

TurboNews

The Info Magazine of BorgWarner Turbo & Emissions Systems 1/06

Power for Pontiac

Pontiac Solstice launched with most powerful GM EcoTec 2.0 liter DI turbocharged engine ever seen



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Fully loaded

New Sprinter with BorgWarner R2S™ charging system

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Tough guys

John Deere counts on VTG turbochargers from BorgWarner

Editorial

Equipped for the future

Dear Readers,

The strong growth in the turbocharger business is continuing unabated. Two specific causes can be identified for this, both of which represent new challenges for a manufacturer such as BorgWarner.

Firstly, more and more gasoline engines are being offered with turbochargers. A growing number of new projects, ever shorter development cycles and global project teams are making it necessary for turbocharger developers to significantly improve their processes and efficiency. The second engine driving growth is China – which has become one of the most important passenger vehicle and truck markets in the world in the space of just a few years and now needs expert local support in developing economic and low-emissions engines.

In this edition of TurboNews we introduce you to several projects which will help BorgWarner prepare itself even better for the tasks of the future. These include the opening of a new plant in Ningbo, the construction of an ultra-modern prototype center in Kirchheimbolanden, the introduction of the innovative product development and release process DaRT and the merging of the Turbo and Emissions divisions to form BorgWarner Turbo & Emissions Systems.

Alongside these topics, in this edition of TurboNews you can also find further interesting reports on new vehicles that are being launched this year with innovative boosting systems – such as the new Mercedes Sprinter, the Pontiac Solstice and many agricultural machines by John Deere.

We hope you have fun reading!

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THE HUGE POTENTIAL OF GASOLINE ENGINES EMPLOYING A COMBINATION OF DIRECT INJECTION AND TURBOCHARGER TECHNOLOGY

Perfect combination

With the global increase in oil prices to their highest ever levels and the continuing discussion regarding the effects of CO₂ emissions on climate change, the motor vehicle industry is under enormous pressure to manufacture engines that are more economical and produce lower emissions.

Although diesel engines are already very popular in Europe and several parts of Asia, and hybrid engines are a hot topic in the US, engine designers are still making great efforts to further improve gasoline engines. After all, most of the world's passenger vehicles still run on gasoline – something which is unlikely to change, despite the increase in the number of diesel engines. The consistent further development of gasoline engine technology therefore makes an important contribution to keeping individual mobility affordable in future and reducing its effects on the environment.

Launches of new and innovative engine concepts in the last few months have shown how much potential gasoline engines still have. Making engines smaller and combining direct injection with turbocharging are two key areas of development here. As is the case in diesel engines, when combined these two technologies offer significant improvements in terms of performance, fuel consumption and emissions.

The 2.0 TFSI and the brand new 1.4 TSI by Volkswagen/Audi as well as the 2.3 DISI Turbo by Mazda clearly demonstrate the advantages of such engines. Indeed, Volkswagen's 1.4 TSI model is a particularly good example of how much fuel consumption can be reduced in gasoline engines without having to accept compromises in terms of dynamics and power output. The 2.0 EcoTec Turbo-DI recently presented by GM and the 1.6 DI-Turbo from the cooperation between BMW and PSA will certainly also find many happy owners in the near future.

All these engines came about with the support of BorgWarner Turbo & Emissions Systems, with the engineers at BorgWarner drawing on their many years of experience and leading technology in gasoline engine turbocharging. We now look forward to further cooperation projects with customers in which we can redefine the boundaries of the driving experience, fuel consumption and emissions.



Ulli Froehn, Vice President Business Development & Marketing with BorgWarner Turbo Systems

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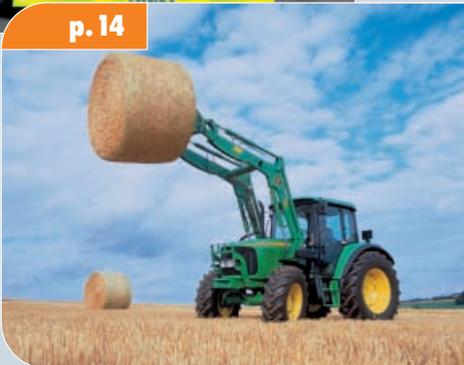
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PONTIAC SOLSTICE LAUNCHED WITH MOST POWERFUL GM ECOTEC 2.0 LITER (122 CUBIC INCH) DI TURBOCHARGED ENGINE EVER SEEN

Power for Pont

At the start of 2006 the Pontiac Solstice GXP celebrated its world premiere at the Auto Show in Los Angeles. This is the sportiest version of Pontiac's roadster ever made. The Solstice GXP has a 122 cubic inch EcoTec turbo engine with direct fuel injection and variable valve technology. With this engine the parent concern General Motors presents not only the most powerful 4-cylinder in the so-called L850 generation of engines, but also its first gas engine with direct fuel injection in the US market.

