

AdBlue®

VDA | Verband der
Automobilindustrie





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Reducing Emissions

Selective Catalytic Reduction (SCR) using AdBlue® and NO_x Storage Catalyst (NSC) technology enable diesel passenger cars to comply with the Euro 6 exhaust standard.

Keeping ahead of emission legislation

The German automotive industry has always kept ahead of emission legislation of the European Union by implementing rapid technological developments. The Euro 6 exhaust standard will come into force in 2014. Emissions of nitrogen oxides during normal operation must then be 80 per cent below those from today's diesel vehicles without NO_x aftertreatment. This represents the greatest challenge facing diesel vehicles since the introduction of the EU's first exhaust standards! Yet once again the automotive industry already has solutions for meeting the exhaust standard of tomorrow: optimised engines, NO_x Storage Catalysts (NSC) and Selective Catalytic Reduction (SCR). The latter treats exhaust using a new aqueous solution. Its name: AdBlue®.

For years now German automotive manufacturers have achieved continual significant improvements in the fuel economy and emissions of new vehicle models. Average consumption by passenger cars has fallen by 40 per cent in comparison to 1990 levels. In the last five years alone, fuel consumption in Germany has gone down by an average of around 16 per cent. More than 60 per cent of all newly registered cars in Germany now have a standard consumption of under six litres per 100 kilometres. The average CO₂ output from German-branded passenger cars fell from 175.2 g/km CO₂ in the year 2006 to 142.4 g in April 2012. In September 2012 it actually went below 140 gram for the first time. The German automotive industry is therefore a world-wide pioneer of safe, reliable cars with clean and efficient drive trains.

The high speed of innovation in the German automotive industry results from the high levels of investment, which the German automotive industry in particular has been pouring into research and development for many years to ensure its long-term competitiveness. It spends around 20 billion euros on R&D every year, which is more than one third of all industrial research spending. Every additional gram of CO₂ saved requires extremely sophisticated processes. Yet despite the hard work and considerable investment, one thing is clear: past great success in reducing CO₂ cannot simply be continued in a linear fashion. The vehicle industry is at a point where there are no more simple solutions. The physical limits of emission reduction have been reached.

Euro 6 and beyond

Against this background, the automotive industry is being challenged by even stricter legal requirements for further emission reductions. A very ambitious proposal from the European Commission envisages regulating the CO₂ output from passenger cars at 95 g/km CO₂ by the year 2020. This corresponds to fuel consumption of less than four litres for every 100 kilometres travelled. The CO₂ regulation already in force sets a limit of 130 gram for the European passenger car fleet in the year 2015. In other words, to achieve the 95 gram target, the European automotive manufacturers must save an average of 35 grams of CO₂ within only five years – from 2015 to 2020. The proposed EU limits values are the strictest anywhere in the world.

The road map for the Euro 6 exhaust standard has now been fixed. From September 2014 onwards, the standard will initially be binding on all new passenger car type approvals. In September 2015 it will apply to all newly registered passenger cars. Two years later, i.e. from September 2017, the Euro 6 exhaust standard is to be tightened even further. The car makers will then have to prove that the engines of all new vehicle models not only comply with the exhaust limits on the dynamometer in the New European Driving Cycle (NEDC), but also in normal, everyday operation. The Introduction of Euro 6 therefore means that effective systems for the aftertreatment of nitrogen oxides are of huge significance.

Two systems have proven effective at reducing nitrogen oxides from optimised diesel engines – depending on vehicle weight and engine size – for almost a decade: NO_x Storage Catalysts (NSC) and Selective Catalytic Reduction (SCR). A NO_x storage catalyst is coated with alkaline earth oxides or carbonates and undergoes a reversible chemical reaction with NO_x . The SCR technology exploits the properties of AdBlue®: a safe, environmentally friendly and high-quality aqueous solution of urea, which reacts with nitrogen oxides in the hot exhaust and converts them into harmless nitrogen and water (more details are given in the section “Cleanliness and efficiency”, page 4).

