Pneumatic Booster System PBS®
Eliminate turbo lag and save fuel

Applications

- Truck
- Bus
- Mobile and stationary construction machines
- Off-road vehicles
- Diesel locomotives

KNORR-BREMSE

Less fuel, more mileage

Road test report: The magazine lastauto omnibus has road-tested a system from Knorr-Bremses which claims to significantly reduce fuel consumption on trucks and buses. The result was astonishing.

We still don't know all the details. What is clear, however, is that after almost twenty years of commercial vehicle emissions standards, Europe is now committed to introducing the first fuel economy standard. This could come as early as 2016, or at the latest by 2020. Rumour has it that cuts of between 14 and 20 percent in fuel consumption may be required. But we still have no clue as to what parameters will be measured, how they will be measured, and against what baseline the reduction will be calculated.

On fuel consumption, commercial vehicle manufacturers have currently reached something of an impasse. They know exactly where further improvements could be made, but when it comes to implementing them they are dependent on legislation – and above all on their suppliers. On the legislative front, they would like to see an increase of about half a metre in maximum vehicle length regulations. This would offer benefits both for aerodynamics and for fuel economy. However, it is doubtful whether such legislation will be forthcoming. A much more realistic avenue is to make use of supplier-developed technologies,

ROAD TESTS WITH PBS

	Systems	Fuel consumption l/100 km	Fuel consumption difference	Average rpm
Test 1	without PBS/Eco	33,35	–	1.310/min
Test 2	with PBS	32,71	–1,9 %	1.264/min
Test 3 [1)]	with PBS and Eco	31,74	–4,9 %	1.222/min
Test 4	with PBS and Eco	31,06	–6,9 %	1.251/min

[1)] Traffic disruption en route

1 The test vehicle: a 430 hp MAN TGA semitrailer rig with automated transmission.

such as Knorr-Bremse's Pneumatic Booster System (PBS).

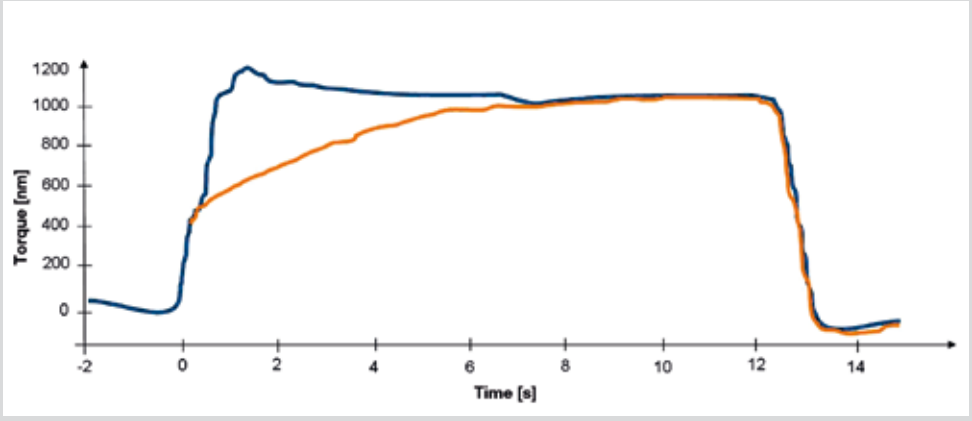
"PBS will be on the road by late 2012," promises Knorr-Bremse test engineer Daniel Geis-Esser. Since Knorr-Bremse manufactures air brake systems, it is perhaps not surprising that PBS too is a compressed air-based system. This is hinted at by the "P" in the initials, which stands for "pneumatic". In a nutshell, the PBS system has the ambitious aim of eliminating turbo lag – by injecting compressed air into the engine's intake manifold. A large turbodiesel engine normally takes three or four seconds or even longer between the driver stepping on the accelerator and producing its maximum torque. With PBS however, air from the compressed air tanks eliminates this performance lag and ensures faster throttle response. As a result, the acceleration shift points can be lowered, with a positive impact on fuel consumption. Depending on application, Knorr-Bremse says the system can achieve between three and five percent fuel savings.

