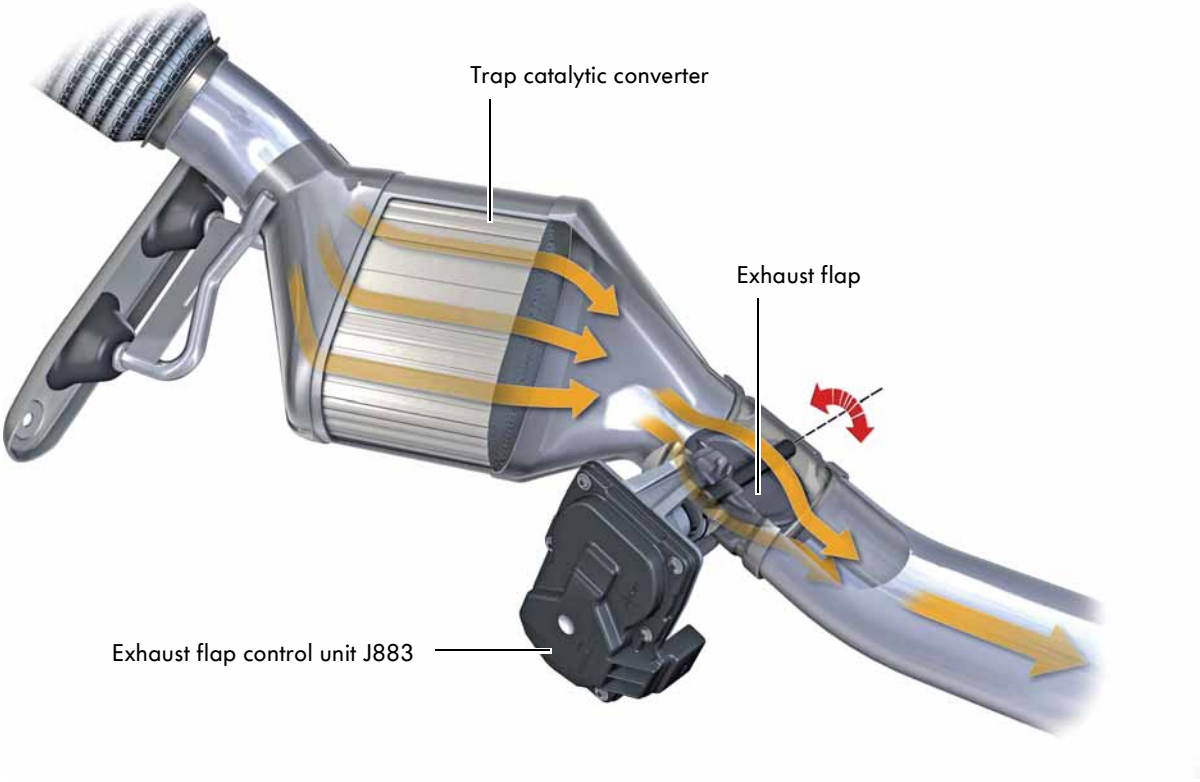
Trap catalytic converter

A trap catalytic converter is integrated into the exhaust system. It is located downstream of the emission control module. The trap catalytic converter has two different coatings.
One coating is made of copper-zeolite, which functions as a reduction catalytic converter. Any ammonia (NH_3) that manages to get past the emission control module will be stored on this coating in the trap catalytic converter. The stored ammonia is used to convert the nitrogen oxides remaining in the exhaust gas into nitrogen (N_2) and water (H_2O).

Furthermore the trap catalytic converter has a coating made of platinum and palladium. The carbon monoxide (CO), which is produced during the regeneration of the diesel particulate filter, oxidises on this coating to form carbon dioxide (CO_2). Excess ammonia is also oxidised. This coating therefore acts as an oxidising catalytic converter.



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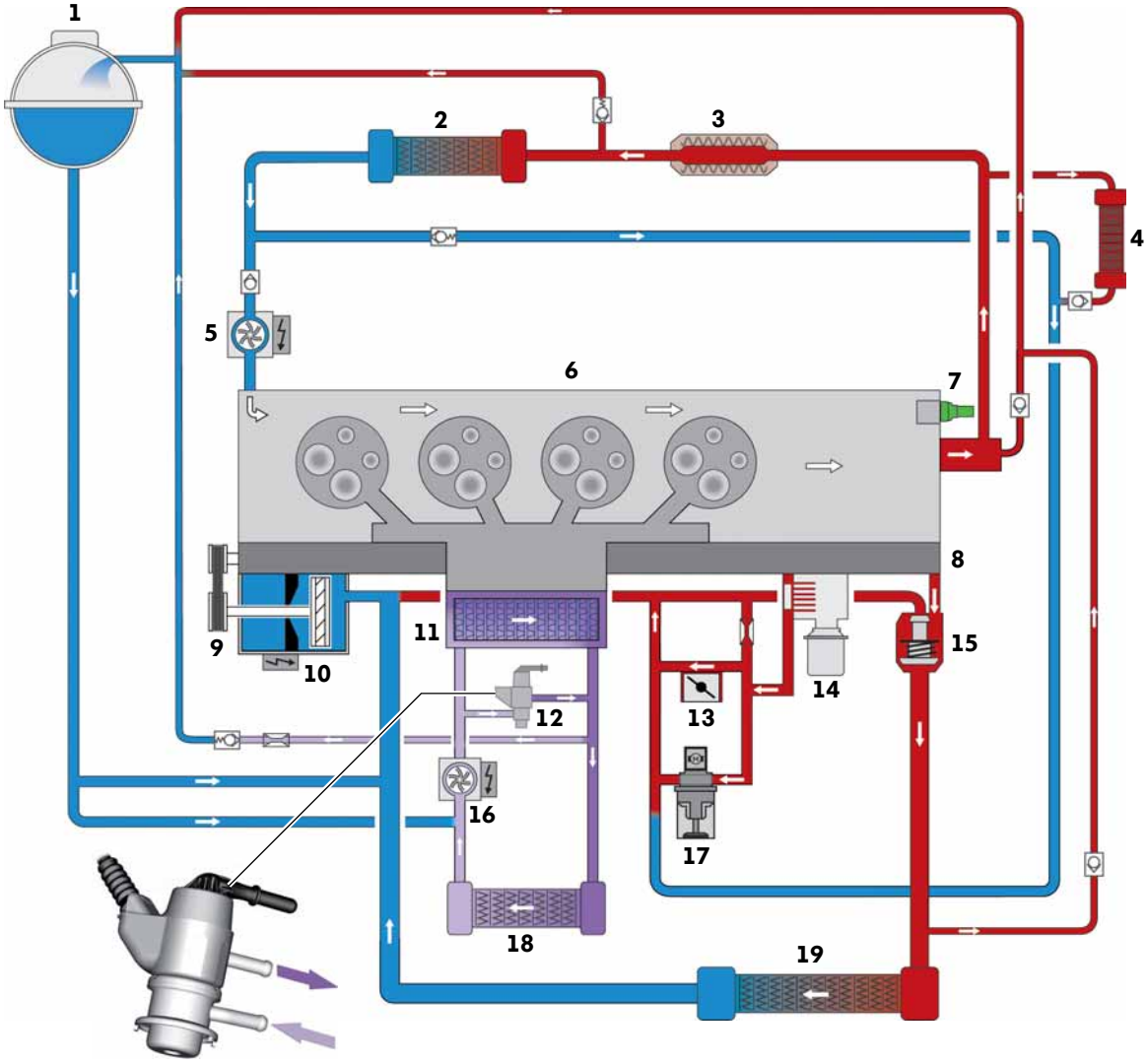
Coolant circuit – general overview



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The injector for reducing agent N474 has been incorporated into the low-temperature circuit in the engine cooling system.

