Sealing materials for AdBlue® applications

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Clean Diesel

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AdBlue® is the registered trademark for an aqueous urea solution. After conversion into ammonia, it is used in SCR exhaust gas aftertreatment systems of modern diesel-powered vehicles to reduce nitrogen oxides (NOx). Offering a range of sealing materials that are suitable for use with AdBlue® now and through accelerated development of new elastomer compounds Parker addresses the increasing use of this eco-friendly technology in trucks as well as in future passenger vehicles.

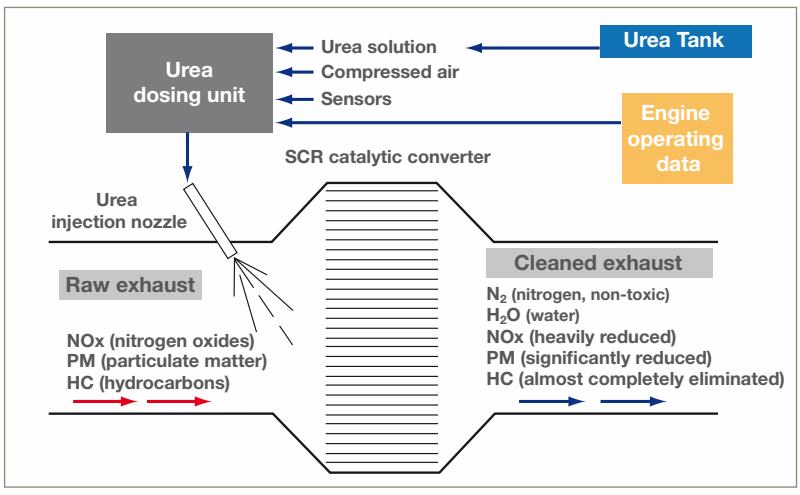
In 2005, the Euro IV emission standard came into effect. It required nitrogen oxide emissions of new vehicles to be reduced by 30 %, and emissions of particulate matter (PM) by 80 %. When the Euro V standard came into force in 2008, nitrogen oxide limits were reduced by another 40 %.

In addition to the required reduction of PM levels, the more stringent nitrogen oxide limits are particularly relevant for diesel engines which, compared with petrol engines, produce about three times as much NOx in their exhaust emissions.

On the other hand, the higher energy efficiency (= less fuel consumption) of diesel engines and the development of modern, powerful turbo diesel units has resulted in a consistent increase of diesel technology in passenger cars, besides their traditional, wide-spread use in commercial vehicles.

The high nitrogen oxide production of diesel engines – particularly of turbo diesel units – results from their particularly high combustion temperatures and pressures. Since measures inside the engine affecting the combustion process do not suffice to achieve the required reduction of NOx emissions, there are various exhaust gas aftertreatment systems on the market, such as NSR (NOx storage catalytic reduction) or SCR (selective catalytic reduction) systems. SCR, which has been used in buses and trucks for a number of years and will soon be found in passenger cars as well, is increasingly gaining ground, not least due to the fact that, unlike other techniques, it consistently retains the high efficiency of diesel engines.

During the selective catalytic reduction process the nitrogen oxides are “selectively” (i.e. ahead of other substances) reduced in an SCR catalytic converter located behind the oxidation catalyst and the diesel particulate filter. This is achieved through a chemical reaction of the exhaust gas with ammonia. The ammonia is injected in the form of an aqueous 32.5 % urea solution (AdBlue® - the trademark is held by the German VDA; the composition is prescribed by DIN 70070) from a separate tank into the exhaust system in front of the SCR catalytic converter. In a hydrolytic reaction



in the exhaust system ammonia is released from AdBlue® and then reacts in the SCR catalytic converter with the nitrogen oxides to produce nitrogen and water – two substances which are harmless to the environment. This technology reduces nitrogen oxides in exhaust emissions by up to 80 %.

Exacting demands on sealing materials

A large number of O-rings are used in the AdBlue® dosing module. They serve to provide sealing in the filter element, in pressure and temperature sensors, in connectors or in control valves, for example. The elastomer materials used for these seals must exhibit good media resistance against AdBlue® at temperatures up to 80 °C (short-term up to 100 °C). In addition, due to the high water content of the urea solution, good resistance to hot water up to 100 °C is essential as well as thermal resistance in hot air up to 120 °C. In the low-temperature range the elastomer materials must have cold flexibility down to –20 °C (below this temperature, the AdBlue® solution will freeze). Some customers also require sufficient diesel resistance of the elastomer to avoid excessive swelling of the seals in case the AdBlue® tank should accidentally be filled with diesel fuel.