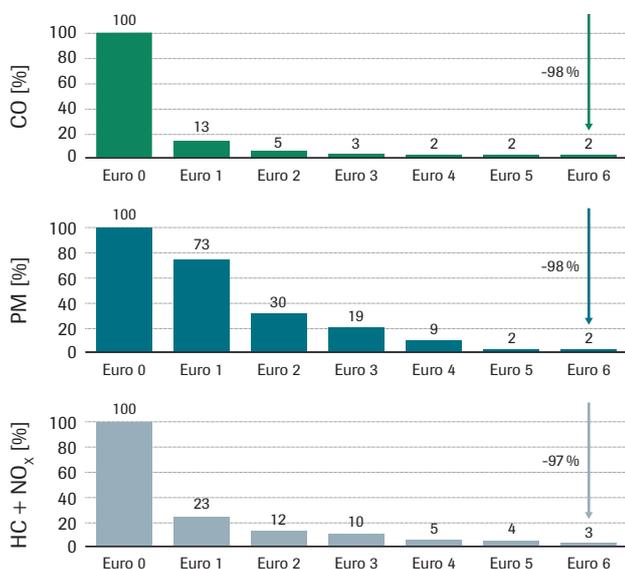
SCR technology with AdBlue® laid the technological foundations for bringing down pollutant emissions – especially of nitrogen oxides – from diesel-powered commercial vehicles. In the case of very heavy vehicles, AdBlue® has proved its value and established itself as an effective solution for exhaust aftertreatment. Modern commercial vehicles using it now run almost free of emissions. The success story of German light diesel trucks in the USA would be inconceivable without SCR technology.

Sustainability brings obligations

Now AdBlue®'s time has also come for passenger cars with a diesel powertrain. Most diesel cars satisfying the Euro 6 exhaust standard from 2014 onwards will be fitted with an SCR system. To promote sustainability, the automotive industry is today already applying this solution for individual transport and will continue to do so. As half of all new cars registered in Western Europe are diesels, the number of private cars with SCR technology will rise accordingly.

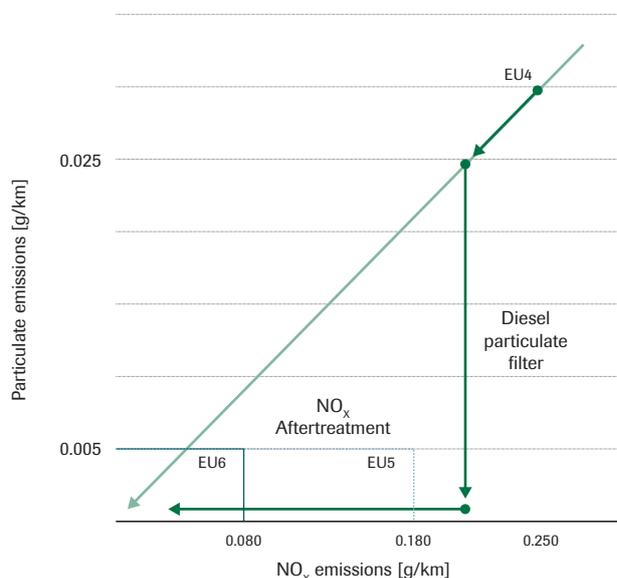
The automotive industry's tried-and-tested technologies for exhaust aftertreatment and for using the proven AdBlue® additive are good preparation for meeting the requirements of future strict EU laws on emission reduction in private transport. Employing SCR technology is one way of meeting the stringent legal requirements. It brings the cleanest diesel vehicles of all time to the level of petrol-driven automobiles.

Development of exhaust-gas stages for diesel passenger cars



Source: VDA

Technical measures for Euro 6



Source: VDA

Cleanliness and Efficiency

The German automotive industry has turned out to be a technological pioneer with its advanced diesel engines.

Diesel 2.0

An unusual automobile that has just recently been given wheels: it has an unassuming appearance – a “modern classic” diesel car that is more than 20 years old. But watch out if you step on the accelerator! It is equipped with the latest generation diesel technology and demonstrates the entire potential of its state-of-the-art four-cylinder diesel engine.

