

TurboNews

1/10 Issue

The Info Magazine of BorgWarner Turbo Systems

Exploring new pastures

BORGWARNER SUPPLIES VTG TURBOCHARGERS
FOR NISSAN'S NAVARA AND PATHFINDER



A welcome boost

R2S technology makes Volkswagen's turbodiesel a true all-rounder

Top per-ford-mance

Driving pleasure combined with savings in Ford's new EcoBoost engine

The joy of saving

R2S and VTG technology combined for the first time ever in the BMW 740d

Innovation is the trump card

Dear readers,

While the world of politics is involved in heavy discussions on spending cutbacks and budget deficits, the automotive industry is enjoying massive investment. Manufacturers are working hard on new, pioneering powertrain solutions and bringing attractive new vehicle concepts to the market. Customers are getting excited about the new models and the increase in orders associated with this means that manufacturers can now finally start ramping up production again.

Innovation is the key to success here – a theory which is further reinforced by the growing number of development projects that BorgWarner Turbo Systems is currently engaged in for vehicle manufacturers throughout the world.

It is rare for us to be able to present so many innovative autos in a single edition of TurboNews, but in this issue you can read about a whole range of the latest vehicles. Examples include the BMW 535 GT with Twin Scroll turbocharger or the BMW 740d, which combines both R2S and VTG technologies with one another for the first time. You can also discover how Volkswagen has made its T5 and Amarok models into economical all-rounders through use of R2S technology. And thanks to BorgWarner's VTG technology, the construction equipment manufacturer JCB is able to present the world's cleanest engine for off-highway applications. Alongside this, Ford, Hyundai, Kia and Nissan are all putting their trust in the innovative force of BorgWarner in designing their new drives.

The turbocharger specialist also provides excellent services beyond its own development departments. Examples of this include the exemplary results of the audit at the Bradford facility and the LEED certificate awarded to the Rzeszów facility in Poland.

We hope you have fun reading!

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The world of automobiles has changed

Following an unprecedented collapse in the vehicle markets in 2009, the automotive industry is now once again enjoying significant increases in demand this year. But was the sector able to survive the crisis year without any scars? Definitely not, as the crisis was only one of many factors that the global automotive market had to face and which are set to continue presenting manufacturers with new challenges in future.

While the passenger vehicle and commercial vehicle business in North America, Europe and Japan saw a massive drop in demand and could only be stabilized through political bail-outs and concepts such as the scrappage allowance, the situation in other markets was quite different. Indeed, markets such as China, India and South America continued to enjoy unabated growth. This allowed them to further build on their position as important motor vehicle markets and they are set to become even more important in the future. The shifts in global sales markets were accelerated by the crisis year and are now irreversible – a fact that both vehicle manufacturers and suppliers will have to take into account in future strategies.

The crisis year also rekindled the discussion on environmentally friendly drive solutions, with many manufacturers being accused of missing out on opportunities in this sector due to a lack of innovation. At the same time, however, important foundations were laid for more environmentally friendly individual transport options, for example through stricter emissions regulations in the US (CAFE). Reduction in fuel consumption and development of alternative drives, all the way up to electric vehicles, therefore rank among the great challenges that developers worldwide must now face. However, the internal combustion engine will remain the dominant power

source until long after 2020 and is therefore under very special scrutiny. Engine developers and suppliers must work intensively and cooperatively on fast implementation of new engine concepts – with a key focus on downsizing.

If we look at the year 2010, we can see a pretty successful overall turnaround in the automotive industry. This is due to the significant increases in production volumes of vehicle manufacturers, but also the booming global demand for turbochargers. Indeed, manufacturers now have great challenges to face in terms of getting their own capacities up to speed and optimizing their entire supply chain. And all of this must of course be done following a year of considerable cutbacks. At BorgWarner Turbo Systems, the recovery can also be seen in the sharp increase in the number of development projects for various customers. The key now is to meet today's demand, while at the same time focusing energy on developing the products of tomorrow. The tasks of a successful powertrain supplier are now more diverse and demanding than ever. Yet we are well prepared to master these challenges together with our customers.



Ulli Fröhn, Vice President Sales & Marketing
bei BorgWarner Turbo Systems.



