

TurboNews

1/07 Issue

The Info Magazine of BorgWarner Turbo & Emissions Systems



Powered by Downsizing

PSA AND BMW DEVELOP A NEW
GENERATION OF ENGINES WITH
"TWIN SCROLL" TURBOCHARGING

Built to be wild

Opel Corsa OPC with
BorgWarner turbo

Diesel Power

Ford and ITEC rely on 2-stage regulated
turbocharging by BorgWarner

Lower Emissions

Pioneering technology for reduction
of exhaust emissions

New Concepts for the Future

Dear Readers,

Although no concrete figures or limits were set at the G8 summit in Heiligendamm (Germany) in terms of climate protection, there is clear agreement about one important objective: Worldwide carbon dioxide emissions must be reduced significantly. Technological progress in this area is all the more important, when we consider that growth in private transport has only just begun in countries such as China and India.

With exhaust gas turbocharging, BorgWarner has developed a key technology for achieving ambitious climate protection targets, and ultimately to safeguard the future of individual mobility. Concepts such as downsizing in engine design have enabled good progress to be made here, without sacrificing comfort or driver enjoyment. In this issue of TurboNews, we'll be giving you examples of this, with articles about the Opel Corsa OPC and the new generation of engines with twin-scroll turbocharging from PSA and BMW. BorgWarner is pursuing another concept for reducing fuel consumption and CO₂ in North America, where demand for large-capacity engines remains high in many market segments. Diesel engines with regulated 2-stage regulated turbocharging offer the ideal solution here, as you can read in our article on Ford and ITEC.

The subject of emissions reduction also crops up in our article about a pioneering new secondary air pump from BorgWarner. The pump highlights the fact that Turbo & Emissions Systems are looking to increasingly provide comprehensive system solutions in the whole area of boosting and exhaust management.

Other interesting topics in this issue: Data tracking, with which BorgWarner will soon be fulfilling extremely challenging automotive industry quality requirements and the PACE Awards, which gave the BorgWarner and Porsche collaboration three causes for celebration at once.

We hope you have fun reading!

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SIGNIFICANT REDUCTIONS IN FUEL CONSUMPTION ARE BOTH NECESSARY AND ACHIEVABLE

Exploiting Full Potential

With rising fuel costs, in particular in Europe and North America, as well as the intense public discussion on global warming, auto manufacturers have been subject to criticism from all angles in the last few months. Consumers and politicians are placing increasing pressure on the automotive industry to develop more economical drive systems.

Yet if we take a look at the progress made in engine development over the last few years with the necessary objectivity, we can see that the manufacturers have already gone a long way toward meeting the demands placed on them. Despite the weight of the vehicles, which has increased due to improved comfort and safety requirements and the trend toward larger vehicles, it has still been possible to reduce average fuel consumption. For example, according to surveys conducted by the EU, the European auto industry managed to reduce average CO₂ output by 25 g to 165 g between 1995 and 2004. This represents a 13 % drop in CO₂.

However, this is clearly just the first step on a long road. New developments, such as downsizing using turbocharging, offer further potential for significantly lowering consumption figures. Innovative boosting technologies and improvements to existing products will open up new opportunities for the developers of gasoline and diesel engines. And the use of turbocharging in gasoline engines is one area that is likely to see major progress in the

future. The last few editions of TurboNews have included several articles with initial examples of new turbocharger technologies and the trend toward downsizing. You can also find fascinating reports on small turbocharged gasoline engines in this edition. These represent just the beginning of a fast-paced development.

Low fuel consumption gasoline engines and the further expansion of clean diesel technology in North America and Asia will make a significant contribution to global reduction in traffic-based CO₂ emissions. This is both an exciting and challenging time for the automotive industry and its suppliers, since consumers are looking for affordable and ecologically sound mobility.



Ulli Fröhn, Vice President Sales & Marketing Europe at BorgWarner Turbo & Emissions Systems.

OPEL CORSA OPC LAUNCHED WITH TURBOCHARGER BY BORGWARNER

Built to be

Auto manufacturer Opel not only targets those in the market for a quality gas-driven vehicle at an affordable price – the company is also keen to ensure that customers with racing driver ambitions can find the right car in its range of models. It was for precisely this market that the sporty OPC line was created in 1999, and a Corsa with an impressive output of 192 bhp now rounds off the range.