The engine is the result of close cooperation between the global GM Powertrain development team and its development partners from the supply industry. Generating 260 bhp from a displacement of just 122 cubic inches, it has the highest specific power output per unit displacement of any GM engine (2.13 bhp per cubic inch). Its maximum torque of 258 lb-ft, which is available from 2000 rpm, offers the best prerequisites both for sporty driving and easy cruising at low revs.

DI plus turbo – a convincing combination

As supplier of the powerful boosting system, BorgWarner Turbo & Emissions Systems played a key role in the development of the engine. The developers had ambitious aims, and were keen not only to generate high power from a small engine, but also to achieve smooth delivery across a wide rev band and keep fuel consumption and emissions to a minimum. To achieve this it was necessary to exploit all the advantages offered by a combination of gasoline direct injection and exhaust gas turbocharging. The decision was therefore taken to use a K04 turbocharger with inno-

vative twin-scroll technology and a cast steel turbine housing.

The K04 by BorgWarner uses two channels, with one channel carrying the exhaust gas from cylinders 1 and 4, and the other from cylinders 2 and 3. These two channels are kept separate right up to the turbine infeed. This allows full exploitation of the exhaust pulse at low revs and the extremely favorable scavenging common to direct injection gas engines. Further features of the BorgWarner turbocharger include a latest generation high-efficiency turbine wheel and an integrated diverter valve.

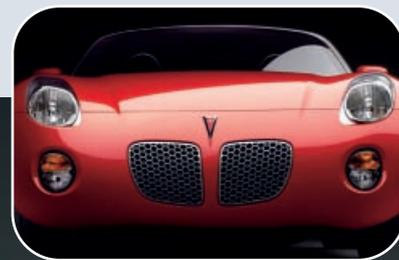
Successful global cooperation

The global cooperation with GM Global Powertrain in the US and Europe was as ambitious as the goals for the engine. At BorgWarner an interdisciplinary project team with members from Auburn Hills (USA) and Kirchheimbolanden (Germany) worked together to successfully meet the targets.

With this project BorgWarner was once again able to demonstrate its high technical competence, building on its position as the leader in gas engine turbocharging technology. The turbo-



iac



Pure performance. Purist design.

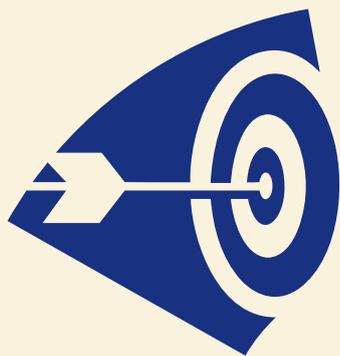


charger specialist's ability to work on a massive development project with a global, interdisciplinary customer team and provide the best resources available worldwide were also crucial factors contributing to the success of the project.

The new EcoTec turbocharged engine with direct injection offers truly impressive performance in the attractive Pontiac Solstice, Saturn Sky and Opel GT sport coupes. And it demonstrates the amazing potential offered by combining direct injection and turbocharging in gas engines.



The K04 turbocharger from BorgWarner offers a particularly high level of efficiency.



BORGWARNER INTRODUCES PIONEERING NEW METHODS IN PRODUCT DEVELOPMENT

DaRT - The process turbo

More and more auto manufacturers are developing new products in networks. And development responsibility is increasingly being transferred to suppliers with specialist know-how. This is making development projects increasingly complex with increased pressure for innovation, while development times are being drastically reduced – in particular for passenger vehicles.

who is in charge of Engineering Standards & Procedures. “Our goal with DaRT is to establish a standardized product development and release process that is perfectly matched to the altered framework conditions. It will make a decisive contribution to improving the exchange of information between the development teams, as well as offering optimized coordination, documentation and validation of development steps – thereby bringing concrete advantages in terms of development time, development costs and quality”, comments Michael Flörchinger, highlighting the most important aims of DaRT.