BORGWARNER SUPPLIES VTG TURBOCHARGERS
FOR NISSAN'S NAVARA AND PATHFINDER

Exploring new pas

Nissan recently presented a facelift for both the Navara and the Pathfinder, two of its highly successful models. But the SUV and the pickup now not only look more dynamic, they also offer improved performance. Under the hood, a revised 2.5 liter (152 cubic inch) diesel unit with BorgWarner VTG turbocharger generates more torque – while also reducing fuel consumption.



Versatile SUV or hard-working pickup – when choosing their vehicle, customers can rely on a modern turbocharged diesel engine with BorgWarner VTG.

Nissan has worked hard on its four-cylinder diesel unit, completely redesigning the inner workings of the 2.5 liter (152 cubic inch) engine from the ground up. The main aim here was to make the basic engine offering in both vehicles more agile, while keeping a close eye on the new EU5 standard. This is why

Nissan's developers opted for close cooperation with BorgWarner Turbo Systems. The new generation of VTG turbochargers fended off all competition and helped the diesel engine achieve a significant increase in power output while also reducing emissions. Indeed, it was possible to increase maximum

torque from 403 to 450 Nm (297 to 332 lb-ft), boost power output by 19 HP to just under 190 HP, while fuel consumption was also improved to 27.7 mpg US (33.2 mpg UK). With this new setup, the Navara and the Pathfinder achieve CO₂ emissions of 224 g/km (358 g/mile).

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TURBO SYSTEMS IN BRADFORD PASSES AUDIT
WITHOUT A SINGLE POINT OF CRITICISM

Top marks for Bradford

Auto manufacturers demand that their suppliers demonstrate how they meet the highest quality standards. BorgWarner therefore had its quality management system certified to the strictest standards early on and constantly works on further improving quality. With success, as the latest audit of the Bradford facility shows.

Variable powerhouse

The VTG turbocharger provided by BorgWarner sits at the heart of the completely reworked 4-cylinder engine. Equipped with an electric actuator, the water-cooled BV45 guarantees high efficiency and excellent controllability. It was created in close cooperation with the BorgWarner engineers on site in Japan, the manufacturing facility in Korea and with the support of the development department in Kirchheimbolanden. This ensured that the VTG turbo was tailored perfectly to the customer's requirements. The joint development work is also a prime example of the successful cooperation between a global OEM and a supplier. The BV45 is manufactured in Pyongtaek and delivered both to Japan and Spain.

Fit for tough terrain

With all-wheel drive, ground clearance of around 23cm (9 inches) and a reassuring fording depth of 45cm (17.7 inches), the robust Navara and the versatile Pathfinder are also ideally suited for rough terrain. And it is in environments like these that the new diesel unit with BorgWarner VTG technology offers significantly more driving pleasure, while also allowing drivers to go further between trips to the pump.



Steve Brooksbank (Quality Manager),
Stephanie Dixon (Quality Systems Engineer)
with the Bradford assembly team.



It was early in 2010 when the time came for the next audit. Just like every year, the renowned auditor DNV arrived at the Turbo Systems site in Bradford (Great Britain) to check whether the facility's quality management system was aligned with the guidelines of the Technical Standard ISO/TS 16949.

When all was said and done, the results exceeded everyone's expectations. The DNV representative commissioned to perform the audit not only recorded "zero non-compliance" in his report, but also noted four considerable endeavors to achieve greater quality. "In the six years since I started doing audits, this is only the second time I have not recorded a single non-compliance for a company", he explained in his summary.

This is a real success story and is largely thanks to the efforts of every single staff member. The Bradford team has worked extremely hard in the last few years to further improve the quality management system, including reworking documentation of the most important processes from the ground up. The development of process definitions as per the SIPOC method also helped to highlight how the most efficient processes, optimum interaction with customers and supply partners, as well as the desired output can be achieved in every process stage. And the site is keen to keep up its efforts to achieve even greater quality in future.

THE NEW BORGWARNER TWIN SCROLL TURBOCHARGER IN THE BMW 535 GT DOES THE WORK OF TWO

Less is more

Downsizing is the magic word when it comes to combining greater performance with lower fuel consumption. In the new BMW 535 Gran Turismo this applies not only to the engine block, but also to the Twin Scroll turbocharger concept provided by BorgWarner.

BMW presented the 5 series GT at the IAA fair in Frankfurt last fall. The Gran Turismo combines an innovative and versatile new design concept with excellent handling and agility, the virtues typically associated with the Bavarian auto manufacturer. And BMW's Efficient Dynamics package, which promises lower fuel consumption and greater driving pleasure, is of course also on board.

