

BNOx SYSTEM SYSTEM OVERVIEW

The BNOx system comprises a BNOx (ammonia) generator that meters the NH₃ gas directly into the exhaust line. As a result of this operating principle, no function-critical hydrolysis in the exhaust gas stream is required (unlike with conventional SCR systems). This provides many benefits:

- The system functions already from an exhaust gas temperature as low as 150°C
- NOx reduction rates of 95% possible (test cycles)
- "Real Drive" NOx emissions are reduced by 94%
- Small package space required, compact construction
- No AdBlue deposition in the exhaust system, even at low exhaust gas temperatures

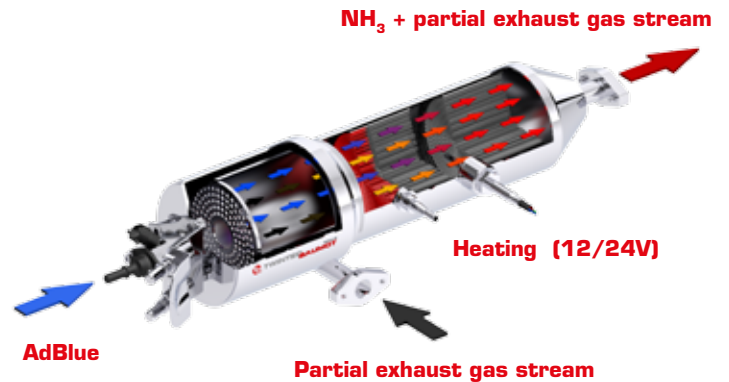


Fig. 1. BNOx generator

BNOx SYSTEM OPERATING PRINCIPLE

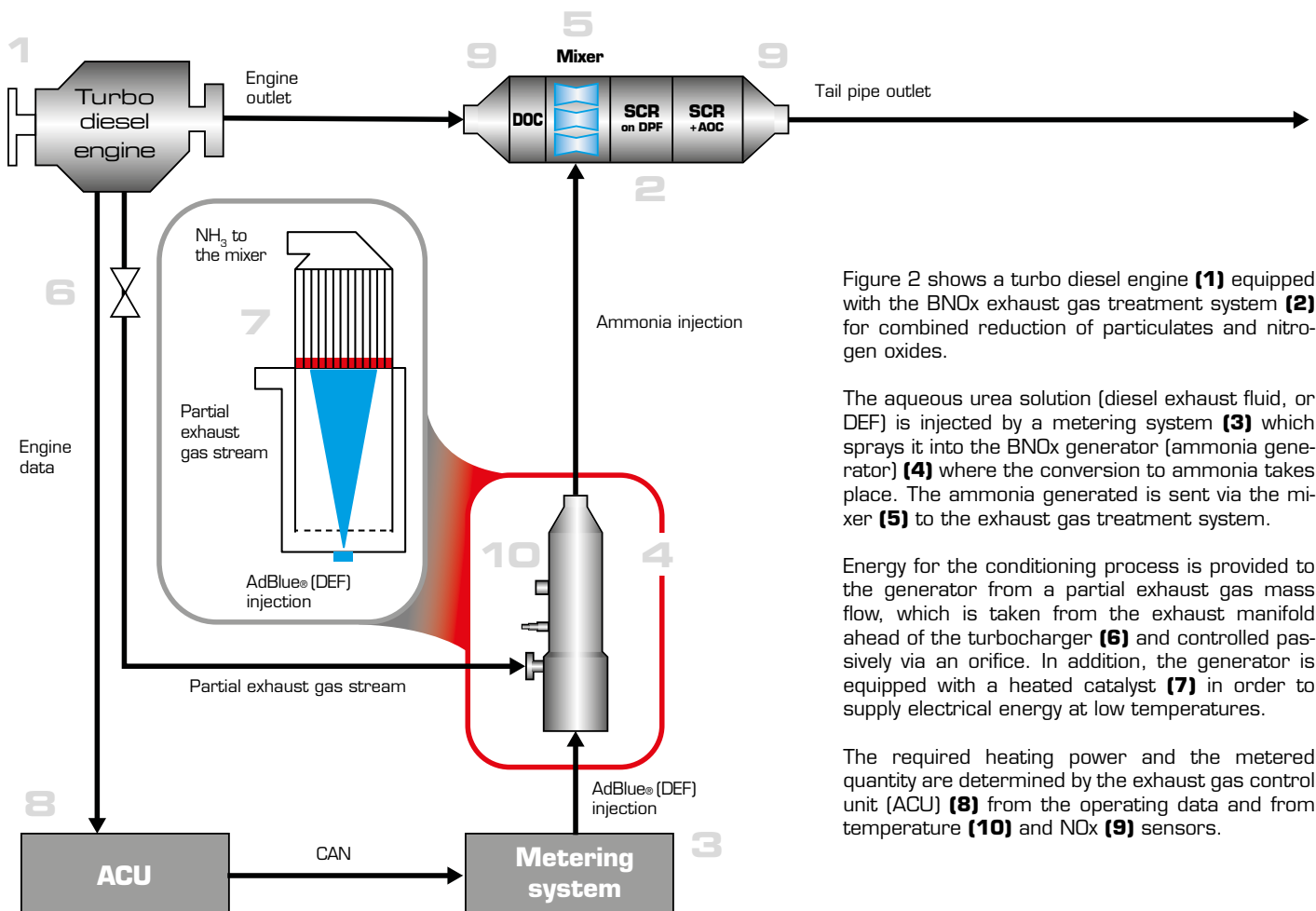


Figure 2 shows a turbo diesel engine (1) equipped with the BNOx exhaust gas treatment system (2) for combined reduction of particulates and nitrogen oxides.

The aqueous urea solution (diesel exhaust fluid, or DEF) is injected by a metering system (3) which sprays it into the BNOx generator (ammonia generator) (4) where the conversion to ammonia takes place. The ammonia generated is sent via the mixer (5) to the exhaust gas treatment system.

Energy for the conditioning process is provided to the generator from a partial exhaust gas mass flow, which is taken from the exhaust manifold ahead of the turbocharger (6) and controlled passively via an orifice. In addition, the generator is equipped with a heated catalyst (7) in order to supply electrical energy at low temperatures.