FMEA, was implemented in the fall of 2005. With this, BorgWarner provides an important service that more and more auto manufacturers are demanding of their suppliers. Within the “Engineering Standards & Procedures” field, FMEA coordination has been introduced, serving as a starting point for creation of project-specific FMEAs, as well as maintenance of existing standard FMEAs and FMEA methods.

New turbocharger designs are generally derived from tried and tested turbochargers already in serial production. The key here is for the application engineer to have access to standardized, secured information when deriving the first configuration. This prevents old serial parts that are no longer used from being included by accident. It also prevents new part numbers from being assigned unnecessarily and new designs from being initiated, when tested standard components are already available. With its product configuration tool, the “Best Turbo” sub-project now makes it possible to keep information on sound technical turbocharger configurations and, when needed, derive new ones. An SAP-based pilot application has already been implemented for two turbocharger series.

The introduction of DaRT started with the analysis of the existing development process and definition of a target for the future DaRT process. Modules for specific procedures were also identified during the analysis phase. These were then defined in cooperation with the various departments, and are now being introduced step by step.

The DaRT modules

One important module is the DVP&R – the Design Verification Plan and Report. This serves as an important standard instrument for planning, monitoring and reporting the validation and test measures that are performed in a project. Alongside test runs for the turbochargers manufactured, virtual tests performed in simulations are also taken into account here. The DVP&R enables BorgWarner’s team of developers to document the status of tests already performed and those scheduled, including tests to be performed by the customer – thereby keeping customers up-to-date on project progress.

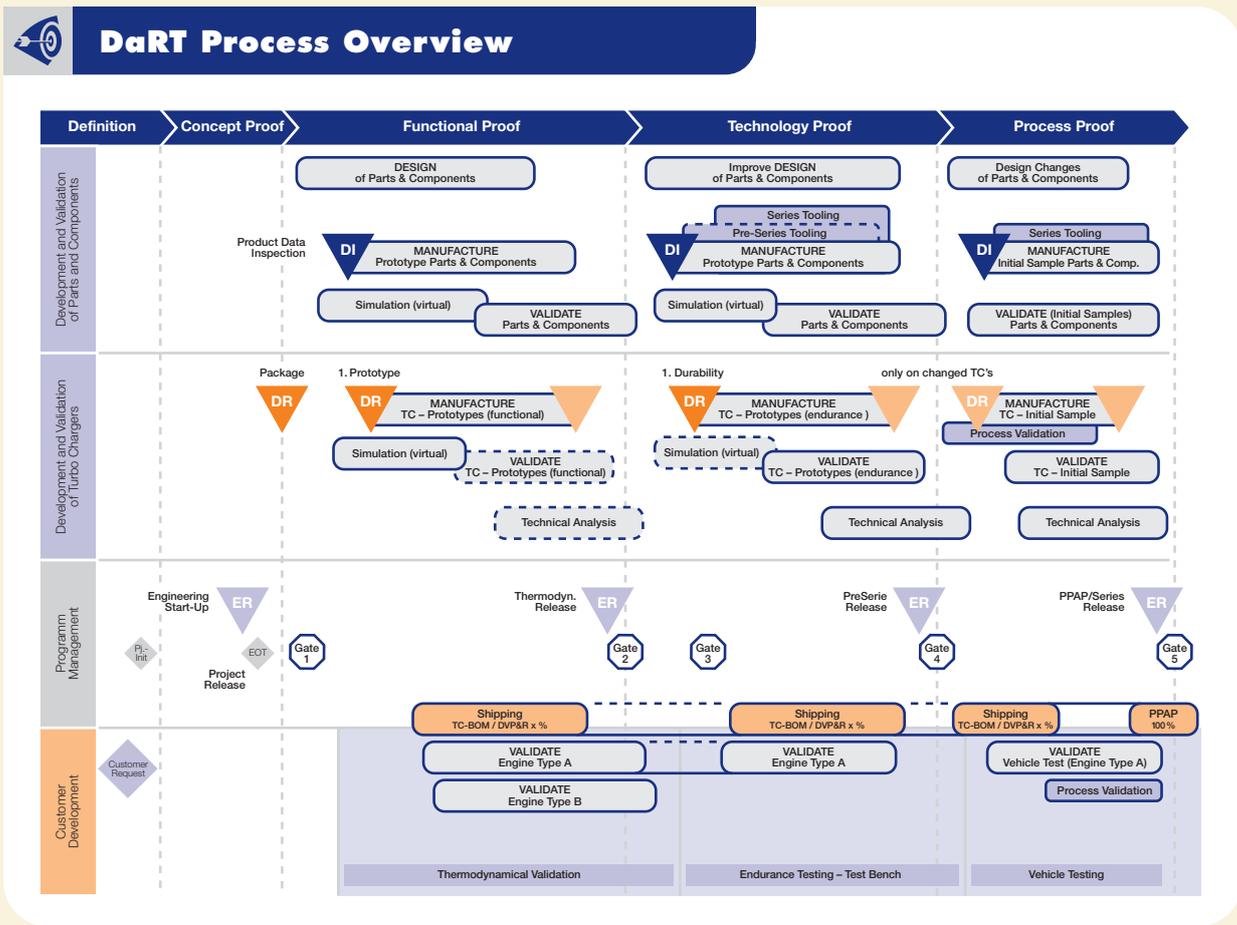
A second significant DaRT module, the function-based product for analyzing potential errors and influences named