AdBlue® compatible Parker materials

The Parker material E8556-70 (EPDM, peroxidically cross-linked, 70 Shore A) exhibits very low volume swelling and changes to its mechanical properties, and thus provides outstanding resistance to AdBlue® at temperatures up to 100 °C (Table 1). In addition, a plasticizer-free EPDM compound with 60 Shore A is available for AdBlue® applications.

The Parker material N3831-70 (HNBR, 70 Shore A) offers good resistance to AdBlue® at temperatures of < 100 °C in combination with sufficient diesel fuel resistance. (Table 2)

Temperatures of > 100 °C occur in the AdBlue® injectors. Therefore, the sealing materials used in the AdBlue® injection system have to meet increased temperature requirements of 120 °C (short-term up to 150 °C).

At temperatures of approx. 120 °C the urea solution disintegrates and ammonia is created which chemically attacks EPDM and HNBR and starts a de-polymerization process. FKM cannot be used at these temperatures either, since it is chemically attacked and destroyed by ammonia as well. Even highly fluorinated or so-called standard base-resistant FKM types exhibit significant swelling and a notable reduction of their mechanical properties.

Only FFKM types (Parker Parofluor®) with a special formulation offer outstanding chemical resistance to the AdBlue® solution, even at 150 °C. However, on account of the very high price of polymers and their relatively poor cold flexibility, the suitability of FFKM compounds for use in urea injection systems is limited. At the moment, there are no lower-cost elastomer materials available which offer the required performance features for these extremely demanding applications. Therefore, Parker's material development is currently focusing increased attention on this area in order to soon provide the market with suitable elastomer compounds exhibiting sufficient media resistance for urea injection applications.

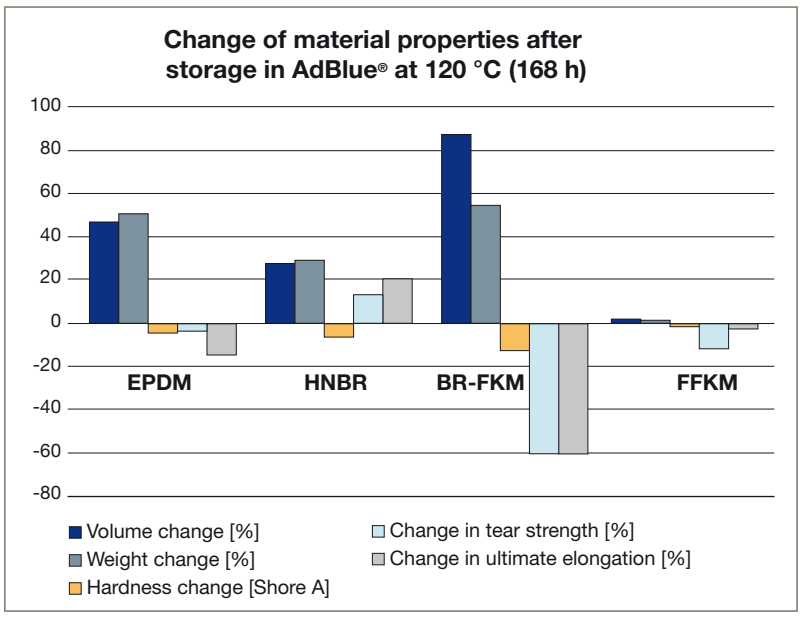


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Table 1: **EPDM E8556-70 – storage in AdBlue®**

Test	Dimension	AdBlue® 168 h / 80 °C	AdBlue® 168 h / 100 °C	AdBlue® 168 h / 120 °C
Volume change	%	1.4	0.6	46.6
Weight change	%	1.9	1	50.6
Hardness change	Shore A	0	0	-4
Tensile strength / change	N/mm² / %	17.1 / 1	17.1 / 1	16.5 / -3
Ultimate elongation / change	% / %	246 / 2	248 / 2	204 / -14
100% modulus	N/mm² / %	4.96 / -3	4.87 / -3	6.18 / +20

Data obtained on a test specimen.

Table 2: **HNBR N3831-70 – storage in AdBlue®**

Test	Dimension	AdBlue® 1000 h / 80 °C	AdBlue® 168 h / 95 °C
Volume change	%	20.3	3.7
Hardness change	Shore A	-6	-5
Tensile strength / change	N/mm² / %	21.6 / -1	23.9 / 1
Ultimate elongation / change	% / %	274 / -15	332 /2

Data obtained on a test specimen.

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