The required heating power and the metered quantity are determined by the exhaust gas control unit (ACU) (8) from the operating data and from temperature (10) and NOx (9) sensors.

Fig. 2. BNOx system configuration

CHALLENGES OF GENERATING AMMONIA FROM AdBlue WITH CONVENTIONAL SCR SYSTEMS

- Exhaust gas: large differences in exhaust gas mass flow, exhaust gas temperatures and pressures during operation
- AdBlue® conversion: low exhaust gas temperatures < 250°C; long vaporization distances required (e.g. 700 mm)
- Spray: spray angle, wall film formation, droplet distribution, mixing
- Problems during operation: formation of deposits, nozzle plugging, poor mixing and low SCR performance

TECHNICAL SOLUTIONS FOR IMPROVING THE DENOX PERFORMANCE OF THE SCR SYSTEM

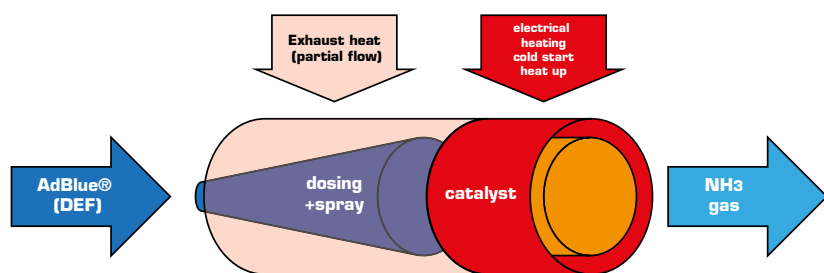


Fig. 3. Reactor concept of the BNOx generator

- Ammonia direct metering into the exhaust system
- BNOx generator is ready for use in approx. 100 seconds after cold start
- NOx reduction by the BNOx generator at nearly all operating points, especially at low exhaust gas temperatures
- Extremely high mixing efficiency via the ammonia-exhaust gas mixer
- Very highly uniform distribution of the ammonia in the exhaust system, and therefore optimal catalyst utilisation
- Very high SCR performance under nearly all operating conditions