The sportiness of the Opel Corsa OPC is evident from the very first glance.

Racing car feel in a Corsa

Opel is really stepping on the gas this spring. The top model of the Corsa will be fitted with a powerful 1.6 liter turbocharged engine with 192 bhp, which allows the compact three-door vehicle to sprint from 0 to 60 mph in around 7 seconds. The new engine is also extremely elastic, allowing the Corsa

to accelerate from 50 to 75 mph in 6.7 seconds. The top speed is 139 mph. The new engine comes with a six speed transmission as standard. And with Opel's "Overboost System", which also comes as standard, the maximum torque of 169 lb-ft can be increased to 196 lb-ft for short periods.

Improved dynamics thanks to the K03 turbocharger

To realize this impressive performance in a compact unit with favorable consumption figures, the new engine was fitted with a turbocharging system by BorgWarner. The water-cooled K03 exhaust gas turbocharger with integrated exhaust manifold, integrated recirculation valve and waste gate is a

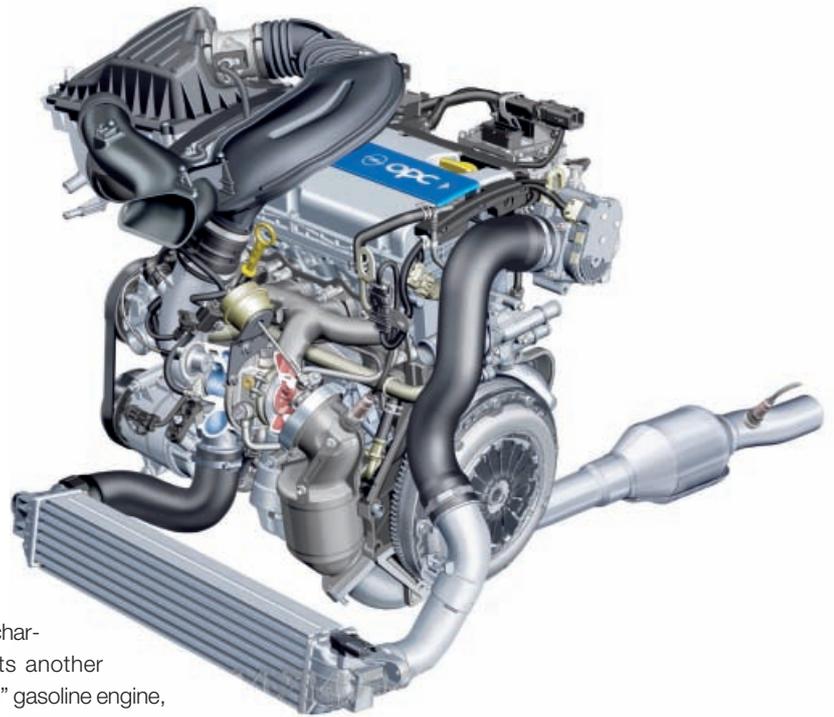
wild

further development of the turbocharger which has been used since the start of 2006 in the 1.6 liter engine of the Meriva OPC (180 bhp). And the Astra Turbo Ecotec with 1.6 liter engine and 180 bhp also came from this range in the spring of 2007. The 4-cylinder turbocharged engine offers pure driving pleasure with impressive fuel consumption figures (29.5 mpg US, 35.8 mpg UK). It also meets the Euro4 emissions standard.

Performance training included

From the very first glance, it is clear that the Corsa OPC is not a typical small car. Its form embodies pure performance. It is not just the Arden blue, the characteristic color of the OPC family, but rather the triangular form that is the key element flowing throughout the bodywork and interior. The abbreviation OPC stands for Opel Performance Center and is a synonym for pure driving pleasure. To ensure that drivers can exploit the full potential of the Corsa OPC safely, Opel offers an OPC Performance Training Course, which is accompanied by racing legend Manuel Reuter.

Opel's new 1.6 liter (97.6 cubic inch) turbocharged engine represents another successful "downsized" gasoline engine, which combines familiar sports car performance with lower fuel consumption. It is an impressive example of the excellent cooperation between Opel and BorgWarner Turbo & Emissions Systems in the development of turbocharged gasoline engines and underlines the skills of the turbocharger specialist in the field of gasoline engine turbocharging.



The 1.6 liter turbocharged engine with K03 turbocharger by BorgWarner.



