Two supplementary air tanks, providing 6 litres of additional compressed air capacity, were fitted behind the side panels. The PBS system is based on a piston, a turbine 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 to 1050 rpm, steadily and vigourously again. The same principle applies when coasting in fully 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 relatively frequent starting from rest, vigorous acceleration and hilly topography, like the test route used by lastauto, will probably make its debut in a bus.

The big plus point is the relatively modest price (max. 600 euros).

This document is subject to alteration without notice and therefore a printed copy may not be the latest revision. Please contact your sales representative for information about rights applications. Knorr-Bremse AG retains any power of disposal, such as for copying and transferring. Released: 11/2011
Less fuel, more mileage

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

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, 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 softwares whose job it 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 display shows a swift surge in turbocharger speed from slightly above 5000 to 15000 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, driven by a 516 kW (450 hp) MAN tractor unit with automated transmission. The test rig, rating 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 positively 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 1300 rpm, it will "look" at the throttle and initiate another shift down. Because PBS causes boost pressure to rise so quickly, the transmission always shifts to a lower ratio.

Road tests with PBS

<table>
<thead>
<tr>
<th>Systems</th>
<th>Fuel consumption l/100 km</th>
<th>Fuel consumption difference</th>
<th>Average rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>without PBS (Eco)</td>
<td>33.9</td>
<td>1.250/min</td>
</tr>
<tr>
<td>Test 2</td>
<td>with PBS</td>
<td>30.2</td>
<td>+1.6%</td>
</tr>
<tr>
<td>Test 3</td>
<td>with PBS and Eco</td>
<td>31.0</td>
<td>+0.8%</td>
</tr>
<tr>
<td>Test 4</td>
<td>with PBS and ECO</td>
<td>31.6</td>
<td>+0.4%</td>
</tr>
</tbody>
</table>

*Incl. diesel tax rate

1. The test vehicle: a 450 hp MAN TGA semi-trailer rig with automated transmission.
2. Precise fuel consumption measurement: the 30-litre test tank was weighed before and after each lap, then refilled.
Less fuel, more mileage

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

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

"PBS will be on the road by late 2012," promises Knorr-Bremse test engineer Daniel Gato-Eska. Since Knorr-Bremse manufactures air brake systems at its plants, it is perhaps not surprising that PBS too is a supplier-developed technology. It 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 to 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.

Road tests with PBS

<table>
<thead>
<tr>
<th>Systems</th>
<th>Fuel consumption l/100 km</th>
<th>Average rpm</th>
<th>Test</th>
<th>1. Test vehicle: a 430 hp MAN TGA semitrailer rig with automated transmission. 2. Precise fuel consumption measurement: the 38-litre test tank was weighed before and after each lap, then refilled.</th>
</tr>
</thead>
</table>
| Test 1  | without PBS/Eco          | 33.65       | 1.264 rpm |sand on the road by late 2012,” promises Knorr-Bremse test engineer Daniel Gato-Eska. Since Knorr-Bremse manufactures air brake systems at its plants, it is perhaps not surprising that PBS too is a supplier-developed technology. It 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 to 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. In which case, the digital test instrument display shows a swift surge in turbocharger speed from 1000 to 1500 rpm. As soon as the pressure on either side of the throttle-valve has equilibrated, the valve opens again and normal operation is resumed.

The 37-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...
Less fuel, more mileage

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

“PBS will be on the road by late 2012,” promises Knorr-Bremse test engineer Daniel Cato Esner. Since Knorr-Bremse manufactures air brake systems, it is perhaps not surprising that PBS is a compressed-air-based system. This is hinted at by the “P” in the initials, which perhaps not surprisingly 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 replacing turbo lag – by injecting compressed air into the engine’s intake manifold. A large turbocharged 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 it 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 command. 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 causes the engine to respond much faster to 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

ROAD TESTS WITH PBS

<table>
<thead>
<tr>
<th>Systems</th>
<th>Fuel consumption l/100 km</th>
<th>Fuel consumption l/100 km</th>
<th>Average rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>without PBS/Eco 33.55</td>
<td>33.55</td>
<td>1.315/min</td>
</tr>
<tr>
<td>Test 2</td>
<td>with PBS 32.71</td>
<td>32.71</td>
<td>1.264/min</td>
</tr>
<tr>
<td>Test 3</td>
<td>with PBS and Eco 31.06</td>
<td>31.06</td>
<td>1.253/min</td>
</tr>
<tr>
<td>Test 4</td>
<td>with PBS and Eco 31.06</td>
<td>31.06</td>
<td>1.253/min</td>
</tr>
</tbody>
</table>

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

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, driven by a 316 kW (429 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 positively 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
of 4.3 percent. Obviously, the actual consumption of 31.06 litres/100 km instead of 33.35 litres/100 km is a 6.9 percent saving, or fuel consumption due to traffic disruption en route.

Test lap 4. Test lap 3 had already recorded driving time spent in top gear, a substantial portion of test route used by lastauto turbo. The same principle applies when coasting in hilly terrain. A single-cylinder compressor proved to be sufficient, although supplementary tanks were fitted to increase air capacity 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) system increases compressed air consumption by between 20 and 30 percent, 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 liters. The biggest advantage of PBS will be clear. The biggest benefits of PBS will be relatively frequent starting from rest, frequent acceleration and hilly topography. Like the test route used by lastauto turbo, the Pneumatic Booster System PBS® 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 liters. The biggest advantage of PBS will be clear.
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 diaphragm 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 quality and visibly again. The same principle applies when coasting in full throttle. A slight dip of the accelerator, resulting in PBS activation, may be sufficient to overcome the increased resistance when ascending a slight uphill grade.

PBS may be sufficient to overcome the increased resistance when ascending a slight uphill grade. Without PBS activation, may be sufficient to overcome the increased resistance when ascending a slight uphill grade. A 4.3 percent saving, or fuel consumption of 31.06 litres/100 km instead of 33.35 litres/100 km, means for Véhicules Commercialisés Polska.

Tests conducted earlier by Knorr-Bremse produced a 4.8 percent saving, but had to be repeated to confirm the results. Test lap 4. Test lap 3 had already recorded a 4.1 percent saving. Working down the hill, PBS may be sufficient to replace a larger engine without this feature. PBS is activated and rpm climbs quickly and...