If they wish to succeed in this environment, suppliers to the automotive industry need to be able to meet all their customers’ requirements and integrate themselves seamlessly into their processes and systems. At BorgWarner, DaRT is crucial for product development. The term stands for Development and Release of Turbochargers – and defines a highly efficient development process that was launched in the fall of 2005 and is being implemented in stages at BorgWarner.

More efficient development with DaRT

The project for the introduction of DaRT is being managed by Michael Flörchinger,





The engineering start-up meeting is held at the start of the project. It is used for an early exchange of information between the project team, the engineering and production departments and staff members from prototype production. The key activity of the meeting is to work through questions based on a structured checklist: Are we starting with the right turbocharger configuration? Is there a spec sheet? Is a first DVP&R already in place that contains the planned tests and simulations? Is there an up-to-date resources plan? Are all relevant departments and areas involved and informed? In this way the engineering start-up meetings ensure that all relevant knowledge is shared with everyone involved at a time where problems can be explained and solved quickly and easily.

Design and engineering reviews are then held when a product has reached a certain stage of development or if the development work needs to be inter-

rupted to coordinate with the customer. Design reviews check and document the conscious step of going into production or building a prototype at a certain stage of development that is later sent to the customer. Design and engineering reviews ensure product development can be understood and also improve the process quality through standardized procedures.

Systematic document management

An important aim for BorgWarner is to have an overview of the current turbocharger configuration, the status of components, supplier parts and turbocharger validation at all times throughout development and to describe this with accompanying documentation. This places great demands on project and product data management. The EASY DMS document management solution from SAP was therefore implemented to accompany the introduction of the DaRT process. This allows important

project and engineering documents to be managed centrally in an audit-friendly system.

Moving forward with DaRT

This year BorgWarner is working intensively to drive forward the implementation of design and engineering reviews in the DaRT process for all turbocharger projects. In addition, the processes for serial release and also product management in SAP (product configuration tool, parts lists, release procedure) are to be improved.

“With the DaRT project we constantly face the challenge of implementing changes in processes, organization and IT. And we have learnt that the best approach here is to take small steps. So we will keep working consistently toward achieving our ambitious goals”, concludes Michael Flörchinger, describing the progress of the DaRT project.

NEW SPRINTER GETS AHEAD WITH BORGWARNER R2S™ TURBOCHARGING SYSTEM

Fully loaded

Having sold some 1.3 million units in 11 years, the 1st generation Sprinter raced ahead of the competition to become class leader. However, Mercedes-Benz felt it was time to build on their dominance in the van sector, and in 2006 the automotive pioneers finally launched the new version of the Sprinter. This all-new model offers even more space inside, improved safety, exceptional comfort and engines that deliver impressive performance while remaining economical and environmentally friendly.

Pick your design

With the new Sprinter, Mercedes-Benz gives every customer the feeling of having a van tailored to their exact needs. The comfortable new cab, for example, is as individual as the whole program of the new Sprinter. And with more than 1,000 different options available – from low-frame chassis models right up to panel delivery trucks, from station wagons right up to flatbed trucks – everyone is sure to find the perfect solution for their application.