ITEC AND FORD RELY ON REGULATED 2-STAGE
TURBOCHARGING BY BORGWARNER

Diesel Power

Improved power output and torque while meeting stricter emissions standards – these are the trends that are continuing to drive the North American diesel engine pickup truck market. These requirements are compelling manufacturers to find new technologies to meet the challenge of generating more power while simultaneously lowering consumption and emissions.

PowerStroke – The turbo diesel engine for the US

International Truck and Engine Corporation as well as Ford Motor Company have together overcome this challenge with the development of the all new PowerStroke 6.4 liter V8 diesel engine. A key technology that allowed these goals to be met is the R2S™ regulated 2-stage turbocharging system by BorgWarner Turbo & Emissions Systems which came about through close cooperation between the two manufacturers. The result is a dual turbocharged V8 engine with technology that will play a major role in the further spread of the diesel engine in the US market. The R2S system allows engines to be designed that meet the stringent new emission requirements without having to sacrifice horsepower or torque.

The powerful new engine will be installed under the name PowerStroke in the F series by Ford, including the heavy duty pickup trucks F250, F350, F450, and F550. It will also be used in light trucks from International, where it will go by the name of MaxForce7. With the launch of the PowerStroke 6.4-liter V8 diesel engine, Ford, the US market leader in the heavy-duty pickup segment, is sending a clear signal for the wide-scale introduction of R2S technology in this vehicle category.

Two premieres under one hood

The new V8 diesel engine gives the American heavy-duty pickup segment the first opportunity to take advantage of the numerous benefits of regulated two-stage turbocharging. The R2S™ turbocharging system consists of two differently sized turbochargers arranged in series. The smaller high-pressure turbocharger responds spontaneously at low engine speeds, while the larger low-pressure unit is responsible for providing boost at higher engine speeds.

To increase the efficiency of the system for every engine operating state, a turbocharger with variable turbine geometry (VTG) is used in the high-pressure stage – a world premiere in combination with the R2S system. Fast and precise adjustment of the VTG turbine vanes is ensured by an electric actuator motor, which BorgWarner Turbo & Emissions Systems developed specially for this turbocharger. The V8 engine offers excellent acceleration,



The new R2S™ system is the world's first system to combine 2-stage regulated charge with VTG.



The PowerStroke engine helps the new Ford Pickups achieve dynamic performance with reduced consumption.

high torque and an impressive power density. The compact dimensions made it possible to accommodate the entire R2S assembly in a space-saving manner in the V of the eight-cylinder diesel.

The innovations featured in this fuel-efficient diesel engine are also beneficial to the environment. To further reduce NOx emissions, exhaust gas recirculation (EGR) also takes place at full load. This allows the modern 6.4 liter diesel engine to comply with even the strictest US emissions standards.

Leader in the field of 2-stage regulated charging

In its successful cooperation with International and Ford, the turbocharger specialist BorgWarner has once again demonstrated its technological leadership in the field of regulated two-stage turbocharging. The benefits of this innovative turbocharging system are now available in every segment of the market – from passenger car engines right up to large power units for trucks. The production figures planned by

Ford with its F series make the PowerStroke the largest R2S™ project yet for BorgWarner Turbo & Emissions. To meet the huge demand for turbochargers, BorgWarner has designed, built and put into operation state-of-the-art production lines for the manufacture and assembly of the new R2S™ systems at its turbocharger plant in Asheville, North Carolina.

Cooperation between BorgWarner Turbo & Emissions Systems and International began several years ago, when Turbo & Emissions Systems developed VTG turbochargers for the 6-cylinder inline commercial vehicle engine, followed by the introduction of R2S technology in International's 4.5-liter V6.



The innovative V8 turbocharged diesel engine is also available in International's light commercial vehicles under the name MaxForce7.

BORGWARNER DEVELOPS PIONEERING TECHNOLOGY FOR REDUCTION OF EXHAUST EMISSIONS

Lower Emissions by Design

Anyone working in the automotive industry will be familiar with BorgWarner Turbo & Emissions Systems as an innovative turbocharger specialist. However, many people do not realize that the company also develops pioneering exhaust gas after treatment solutions – such as the new 1000-T3 secondary air pump, which brings a whole range of advantages. With this new product, BorgWarner is positioning itself as a full service partner for reducing exhaust emissions – a factor which is becoming increasingly important in engine development worldwide.