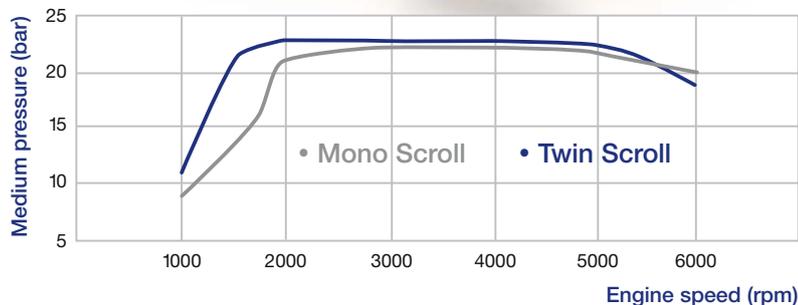
Six in a row

BMW's 3.0 liter (183 cubic inch) inline 6-cylinder gasoline engine has always received praise for its silky smooth running characteristics. But to achieve the impressive performance expected of the new 535 GT, for the first time ever the unit has been equipped with a combination of variable valve control, a newly developed direct fuel injection system and a BorgWarner Twin Scroll turbocharger. This combination allows the engine to generate V8-rivaling power of 306 HP, while the efficient technology, weight reduction and minimized frictional losses also help reduce fuel consumption.

In designing the new 535 GT, BMW not only put its faith in a lightweight and space-saving 6-cylinder unit, but also in BorgWarner's improved turbocharger technology. Rather than using two exhaust gas turbochargers operated in parallel, as was the case in the previous engine, a Twin Scroll turbocharger is now used. This technology allows a single unit to achieve the performance and dynamics that are otherwise only possible with twin-turbo applications. And fitting a single Twin Scroll turbocharger also offers clear advantages



The two-channel exhaust gas flow system in the turbo coaxes impressive torque out of the inline 6-cylinder unit from very low revs.



over the use of dual turbocharging systems in terms of packaging, weight and costs.

Turbocharging with 2-channel technology

The boost process is based on the completely new design of the exhaust manifold and turbine casing geometry. It employs two channels, each of which is fed by three cylinders and is kept completely separate from the other in both the manifold and the turbocharger until just before the turbine. This optimized exhaust gas flow reduces exhaust back pressure, particularly at low revs, and thereby makes the maximum torque of 400 Nm (295 lb-ft) available

from an amazing 1,200 rpm. Even though the GT weighs in at around 2 tonnes, it still makes the sprint from 0-62 mph in just 6.3 seconds, while offering average consumption of 26 mpg US (31.7 mpg UK). The CO₂ emissions are also limited to just 209 g per km (334.4 g/mile).

In its new 3.0 liter inline 6-cylinder engine with BorgWarner Twin Scroll technology, BMW has once again set the standard for turbocharged gasoline engines. This unit is now also to be introduced gradually in many of BMW's models and set a benchmark for sporting performance and efficiency – perfectly in keeping with the concept of efficient dynamics.

BORGWARNER COMBINES R2S AND VTG TECHNOLOGY
FOR THE FIRST TIME EVER IN THE BMW 740D

The joy of saving

Regulated two-stage turbocharger technology (R2S®) by BorgWarner has already set new standards twice in BMW diesel engines. But now, R2S and VTG technology have come together for the first time ever in the new BMW 740d – for the joy of saving.

The R2S turbocharger concept celebrated its world premiere in a diesel-powered passenger vehicle in 2004, when the BMW 535d was launched. Three years later, BMW's 2.0 liter diesel unit with BorgWarner's two-stage turbocharger technology then impressed everyone with its high performance and low fuel consumption. And in the BMW 740d, an R2S system has now been combined with variable turbine geom-

etry (VTG) for the first time ever in a passenger vehicle with diesel engine. Both of these systems have already received the PACE Award individually, but when combined they help BMW's new 3.0 liter (183 cubic inch) diesel unit achieve extremely impressive performance, while also reducing fuel consumption by 4 %.