The combination of past and present technology emerged from an evening meeting at which experts were wondering how best to illustrate the huge advances made in diesel technology during the past 20 years. Then equally far-reaching changes in safety and comfort during this period were left out of the equation. The result of chewing over these ideas was a special kind of tuning: the “Generation Blue” diesel engine accelerated the modern classic car from zero to 100 km/h in 6.2 seconds. The vehicle of a bygone age – although not all that long ago – covered the standard sprint exactly 11.9 seconds faster than would have been possible with its original diesel engine dating from 1983.

Even more impressive than this super sprint are the differences in the two generations’ fuel economy. Despite the clear improvement in performance, from 72 hp at the end of the 1980s to 204 hp in 2009, the new engine in the old body used 4.9 litres to travel 100 kilometres in the NEDC. Just for comparison, in 1988 it took 7.3 litres of diesel fuel to cover the same distance. But the really astounding fact is that measured against the German standard in force when the classic car was built, the current “Generation Blue” diesel engine needs only 4.6 litres for 100 kilometres in the “Euro Mix”; even in today’s NEDC the figure is only 5.1 litres for 100 kilometres. That is an improvement of around 30 per cent – not to mention the emissions figures.

Rapid progress

The experimental vehicle is a clear illustration of the rapid technological progress in diesel engines. In the last five years alone, average fuel consumption in Germany has fallen by around 16 per cent. Now more than 60 per cent of all passenger cars newly registered in Germany have an official consumption of under six litres. The German automotive OEMs already have more than 400 models and model variants available consuming about five litres of fuel over 100 kilometres. Economical diesel engines have made a major contribution to this achievement.

Modern diesel engines are high-tech systems offering a unique package of innovations. The vehicles have common-rail direct injection at pressures of up to 2,200 bar or more. The very fast piezo injectors and the advanced magnetic valve injectors allow up to five injections per stroke. The turbochargers with variable turbine geometry produces effective charging with spontaneous response over a wide range of engine speeds. Some engine variants even have multi-stage charging with up to three turbochargers, or indirect charge-air cooling. Electrically controlled exhaust gas recirculation with bypass-channel and optimised cooling helps in producing minimal emissions of nitrogen oxide.

And progress is not stopping there. Following the commercial vehicles and models for the USA, which have to comply with the strict Tier 2/Bin 5 legal standard there, now more and more diesel passenger cars with NO_x Storage Catalysts (NSC) or Selective Catalytic Reduction (SCR) are also coming onto the German market. In the SCR system the exhaust is treated using AdBlue® to significantly reduce the levels of nitrogen oxides.

BlueTEC, BluePerformance, BlueTDI, clean diesels, BlueInjection and ECONetic are the models from Mercedes-Benz, BMW, Volkswagen, Audi, Opel and Ford that are equipped with NO_x exhaust aftertreatment. SCR systems inject an aqueous solution of urea, called AdBlue®, into the exhaust flow. Further downstream, in the SCR catalytic converter, the ammonia released reduces up to 80 per cent of the nitrogen oxides (NO_x) to harmless nitrogen (N₂) and water (H₂O). This type of NO_x aftertreatment means that diesel vehicles with this technology already meet the targets in effect from 2014 when the Euro 6 exhaust standard comes into force, and are thus cleaner than currently demanded by law. The German automotive industry is once again a pioneer in cleanliness and efficiency.

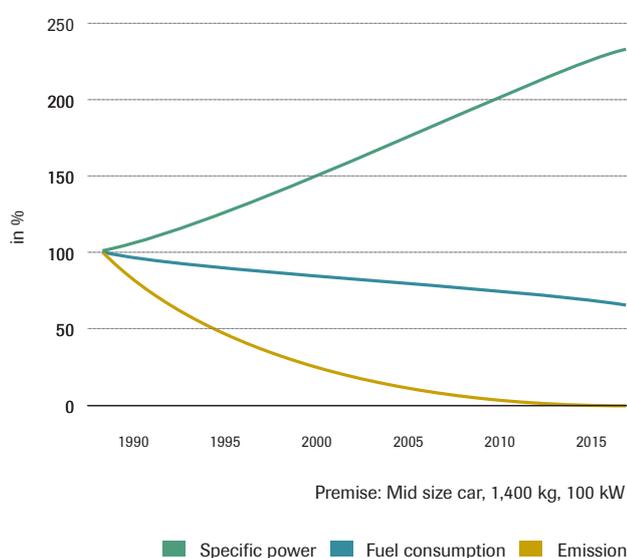
As clean as petrol engines

This unprecedented rate of denoxing in normal, everyday driving achieves the lowest emissions with the best possible fuel economy. Denoxing is a key factor enabling diesels to meet the most demanding exhaust standards around the globe.