Key

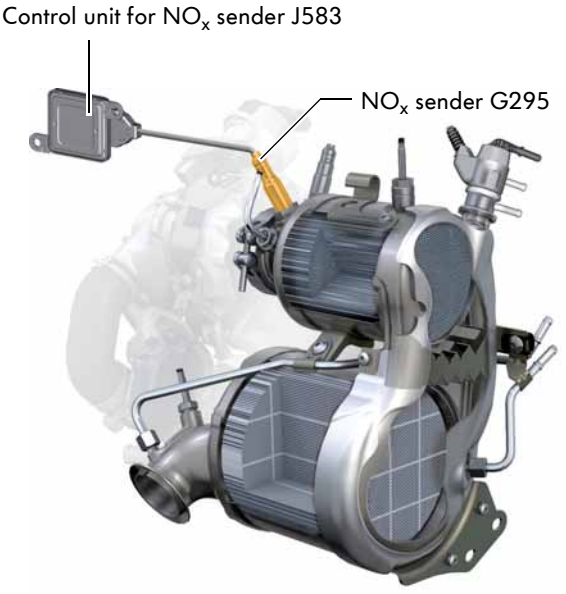
1	Coolant expansion tank
2	Heat exchanger for heater
3	Exhaust gas recirculation cooler
4	Gear oil cooler
5	Auxiliary pump for heating V488
6	Cylinder head
7	Coolant temperature sender G62
8	Cylinder block
9	Coolant pump
10	Coolant valve for cylinder head N489
11	Charge air cooler
12	Injector for reducing agent N474
13	Throttle valve module J338
14	Engine oil cooler
15	Thermostat
16	Charge air cooling pump V188
17	Exhaust gas recirculation control motor V338
18	Water radiator for charge air cooler
19	Radiator

Low-temperature circuit

High-temperature circuit

NO_x sender G295

The NO_x sender G295 is screwed into the emission control module flange. It is located in front of the oxidising catalytic converter in the direction of flow. The engine control unit uses the signal from the NO_x sender to determine the nitrogen oxide content in the exhaust gas. Since the signal currents from the NO_x sender are in the microampere range, they are processed by the control unit for NO_x sender and transmitted to the engine control unit.



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Signal use

In compliance with the European On-Board Diagnosis regulations, the signals from the NO_x sender G295 are evaluated by the engine control unit to monitor the efficiency of the SCR system and the quality of the reducing agent.

Monitoring the efficiency of the SCR system

In order to monitor the efficiency of the SCR system, the engine control unit compares the values measured by the NO_x sender with a nitrogen oxide calculation model. If the system falls below a certain efficiency level, the exhaust emissions warning lamp K83 and the warning display for SCR system errors will be activated in the dash panel insert. Furthermore an entry is added to the event memory in the engine control unit.

Monitoring the quality of the reducing agent

In addition to monitoring the efficiency, the NO_x sender also checks the quality of the reducing agent.

The EU6 emission standard requires that the reducing agent quality is monitored. An appropriate diagnosis system needs to issue a warning if the reducing agent tank is not filled with the correct fluid.

The design and function of the NO_x sender are described in Self-study Programme no. 424 “Exhaust Gas Aftertreatment System Selective Catalytic Reduction”.

Exhaust gas treatment system

Checking the efficiency and the quality of the reducing agent

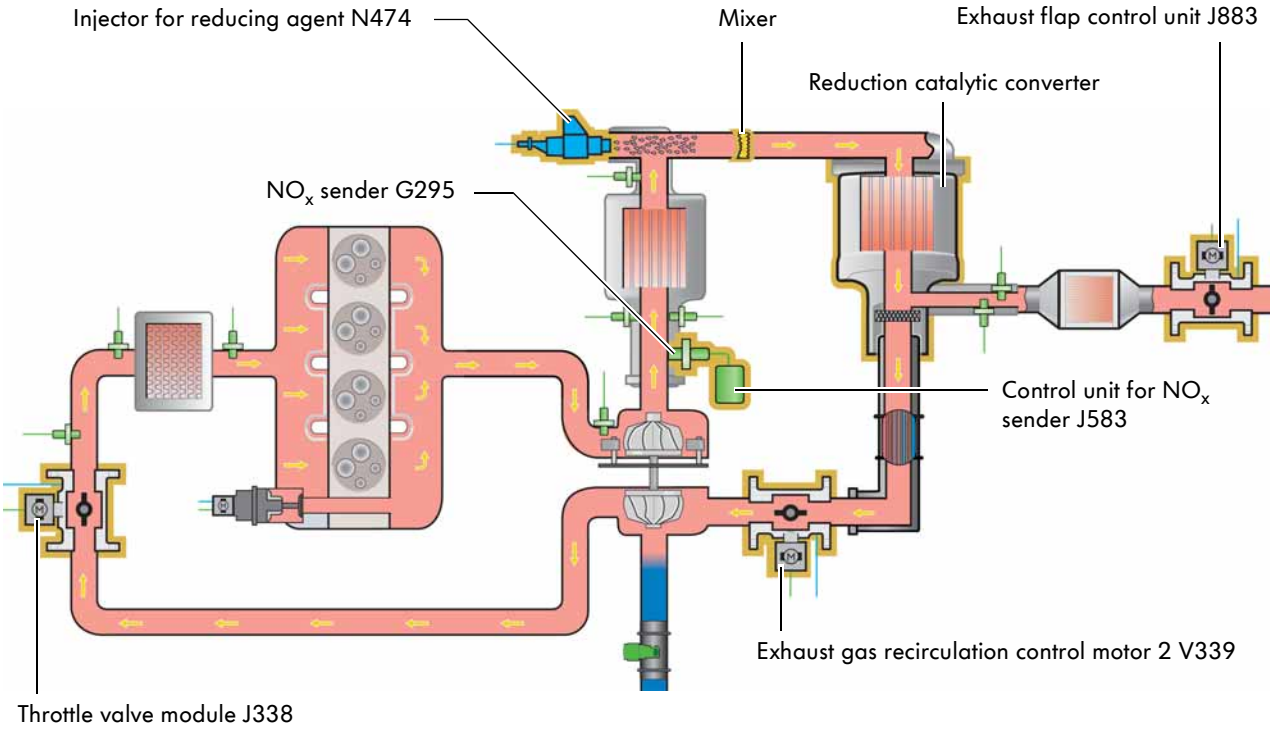
The efficiency and the quality of the reducing agent are checked by the engine control unit simultaneously in one test. This test is performed at regular intervals when the engine is in overrun phases.

Specific operating conditions are required for the test in which different temperatures and air mass flows are examined by the engine management system. The overrun phase of the engine needs to last at least 4 seconds for the test to be completed successfully.

Function

When the test conditions are met, the engine control unit will close the exhaust flap from the time when the engine switches from load operation to overrun. The exhaust gas and its nitrogen oxide content can now no longer escape from the exhaust system. It is fed via the low-pressure exhaust gas recirculation system, the intake manifold and the combustion chambers to the NO_x sender.

The exhaust gas is therefore recirculated and no air can be drawn in. At the same time, reducing agent is still injected via the injector.



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Assessing the efficiency

During the system test, the engine control unit monitors the NO_x content measured by the NO_x sender and compares it with a calculated target value.

If the difference is too great, the efficiency of the SCR system will be assessed as too low.

Assessing the quality of the reducing agent

In addition to monitoring the efficiency, the engine control unit determines the rate at which the NO_x concentration in the exhaust gas decreases. If the NO_x concentration falls rapidly, the quality of the reducing agent is fine. If the NO_x concentration stagnates or falls only slowly, the reducing agent quality is assessed as poor.

Poor quality can arise, for example, if the reducing agent tank has been filled with water instead of reducing agent.

If the engine control unit detects that the efficiency level is too low or the AdBlue® has a poor quality, an entry will be made in the event memory. The warning display for SCR system errors will appear and the exhaust emissions warning lamp will light up in the dash panel insert.

Effects of signal failure

If the signal fails, an entry will be made in the engine control unit event memory. The exhaust emissions warning lamp K83 (MIL) and the AdBlue® warning display for SCR system errors will be switched on in the dash panel insert.

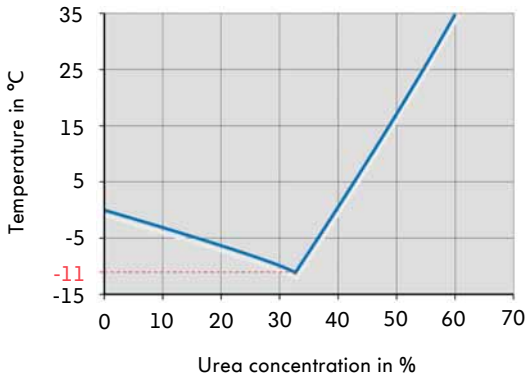
Reducing agent tank system

AdBlue® reducing agent

The ammonia required to reduce the nitrogen oxides is not used in its pure form, but in the form of a urea solution. In its pure form, ammonia irritates the skin and mucous membranes, and also has a unpleasant odour. Diesel exhaust fluid or DEF, which is commonly referred to under its brand name AdBlue® throughout the automotive industry, is used as the reducing agent for the SCR system. It is a high-purity, transparent aqueous solution containing 32.5% urea. It is manufactured synthetically.