Pick your engine

Customers are also spoilt for choice when it comes to selecting the engine, with six different models available. Two of the six models are four-cylinder turbocharged diesel units, and are equipped with the BorgWarner Turbo & Emissions Systems R2S™ regulated 2-stage turbocharging system – an unprecedented move in the light duty vehicle segment. The engineers at Mercedes-Benz and BorgWarner together succeeded in developing two extremely attractive and pioneering units for the Sprinter which set new

standards in terms of performance and consumption, while fulfilling the strict Euro 4 emissions standard.

The powerful 315 CDI generates 150 bhp at 3,800 rpm and offers the driver an impressive 240 lb-ft of torque between 1,200 and 2,400 rpm. This new engine's response has been greatly improved, offering better acceleration and hill-climbing grunt at lower revs. The 313 CDI generates 129 bhp and a torque of 224 lb-ft. Both diesel engines allow a top speed of just over 100 mph and are fitted with particle filters as standard. To help the diesel engines get their power on the road in every situation, they drive the rear wheels via a six-speed manual gearbox – unless the customer decides to opt for the smooth automatic.

BorgWarner's R2S™ regulated 2-stage turbocharging system makes a key contribution to the impressive performance of the two engines. The inline exhaust gas turbochargers of different dimensions are the key to this system, as they change the way they interact based on requirements.

Sharing the load

The exhaust gas turbochargers run constantly with the engine. The smaller high-pressure exhaust gas turbocharger – a KP39 unit with turbine casing as exhaust manifold module with integrated Venturi butterfly valve, controlled via a pneumatic actuator – does the work at low revs, ensuring excellent response. As the engine then revs faster, the power comes increasingly from the larger low-pressure turbocharger – a K04 whose turbine casing is equipped with a connecting flange and an integrated waste gate.

Another first on the new Sprinter is the integration of a self-regulating bypass valve in the compressor. This performs the job of the compressor bypass valve with vacuum actuator that disconnects the high-pressure turbocharger from the exhaust gas stream at high revs. This not only helps reduce production costs – it also makes the whole system significantly more compact.

So that the engines also meet the strict Euro 4 standard in terms of nitrogen oxide emissions, exhaust gas recirculation (EGR) is also applied at full power. This makes high boost pressures necessary over a broad operating range, which is what ultimately led to the use of the 2-stage system in the Sprinter.

Visibly dynamic

The design of the vehicle hints at the dynamics hidden within the new Sprinter. The oval grill has two elegant horizontal bars, while molded clear glass headlights round off the vehicles "face". Generously equipped with straps and wide protective boards and with a side profile line that rises toward the rear, the Sprinter appears powerful and dynamic. Side blinkers integrated in the wing mirrors and molded tail lights are also part of the new Sprinter design. Alongside its versatility and modern engines, this new look will certainly help the new Sprinter race to the top of the sales charts.



The R2S™ turbocharging system offers an outstanding torque of 243 lb-ft from just 1,200 rpm¹.



BORGWARNER OPENS NEW PROTOTYPE CENTER IN KIBO

Equipped for the future



The turbocharger has enjoyed a real boom in the last few years. However, the increase in demand has not only led to ever stricter requirements in terms of the flexibility and capacity of serial production, it also represents a growing challenge for the manufacture of pilot series and prototypes.

40 % more prototypes

The number of prototypes produced by BorgWarner increased by around 40 % between 2003 and 2005. Added to this is the fact that new technologies, such as VTG (variable turbine geometry) or regulated 2-stage turbocharging systems, are making new products increasingly complex. And costs for documenting and measuring prototypes are also on the rise.

To fulfill these stricter requirements, both now and in future, BorgWarner Turbo Systems GmbH has not only continued to improve processes and procedures, but also invested in expanding prototype manufacture. In the fall of 2005 the Kirchheimbolanden plant opened a new prototype center with a

state-of-the-art production area which it uses to produce prototypes of next generation boosting systems.

As diverse as the requirements

Staff were able to move into the new workshops just 3 months after work on the new center began, and the running production process only had to be interrupted for a few days. The turbocharger specialist has invested a total of around €1.7 million in the production of pilot series and prototypes, and today employs over 50 staff members in this field.

The production facility has modern CNC, drilling, turning, milling and grinding machines for processing bearing, compressor and turbine housings, shafts, wheels and special parts of all sizes. Added to this are devices for welding and also high speed balancing benches, all of which are geared to production of individual orders with batch sizes of 1 or above.