Diesels have thus become as clean as petrol engines. AdBlue® is an important part of this highly efficient and clean powertrain concept. The independent research company Integer Research forecasts annual Europe-wide production of five to seven million passenger cars, SUVs and vans with SCR technology by the year 2020 (this was backed up by other studies, too). The German Association of the Automotive Industry (VDA) now estimates that more than 20 million vehicles with this modern technology will be on the roads in Western Europe by 2020. There is no doubt that the combination of SCR and AdBlue® is developing into a major technology component for diesel vehicles.

Increase in efficiency of the clean diesel

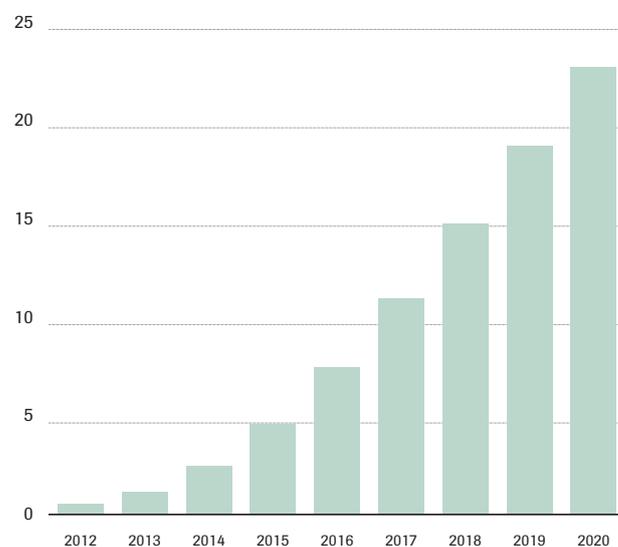
The Clean Diesel offers high potential for further innovation



Source: Bosch

SCR vehicle inventory in Europe, only German brands

In millions



Source: VDA

Passenger Car Diesel Engines

New diesel powertrains for passenger cars combined with the highly effective SCR technology already meet the requirements of future exhaust standards.

AdBlue® makes for high-tech engines

Reducing exhaust emissions will become an ever greater challenge for vehicle manufacturers. Future legal regulations such as the Euro 6 exhaust standard will require more than optimised engines. Additional aftertreatment to remove nitrogen oxides is necessary. Key technologies for doing this are the NO_x Storage Catalysts (NSC) and the Selective Catalytic Reduction (SCR) already familiar in commercial vehicles. A growing number of modern passenger cars with diesel engines will be fitted with SCR.

A selective catalytic converter reduces nitrogen oxides using an additional, finely dosed fluid. It is a synthetically produced aqueous solution of urea that is marketed under the name of AdBlue® and stored in an extra tank on the vehicle. A controlled amount of AdBlue® is injected from the tank into the exhaust system, where it releases ammonia (NH₃) that reacts with nitrogen oxides (NO and NO₂) in the catalytic converter to form nitrogen (N₂) and water (H₂O). With this technology the German automotive industry is once again setting standards around the world in reducing exhaust emissions, and already enabling its customers to drive diesel vehicles complying with Euro 6 long before they are legally obliged to do so.