Freezing point of AdBlue®

AdBlue® has a urea content of 32.5%. The reducing agent has the lowest freezing point of -11°C in this mixing ratio. A different mixing ratio with too much urea or too much water will cause the freezing point of AdBlue® to rise.



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Properties of AdBlue®

- AdBlue® freezes at temperatures below -11 °C.
- AdBlue® ages at high temperatures. This results in the formation of ammonia and an unpleasant odour can therefore be produced.
- Contamination from foreign substances and bacteria can render AdBlue® useless.
- Urea that leaks and crystallises causes white marks. These marks can be removed with water and a brush (as soon as possible).
- AdBlue® is highly penetrative.
  Ensure that AdBlue® does not get into electrical components or connectors.

Notes on handling AdBlue®

- Only use AdBlue® that complies with the approved manufacturer's standard and from original containers.
- Drained AdBlue® must not be reused to prevent contamination.
- The reducing agent tank may only be filled using containers and adapters approved by the manufacturer.
- The reducing agent can irritate the skin, eyes and respiratory organs. If this fluid comes into contact with skin, it should be immediately washed off with plenty of water.

Refilling reducing agent with an AdBlue® pump

The reducing agent tank in the Passat 2015 can be filled using the pump nozzles provided by the European AdBlue® filling station network for heavy goods vehicles. Since these pumps fill the tank at a very high rate, the tank needs to be quickly vented during the filling process.

In contrast, when you fill the tank with a refill bottle, the air can escape more slowly. The different filling speeds can result in different filling quantities in the reducing agent tank.

S540_031

Filling system	**Filling speed**
AdBlue® pump for heavy goods vehicles	Max. 40 l/min
AdBlue® pump for cars *)	3.5–10 l/min
AdBlue® refill bottle	Approx. 3 l/min

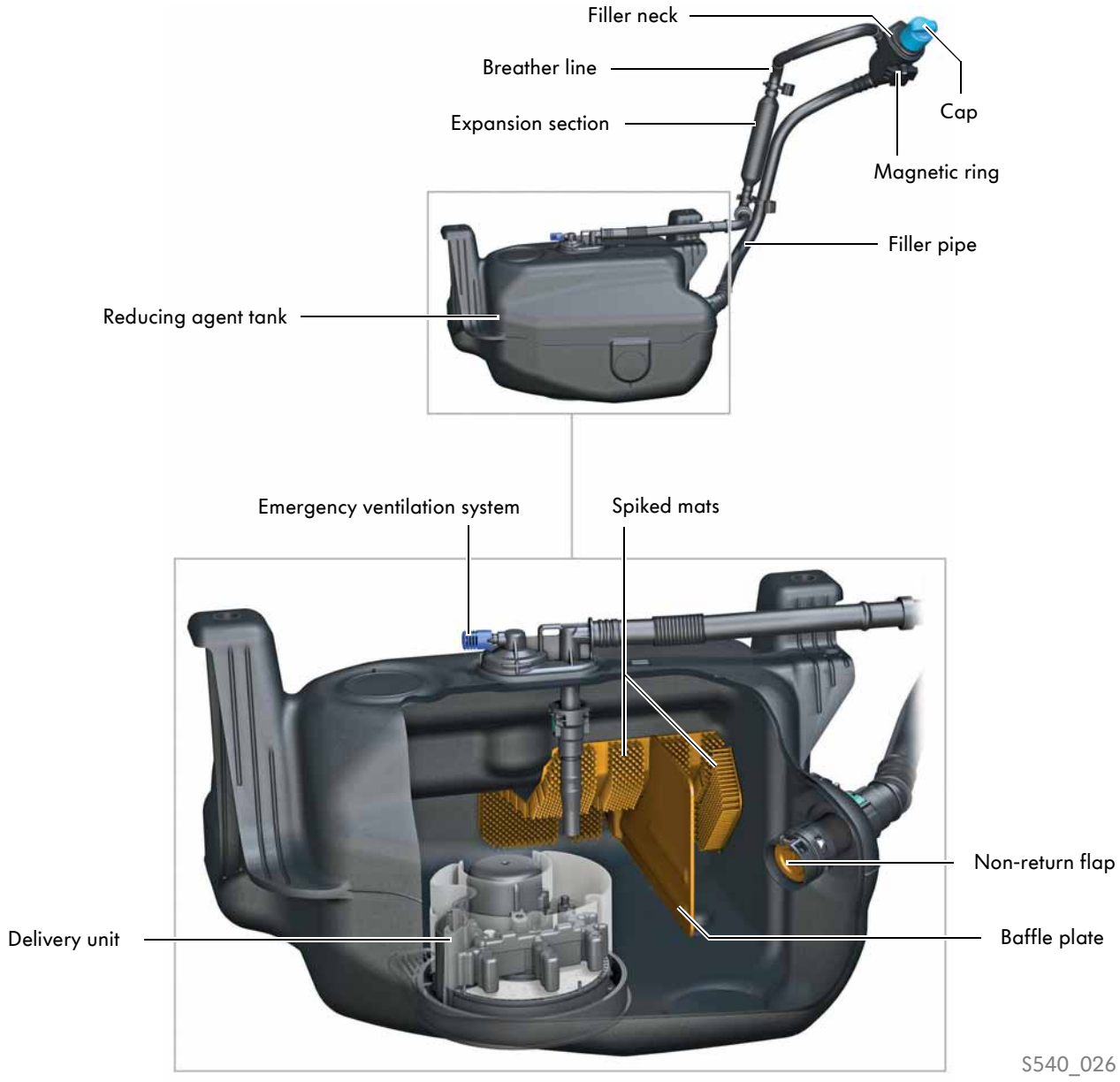
*) A wide network of AdBlue® pumps for cars is not expected in Europe before 2018.

Only fill the reducing agent tank with the intended containers and filling systems. This guarantees the correct filling speed and prevents the tank being overfilled. Furthermore this ensures that a sufficiently large expansion volume is retained for the reducing agent in the tank.

Reducing agent tank system

Design of tank system

In the Passat 2015, the reducing agent tank is located at the rear right underneath the vehicle floor. The tank is made from plastic and has a volume of approximately 13 litres.



Delivery unit

The sensors and actuators for the reducing agent tank system are located in the delivery unit for reducing agent metering system GX19. The delivery unit is sealed to the reducing agent tank.

Cap
There is a diaphragm in the cap for the filler neck. It forms part of the breather system for the reducing agent tank together with the emergency ventilation system.

Non-return flap
There is a spring-loaded non-return flap at the bottom end of the filler pipe. It prevents reducing agent escaping from the filler neck at the end of a high-speed filling process.

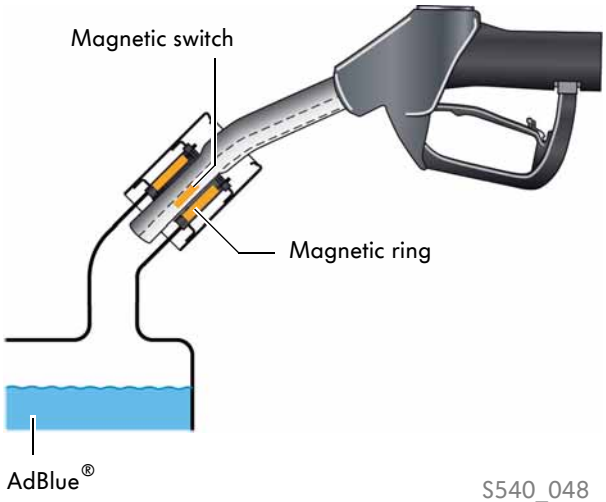
Expansion section
If reducing agent rises inside the breather line during a high-speed filling process, it can be held and settle in this expansion section.

Spiked mat and baffle plate
The spiked mat and the baffle plate reduce “sloshing noises” that are caused by reducing agent flowing back and forth while you drive.

Emergency ventilation system
If ventilation is not possible via the filler cap because the reducing agent has frozen, the pressure in the tank will be compensated exclusively via the emergency ventilation system.

Magnetic ring for unlocking AdBlue® pump nozzles for heavy goods vehicles

The filling tube on AdBlue® pump nozzles for heavy goods vehicles contains a magnetic switch. This magnetic switch functions as a safety valve to prevent the fluid being delivered into the wrong tank. It can only be opened with a defined magnetic field that is applied externally. The filler neck features a magnetic ring that allows you to fill the reducing agent tank with an AdBlue® pump for heavy goods vehicles. The magnetic switch is opened by the magnetic ring when you insert the pump nozzle.