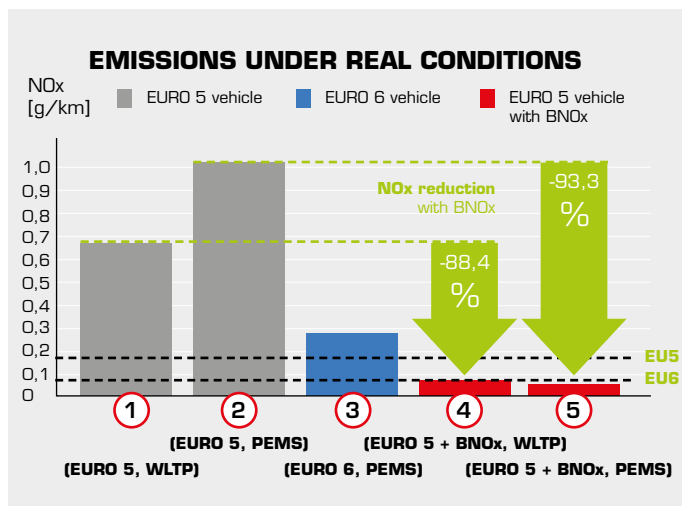
CASE STUDY RETROFIT OF A VW PASSAT B7 1.6 TDI (EU5)

This diagram shows the nitrogen oxide (NOx) emissions of a passenger car tested according to pollution class EURO 5 standards under laboratory conditions. Two different test cycles were used: the current EURO 6 test method (WLTP¹, test stand) and the EURO 6c RDE² cycle, which will apply from September 2017. (PEMS³, on-road).

Along with the BNOx system, the upgrade included the installation of existing VW EURO 6 series production components from the original VW spare parts catalogue⁴. **Bars 1 and 4** indicate the NOx exhaust gas values (0.68 g/km and 0.079 g/km) under the new EURO 6 test method, WLTP¹. **Bar 1** shows that according to the WLTP¹ method, the EURO 5 vehicle emits over seven times more nitrogen oxides (0.68 g/km) and is therefore far above the EURO 5 limit of 0.18 g/km under real conditions.

Bar 4 shows the same test where the vehicle was retrofitted with the BNOx system. The NOx emissions are reduced to 0.079 g/km and achieve, by comparison, an NOx reduction of **88.4%** under real conditions in the WLTP¹ test. **Bars 2 and 5** show a PEMS³ measurement without (1.03 g/km) and with BNOx (0.069 g/km) according to EURO 6c approval procedures in Berlin. An NOx reduction of **93.3%** is achieved there with the BNOx retrofit kit.

For comparison purposes, **bar 2** shows the NOx emissions (0.118 g/km) of a comparable EURO 6 vehicle⁵. Versus the EURO 5 vehicle with BNOx system (0.069 g/km), it emits nearly twice the quantity of NOx. From this, it is clear that the retrofitted EURO 5 vehicle complies with the EURO 6 limit values, also under real conditions.



	Pollution class	Limit value [g/km]	Test method	NOx emiss. [g/km]	NOx emiss. without BNOx [g/km]	NOx reduction
1	EURO 5	0,18	WLTP ¹	0,68	-	-
2	EURO 5	0,18	PEMS ³	1,03	-	-
3	EURO 6	0,08	PEMS ³	0,228	-	-
4	EURO 5	0,18	WLTP ¹	0,079	0,68	-88,4 %
5	EURO 5	0,18	PEMS ³	0,069	1,03	-93,3 %

¹ WLTP, Worldwide Harmonized Light-Duty Vehicles Test Procedure ² RDE, Real Driving Emissions
³ PEMS, Portable Emissions Measurement System ⁴ (DOC, DPF with SCR coating and SCR) ⁵ VW Golf 1.6 TDI Variant