Classic solution suffers from disadvantages

Blowing fresh air into the exhaust gas system of a combustion engine allows emissions to be significantly reduced in the cold start phase. This is typically done using a secondary air pump, which introduces air into the exhaust channel in the area of the outlet valve thereby increasing the exhaust gas temperature through a chemical reaction.

This in turn reduces the amount of time needed to heat up the catalytic converter, allowing the catalytic converter to reach its ultimate operating temperature faster. The optimized air feed into the exhaust manifold paves the way for the use of cheaper catalytic converters with a lower precious metal content. However, in engines with large displacement, engine developers have sometimes had to use two pumps to get the necessary volume of air to meet current emissions standards. While this twin pump system does achieve the desired effect, disadvantages for vehicle manufacturers include additional weight, greater space requirements and extra costs.

No-compromise emissions reduction

The emissions experts at BorgWarner Turbo & Emissions Systems therefore set their sights on developing a powerful secondary air pump that would save weight, space and costs. This system, with the designation 1000-T3, is not only more compact, lighter and cheaper than a twin pump system, it also allows faster energy transfer.

Smaller, lighter and more efficient

The engineers at BorgWarner developed a particularly compact and lightweight electrical motor, which operates at high speed. Using comprehensive CFD (computational fluid dynamics) analyses and pressure/speed simulations, they also optimized the geometry of the impeller and the shape of the pump casing. With these measures it was possible to significantly increase the air throughput of the 1000-T3 pump.



Function of the secondary air pump system

To meet the increasingly stringent emissions standards for gasoline engines in the US, Asia and Europe, engine developers are having to employ special measures to further reduce emissions, in particular during cold starts. Secondary air pumps have been used for this for many years. These pumps feed additional oxygen during a cold start to ensure that any

unburnt exhaust particles are then burnt. Carbon monoxide (CO) and hydrocarbons (HC) oxidize at high temperatures to water (H₂O) and carbon dioxide (CO₂). Secondary air pumps therefore make a decisive contribution to helping auto manufacturers reduce the emissions of their engines and meet emissions standards.

The new 1000-T3 secondary air pump is particularly light and compact, helping to save costs.

INNOVATIVE VTG TURBOCHARGER TECHNOLOGY
IN PORSCHE 911 TURBO COMMENDED

BorgWarner wins PACE Innovation Award 2007

On 16 April BorgWarner Turbo & Emissions Systems came away from an awards ceremony in Detroit with a significant accolade. The American magazine "Automotive News", along with the companies SAP, Microsoft and TRC, presented the turbocharger specialists with the PACE Innovation Award 2007 for their development of the gasoline VTG in the Porsche 911 Turbo (see TurboNews 2/2006).

3 awards for Porsche and BorgWarner

At the same time, Porsche received the PACE Collaborators Award 2007 for its highly successful cooperation with BorgWarner in the development of the turbocharged engine. Porsche also won the same award for its close collaboration with BorgWarner TorqTransfer Systems in the development of the all-wheel-drive system for the 911 Turbo. The PACE Awards (Premier Automotive Supplier's Contribution to Excellence Awards) rank among the most coveted trophies in the automotive industry. They are awarded annually to companies in the automotive suppliers sector for outstanding performance.

Materials used in space technology

The acclaimed gasoline VTG is the world's first VTG turbocharger for a gasoline engine. The variable turbine geometry technology had previously been reserved for diesel engines.

In adapting this technology for gasoline engines, a significant technological challenge first had to be overcome. This was to find materials that could cope with the considerably higher exhaust gas temperatures in gasoline engines. By developing high-temperature alloys – the same, incidentally, as those used in space technology – the engineers at BorgWarner were able to solve the problem.

Solution for the future

The VTG turbocharger significantly enhances elasticity and acceleration, particularly in the low rpm range. After its successful premiere in the Porsche 911 Turbo, BorgWarner Turbo & Emissions Systems are expecting this technology to establish a firm footing over the next ten years.

And this system also offers further decisive advantages. The use of a smaller electrical motor allowed the weight and space requirements of the pump to be significantly reduced. The 1000-T3 can be far more flexibly positioned. There is also less need for piping to the engine, which is often complex in design and reduces efficiency. In contrast to previous models, the motor of the 1000-T3 pump also uses electrical energy far more efficiently. This effectively reduces the drain of the onboard power supply during a cold start.

