A boost for precise maneuvering

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A smart move to reduce Total Cost of Ownership
ABB Turbocharging is proud of its two-stage turbocharging system – Power2 800-M. Thanks to a well-coordinated development effort inside the company and equally well-coordinated collaborations with engine builders, the system is now in its second generation and ready for marine four-stroke applications. Application Engineer Thomas Matt, who was part of the development team from day one, shares his experiences from the product development process in an interview starting on page 4.

While two-stage turbocharging is the talk of the industry, our single-stage A100-M turbochargers still have great potential to improve engine emissions, fuel consumption, power density and, importantly, Total Cost of Ownership. The latest A150-M and A155-M frame sizes represent ABB’s largest radial turbochargers and are characterized by their excellent combination of high performance and high reliability.

Please take time to have a look at these two fascinating pieces of technology at Marintec, Shanghai, from December 1 to 4, Hall N1, Stand J31.

This issue of charge! also elaborates on the benefits of our service offering. We write about service agreements (pages 16 to 17) and the numerous advantages of turbocharger upgrades on rail traction applications are presented by Robert Dötl, starting on page 18.

And you can learn even more about our activities in the railway industry by visiting us at Automation Power World India, ABB’s flagship event taking place in the Manekshaw Centre in Delhi from November 4 to 6. It would give us a great pleasure to see you there, but in the meantime: Please enjoy this issue of charge!
“A good product has been created”

Second-generation Power2® represents a quantum leap in turbocharging technology for large engines. Newly launched on the four-stroke marine market, its strengths and potential are discussed in this interview with Thomas Matt of ABB Turbocharging.

Interview Tiziana Ossola Auf der Maur, Photography Dominik Baur, Frederic Meyer
charge! Second-generation two-stage turbocharging for large engines is considered a quantum leap. Why?

Thomas Matt: With the second-generation Power2 series 800-M we have developed a system that is in advance of anything that has gone before, and an improvement in all important points. With an achievable turbocharging pressure ratio of 12, combined with 75 percent plus turbocharging efficiency, this two-stage turbocharging system is an absolute innovation. Power2 800-M gives engine builders the options of a 20 percent increase in engine power output, fuel consumption savings of up to 10 g/kWh or reductions in NOx emissions by as much as 60 percent. These represent significant leaps forward, in addition to having great benefits for customers.

Where will second-generation Power2 be used?

An important field of application is and remains power stations, where the first generation of Power2 two-stage turbocharging is already being used. On engines in power plants the main benefit from Power2 800-M is a significantly lower level of fuel consumption, which translates directly into more profit for the engine operator. In addition, power plants can gain a great advantage from the system’s increased pressure ratio. This is especially interesting for power stations at high altitudes. Engines for power stations can be run at high power density (bmep > 30 bar) at 2,000 meters above sea level without having to reduce their power – i.e. derating.

“With an achievable turbocharging pressure ratio of 12, combined with 75 percent plus turbocharging efficiency, this two-stage turbocharging system is an absolute innovation.”
Marine engines are now joining the field of applications.

Exactly. The application possibilities of second-generation Power2 are enormous. There are potential uses in the offshore oil and gas industry as well as for marine main propulsion and auxiliary engines in general shipping. For example, the power range of Wärtsilä’s W31 engine, the first marine engine to use Power2 800-M, now covers 4,200 to 9,800 kW.

What effect does two-stage turbo-charging have on an engine’s running characteristics?

In combination with variable valve timing a user will notice considerably better engine response in the important part load operating range; for example, when accelerating the engine from idling to full load. This is important for ships with frequent changes of load and speed and especially for maneuvering. An ice-breaker or offshore vessel can move more rapidly and be positioned more precisely. The end user will also notice that he will need considerably less fuel at the engine’s design power rating than with single-stage turbocharging. Although it should also be emphasized that the fuel savings will be measurable almost everywhere over the engine’s complete load range.

Do the fuel savings work with every fuel?

Yes. Power2 works with all fuels and the increase in engine efficiency it enables is also valid for all fuels. For example, with the combination of Power2 800-M and the VCM® variable valve timing system from ABB Turbocharging, users of gas engines will have an excellent setup at their disposal.