Smooth power delivery

The luxury sedan sprints from 0-62 mph in just 6.3 seconds and offers amazing average combined consumption of 34 mpg US (40 mpg UK). The smaller of the two turbochargers ensures optimum response at low revs thanks to the VTG. It is used as a high-pressure turbo here and is capable of covering a much broader range with high efficiency than a fixed geometry solution. This results in an increase of the boost pressure available, in particular at low engine speeds. Indeed, the unit is capable of deliver-



ing 75 % of its maximum torque from just 1,000 rpm. Once the small turbo reaches the limit of its throughput, the larger turbo then takes over and secures plentiful power delivery at higher revs from the inline 6-cylinder engine.

Peak performance across-the-board

The combination of R2S and VTG technology not only enables silky smooth and economical power delivery (combined CO₂ emissions: 181 g/km, 334 g/mile), but also impresses with its excellent elasticity, maximum torque of 600 Nm (442 lb-ft) and nominal power of 306 HP at 4,400 rpm. With its new turbocharger technology, the engine offers performance figures that were previously reserved for 8-cylinder and 10-cylinder units. And it achieves all of this with a significant reduction in both weight and fuel consumption. The 3.0 liter (183 cubic inch) diesel engine with R2S and VTG therefore represents another milestone in the successful collaboration between BMW and BorgWarner.



Powerhouse: BMW's inline 6-cylinder engine offers better performance than many 8-cylinder competitors, while saving both weight and fuel.

THE NEW 2.0 LITER (122 CUBIC INCH) ECOBOOST ENGINE FROM FORD BRINGS BOTH DRIVING PLEASURE AND SAVINGS THANKS TO DIRECT FUEL INJECTION

Top per-ford-

Ford is launching a completely new generation of particularly economical and low-emission 4-cylinder gasoline engines. This new range is headed by a 2.0 liter (122 cubic inch) direct fuel injection unit, which is initially set to transform the S-Max and Galaxy models into "eco" sports vehicles.

Ford's innovative 2.0 liter EcoBoost combines the latest generation of direct fuel injection with a newly developed BorgWarner turbocharger and variable valve timing. This is an impressive package that offers both sporting performance and a 20% reduction in fuel consumption over conventional gasoline engines. From its 2.0 liter (122 cubic inch) displacement, the 4-cylinder unit generates 203 HP as standard with the Ford PowerShift automatic transmission, while offering an impressive 29 mpg US (34 mpg UK) and thereby achieving a CO₂ emissions value of 189 g/km (302 g/mile). As such, drivers do not need to have a guilty conscience about the driving pleasure and performance on offer.

Clean and powerful

The high efficiency of the unit results from the perfect interaction of the newly developed components. The direct fuel injection system, for example, enables more powerful internal cooling, as heat is removed from the surrounding area through vaporization of the fuel directly

in the combustion chamber. This allows greater compression and thereby a clean and particularly energy-rich combustion process. And the VVT variable valve timing of the two camshafts also prevents a delayed response of the turbocharger by adjusting the opening times of the inlet and outlet valves based on the actual speed and throttle valve position. This secures the most efficient cylinder filling possible across the entire rev band.

No trouble handling the heat

The completely new BorgWarner K03 turbocharger ultimately ensures sporting performance, allowing the engine's maximum torque of 300 Nm (221 lb-ft) to be available from just 1,750 rpm. And this already impressive torque can be increased even further to as much as 320 Nm (236 lb-ft) for short periods using the overboost. With the involvement of engineers from Ford, Volvo and



For pure driving pleasure: The Ford S-Max with EcoBoost engine.



mance

BorgWarner in the US and in Europe, it was possible to adjust the turbocharger optimally to the combustion process of Ford's new 4-cylinder EcoBoost engines. One particularly noteworthy feature of the turbocharger is the turbine casing, which is integrated in the exhaust manifold. The exhaust manifold and turbine casing have also been manufactured from sheet steel for the first time rather than cast metal. This enables the turbo to comfortably handle the extremely high exhaust gas temperatures of up to 1,050 °C generated in turbocharged gasoline engines. The system also improves emission control by getting the catalytic converter up to its operating

temperature more quickly. To prevent high temperatures from being unintentionally emitted in undesired directions, a layer of insulation is fitted to reduce outward heat dissipation.

The new 2.0 liter (122 cubic inch) engine easily complies with the Euro-5 emis-

sions standard and is also to be used in various Volvo vehicles alongside other Ford models. And anyone seeking even more impressive performance can look forward to a 240 HP version due for release later this year.