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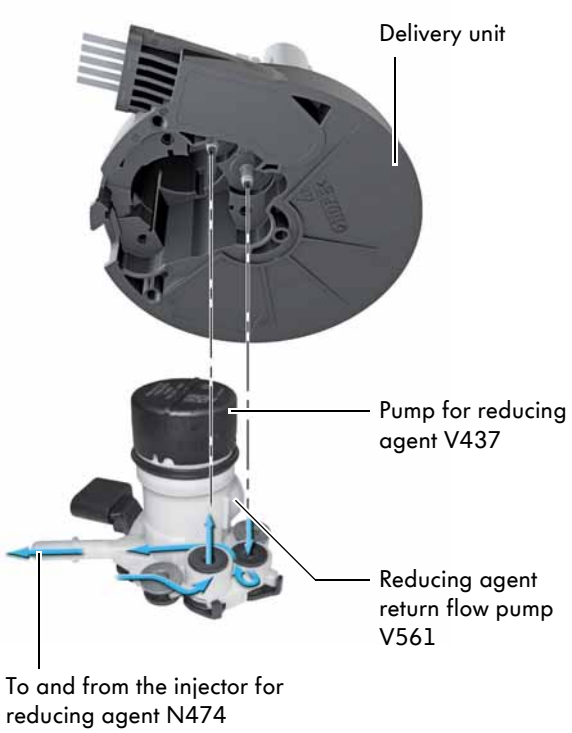
Delivery module

The delivery module is bolted to the bottom of the delivery unit. Two pumps are integrated into the delivery module:

- Pump for reducing agent V437
- Reducing agent return flow pump V561

Both pumps are solenoid-actuated diaphragm pumps. They are activated by the engine control unit.

Please observe the information and notes in the workshop manual when installing and removing the delivery module.



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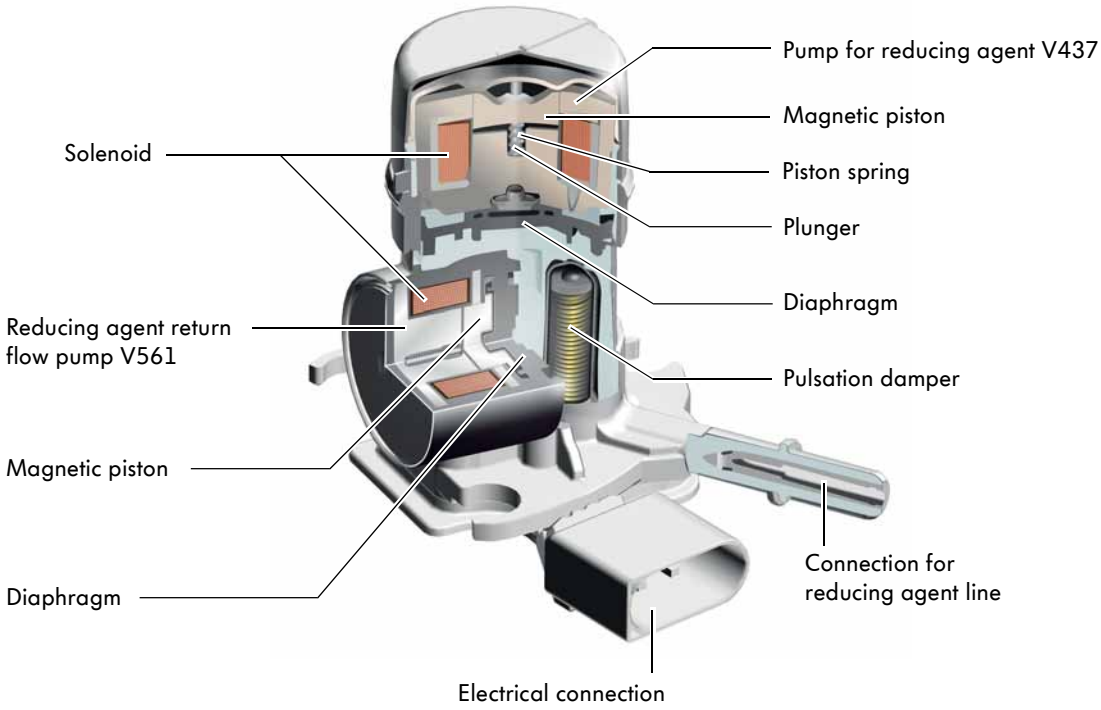
Design



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Pump for reducing agent V437

The pump for reducing agent is a solenoid-actuated diaphragm pump. The solenoid functions as a pump drive for the magnetic piston that moves the diaphragm below it up and down via a plunger. Non-return valves at the inlet and outlet control the supply of reducing agent to the pump chamber. The pump delivers the reducing agent by activating the solenoid to move the piston. The pump draws in the reducing agent during the return movement of the piston caused by the spring.

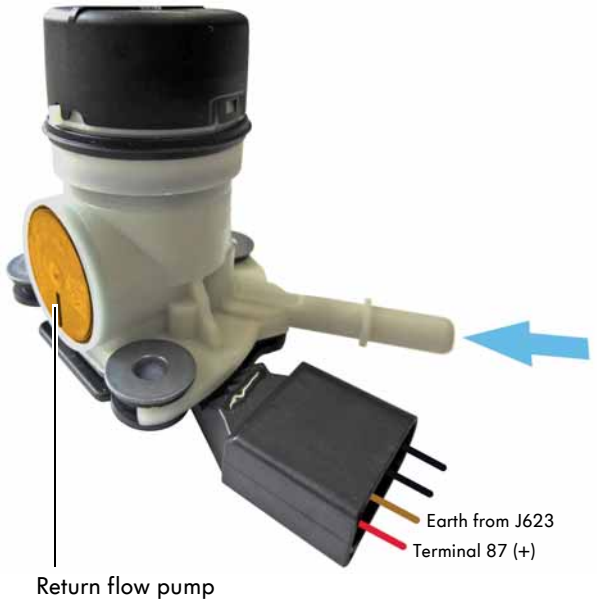
S540_013

The voltage for both reducing agent pumps is supplied via the relay for reducing agent metering system J963.

Reducing agent return flow pump V561

The return flow pump extracts the reducing agent partially from the supply line after the engine has been switched off. This prevents the reducing agent from freezing in the injection valve at low temperatures and causing damage due to ice expansion.

Immediately after you switch off the engine, the return flow pump is activated by the engine control unit for approximately 5 seconds to extract a sufficient quantity of reducing agent from the supply line. The injector remains closed initially so that hot exhaust gases are not drawn into the supply line. The injector is then opened to compensate the vacuum in the supply line during the extraction process.



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Reducing agent tank system

Monitoring the system pressure

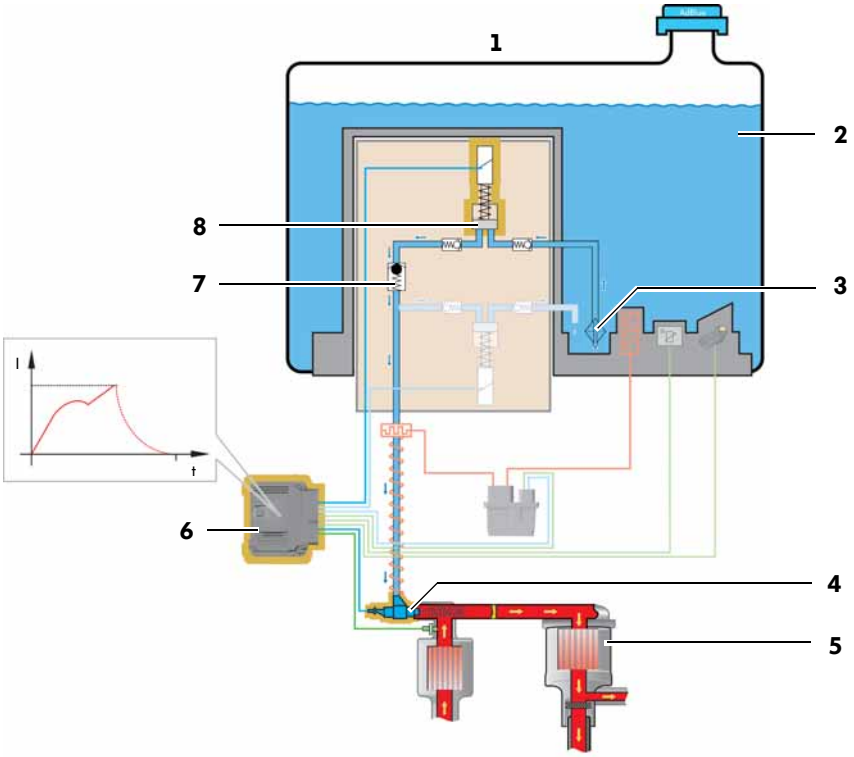
Function

The pump for reducing agent V437 delivers the reducing agent from the reducing agent tank with an almost constant stroke volume and delivers it to the injector for reducing agent N474. The quantity of reducing agent that is injected depends on the nitrogen oxide content in the exhaust gas. The engine control unit uses the injector opening time and opening frequency to set the quantity. A pressure equilibrium of approximately 6.5 bar (+/- 2 bar) is set in the reducing agent system due to the continuous injection and the constant stroke volume. The engine control unit evaluates the current flowing through the pump for reducing agent in order to monitor the hydraulic pressure of the reducing agent in the SCR system.