Second-generation Power2 800-M: Benefits at a glance

- Increased pressure ratio capabilities up to 12
- Turbocharging efficiency beyond 75 percent (single-stage: 65 – 70 percent)
- 20 percent higher power density
- Fast service due to the extractable cartridge concept
- Fuel flexibility
- Fuel savings of up to 10 g/kWh (compared to the same engine with single-stage turbocharging)
Can you forecast with which fuel Power2 will be used the most: distillate diesel oil, heavy fuel or dual-fuel, i.e. gas?

This will depend on the way the markets for the fuels develop. There are, of course, overall trends. On the power station side, gas is constantly gaining in importance. In the marine sector there is a strong trend towards LNG. Dual-fuel engines are an obvious move in several respects, whether in terms of the availability of LNG, its economics or with regard to IMO Tier III. With Power2 the user can operate his dual-fuel engine in gas mode in an ECA and be in full compliance with the Tier III emissions limits. Outside the ECA he can switch to heavy fuel. For engines burning only liquid fuel, IMO Tier III can be attained using selective catalytic reduction (SCR). In combination with Power2 800-M, both fuel consumption and raw NOx emissions can be significantly reduced on diesel engines, leading to lower consumption of urea in the SCR catalyst.

Let’s talk about engine rooms. Does Power2 need more space? After all, there are two turbochargers to accommodate.

At first glance it would seem so, but you have to look at the complete picture. Let’s take the case where a ship needs a total output of 30,000 kW. With single-stage turbocharging an end user would need five 12-cylinder engines producing 6,000 kW each. Two-stage turbocharging will give him an extra 20 percent output per engine, so he can fit either five 10-cylinder engines or two 12-cylinder engines and two 14-cylinder engines. This enables the required engine room space to be considerably reduced – and the cargo payload increased.

Additionally, with Power2 800-M very compact turbocharger arrangements can be realized by applying rational design. However, care must be taken to keep pressure losses as low as possible. On the Wärtsilä W31 engines a very compact configuration has been realized.

A further important point during the development of Power2 800-M was service friendliness. Can you tell us a bit more?

There are, of course, two turbochargers to be maintained, but the extractable cartridge concept dramatically reduces the complexity of servicing. Only the inlet casing and air filter silencer, together with the compressor insert wall, need to be dismantled in order to remove the cartridge. That means that all the other application-specific connections can stay in place. Service work is thus rapid and relatively uncomplicated. Also, by using specially developed tools the turbocharger can be overhauled directly on site. In this way engine downtime is massively reduced.

What will be the further stages in the evolution of Power2?

This year we have seen the industrial release of the frame size Power2 850-M, and we are working intensively on the development of the Power2 845-M frame size.

Looking back, how is a quantum leap made to happen?

It was an exciting time. In the past three years we were involved in numerous discussions with engine builders. First, the product objectives had to be defined: what must the product be able to do and what air delivery range should it be able to cover? In this early phase the major decisions were taken regarding concept, size, etc. We developed the two-stage turbocharging system in parallel with the development work being carried out by the engine builders. Product development is something dynamic and requires continuous engagement with potential customers. As already mentioned, a major goal in the design phase was to achieve a compact system with high levels of efficiency and service friendliness. All in all, we progressed step by step and a really good product has been created.

“The application possibilities of second-generation Power2 are enormous. There are potential uses in the offshore oil and gas industry as well as for marine main propulsion and auxiliary engines in general shipping.”

Thomas Matt was involved as an Application Engineer on the second-generation Power2 development project from day one. He acted as the point of contact between ABB Turbocharging and Wärtsilä as the customer. His task was to bring the customer’s requirements into ABB Turbocharging’s internal development processes, while taking into account the views of other potential engine builder customers. Thomas Matt gained a degree in mechanical engineering from HTWG Konstanz, Germany, in 1997.
A100 – a single performer in a class of its own

While two-stage turbocharging is the talk of the industry, single-stage turbocharging is still very much the state of the art. In a continuing product development process, ABB is still exploring and extending the performance envelope of its A100 series.