BorgWarner's K03 turbocharger offers both excellent performance and low fuel consumption.



R2S TECHNOLOGY MAKES VOLKSWAGEN'S TURBODIESEL
A TRUE ALL-ROUNDER

A welcome boost

With R2S turbocharging from BorgWarner, Volkswagen's new 2.0 liter (122 cubic inch) basic diesel engine has been transformed into a dynamic yet low-consumption drive. And the common-rail diesel covers all bases in the ever popular Transporter and the new Amarok pickup.



With its practical values and the reliability which made VW famous, the VW Transporter is as popular today as when it was launched. In the latest generation, it also takes on the role of flagship for leading-edge technology.

The VW Transporter has been the reference standard among light commercial vehicles for 60 years, ever since the first chubby-looking vehicles with air-cooled boxer engine and 25 HP left the production line back in 1950. With a payload of over 900 kg (1,985 lb), the vehicle based on the VW Beetle and referred to internally as "T1" soon developed into one of the most popular vans due to its reliability – subsequently being offered in countless different versions, from flatbeds, through closed vans, right up to buses. Volkswagen has now been producing the 5th and latest generation since 2003. A new facelift was also presented for the anniversary year 2010, but you have to look under the hood to see the greatest new development.

Pulling power

A newly developed 2.0 liter (122 cubic inch) 4-cylinder common-rail engine now covers the entire performance spectrum in the diesel segment, replacing the former 1.9 liter 4-cylinder and 2.5 liter 5-cylinder units. In its basic version, the engine derived from the 1.6 liter 4V TDI generates 84 HP, with a more powerful version achieving 140 HP. For the top performance engine, Volkswagen decided to go with BorgWarner's R2S technology. With its biturbo, the 4-cylinder generates 180 HP and 400 Nm (295 lb-ft) of torque – impressive performance figures, especially considering that both are available across a very wide rev band. Equipped with this engine the

T5 offers excellent response in every situation, even when fully laden, and is also comparably economical and low in emissions with an average of 31 mpg US (37 mpg UK) and CO₂ emissions below 200 g/km (320 g/mile).

Commercial vehicle as a flagship for leading-edge technology

At the start of development, the Borg Warner engineers had to resolve the conflict of objectives in targeting both dynamic behavior and low emissions. The impressive figures of the new 2.0 liter (122 cubic inch) unit, which was designed based on the downsizing principle, could ultimately only be realized through regulated two-stage turbo-



All diesel versions of the Transporter and all Amarok models share the same 2.0 liter (122 cubic inch) common-rail diesel engine. This underlines the massive potential of the smooth running 4-cylinder unit.

Heavy loads? No problem

Volkswagen is now offering the 2.0 liter (122 cubic inch) diesel engine with regulated two-stage turbocharging in its commercial vehicles, including the Amarok. The biturbo version of the pickup first presented at the 2010 Geneva Motor Show shines with its excellent off-road capability, massive load capacity and economical fuel consumption. One tonne on the loading area, a 100 % slope angle

and 1000 km (620 miles) between trips to the pump are no problem for the robust pickup, which is also available in an all-wheel drive version with torsion differential. In the Amarok, the common-rail TDI generates 163 HP, and its maximum torque of 400 Nm (295 lb-ft) is available from just 1,500 rpm. In the 4x2 version, it achieves 31 mpg US (37 mpg UK) and sets new standards in its class.

charging. The T5 sets a new benchmark in its class with BorgWarner's R2S system. No other concept of two-stage turbocharging systems can offer comparable performance in diesel engines with regard to low-end response, maximum torque, specific output, efficiency across the entire characteristic range and compact overall dimensions.

High-tech in the tightest of spaces

The compact dimensions of the system were a particular challenge during development. Yet despite the fact that space was at a premium with the transversely mounted engine, the routing of the connection pipework and valves had to keep any flow losses as low as possible. To this end, the development process was supported by a 3D flow analysis for the entire turbocharged system. With the R2S technology, the new VW engine was even able to considerably surpass the tough design specifications.



With its all-wheel drive and powerful biturbo, the new Amarok also cuts a fine figure off the beaten track.