For this purpose, the times from the start of energisation to the first movement and to the end position of the magnetic piston are measured. In addition, the strength of the current flow is evaluated. The engine control unit uses this data to calculate the pressure of the reducing agent in the SCR system.

Examples of possible system faults:

- The reducing agent line is damaged and is leaking.
- The pump is jammed.
- The metering holes on the reducing agent injector are blocked.
- The intake area for the delivery unit is blocked.



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Key

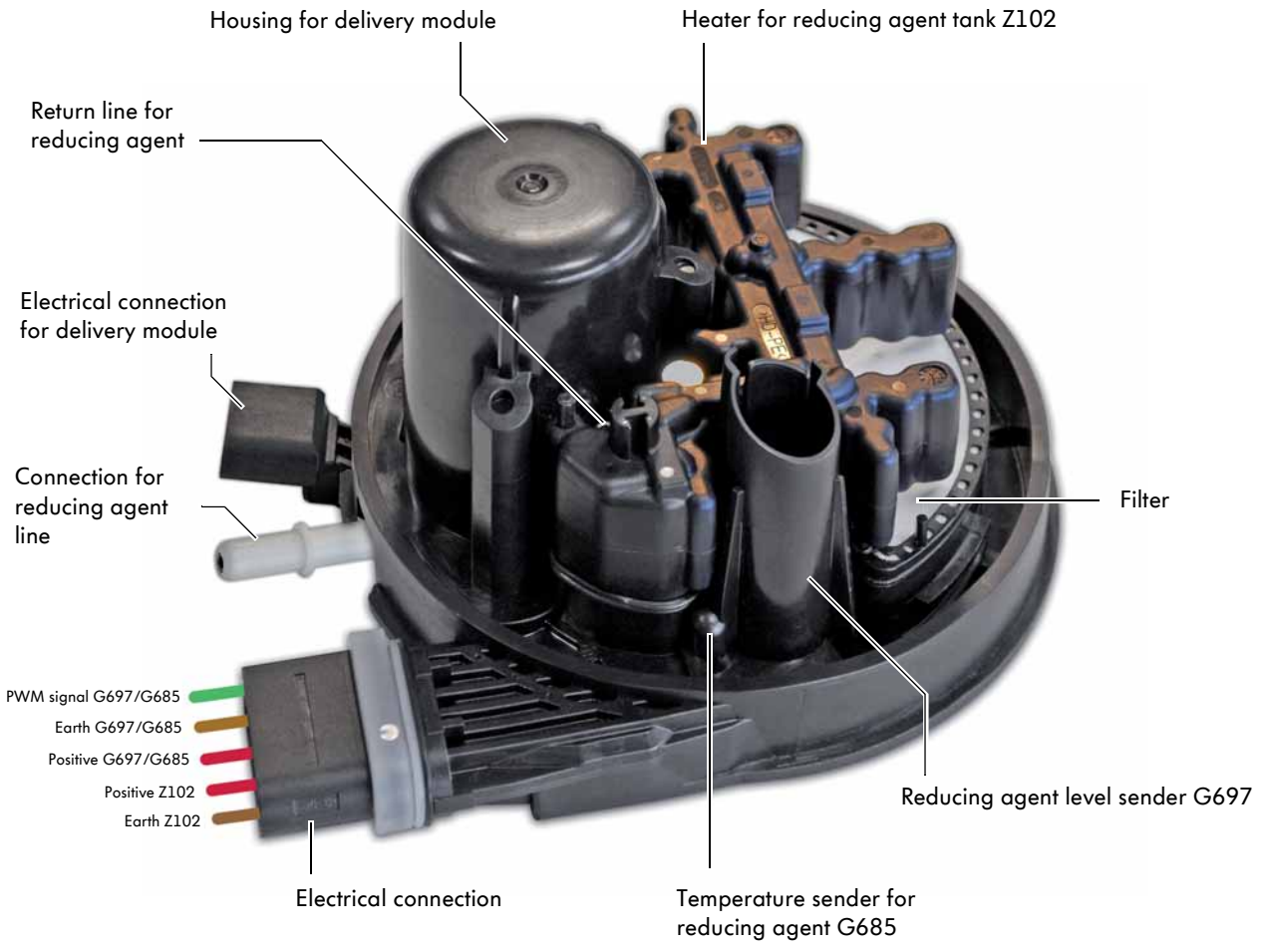
1 Reducing agent tank
2 Reducing agent
3 Filter
4 Injector for reducing agent N474
5 Diesel particulate filter (reduction catalytic converter)
6 Engine control unit J623
7 Pulsation damper
8 Pump for reducing agent V437

Delivery unit for reducing agent metering system GX19

The delivery unit contains the sensors and actuators for the reducing agent tank system. It is sealed into the reducing agent tank. The reducing agent level sender G697, the temperature sender for reducing agent G685 and the heater for reducing agent tank Z102 have been permanently integrated into the delivery unit. The delivery module with the reducing agent pumps is bolted to the delivery unit and can be exchanged if necessary.

A filter in front of the intake prevents the SCR system being damaged by particles of dirt in the reducing agent. The reducing agent drawn in from the reducing agent line by the return flow pump is fed back into the reducing agent tank.

Design



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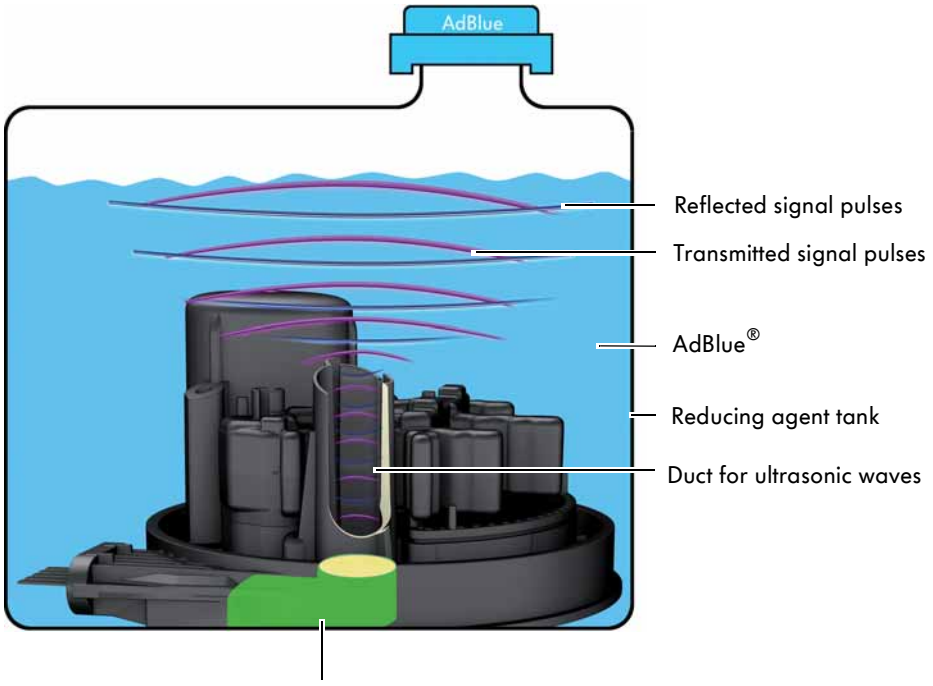
Reducing agent tank system

Reducing agent level sender G697

Design and function



The reducing agent level sender G697 is an ultrasonic sensor. The sound waves emitted by the sensor are guided through a duct. This prevents scatter and reflections that could distort the signal. The ultrasonic waves are reflected by the boundary layer between the reducing agent and the air. In this case, the reducing agent level is determined from the time difference between the emitted signal pulse and the received signal pulse.