An effective mixture

AdBlue® consists of 32.5 per cent urea and 67.5 per cent demineralised water. It is odourless, clean and nontoxic. The concentration of urea remains constant even if the tank freezes. The standards ISO 22241 and DIN 70700 set a high level of purity for AdBlue®. The German Association of the Automotive Industry (VDA) has the manufacture and distribution monitored, in order to ensure that SCR functions reliably.¹

The catalytic converter and the other components form an SCR system that is exceptionally effective under all operating conditions. Drivers of diesel vehicles using AdBlue® fill them up via a special filler pipe leading to a separate tank. This filler pipe may be located in the boot of the vehicle, or under the fuel cap next to the filler for diesel fuel. The actual filling process does not require any extra equipment. Independent of the intervals between services, drivers can fill up on AdBlue® themselves, just as they do with fuel.

The AdBlue® tank is equipped with a heater that will always defrost sufficient liquid if there is a sharp frost (AdBlue® freezes at -11.5 °C), so the system will rapidly be available. The AdBlue® solution is fed from the tank through heatable pipes to an injection module regulated by the engine control unit. This module ensures that always the right quantity of AdBlue® is injected for the engine speed and the vehicle's load. The exhaust system downstream of the dosing module is designed (generally with a metering unit) so that the best possible distribution of AdBlue® (or the ammonia released) is achieved throughout the catalytic converter. Sensors both upstream and downstream of the catalytic converter measure parameters including the concentration of nitrogen oxides and the temperature, and send signals to the control unit. This ensures even more precise injection and simultaneously monitors correct operation of the SCR system.

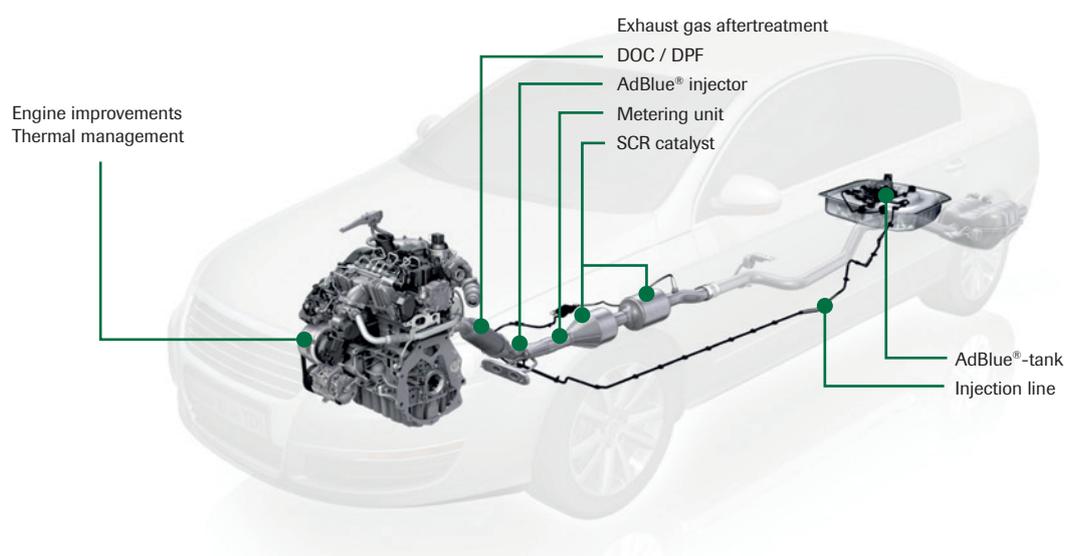
¹AdBlue® is a registered trade mark of the Verband der Automobilindustrie e. V. (VDA). For further information see www.vda.de.

Results of continuous development

The SCR system is carefully designed so that all the components of the diesel engine and of the exhaust aftertreatment will work together well. Optimised fuel injection, exhaust recirculation, the oxidation catalyst and the additional diesel particulate filter make it possible to satisfy the future exhaust standards today. All the development steps together form the basis for employing the future SCR technology.