R2S for VW – a challenge for production

R2S systems are made up of two turbochargers arranged in series. As such, they are significantly more complex to assemble than a single-stage turbo. Added to this are the larger dimensions and heavier weights of the systems, which represent additional challenges for both machine planning and assembly staff. Due to its highly complex design and the many assembly steps associated with this, the R2S system for Volkswagen's 2.0 liter (122 cubic inch) common-rail diesel engine places great demands on fitters and assembly planning. BorgWarner therefore had to develop a new strategy to secure an optimum production process.

Various objectives

The task for the production planners at BorgWarner lay in creating a shared assembly system for the T5 and the Amarok. Assembly was to take place manually to ensure the greatest possible flexibility and a high degree of machine availability – as the key was for the speed of assembly to be adjusted strictly to the customer's own production pace at all times. For this reason, the turbocharger specialist also selected the one-piece-flow principle – with no 'run-up production' and no waiting times. The goal was also to establish easily comprehensible and robust processes as a way of avoiding assembly errors and improving ergonomics.

A clear strategy

Assembly processes with long cycle times prevent precise matching of machine capacities to customer requirements. To avoid undercapacities and overcapacities during assembly, the steps in the production process were distributed across various stations. Rather than employing five individual assembly stations, each working independently of one another, the R2S system is produced at ten linked stations. This allows the complex assembly steps to be broken up, which significantly reduces the training period for the fitters. Simple, easily-learned and quickly repeated actions also help prevent errors. And a final visual check is also performed at the end of the line.

Innovation in assembly

The new VW assembly line is based on an innovative concept. The turbochargers are transported via a driven transfer system with workpiece holder. An assembly device is aligned with the loader via a sliding carriage. This allows all tools, such as adjustment gauges, sensors, specific testing technology, calipers, etc. to be positioned in the direct vicinity of the turbocharger. The workpiece holder with the turbocharger assembly then moves into the station, the equipment is aligned to the R2S system and the fitter begins assembly. As soon as he is finished, the equipment returns to its starting position and the workpiece holder moves onto the next station. This method of assembly facilitates very simple and affordable transfer technology, since no lift and traverse units or diverting stations are required. The machine frame and transfer technology form a unit and have a modular design. This offers fitters optimum ergonomics at their workplace.

Reliable material provision

The parts required for assembly of the turbocharger system are located on moving material trolleys, which are stored at the rear of the system ready for use. The VW models T5 and Amarok each have dedicated trolleys, which are filled continuously by a logistics service provider. A self-supporting construction developed specially for BorgWarner Turbo Systems enables ergonomic materials provision in the direct vicinity of where the work is being performed throughout the entire transfer system.

Summary

With the latest data acquisition and planning methods, the facility in Kirchheimbolanden has been able to implement a highly efficient assembly line, which not only caters to customer requirements (error-free and affordable assembly of large numbers of units), but also offers staff optimum working conditions in terms of ergonomics and loading.

JCB PRESENTS THE WORLD'S CLEANEST ENGINE
FOR OFF-HIGHWAY APPLICATIONS

Clean machine

JCB is one of the world's leading manufacturers of construction machinery. The vehicles and machines produced by the British company are manufactured for the toughest of off-road jobs. And with the new 4.4 liter (268 cubic inch) Ecomax T4 engines, JCB is now presenting the cleanest generation of engines in the world for off-highway applications. The top models in the range are equipped with BorgWarner VTG turbochargers.



Clean, cleaner, cleanest – the new Ecomax T4 engine with BorgWarner VTG turbocharger.

As they face such tough challenges, construction and agricultural machines must be extremely robust and reliable. Yet in light of increasing fuel prices and ever stricter emissions standards, both manufacturers and customers are now placing greater emphasis on fuel consumption and emissions. JCB has therefore invested around £80 million (around €100 million or \$117 million US) into the development of a new generation of engines that sets new standards in the off-highway segment. The Tier 4/Stage III B emissions standard prescribes a reduction in nitrogen oxide emissions of up to 50% compared to previous standards. And the pioneering Dieselmex engines comply with this strict standard without any additional exhaust gas after-treatment or particle filters.

Efficient thanks to VTG

The Ecomax T4 is an inline 4-cylinder diesel engine, which is set to be produced from 2012 in various performance levels ranging from around 75 to 175 HP. The diesel unit will be used in many applications, including agricultural, construction and lifting equipment. BorgWarner Turbo Systems developed an ultra-modern turbocharging system with variable turbine geometry (VTG) for the T4 engines.