The design and operation of PBS are delightfully simple. The system consists of a cylindrical pipe with a centrally located throttle valve, two pressure sensors, two diaphragm valves of different sizes and software whose job is to decide whether to inject compressed air and if so how much and for how long. Whether compressed air injection is required will depend mainly on the driver's throttle commands. The quantity of air supplied can range from 40 to 90 litres. The air is injected into the intake manifold at a pressure of twelve bar, for a period of between 0.8 and 1.6 seconds.
When PBS is activated, a number of things happen: the PBS throttle valve closes, air is injected audibly into the manifold, the engine rapidly builds up the necessary torque to match the throttle command and the rev needle flicks up by 100-200 rpm. Simultaneously, the turbocharger comes up to speed much more quickly than it would without PBS, since the increase in torque is translated directly into a corresponding increase in exhaust gas energy. The digital test instrument

2 Precise fuel consumption measurement: the 30-litre test tank was weighed before and after each lap, then refilled.

display shows a swift surge in turbocharger speed from 50,000 to 100,000 rpm. As soon as the pressure on either side of the throttle valve has equalised, the valve opens again and normal operation is resumed.

On the 27-kilometre test route, PBS on its own (without ECO mode) already brought a 1.9 percent improvement in fuel consumption (see table, test 2). The tests were carried out with an almost fully laden semitrailer, drawn by a 316 kW (430 hp) MAN tractor unit with automated transmission. The test rig, sporting a complete array of test equipment, completed five laps of the relatively low-traffic test route, the first one being a familiarisation lap. As the tests showed, the full potential of PBS only reveals itself when it is combined with a transmission controller with selectable Eco mode. Because PBS causes the engine to respond powerfully to all throttle commands, even at very low engine speeds, this can be exploited to lower the transmission's shift points. When accelerating, the automated transmission will then shift up at, say, 1300 rather than 1500 rpm. When the engine speed drops back just below



With PBS (blue), a turbodiesel engine develops boost pressure and torque much faster than without (orange).

Two supplementary air tanks, providing 80 litres of additional compressed air capacity, were fitted behind the side panels.

The PBS system is based on a pipe, a throttle valve, two temperature sensors, two diaphragm valves, a processor – and lots of development work.

1000 rpm following the shift, PBS is activated and rpm climbs quickly and vigorously again. The same principle applies when coasting in hilly terrain. A slight dip of the accelerator, resulting in PBS activation, may be sufficient to overcome the increased resistance when ascending a slight uphill grade. Without PBS, the transmission would shift down at this point. Positive effects of PBS noted in the test were: an increased amount of driving time spent in top gear, a substantial rpm reduction and, finally, a hefty 6.9 percent reduction in fuel consumption on test lap 4. Test lap 3 had already recorded a 4.8 percent saving, but had to be repeated due to traffic disruption en route.

A 6.9 percent saving, or fuel consumption of 31.06 litres/100 km instead of 33.35 litres, actually goes well beyond the manufacturer's own claims. Similar measurements conducted earlier by Knorr-Bremse indicated a savings potential in the order of 4.3 percent. Obviously, the actual savings achieved depend very much on the route being driven. Routes with relatively frequent starting from rest, frequent acceleration and hilly topography, like the test route used by lastauto omnibus, result in higher savings. But even in long-haul operation, PBS should still be capable of achieving savings of two percent, partly because a lower final-drive ratio can be used. That said, clearly the biggest benefits of PBS will be in short-radius distribution and local public transport, where the system can be used to support engine downsizing, i.e. a smaller engine with PBS can replace a larger engine without this feature. PBS will probably make its debut in a bus.
So what are the downsides? Well, the system increases compressed air consumption by between 20 and 30 percent, which may require a larger air compressor and larger air tanks. On our test rig though, the standard-specification (360 cc) single-cylinder compressor proved to be sufficient, although supplementary tanks were fitted to increase air capacity by 80 litres. The big plus point is the relatively modest price (max. 600 euros).

Doc. No. Y135981 (EN - Rev.000)

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