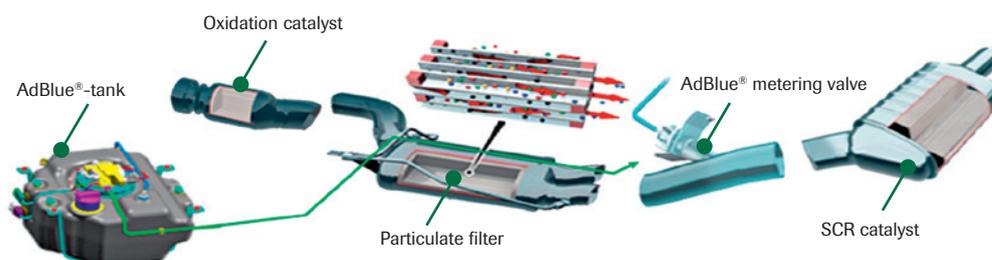
Depending on the vehicle model, these and other components will be individually adapted and continuously improved. To prevent as much carbon dioxide as possible, developers pay particular attention to reducing the vehicle weight and exploiting the available space. For this reason, and because space for the AdBlue® tank is limited, vehicle developers are searching for a balance between suitability for everyday use and additional weight. This means that customers will have to fill their vehicles up with AdBlue® themselves between services.

Integration in the vehicle



Source: Volkswagen AG

The clean diesel with particulate filter and NO_x reduction system: an effective CO₂-saving technology



Source: Volkswagen AG



Source: Audi AG

Filling Up

AdBlue® has established itself internationally as an innovative technology for exhaust aftertreatment. Motorists can fill up the special tank with AdBlue® just like they fill up with diesel.

A familiar procedure

Drivers of diesel vehicles with modern SCR technology will reach for the new pump for AdBlue® increasingly often in the foreseeable future. This is because the Euro 6 exhaust standard will come into force soon, in the year 2014. And modern diesel cars cannot manage without the new additive. Filling up with AdBlue®, which converts toxic nitrogen oxides into in water and nitrogen in the exhaust system, should be just as simple as filling up on fuel: unhook the nozzle, insert it into opening of the small tank, and operate the mechanism. Done. It takes only seconds. The developers working for the automotive and petroleum industries have invested a significant amount of time and effort in the system.

Filling Up AdBlue®

A lot of attention has been given to the filling adapter for diesel cars using AdBlue®. Its development took a whole series of aspects into consideration: integration at filling stations, the filling process, matching pump nozzle and filling pipe, the optimum filling speed and a clean, drip-free process. This resulted in a standardised, user-friendly AdBlue® pump nozzle for filling stations throughout Europe which was developed jointly by the automotive and petroleum industries, and which is both easily recognisable and conforms to ISO requirements. The first filling stations already have these AdBlue® pumps and expansion of the infrastructure is planned (see "Infrastructure", page 10).

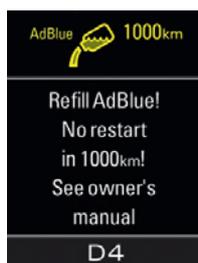
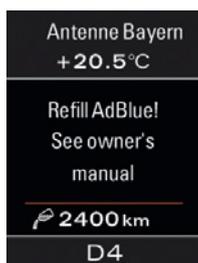
Consumption of AdBlue® depends on the vehicle weight and on individual driving style. On average a passenger car will consume about one and a half litres over 1000 kilometres. Before AdBlue® pumps provide total coverage, motorists can use bottles of AdBlue® containing almost two litres, or canisters of five litres, to help during the transition period. Filling stations are already offering both containers. So filling up is very simple, clean and straightforward. Open the bottle or canister, screw it onto the car's filler, and hold it there. The instructions give you all the details.

No worries about an empty tank

The driver will be warned in good time if AdBlue® begins to get low. The first reminder to fill up is displayed by the instrument cluster before the AdBlue® tank is empty. So there is plenty of time to go and fill up. The vehicle makers' service partners, filling stations and dealers will usually keep AdBlue® in the practical five-litre containers or in "Kruse" bottles holding nearly two litres. Unlike truck drivers, most private motorists are not yet familiar with AdBlue®, and for technical reasons passenger cars are generally not allowed to fill up on AdBlue® from truck pumps. Information for each vehicle is contained in the instructions for use, or alternatively can be obtained from the contractual partners (see "Infrastructure", page 10).

The concept of the German automotive industry for the owners of modern diesel vehicles filling up regularly is based on customer information and the introduction of drip-free systems which make filling up with AdBlue® as easy as refuelling.