New materials

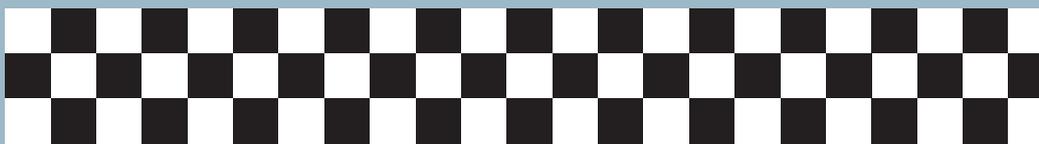
To ensure that the pioneering pump generation is perfectly tuned to the altered application conditions, new gasket materials with significantly greater resistance to high temperatures are used. The components of the 1000-T3 pump are specially designed elements made of injection molded engineering resins and a die cast aluminum housing, which offer the secondary air pump greater stability.

Equipped for the future

By reducing the size and significantly lowering the weight of the unit, BorgWarner has reacted quickly to the growing demands of engine developers. And since the new pump generation allows the use of cheaper catalytic converters, this also helps auto manufacturers improve their profitability. The new pump is expected to hit the market in 2010.



The Porsche 911 Turbo is the first gasoline-powered vehicle worldwide to have a VTG turbocharger.



PSA AND BMW DEVELOP A NEW GENERATION OF ENGINES WITH "TWIN SCROLL" TURBOCHARGING

Powered by Down

High quality small cars with powerful engines are very much in fashion. This is why PSA and the BMW Group decided to work together in developing a new generation of powerful engines that could be produced economically in large numbers. The result of the cooperation is a family of 4-cylinder engines with 1.4 or 1.6 liter displacement and many technical highlights. The units go by the name "Prince". The top model is a 1.6 liter turbocharged gasoline engine offered with either 150 or 175 bhp.



The most powerful engine initially available in the Peugeot 207 will be a 1.6 liter turbocharged gasoline engine with 150 bhp.

Flying Frenchman

The new Peugeot 207 1.6 16V THP (Turbo High Pressure) is fitted with the 150 bhp version of this engine. It sprints from 0-60 mph in just over 8 seconds. With a top speed of 130 mph and a massive 177 lb-ft of torque available from 1,400 rpm, the new 207 can more than hold its own against the competition.

The engine guarantees excellent power delivery and avoids the dreaded "turbo

hole". Its low fuel consumption is also thanks to the new turbocharger. According to Peugeot's specifications, the new 207 achieves 33 mpg US and 40 mpg UK. This version of the engine is only fitted in the 207 series. Oliver Dardart, Head of Peugeot Germany, described the Peugeot 207 as "a car for people who are not only looking for performance, but also have to take the kids to school in the morning".

Petite and Powerful

The more powerful version of the new engine is used in the new Mini Cooper S. The 175 bhp 1.6 liter engine sprints from 0-60 mph in just over 7 seconds and reaches a top speed of 139 mph. Despite this impressive performance, the vehicle also achieves 33 mpg US/40 mpg UK. Boost takes effect from just 1,000 rpm, and an impressive 115 lb-ft of torque is available at this extremely low engine speed. For blistering accele-

sizing



The 175 bhp version of the Prince engine is also used in the Peugeot 207 Spider Cup.

ration, a short-term increase of boost pressure (overboost) allows peak torque of 191 lb-ft.

And this pleasure is not just reserved for friends of the Mini. Peugeot drivers will soon be able to enjoy the dynamic performance of this 175 bhp engine, as it will be fitted in the upcoming Peugeot 207 RC.

Power boost thanks to Twin Scroll turbocharging

With the new engines by PSA and BMW, the developers at BorgWarner have succeeded in squeezing Twin Scroll turbocharging technology into the 1,600 cm³ displacement class for the first time. In turbochargers of this type, the channels between the exhaust manifold and turbocharger of the first and fourth as well as the second and third cylinders are separated from each other. The exhaust gas streams are directed into so-called scrolls (spirals) and then reunited again directly at the turbine wheel. Separating the streams in this way offers improved performance. With this type of charging, spontaneous boost pressure can be built up 500 rpms earlier, which significantly improves response in the low rev band. The engineers at BorgWarner have also mastered the problem of high exhaust gas temperature in gasoline engine turbocharging – despite the genuine challenge presented by such a compact turbine casing with two scrolls. One approach employed by the engineers here was to develop a new

method of casting turbine casings to improve their temperature resistance and guarantee the quality needed.