Text Jonathan Walker, Photography Michael Reinhard, iStockphoto, ABB

Cartridge assembly of the currently largest radial type turbocharger from ABB Turbocharging.
During their development, A100 turbochargers set record levels of turbocharging efficiency, combined with a pressure ratio potential of up to 5.8. These two aspects, together with a wide compressor map put the A100 series at the cutting edge of turbocharger technology and performance.

A100 for medium-speed engines

For the medium-speed engines that represent one of the true workhorses of the global economy, ABB Turbocharging’s mainstay contender is the A100-M family of single-stage turbochargers. “Especially the larger A100-M family members were developed for medium-speed engines that need the highest turbocharger pressure ratios and turbocharging efficiency from a single-stage turbocharger,” notes Oliver Heinrich, Senior Manager Sales and Application Engineering.

The entire series targets engines with outputs of 500 to 6,000 kW output per turbocharger — i.e. potentially up to 12 MW for a V-configuration engine with two turbochargers. In this engine power class are many of the applications which make medium-speed diesel and gas engines essential to economic activity and development. “These are ideal enablers for robust prime movers that are characterized by their excellent combination of power density and high reliability,” Heinrich continues.

They are thus ideal engines in medium sized ships such as offshore supply vessels, drill rigs, dredgers and tugs. Additionally, a wide range of engine types is engaged in electrical power generation.

Application examples

Fishing vessels

With more than one operating mode, fishing vessels require high power and wide compressor maps so that their main engines deliver efficient power when both trawling their nets at lower speeds and steaming to and from fishing grounds at their design speeds. At the same time, high engine power density means more room for the catch of fish, while turbocharging efficiency ensures low fuel costs.

Offshore

Drill rigs, Offshore Supply Vessels (OSV) or Platform Supply Vessels (PSV): Offshore oil and gas industry using mid-sized four-stroke applications require not only power density but robustness and absolute reliability. The A100 series perfectly fits the demands of this kind of application.

Power plants

The majority of power generation plants using large four-stroke engines run on heavy fuel and cover the so-called baseload of the electrical grid they serve, supplying households, industry or hospitals with dependable electricity. Power plant engines need compact, robust and reliable turbochargers. They should be capable of providing combustion air to engines that can run economically and cleanly at full power for up to 8,000 of the 8,760 hours in a year and with minimum maintenance for optimum Total Cost of Ownership (TCO).
Specific ambient conditions

It is on this class of engine that two-stage turbocharging will have a great impact, but the A100-M series still has potential to improve engine performance with respect to emissions, fuel consumption, power density and TCO.

“Engine builders use the high pressure ratios of the A100-M to realize an increased power output or the application of stronger Miller timings, naturally reducing the engines raw NOx emissions. The latter means that in the case of an SCR installation its overall size can be smaller and its consumption of urea lower,” Heinrich observes.

In addition, the A100-M allows engines to be tuned for specific purposes. This enables just one engine platform to be sold as a high efficiency version in the marine market, capable of dealing with hot ambient conditions, or be applied as an electrical power generator at high altitudes – not de-rated and thus saving installed equipment.

The A100-M allows engines to be tuned for specific purposes.

The achievements behind the benefits

As stated, the excellent performance of the A100 turbocharger family is based on the success of ABB’s development engineers in terms of the three major yardsticks of turbocharger performance:
- Its high turbocharging efficiency.
- Its high pressure ratio.
- Its wide compressor maps.

The features behind the benefits

Key to the A100 series benefits is its thermodynamic performance, based on new compressor stages, executed in aluminum with optional compressor wheel cooling to facilitate highest achievable pressure ratios. It is these components that enable wide compressor maps at the 5.8 full load pressure ratio in combination with a state-of-the-art compressor efficiency.

On the turbine side, a new generation of mixed-flow designs was developed to give an extended operating range, thus powering the new compressor stages over a very wide range of applications. Moreover, the turbine designs have been optimized in such a way that they exhibit efficiencies to complement those of the compressor designs. Further development of sealing technologies has also reduced blow-by, enabling a substantial improvement in turbocharging performance at higher boost pressures.