The assembly area, which for the first time has a dedicated warehouse and picking area,

offers 12 assembly locations as well as testing and adjustment benches that allow the entire range of boosting systems to be processed. The measuring room is used for all checks during production and assembly as well as all accompanying documentation needed to meet the stricter customer requirements.

Optimized processes

With the new building, BorgWarner has taken a further key step toward optimizing and accelerating processes – from the receipt of goods, through manufacturing of components, right up to assembly and delivery of prototypes, including all necessary documentation.

Alongside the new equipment, it is of course the know-how of the staff members and the first class global processes and standards that will keep the prototypes produced by BorgWarner Turbo Systems GmbH in Kirchheimbolanden competitive in future. And in light of the increasingly short development cycles in the automotive industry, this is an important success factor.

TURBO AND EMISSIONS DIVISIONS MERGE TO BECOME
BORGWARNER TURBO & EMISSIONS SYSTEMS

Combined effort

Recently BorgWarner announced the merger of two separate divisions now known as BorgWarner Turbo & Emissions Systems (TES). These two groups joining forces makes sound business sense, especially from a product perspective, since Emissions Systems was already supplying Turbo Systems with electrical turbo actuators. Furthermore, BorgWarner is keen to position itself as an innovative system provider for the automotive industry – something that the integration of the exhaust gas recirculation systems from Emissions Systems into turbocharger development will support.

The Emissions Systems side of TES has nearly five hundred employees located at six facilities globally including the U.S., China, Europe and India. Their Dixon, Illinois facility is the primary hub, generating approximately sixty percent of global Emissions sales from major customers such as DaimlerChrysler, Ford, Toyota, General Motors, BMW and Porsche among others.

In the last few years BorgWarner Emissions Systems has developed into the leading global provider of secondary air systems, exhaust gas recirculation systems and advanced actuators for engines that offer improved performance with reduced consumption and emissions. One reason for the sharp increase in demand for these products is certainly the international tightening of emissions standards.

The merger of Emissions Systems and Turbo Systems makes the new division even better prepared for future challenges and tasks. The combined know-how of the two former business units

creates the perfect foundation for meeting the ever-stricter demands in terms of emissions and fuel consumption. Together with its broad customer base, sound growth potential and innovative technologies, BorgWarner Turbo & Emissions Systems has all the prerequisites for long term success.

Diesel EGR Systems

The innovative BorgWarner system offers integrated exhaust gas recirculation and an intake manifold made of aluminum with a DC motor EGR valve. The compact design guarantees easy installation and the unit reacts quickly to changing environmental conditions. BorgWarner is expanding on this technology in North America, Europe and Asia – the growing markets for diesel engines.

Secondary Air Systems (SAS)

Secondary air systems play a particularly important role, especially during cold starts, when most hydrocarbon emissions occur. The complete system with pump, valve, bracket, relay and hoses also offers the advantage of low noise and vibration. Additionally, the air pump flows can be tailored to meet specific requirements for BorgWarner's diverse list of Electric Air Pump (EAP) customers.

Turbo Actuators

The intelligent actuator design from BorgWarner integrates electronic components that precisely control the speed of the turbocharger and the pressure ratio. It also limits NOx emissions.

Exhaust gas recirculation system



Secondary Air System



BorgWarner
Turbo & Emissions Systems



BORGWARNER SUCCESSFULLY POSITIONED IN CHINA

Turbos for China

China has developed into one of the most important passenger and commercial vehicle markets in the world in the last few years. In 2005 some 4.8 million passenger and light commercial vehicles as well as 425,000 heavy commercial vehicles were produced in the land of smiles. Due to the growing importance of this market, it is essential for a global automotive supplier such as BorgWarner to successfully establish itself in the country as soon as possible.

BorgWarner opens campus in Ningbo

An important milestone for the positioning of BorgWarner as a powerful development partner to the Chinese automotive industry was the opening of the new campus in Ningbo. It took place on 18 March 2006 and drew a lot of public interest. Alongside Tim Manganello, CEO at BorgWarner, other top managers from the group and prominent politicians also took part in the opening ceremony for the new building complex.

Construction work on the new campus took just 12 months. In the first phase of expansion, more than 10,000 square meters of office and production area were completed. BorgWarner currently employs 67 staff members in Ningbo, and this figure is increasing every month. BorgWarner Turbo & Emissions Systems is already producing turbochargers in three production lines in Ningbo, while products are produced specifically for Emissions Systems in a further production line. The production of secondary air pumps is also set to start up shortly. The BorgWarner business unit Morse TEC is set to begin production in Ningbo in 2007. Both divisions will then be represented in the new office building.