The signal from the temperature sender for reducing agent G685 is used to calculate the filling level of the reducing agent. This allows the density of the reducing agent to be taken into consideration at different temperatures.
The measuring system will not work if the reducing agent is frozen.

At least 3.5 to 4 litres of reducing agent need to be filled into the reducing agent tank before the engine control unit can reliably detect the new level.
Please observe the information in the owner's manual.

Effects of signal failure

If the signal from the reducing agent level sender fails, the filling level of the reducing agent tank cannot be measured. The SCR system remains active, however. The AdBlue® warning display for SCR system errors lights up in the display and the exhaust emissions warning lamp K83 is switched on.

Temperature sender for reducing agent G685

The temperature sender for reducing agent is a thermistor sensor with a negative temperature coefficient (NTC). It is located in the delivery unit housing. The engine control unit evaluates the PWM signal from the temperature sender and uses it to calculate the current temperature of the reducing agent in the reducing agent tank. The voltage for the temperature sender is supplied via the relay for reducing agent metering system J963.

S540_041

Temperature sender for reducing agent G685

Signal use

The engine control unit uses the signal from the temperature sender for reducing agent to switch on the heater systems in the SCR system. Furthermore the signal is used to calculate the filling level in the reducing agent tank.

Effects of signal failure

The exhaust emissions warning lamp and the AdBlue® warning display for faults in the SCR system are switched on in the dash panel insert.

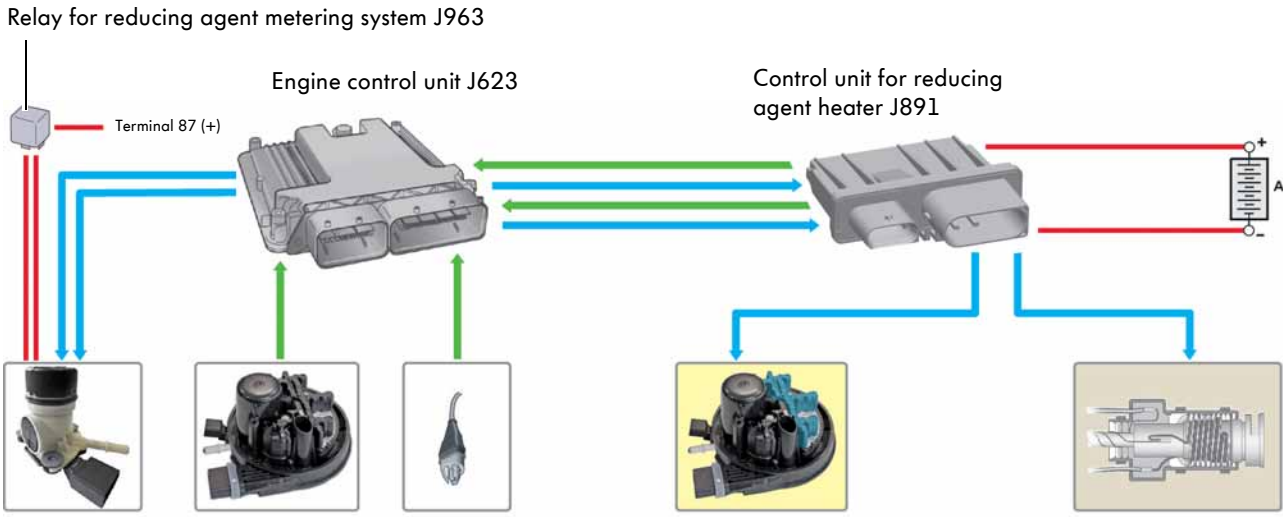
Heater system

Reducing agent heater system

Since the reducing agent can freeze at low ambient temperatures, the reducing agent tank and the line to the reducing agent injector are both equipped with resistance heating systems. Furthermore the two solenoids in the delivery module can be energised if heating is required.

The heater system allows the SCR system to be quickly prepared for operation even when the reducing agent is frozen. It also ensures that sufficient defrosted reducing agent is available at all operating points.

Overview of heater system



S540_030

Function

Using the information from the ambient temperature sensor G17 and the temperature sender for reducing agent G685, the engine control unit J623 determines the heating requirements for the reducing agent. The engine control unit then activates the control unit for reducing agent heater J891, which activates the electrical power supply for the heaters.

European On-Board Diagnosis regulations require that the heating current is monitored to allow failure of or a malfunction in emissions-related components to be detected. The engine control unit receives feedback on the actual heating current flow from the control unit for reducing agent heater.

Control unit for reducing agent heater J891

The control unit for reducing agent heater J891 controls the electrical power supply to the SCR system heaters. It is activated by the engine control unit for this purpose. In the Passat 2015, it is located near the rear right of the luggage compartment.

S540_034

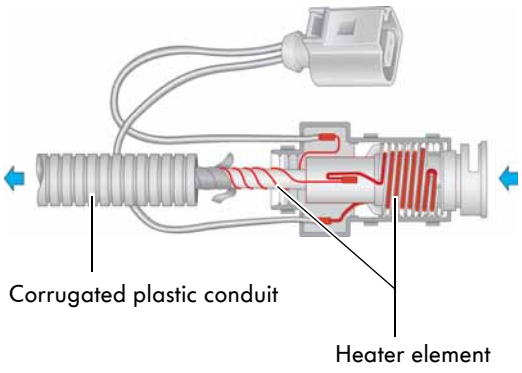
Heater for reducing agent tank Z102

The heater for reducing agent tank Z102 is a positive temperature coefficient heater element (PTC). It is integrated into the delivery unit and heats the reducing agent around the pick-up point in the reducing agent tank. The engine control unit activates it as required via the output stage of the control unit for reducing agent heater.

S540_050

Heater for reducing agent line Z104

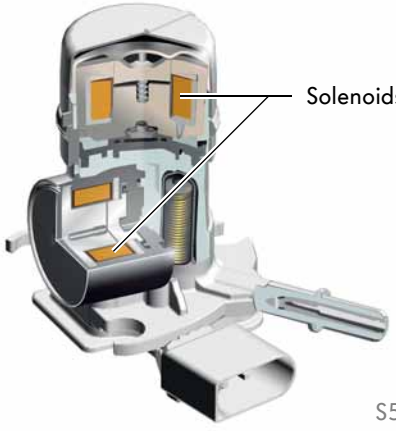
The heater for reducing agent line Z104 consists of a stainless steel wire that is wound in a spiral around the reducing agent line. It functions as a resistance-heating element and is protected on the outside by a corrugated plastic conduit. The heater element is activated by the engine control unit via the control unit for reducing agent heater as required. As a result, the reducing agent in the supply line is warmed thus enabling reliable operation of the SCR system at low ambient temperatures.



S540_042

Heater for reducing agent pump Z103

The two solenoids in the delivery module function as the heater for reducing agent pump Z103. To achieve the heating function, the solenoids are energised by the engine control unit according to the heating requirements and thus generate heat. The solenoids are energised constantly or intermittently depending on the temperature. The temperature of the reducing agent pumps is calculated by evaluating the current flow and a temperature model in the engine control unit.



S540_036

Heater system

Heater circuits and heating duration

The heater control system is sub-divided into three heater circuits. The power for the heater circuits 1 and 2 is supplied by the control unit for reducing agent heater J891. Heater circuit 3 is operated by the engine control unit. The heater circuits are switched on depending on the temperatures in the reducing agent tank, the temperature of the outside air and the temperature of the reducing agent pump. They remain active for a specific time.

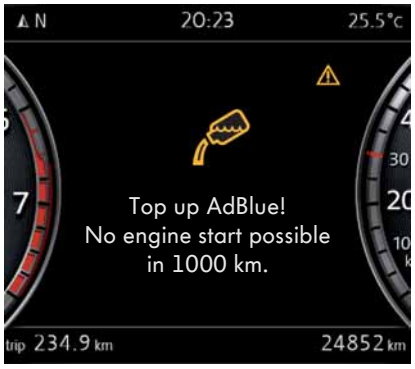
Standby heating starts once the heating time for defrosting the reducing agent has expired. This ensures that a sufficient amount of defrosted reducing agent can always be supplied in all operating ranges.

