BAUMOT GROUP

BNOx SYSTEM SYSTEM OVERVIEW

The BNOx system comprises a BNOx (ammonia) generator that doses 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 operates 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

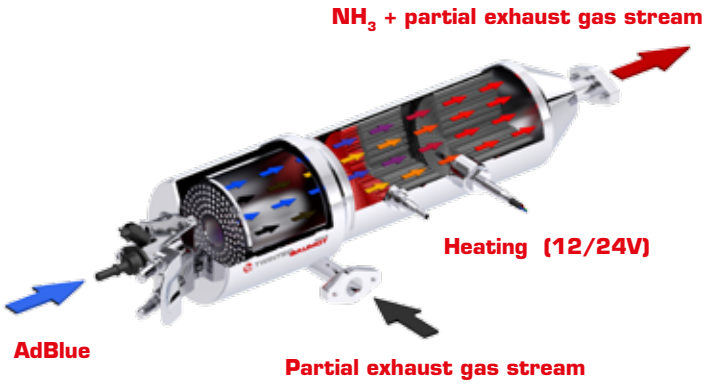


Fig. 1, BNOx generator

BNOx SYSTEM OPERATING PRINCIPLE

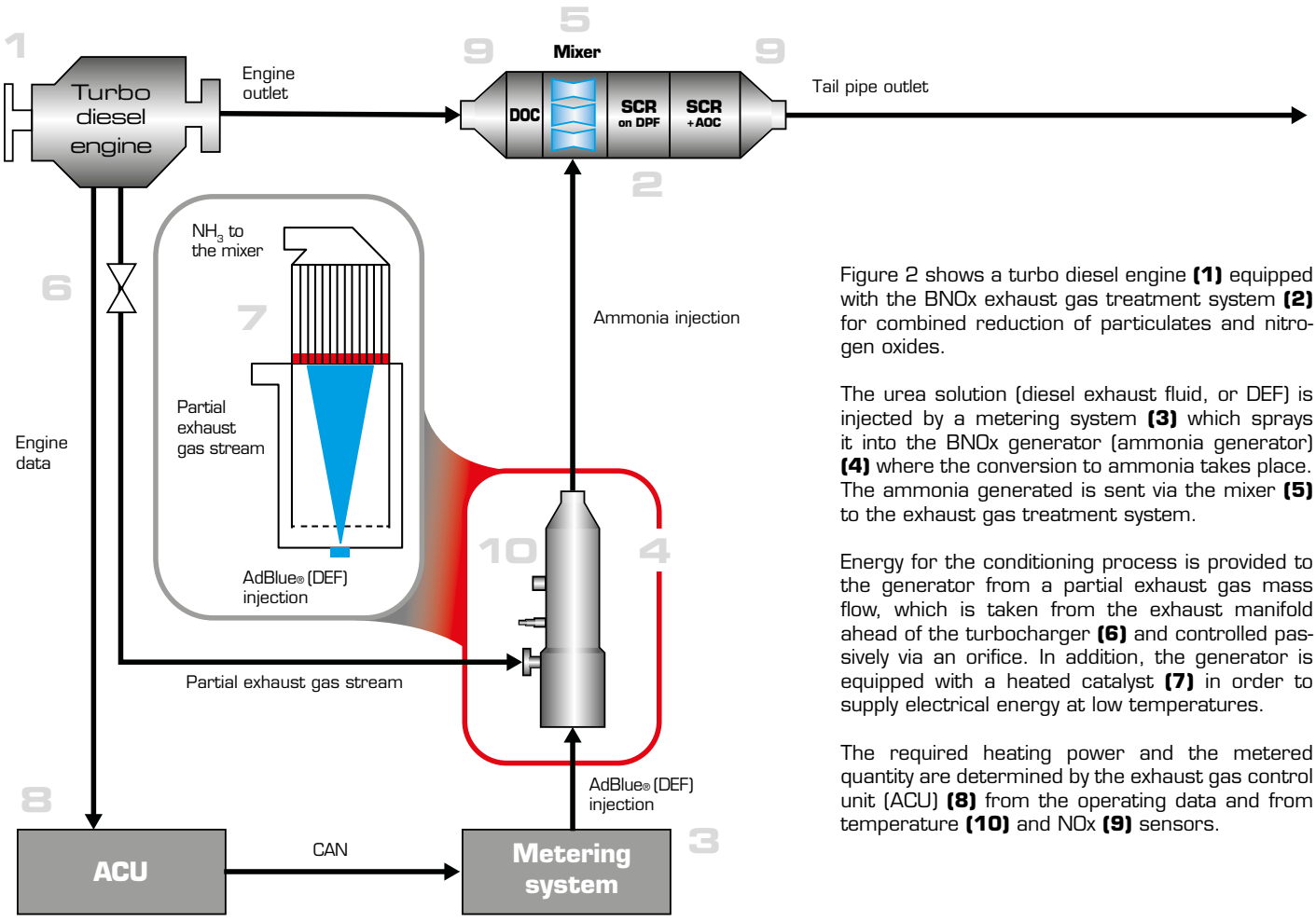


Figure 2 shows a turbo diesel engine **(1)** equipped with the BNOx exhaust gas treatment system **(2)** for combined reduction of particulates and nitrogen oxides.

The 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 IMRPOVING THE DENOX PERFORMANCE OF THE SCR SYSTEM

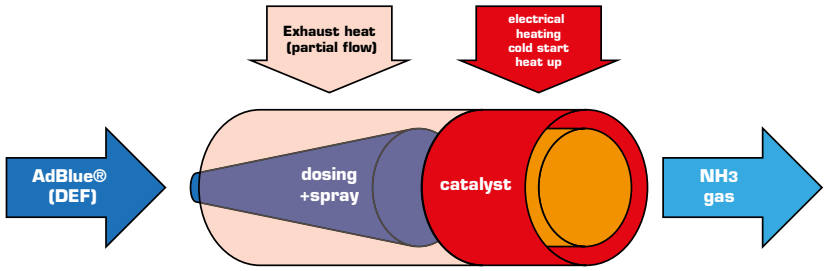


Fig. 3, Reactor concept of the BNOx generator

- 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
- Highly uniform distribution of the ammonia in the exhaust system, and therefore optimal catalyst utilisation