The 75 HP T4 unit is the only model to also use a BorgWarner turbocharger with waste gate. The engines with higher output employ the BV55 VTG turbocharger, which the engineers at BorgWarner matched to the engine in close cooperation with JCB Power Systems. The variable turbine geometry of the modern turbocharging system enables more precise control of the exhaust gas recirculation rates, while precise opening and closing of the turbine vanes allows the exhaust gas pressure and intake

manifold pressure to be optimally controlled. And precise exhaust gas recirculation significantly lowers the proportion of nitrogen oxides and pollutant particles. BorgWarner also equips the BV55 with a robust, brushless servomotor, developed by the BorgWarner Emissions Systems business unit, which has been designed specifically for use in highly stressed turbochargers and with EGR valves.

Clean, economical and robust

Thanks to the VTG turbochargers, the Ecomax T4 engines not only impress through reduced exhaust emissions, but also through their particularly low fuel consumption. And they achieve all of this without compromising service life or reliability. The robust design of BorgWarner's VTG technology also allows permanent use under even the toughest off-highway conditions – conditions that the Ecomax T4 engines face every day.



Built for the tough conditions faced every day in off-highway applications: The BV55 with variable turbine geometry.

NEW VTG TURBO FOR HYUNDAI AND KIA IMPROVES
THE RESPONSE OF DIESEL ENGINES

Highly respons

The latest generation of BorgWarner's VTG turbochargers is now being used with the smallest diesel engine in the Hyundai ix35 and Kia Sportage, two technically related SUVs. Both response and efficiency have been even further improved in the fourth evolution of the turbochargers.

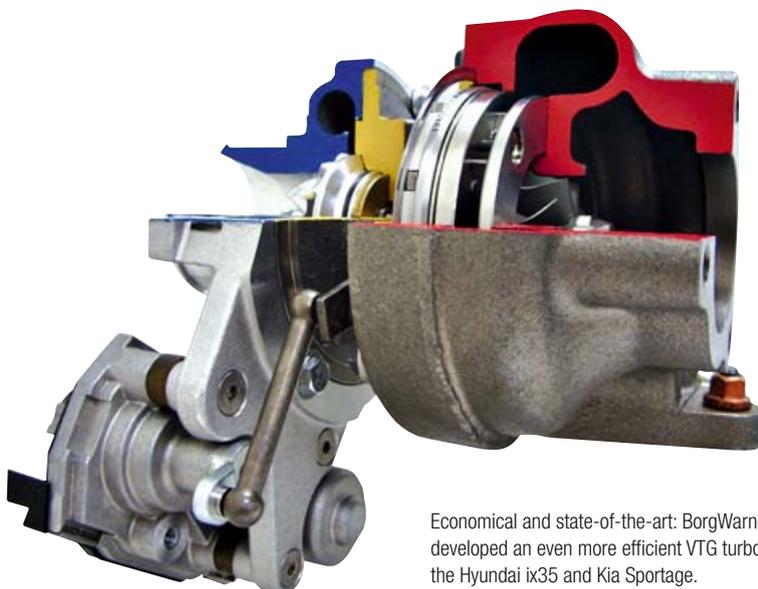
BorgWarner has already been using variable turbine geometry for many years to resolve the conflict of objectives in targeting both excellent engine response and high efficiency in turbocharged diesel engines. Under low load conditions, the vanes are closed and thereby generate relatively high flow energy. This allows the turbocharger to work efficiently at low revs. Under full load conditions, the maximum throughput of the turbine is then achieved in the fully open position of the turbine vanes.

Efficient design

For the newly developed 136 HP 2.0 liter (122 cubic inch) 4-cylinder diesel unit, used in the Hyundai ix35 and Kia Sportage, BorgWarner optimized its VTG system even further. Unlike the



Kia Sportage



Economical and state-of-the-art: BorgWarner developed an even more efficient VTG turbo for the Hyundai ix35 and Kia Sportage.

previous version, whose turbine vanes were all straight in shape, the turbine vanes of the new VTG turbochargers have the S-vane design. These vanes are curved at both ends, with each end cambered in the opposite direction to its counterpart, giving the characteristic S shape. The design offers improved thermodynamics and optimized controllability of the system, which can be adjusted to various operating conditions such as load changes even more quickly. This leads to increased efficiency, particularly at low revs.