The Prince generation is a further range of engines that have been developed using the so-called “downsizing concept”. This once again underlines how units with smaller displacement do not have to sacrifice performance. Indeed, the benefits of the Twin Scroll turbocharging technology and other market-leading technologies by BorgWarner Turbo & Emissions Systems offer passenger vehicles the dynamic performance, low fuel consumption and lower CO₂ emissions needed to dominate the market. In the modern age, these are the driving factors in engine development.



The Twin Scroll turbocharger generates high booster pressure at low revs.

The Mini Cooper S uses a 175 bhp 1.6 liter turbocharged engine.



TURBO & EMISSIONS SYSTEMS INTRODUCES DATA TRACKING

Seamless Quality Assurance

More and more auto manufacturers are requiring their suppliers to introduce so-called data tracking as a way of identifying the origin of defective parts and further improving quality. Following intensive preparation, BorgWarner Turbo & Emissions Systems has therefore implemented this logged system of quality assurance at its Kirchheimbolanden facility for the BV39 turbocharger, which the company produces for Volkswagen.



The labeling of components with a DataMatrix code is essential to the introduction of data tracking.

Reliable camera-based identification

The data is recorded at the machining centers of the respective process steps using industrial PCs. On the input side, these are equipped with a camera system for code identification. They are also connected to the database of measured values or a control system. On the output side, the PCs are connected to the BorgWarner database and the SAP system.

Labeling using Data Matrix Codes

Data tracking involves unique labeling of specific components to be produced for an exhaust gas turbocharger. Each component is given an individual key, to which product, process and assembly data is assigned in a database. The keys used are 28-digit codes, which contain details on the manufacturer, production location, production unit as well as counter number and component number. They are printed on a 15 x 5 mm label/sticker and attached to the core turbocharger assembly both as a machine-readable Data Matrix Code and in standard characters. In future, this label is to be completely replaced by inkjet direct labeling.

The Data Matrix Code is a two-dimensional machine-readable code, which offers a large volume of information in a small space. It also remains reliably readable at any angle of rotation and for moving objects. With all these factors

and reliable error correction, it guarantees error-free identification of the component in question.

Before the start of the actual project, the requirements of the new data tracking system first had to be defined. These requirements came both from the customer and the production/assembly departments at BorgWarner. A key requirement was to be able to precisely track the unbalance and setting values for every single turbocharger when assembling the flow housings. The idea was to link these values to the model designation and job serial number using the Data Matrix Codes. For the code to meet this requirement, it has to fulfill certain criteria. These include fast identification of the serial and design number as well as secure prevention of duplicates, which could cause confusion. Secure reading of the code must also be guaranteed in the event of subsequent damage to or soiling of the turbocharger housing.

The codes are generated in packages by the database system and can be called up instantly. They are also sent one time via a PC to the printer. The adhesive labels, on which the Data Matrix Code and the standard characters are printed, are currently still attached to the core assembly by hand during fitting.

When performing a procedure for which data is to be recorded in the subsequent process steps, the code is scanned by camera and saved on the assigned computer. The data of this step is also requested by this computer and then assigned to the code. After completing the process step or once confirmation has been issued by the respective unit, the data packet is sent with the code to the database and the product is released for further processing. Should a process stage have generated waste/rejects, this is also recorded in the database. The respective component or code is then automatically locked out from further processing steps.

BORGWARNER PRESENTS ITS PRODUCTS AND SERVICES AT AUTOMECA 2007

Showtime in São Paulo

In April, all eyes in the South American automotive industry were on Brazil, the host of the 8th AUTOMECA trade fair. This event is not just the most important international trade fair in the southern hemisphere for the automotive supply industry, it has now become one of the most important automotive fairs worldwide. AUTOMECA has always been held in São Paulo – the capital of the State and home to around 13 million vehicles and over 12,000 car accessory businesses.

Codes in line with customer specifications

To safeguard the data, it is stored temporarily on the computer assigned to the unit. To exchange data records with the data server and allow remote maintenance, a WLAN interface connection was set up between the computers and the company network. A further Data Matrix Code is permanently attached to the nameplate (defined precisely by the customer) to safeguard the link between recorded data records and the respective model numbers and turbo-charger serial numbers.