	Heater circuit 1	**Heater circuit 2**	**Heater circuit 3**
Heater element	**Heater for reducing agent tank Z102**	**Heater for reducing agent line Z104**	**Heater for reducing agent pump Z103**
Trigger for activation	• Temperature in the tank • Temperature of outside air	• Temperature in the tank • Temperature of outside air	• Temperature in the tank • Temperature of outside air • Temperature of pump
Activation and heating duration for defrosting	• Approximately 20 min. at temperatures from -7°C to -15°C in the tank and up to 45 min. at -25°C	• Approximately 5 min. at temperatures below -7°C in the tank or outside air and up to 21 min. at -25°C	• Approximately 20 min. at temperatures from -7°C to -15°C in the tank and up to 45 min. at -25°C
Activation of standby heating	• Temperature of outside air: below -7°C and temperature in the tank below +5°C	• Temperature in tank or of outside air below -5°C	• Temperature in tank or of outside air below 0°C and pump temperature below +40°C

AdBlue® displays in dash panel insert

The AdBlue® displays appear in the dash panel insert to inform the driver in sufficient time if the reducing agent needs to be topped up or to indicate an error in the SCR system.

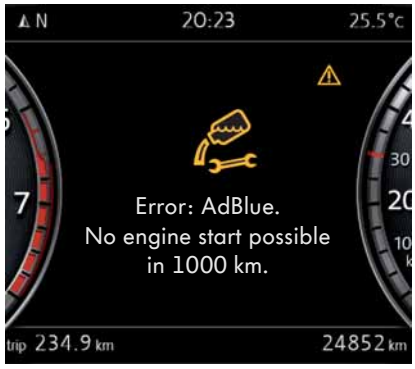
Warning display for filling level



S540_018

- When the filling level becomes too low, the reducing agent tank needs to be filled with AdBlue®.

Warning display when there is an error in the SCR system



S540_020

- If there is an error in the SCR system, the car will need to be taken to a qualified workshop.

Failing to observe the warnings will result in an engine restart lockout after the remaining range has been used up. You can then no longer start the engine once you switch off the ignition.

Display strategy sequence

Depending on the remaining range, the warning displays about the filling level or system errors are shown in several stages. After a specific distance has been covered, the intensity of the visual and acoustic warnings will increase. In addition, the warning message will be displayed repeatedly in the dash panel insert depending on the time and distance covered.

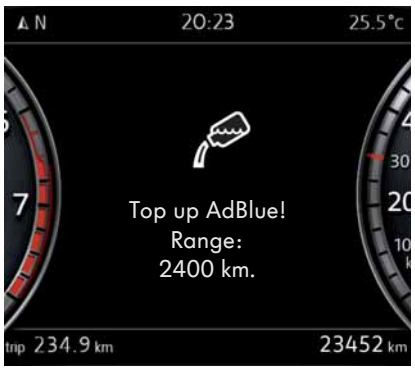
Remaining range	Colour of warning display	Repeat of warning display	Acoustic warning
From 2,400 km	White	The warning is repeated every 400 km or every 8 hours and displayed in the dash panel insert. The figure for the remaining range is displayed in steps of 100 km.	1 x acoustic warning
From 1,000 km	Yellow	The warning is repeated every 100 km or every 4 hours and displayed in the dash panel insert. The figure for the remaining range is displayed in steps of 50 km.	1 x buzzer
From 200 km	Yellow	The warning is repeated every 20 km and displayed in the dash panel insert. The figure for the remaining range is displayed in steps of 10 km.	1 x buzzer
0 km	Red	Warning: engine start not possible.	3 x buzzer

AdBlue® display system

AdBlue® warning displays about the filling level in the reducing agent tank

Filling level warning stage 1

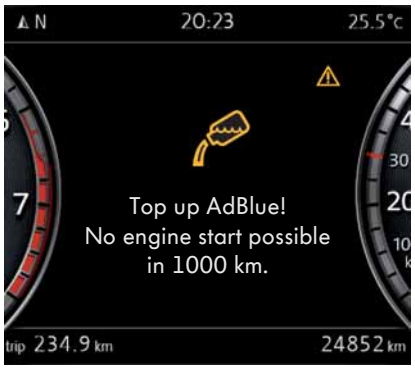
The first request to refill reducing agent is displayed when the remaining range that can be driven with the available AdBlue® reaches 2,400 km. The engine control unit calculates the remaining range on the basis of the quantity of reducing agent in the tank and the reducing agent consumption.



S540_017

Filling level warning stage 2

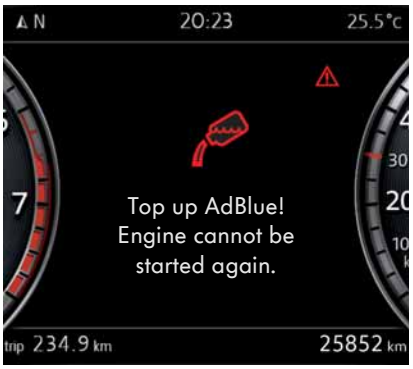
The warning is intensified once the remaining range reaches 1,000 km. It is also displayed in yellow and a warning triangle is added. You can only drive for the displayed remaining range. If you do not refill a sufficient quantity of reducing agent, you will no longer be able to restart the engine after the remaining range has been used up and the ignition is switched off.



S540_018

Filling level warning stage 3

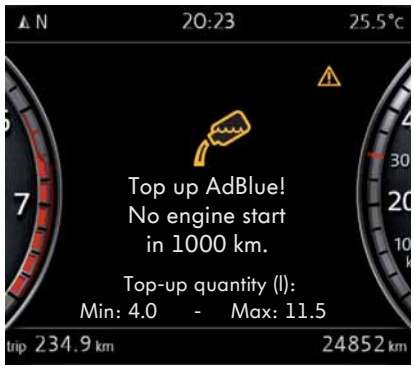
If there is no more AdBlue® in the reducing agent tank, the warning symbol will be displayed in red. Reducing agent needs to be refilled in order to end the engine start lockout.



S540_019

Extended display of the remaining range

In the Passat 2016, the AdBlue® warning display about the filling level in the reducing agent tank will be supplemented with indications of the minimum and maximum refill quantity.
You need to refill at least as much reducing agent as indicated by the minimum refill quantity to clear the warning from the dash panel insert.
A smaller refill quantity cannot be reliably detected by the engine control unit.



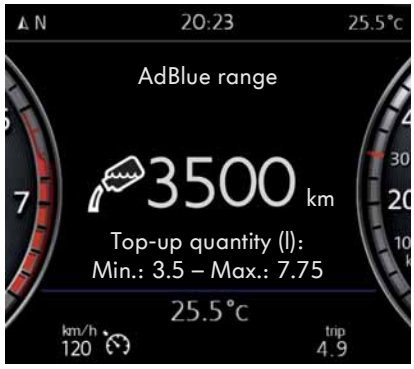
S540_047

Display of remaining range on the multifunction display

In the Passat 2016, the driver will also be able to check the current remaining range via the multifunction display menu before the warning range is reached.

Minimum top-up quantity
The figure for the minimum top-up quantity indicates the minimum quantity of AdBlue® that needs to be delivered into the tank to cause the display to change after filling.

Maximum top-up quantity
The figure for the maximum top-up quantity helps you choose a suitable refill container if you are using one.



S540_043

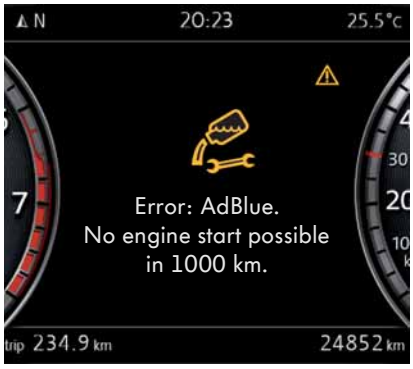
AdBlue® display system

AdBlue® warning displays for SCR system errors

If the engine control unit detects an error in the SCR system or insufficient efficiency via the NO_x sender, a warning display will appear in the dash panel insert that indicates a malfunction in the SCR system.

System fault warning stage 1

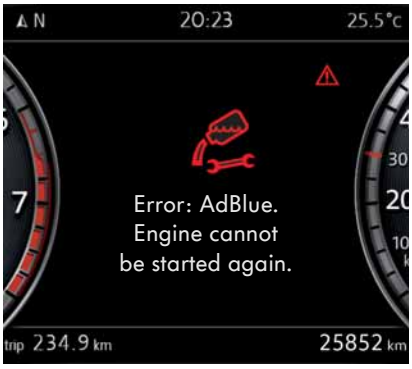
If a fault is detected in the SCR system and you have covered a distance of 50 km, the warning display will be shown in yellow. A spanner symbol will also be displayed as a visual indicator of a system fault. The remaining range is 1,000 km. The distance already covered is immediately deducted from this figure. This is not based on the reducing agent tank level nor the reducing agent consumption.