BorgWarner has already been present in China for some time – since 1993 with the joint venture Beijing TorqTransfer Systems and since 2001 with the joint venture Ningbo Thermal Systems Shenglong. The new plant in Ningbo is the first company in China to be 100% controlled by BorgWarner – a so-called wholly foreign-owned enterprise (WFOE). It will initially supply customers such as China National Heavy Duty Truck (SinoTruck), Volkswagen/Audi, FAW and Yulin Diesel. However, in future BorgWarner will also produce innovative products in Ningbo for all other important Chinese auto, machine and engine manufacturers.

Successful appearance at the Engine China 2006 trade fair

Engine China 2006 was the second important event of the year for BorgWarner in China. This trade fair is sponsored by the CICEIA (China Internal Combustion Engine Industry Association). The Engine China fair is an important platform for presenting the latest diesel and gasoline engines, as well as alternative drive concepts such as natural gas engines. Alongside the Chinese engine and truck manufacturers, such as FAW, Sino Truck, Shanghai Diesel or Yuchai, many inter-



BorgWarner at the Engine China 2006 trade fair



national manufacturers, such as MAN, Iveco, Perkins, John Deere, Isuzu or Caterpillar also took part in the 2006 event.

On its stand, BorgWarner presented itself as a qualified partner in the field of powertrain technology for passenger and commercial vehicles, construction and agricultural machines, as well as marine applications, generators and other applications. The group underlined its position as product leader. Another point worth noting was the first joint trade fair appearance of BorgWarner and Beru. Both companies presented a comprehensive portfolio of innovative products for engines and transmissions in vehicles and machines.

The BorgWarner stand welcomed many visitors from the industry, as the majority of those attending Engine China were experts in the field of vehicle and component development. And BorgWarner products could also be seen on other stands. Dalian, John Deere, Weichai Power, Sino Truck and MAN all presented a range of powerful engines equipped with turbochargers from BorgWarner.

Events

BORGWARNER TURBOCHARGERS PROVE THEMSELVES UNDER THE MOST EXTREME CONDITIONS

Giants of the race track

Interlagos is the most famous racing circuit in Brazil – and with its mix of long straights and tight corners one of the most demanding in the world. On 21 May it was host to the largest truck race of the year. Over 55,000 fans turned up to watch Roberval Andrade win the race spectacularly in his Scania, just seven seconds ahead of last year's winner Wellington Cirino in his Mercedes-Benz.

Sponsored by BorgWarner

Both drivers' engines were upgraded for the extreme race conditions by BorgWarner Turbo & Emissions Systems. The company, which worked closely with the engine manufacturers, supported the drivers again this year with turbochargers and technical know-how. The BorgWarner boosting systems proved themselves excellently under the extreme conditions of this race "between the lakes". The circuit, which is located just twelve kilometers outside Sao Paulo, is a real challenge for the drivers due to the tropical temperatures and high humidity. Added to this is the extremely uneven surface of the track.

The K365 dominates the field

20 of the 25 participants in this year's competition used specially prepared K365 turbochargers from BorgWarner. Up until 2003 the leading teams were unanimous in their praise of the S400 by BorgWarner as the best turbocharger available – as every single winning vehicle since the first truck race of the championship in 1996 had



been equipped with this unit. Indeed, Renato Martins won the first Brazilian championship in his Scania using a BorgWarner turbo.

The 55,000 enthusiastic fans included the IDS and OEM customers in the BorgWarner guest area. They were all impressed by the outstanding performance in Interlagos – and are already looking forward to next year's event

JOHN DEERE EQUIPS ENGINES WITH VTG TURBOCHARGERS FROM BORGWARNER

Tough guys

Many engine manufacturers saw the introduction of stricter emissions standards for off-highway equipment in the US and Europe as an indication that it was time to revise and modernize their engines in terms of consumption and emissions. Agricultural machine specialists John Deere also took the opportunity to update their engines with state-of-the-art solutions such as exhaust gas recirculation and turbocharging. The manufacturer was supported in this venture by the experts at BorgWarner Turbo & Emissions Systems.