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THE RZESZÓW FACILITY IS THE FIRST LEED-CERTIFIED PROJECT IN POLAND

Green facility

In mid-June 2009, BorgWarner Turbo Systems opened a new production facility for turbochargers in Rzeszów. The new plant, designed as a 'Green Building', has now become the first production site in Poland to receive an LEED certificate.

LEED – which stands for Leadership in Energy and Environmental Design – is a seal of approval developed by the U.S. Green Building Council. The certificate is awarded to companies that design, construct and operate their buildings as environmentally friendly and energy efficiently as possible, while also complying with defined standards. BorgWarner's facility in Rzeszów has a floor area of around 5,500 square meters (59,000 square feet) and was planned according to these standards, underlining BorgWarner's commitment to sustainability as a leading automotive supplier.

Environmentally friendly materials were used in the construction, with some 65 % of material costs being invested in locally sourced building materials and 13 % coming from recycled materials. It was also possible to separate an impressive 80 % of all waste generated by the build for recycling.

The new building offers 23 % better energy efficiency and uses 32 % less water than the guideline figures of the LEED Standard. Among other things, the excellent air quality within the building is secured through use of paints and adhesives containing very low volatile constituents and a strict smoking ban throughout the building. All lighting is free of mercury, while environmentally friendly methods and detergents are even used to clean the building. Recycling bins are also located in all areas of the facility, and every office has waste paper collection points. To reduce heat buildup in summer, the building has light roof areas and concreted corridors. It was also possible to significantly reduce the amount of rainwater drainage into the



Award for environmental protection: BorgWarner's facility in Poland, completed at the end of 2008.



sewage system by sealing as little floor area as possible and instead adding indigenous plants.

A great deal was also done for the employees. To improve health and well-being at the workplace, some 80 % of employees work in areas lit by natural light and 97 % enjoy a view outside. Showers and changing rooms are provided, as are lockable storage areas for bicycles. And to sensitize commuters to the concept of environmentally conscious behavior, preferential parking spaces are available to those that form car pools or drive particularly low-consumption and low-emission vehicles.

Low fuel consumption

This efficiency gain is instantly noticeable in the modern 4-cylinder diesel unit. The engineers at BorgWarner in Korea and the development departments in Germany supported Hyundai in developing a drive that offers impressive performance across-the-board. In the Hyundai ix35 the 2.0 liter (122 cubic inch) diesel engine with new VTG turbo generates 136 HP and offers maximum torque of 320 Nm at 1,800 rpm. Consumption in the front-wheel drive version is impressive at 40 mpg US (48 mpg UK), while the all-wheel drive model is only marginally behind, achieving 39 mpg US (47 mpg UK).

The Hyundai ix35 has been on offer in Germany with the economical diesel engine since March, and the Kia Sportage presented for the first time at the 2010 Geneva Motor Show will enrich the offering of SUVs.



Hyundai ix35



SAP SUCCESSFULLY INTRODUCED IN CAMPINAS



One company – one system

Since April, all BorgWarner business units in Campinas (Brazil) have been connected to the uniform SAP system. A team of employees from Brazil and Kirchheimbolanden had been working on the complex installation since November 2008.

The introduction of the SAP system in Campinas is a further step by BorgWarner to simplify worldwide processes between its business and production units and to secure its own self-imposed high quality standards. BorgWarner operates a manufacturing facility for turbocharging systems and an IDS distribution center (Independent Distributor Service) for Turbo Systems and Thermal Systems at the Brazilian location.

The greatest challenge for the transnational team of employees was Brazil's complicated and highly specific tax law. As such, many aspects of the software had to be adjusted



The SAP team: IT Manager Elaine Moreira, Andrea Neves, Ingrid Winck, Ricardo Carmo, Rodrigo Pelos and Wilson Paiva from Campinas, Alexander Stappert, Frank Kern, Gerd Hötzel, Jörg Balz and Thomas Partenheimer from Kirchheimbolanden.



locally to meet the requirements. But the team mastered all obstacles and managed to implement the SAP system without having to interrupt important business processes. The new SAP system has been in use at the IDS distribution center since 1 October 2009, and then "went live" in the production unit on 1 April 2010.

"The excellent support of the teams from Kirchheimbolanden was essential for the success of the project. The commitment of the Brazilian team and all users of the new system also made an important contribution to a smooth implementation", explains Elaine Moreira, IT Manager in Campinas, praising everyone involved.

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