- Very high SCR performance under nearly all operating conditions

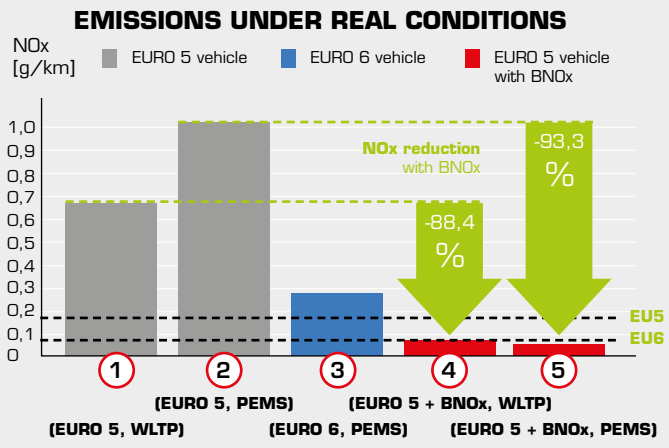
CASE STUDY RETROFIT OF A VW PASSAT B7 1.6 TDI (EU5)

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 (WLTP[1], test stand) and the EURO 6c RDE[2] cycle, which will apply from September 2017. (PEMS[3], 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 catalogue[4]. **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, WLTP[1]. **Bar 1** shows that according to the WLTP[1] 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 WLTP[1] test. **Bars 2 and 5** show a PEMS[3] 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 vehicle[5]. 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.



	Emiss. standard	NOx emiss. limit [g/km]	Test cycle	NOx emiss. [g/km]	NOx emiss. without BNOx [g/km]	NOx reduction with BNOx
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

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