Equipped for the future

BorgWarner started production of the S300V VTG turbocharger for the new John Deere engines in September 2005. These new engines meet the requirements of the US Tier 3 emissions regulations. The turbocharger specialist has developed a total of around 40 versions of the S300V VTG turbocharger, which are used in a broad range of John Deere vehicles. These boosting systems are intended for use in the 414 cubic inch (6.8 liter) and 549 cubic inch (9.0 liter) engines and have impellers made of titanium or aluminum.

John Deere commissioned the engineers at BorgWarner with the task of developing an innovative air manage-

ment system. The goal here was to guarantee clean burning to meet future emissions standards, while simultaneously offering high performance and low fuel consumption. With its variable turbine geometry (VTG), BorgWarner had the right technology to meet its customer's strict requirements.

The VTG technology enables cooled exhaust gas recirculation, which in turn allows the maximum combustion temperatures to be effectively lowered. This helps the new Deere engines lower nitrogen oxide emissions, allowing them to meet the Tier 3 emissions standard. Based on the speed and load of the engine and in combination with the exhaust gas recirculation valve, the VTG turbocharger controls the volume of exhaust gas that is mixed with fresh air and introduced into the combustion chamber of the engine.

Alongside the S300V turbochargers already mentioned, the team of developers at BorgWarner and John Deere also worked on an S430V VTG for the 823 cubic inch (13.5 liter) engine from John Deere, as well as an S200V VTG for the 274 cubic inch (4.5 liter) engine. Both of these also meet the Tier 3 standard. The turbochargers have been in production in small batches since the start of 2006. Production at full capacity is set to start in Q4.

Tailor-made performance

The new engines cover the full range of power requirements from 155 to 600 bhp (116–448 kW). It was also possible to increase the torque generated by around 20 to 35 percent compared to the engines that meet the Tier 2 standard. The turbocharged engines are to be fitted in many different vehicles, including tractors, skidders, power loaders, diggers, picking machines, combine harvesters, forest machines, sprayers and bulldozers.

Economical and environmentally sound

The newly developed VTG turbochargers from BorgWarner have helped reduce the total size of engines, offer excellent performance figures in all operating ranges, have very low fuel consumption and ultimately make a decisive contribution to John Deere engines meeting the Tier 3 standard.

The BorgWarner VTG turbochargers for John Deere:

- S200V (4.5 liter engine)** – 116 kW to 138 kW at 2400 rpm
- S300V (6.8 liter engine)** – 104 kW to 205 kW at 2400 rpm
- S300V (9.0 liter engine)** – 168 kW to 298 kW at 2200 rpm
- S430V (13.5 liter engine)** – 261 kW to 448 kW at 2100 rpm



The VTG turbochargers make it possible to develop particularly compact, powerful and efficient motors.



Nothing happens by accident

Congratulations! The BorgWarner plant in Campinas has reached the two million man-hour mark without a single industrial accident. Turbo & Emissions Systems and Thermal Systems helped make this outstanding result possible by implementing numerous measures that go far beyond the regular safety training courses. One such measure was to inform staff members about the best safety precautions at their workplace. And a safety engineer is available in the workshop at all times to answer questions and note information on any potential risk areas. Machine safety and ergonomic inspections at regular intervals help to prevent injuries. Engineers and maintenance engineers also use their know-how to support the development of new devices and tools to improve working conditions. So the whole company gets involved, demonstrating that safety really is a question of teamwork!



Cultural bonus for the community



Brazilian legislation encourages companies to support cultural, educational or environmental projects with a share of their income tax. Campinas, for instance, invested R\$ 100,000 in a project where 1,500 book packages were distributed to children in the region. Each package contained two picture books, illustrating the topics of education and environmental protection. The national library, all regional libraries and each BorgWarner employee in Campinas received a package, although the majority went to state schools in Campinas. A play was also staged at the schools in the immediate vicinity of the BorgWarner plant featuring the characters in the books. For most of the children this was the first theater performance they had ever seen – and for many of them these were also the very first books of their own. The enthusiasm in their eyes was clear for all to see.

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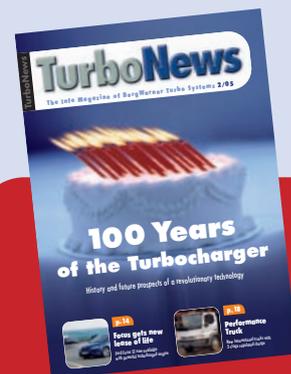
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