Warning Notices for AdBlue®-Refill



Infrastructure

The automotive sector and the petroleum industry are working closely together to rapidly establish an AdBlue® infrastructure for diesel passenger cars.

From canisters to pump network

In the future, motorists will see a new pump more and more often when they call at a filling station. It will be for AdBlue®. This chemical solution converts harmful nitrogen oxide into nitrogen and water while the vehicle is running. Demand for the fluid, which many modern diesel cars require, is expected to reach about 3.5 million tonnes per year by 2015. This makes a crucial contribution to compliance with the Euro 6 exhaust standard that will become effective in 2014. The tried-and-tested additive is fed from a separate small tank through an injection system and into the exhaust pipe. The outlets offering AdBlue® are expected to develop into a network very quickly.

The petroleum and vehicle industries must work closely together to build up a network offering full coverage for passenger cars right across Europe. The count-down has started: several truck stops are now installing pumps for AdBlue®. The first test pumps for private diesel automobiles already running with SCR technology and the environmentally friendly AdBlue® fluid are going into operation at selected filling stations in Germany at the beginning of 2013. Demand will indicate where additional pumps are to be installed.

Containers for the transitional period

However, drivers of passenger cars with an additional tank for AdBlue® do not have to find a special pump before they can fill up. The car makers are offering an interim solution via their dealers by supplying AdBlue® in two different sizes of containers: a 1.89 litre bottle, and a refillable canister holding five litres.

The AdBlue® bottle is already on sale. As demand increases, we can expect to see even more customer friendly solutions at filling stations. Yet in the future motorists will still not want to go without their bottles and canisters. The containers are also useful for carrying reserves on longer journeys. The car manufacturers have promoted easy handling of these recyclable and therefore environmentally friendly containers, so customers can refill internal tanks and use filling devices attached to the exterior of the vehicle. The filling adapter seals to prevent AdBlue® from leaking, which renders the filling process both drip-free and odourless.

The manufacturers' dealers and service partners represent will provide support during the transitional period while the filling infrastructure is set up, where customers can also have their special tanks filled. The OEMs and dealers are already elaborating a workshop solution for fast, clean refilling based on containers and mobile pump systems. For commercial vehicles there is already a complete network of AdBlue® pumps. These systems are however unsuitable for passenger cars (with a few exceptions) because of the very high flow rates required for trucks, and are therefore not normally approved for filling cars. Furthermore, not all truck pumps are easy for passenger cars to access.

Finding your way to the best service

Places where drivers of modern diesel vehicles with an SCR system can fill up with AdBlue® will be shown on a map similar to the website www.findadblue.com. A few simple clicks will quickly show the all current sites of AdBlue® pumps and outlets selling bottles/canisters. Navigation systems and mobile applications will also help show future AdBlue® customers the way to the nearest supply point. As demand increases, this network will be maintained and expanded.

So, very soon, whether a filling station sells AdBlue® or not may well be a criterion for customers when choosing to call in there or drive on to the next one instead.

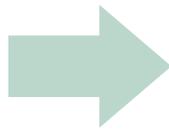
Paying attention to AdBlue® quality

Drivers of diesel vehicles should observe the following rules when using AdBlue. The AdBlue® tank should never be filled with anything except AdBlue®. There is no alternative that can replace AdBlue®. Using contaminated AdBlue® or other liquids such as water can lead to progressive loss of efficacy and ultimately block the catalytic converter. This results in expensive repairs, reduced efficiency and lost time. Furthermore, equipment for handling fuel or lubricants (such as funnels, canisters or other containers) should never be used for storing or filling up with AdBlue®, because this may contaminate the solution. In addition, used AdBlue® containers should never be re-used as this can also cause contamination.

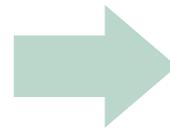
Customer-friendly availability of AdBlue®



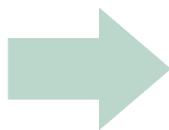
Refilling from standard containers



Possible intermediate solution



Final solution



Uniform pumps and uniform containers are the basic requirements for customer acceptance.

Consultation and cooperation with the mineral oil industry, also for the design of refill containers.



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