The new data tracking system at BorgWarner Turbo & Emissions Systems is now being standardized step-by-step and extended to include other areas of the facility and products. In a follow-up project, machine and operational data as well as CAQ data are all to be collected using a single software tool (MES) and then made available automatically for production and quality assurance. The successful implementation of the project at Production Center 7 by Andreas Adlhoch, Arno Radmacher and Benny Freund demonstrates how effectively the turbocharger specialist can meet complex customer requirements when it comes to quality assurance.

More than 1,300 Brazilian and international exhibitors from around 30 countries presented their latest technologies to 96,000 visitors from 75 different countries. Alongside auto parts, exhibitors at AUTOMECA also presented devices and equipment for repair shops and for selling and overhauling engines. These included lubricants and tools/devices for error diagnosis.

BorgWarner presented two product lines at AUTOMECA – the cooling systems by

BorgWarner Thermal Systems and the turbochargers by BorgWarner Turbo & Emissions Systems. Numerous South American customers visited the BorgWarner stand, taking the opportunity to engage in detailed discussions and learn about new product technologies. "We expect to see good new business results from the numerous new contacts we made at AUTOMECA with companies from South America and the Middle East", explains David Dias Patricio, Aftermarket Manager at BorgWarner in Brazil.



The latest cooling and turbocharger technologies were presented on the joint stand of Thermal Systems and Turbo & Emissions Systems.

EXCELLENT VICTORY FOR MAN AT THE DAKAR RALLY 2007

MAN Wins

BorgWarner develops turbochargers for the rigors of everyday life on the streets of the world, wherever they may be. When it comes to the world of motor sports, the company is not afraid to let others go first. Nonetheless, BorgWarner turbocharging systems prove their exceptional qualities time and again, even in the realm of racing and rallies, as seen in January at the 2007 Dakar Rally, one of the toughest races in the world. More than 500 vehicles lined up on the starting grid in Lisbon (Portugal) before setting off on a grueling 10,000 kilometer-long journey to Dakar in Senegal, via Morocco, Mauritania and Mali. Terrain, speed and temperature all took their toll on both drivers and vehicles.



3 top positions for MAN

The winner in the truck category – in which 80 vehicles started – was Hans Stacey with his MAN TGA Race Truck. The Dutchman, along with co-drivers Charly Gotlib and Bernard der Kinderen, crossed the finishing line with an impressive lead of 3 hours and 10 minutes. This tremendous success was thanks to the consistently strong performance of both driver and engineering. Stacey won 5 of the 13 truck stages and from day 5 couldn't be knocked from first

place. At the wheel of the second MAN TGA Race Truck – also from the Exact MAN team – was Philippe Jacquot from France. His excellent performance earned him sixth place overall in the truck category. Both vehicles were trucks developed specially for motor sports, the TGA 18.531 4x4 BB Dakar. They are powered by the tried and tested D2876 engine, which has a K33 series exhaust gas turbocharger with a cast impeller.

Incidentally, a surprise star of the 29th Dakar Rally was Franz Echter, engineer at MAN. He came tenth in the truck category, driving the Exact MAN team's backup vehicle. His race truck was the new TGA 18.480, which takes over from the L2000 4x4 with D08. We'll be seeing a lot more backup vehicles of this truck type at next year's Dakar Rally.



The support vehicle for the Exact-MAN team took 10th place in the utility vehicle category.

The loneliness of success: From day five of the race, Hans Stacey couldn't be caught in his MAN TGA race truck.

Just to mention: Had Franz Echter not suffered damage to his front axle mounting, costing him a four-hour delay, he would have finished fifth or sixth. Not bad for a vehicle that wasn't even built as a thoroughbred racer! The TGA 18.480 is equipped with the newly developed D26 Common Rail engine, designed specially for Dakar. For the

rally, the performance was adapted and the speed range extended, so that the driver wouldn't have to change down to drive over sand dunes. To improve drivability as well as the reliability required for Dakar, an important enhancement was the installation of a K31 turbo-charger with a milled impeller.