S540_020

System fault warning stage 2

If the error in the SCR system is not rectified within the remaining range, the engine can no longer be started after the ignition is switched off.



S540_021

If there is a fault in the SCR system, this fault and the warning display can only be rectified by using the Guided Fault Finding. In this case, refilling AdBlue® will not lead to the display in the dash panel insert being cleared.

The restart lockout can be overridden for a further distance of 50 km by using the vehicle diagnostic tester. This allows the vehicle to be driven to the next workshop.

AdBlue® filling options for customers

AdBlue® pumps

The reducing agent tank in the Passat 2015 can be filled at a pump (see page 19).

S540_031

Refill bottle

The refill bottle contains 1.89 litres (equivalent to half a US gallon).

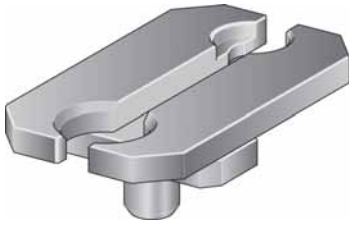
S540_022

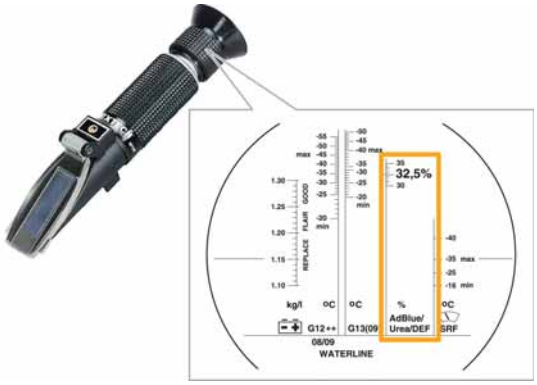
Refill container

The refill container contains 5 litres. The AdBlue tank should be refilled using the corresponding filler hose.

S540_044

Special tools and workshop equipment

Description	Tool	Usage
AdBlue® filling system VAS 6960	 S540_028	The mobile filling system VAS 6960 can be used cordlessly in workshops. AdBlue® is filled from a 60-litre drum via a sensor-controlled filling nozzle into the reducing agent tank in the vehicle. The filling system shuts off automatically when the maximum filling level has been reached.
Filling device for AdBlue® VAS 6542	 S540_023	VAS 6542 can be used to fill reducing agent tanks in a workshop. The container VAS 6542/1 holds 10 litres. The maximum filling level is reached when the breather hose fills with liquid or the container noticeably collapses. Observe the correct height difference between the container and filler neck.
Mounting plate V.A.G 1383A/1	 S540_049	The mounting plate is used to mount the container VAS 6542/1 securely during the filling process with the filling device for AdBlue® VAS 6542.

Description	Tool	Usage
Test case VAS 6532	 S540_024	The tools in the test case are used to test the metering quantity and system pressure as part of the Guided Fault Finding.
Vacuum box VAS 6557	 S540_025	The vacuum box is used to extract AdBlue® from the reducing agent tank.
Refractometer T 10007 A	 S540_038	The refractometer is used to check the concentration of urea in the AdBlue®.

Test your knowledge

Which answers are correct?

One or several of the given answers may be correct.

1. How is the AdBlue® drained from the reducing agent supply line in the SCR system for the Passat 2015 upon "ignition OFF"?

❒ a) The AdBlue® is pumped out of the reducing agent supply line by the reducing agent pump after the reversing valve for reducing agent is actuated.

❒ b) The AdBlue® is pumped out of the reducing agent supply line by the reducing agent return flow pump.

❒ c) After "ignition off", the AdBlue® in the reducing agent supply line is drained via the reducing agent injector and temporarily stored in the diesel particulate filter coating.

2. How is the filling level of the reducing agent tank determined by the engine control unit in the SCR system for the Passat 2015?

❒ a) By using a float with a magnet and six reed contact switches.

❒ b) By using four fill level senders made of stainless steel and evaluation electronics.

❒ c) By using an ultrasonic sensor.

3. Which statement about monitoring the efficiency of the SCR system in the Passat 2015 is correct?

❒ a) The efficiency of the SCR system is monitored by using an NO_x sender before the emission control module.

❒ b) The efficiency of the SCR system is monitored by using an NO_x sender after the emission control module.

❒ c) The efficiency of the SCR system is monitored by using one lambda probe before the emission control module and one after it.

4. What functions does the trap catalytic converter have?

❒ a) It oxidises carbon monoxide into carbon dioxide.

❒ b) It oxidises soot particles into carbon dioxide.

❒ c) It stores excess ammonia, which is used to convert nitrogen oxides remaining in the exhaust gas into nitrogen and water.

❒ d) It stores nitrogen oxides that are converted into nitrogen and water in a regeneration process.

5. The following warning symbol appears in the dash panel insert display. Which statement is correct?

S540_046

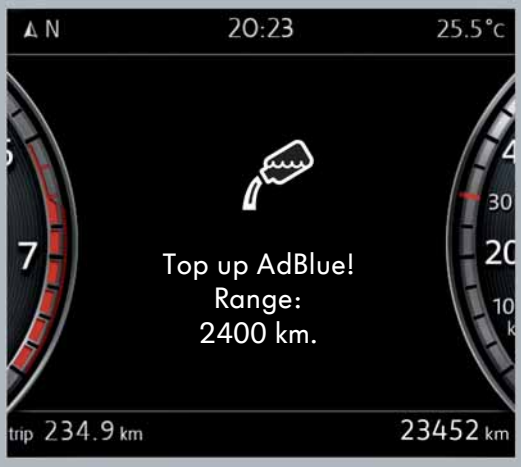
❒ a) The reducing agent tank is empty. The engine can only be started again once the reducing agent tank has been filled.

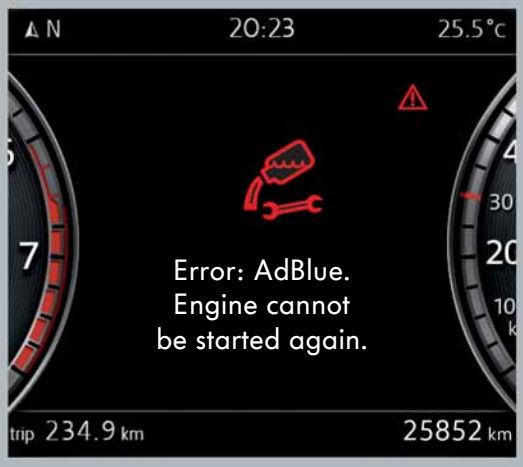
❒ b) The reducing agent tank is empty. The engine can only be started again once the entry in the engine control unit event memory has been deleted.

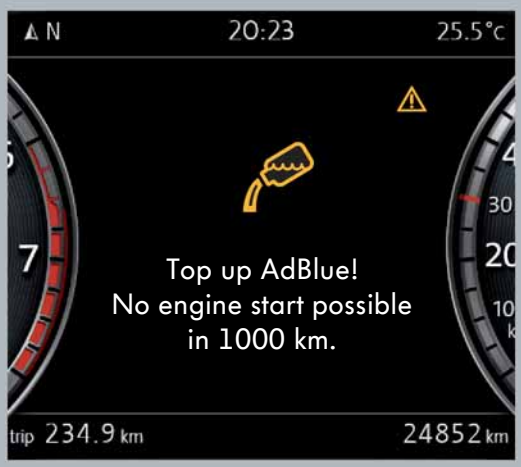
❒ c) There is an error in the SCR system. The engine cannot be started.

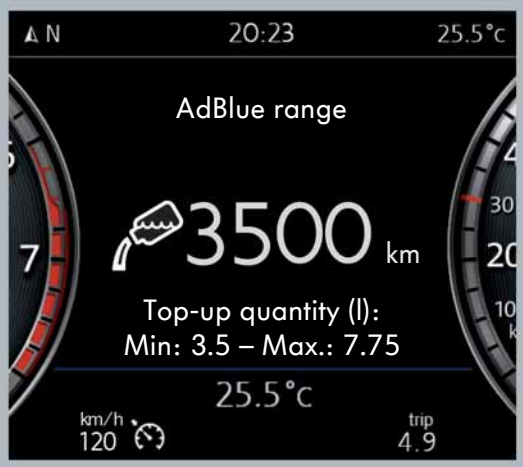
❒ d) There is an error in the SCR system. The engine can be started so that the customer can reach the next workshop.

Answers:
1.) b)
2.) c)
3.) a)
4.) a), c)
5.) c)









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