Everyday turbos

Considering that turbochargers are already among the hardest-working components during day-to-day operation, it is easy to imagine that the strains of the Dakar Rally are incomparably greater. High outdoor temperatures, dusty and sandy slopes, as well as the constant demand for maximum performance over a period of many days result in an extremely high level of thermal and physical strain. It speaks volumes for the day-to-day reliability of the two standard series turbochargers K33 and K31 from BorgWarner that neither gave any cause for concern during the torturous journey.



BORGWARNER EXHIBITS AT THE SHANGHAI AUTO SHOW

China – Market of the Future

China has become a real economic power in the last few years. With its continued economic growth and 1.3 billion strong population, the country is extremely attractive for investors – as it holds enormous market potential. Chinese banks are predicting that by the year 2010 every second Chinese household will own a passenger vehicle. That would be around 180 million cars. So it is no wonder that auto manufacturers throughout the world are keen to successfully establish themselves in this future market.

Massive range of models

The automotive industry's interest in Chinese consumers was clearly visible at this year's Shanghai Auto Show. There were more than 1,300 OEMs and component suppliers showcasing their products. A total of 868 vehicles were presented to the audience. Passenger vehicle producers and global tier 1 suppliers were located in 9 halls, while commercial vehicles were exhibited outdoors.

Trends not yet detectable

The focus of passenger vehicle manufacturers was not on small, cheap vehicles, as many might have expected. Nine of ten companies presented their entire product range. The fact that many auto manufacturers had such a great variety of models on show indicates their uncertainty in terms of which models will be the most popular.

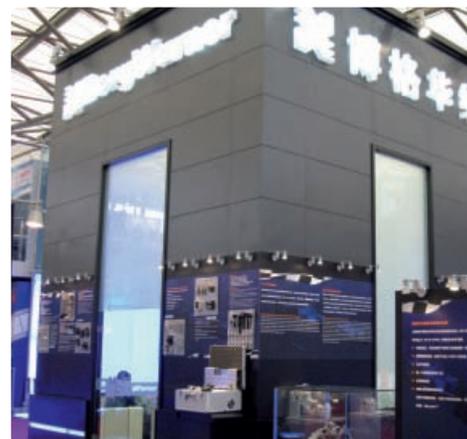
Environmental technologies in focus

The global players among the manufacturers set the tone in terms of technological advancements in vehicle development. General Motors showcased its Volt electric concept car, which is powered by E-Flex. Toyota brought no fewer than five hybrid vehicles to the trade fair. Honda presented its FCX concept car, which is fitted with a fuel cell. And local manufacturers are also catching up technologically. Chery demon-

strated the fruits of its research in the field of flexible fuels, micro-hybrid and bio diesel. SAIC presented a fuel cell drive for the Roewe model and Chang'an showed a hybrid sedan. There was a definite feeling at the trade fair that the focus is now on technologies which allow driving to be more environmentally-friendly and economical. So it should come as no surprise that exhaust gas turbocharging of diesel and gasoline engines is developing into a key technology for the Chinese market as well.

BorgWarner presents innovation

This year's Shanghai Auto Show was the first event in China to be attended by all BorgWarner's business units, including Beru with their products and solutions. The Thermal Systems stand focused on its electronic Visco Fan Drive, as well as water and oil pumps. Morse TEC showed its camshaft drive chains and systems, as well as its gemini chain system and VCT variable valve control. Turbo & Emissions Systems was on site with the R2S system of the four-cylinder diesel engine from the Mercedes Sprinter as well as the new 1.8T FSI Volkswagen/Audi engine, which was recently launched in Europe and China. The business unit presented also its VTG turbocharger range, exhaust gas recirculation systems for diesel engines and secondary air pumps. The 1.8T FSI turbocharger is the first product to be manufactured in large capacities at the new BorgWarner site in Ningbo.



This was the first year that all divisions of BorgWarner attended the Shanghai Auto Show.

Torq Transfer Systems presented its TOD Transfer Case and ITM-I. The dual clutch transmission (DCT), one-way clutches and solenoids displayed by Transmission Systems also drew great interest among the visitors. Beru presented innovative solutions, including the ISS diesel instant start system, the TSS Tire Safety System, PTC heating systems, ignition coils and spark plugs.

The product presentations by BorgWarner were complemented by three lectures on the topics of all-wheel drive, exhaust gas recirculation and dual clutch transmissions. The events were very well attended – both by those in the industry and by scientists.

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