New frame sizes

The latest frame sizes of the A100-M family are A150-M and A155-M. They represent the largest radial type turbochargers from ABB and as key enablers of engine power outputs currently close to 6,000 kW per turbocharger on medium-speed engines, while at the same time meeting the highest levels of efficiency.

Total Cost of Ownership

With their ability to save consumption of fuel and urea in the case of installed SCR systems, A100 turbochargers ensure two of the major preconditions for favorable TCO. Third and fourth TCO essentials are high availability and uptime in combination with ease of work on the turbocharger, either in situ or at one of ABB Turbocharging’s 100 Service Stations around the globe. Here, a dedicated design offers ease of removal of turbocharger parts or of the complete turbocharger.

“The A100-M turbochargers are ideal enablers for robust prime movers that are characterized by their excellent combination of power density and high reliability.”
A milestone on the way to green shipping

The SCR system is an after-treatment device in which urea reacts with nitrogen oxides (NOx) to convert the latter into harmless nitrogen and water, thereby reducing engine emissions. Actual values show that with this system WinGD’s 5RT-flex58T-D low-speed engine – manufactured by Hudong Heavy Machinery Co., Ltd. (HHM) – is able to reduce NOx emissions by nearly eight percent to only 2.58 g/kWh, thereby easily meeting the Tier III emissions standard developed by the International Maritime Organization (IMO).

As is well known, sulfur oxides (SOx), NOx and particulate matters (PM) are the three primary air pollutants emitted by ships. Shipping is a significant and in regions of major ports the dominant emitter of NOx. Seven of the world’s ten largest container ports are in China. Therefore, comprehensive and rigorous control of NOx emissions and effective emission reduction measures are of far-reaching environmental significance not only for China but for the whole world. The successful development of China’s first low-speed engine equipped with an SCR emission reduction system is a milestone in engine external after-treatment for Chinese marine engine manufacturers and an embodiment of their commitment to green shipping.
As a global leader in turbocharger technology for high-power diesel and gas engines, ABB Turbocharging is a long-term strategic partner of WinGD – Winterthur Gas & Diesel AG (formerly Wärtsilä Schweiz AG). The key feature of this WinGD two-stroke diesel engine equipped with an SCR system is that the SCR reactor has to be installed in front of the turbocharger, resulting in a reduction in gas pressure and energy before the exhaust enters the turbocharger. Therefore, the working efficiency of the turbocharger needs to improve accordingly in order to meet the diesel engine’s pressure ratio and air flow requirements. Thanks to a major design improvement at the compressor end, the ABB A200-L series of turbochargers can ensure high efficiency while increasing the air flow by more than 30 percent and significantly improving the pressure ratio, enabling the performance requirements of all available low-speed diesel engines.

Based on the actual space structure, ABB Turbocharging proposed an axial gas inlet casing improvement scheme that enables a more compact arrangement of the turbocharger, the SCR system and the engine.

The “warmly celebrated” engine.

Delivery celebration ceremony of the first low-speed engine with SCR system.

Design improvements at the turbocharger compressor end

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The A270-L turbocharger is produced at ABB Jiangjin Turbo Systems Co., Ltd., which has been successfully introducing the latest turbocharging technologies and products, including the TPS and A100/200 series, to China as part of the company’s ongoing commitment to providing a better service for local customers.

The WinGD engine is deployed on a 22,000 TEU multi-purpose vessel, which started sea trials in August 2015.

A270-L turbocharger.
One brand – one quality

Wherever products from ABB Turbocharging are made, they are produced to the same exacting quality standards. This is thanks to a highly efficient network of engineering, production and sales, managed centrally by ABB Turbo Systems Ltd in Baden, Switzerland.

The warehouse complex at ABB Turbo Systems in Baden, Switzerland, is impressive. On a total area as large as a football field stand storage racks ten meters high. Here are the Original Parts for servicing ABB turbochargers of all series in operation around the world. They can be accessed 24 hours a day, 365 days a year. Whatever the customer requires, it can be dispatched within 48 hours to where it is needed, anywhere in the world.

Indeed, 98 percent of all spare parts are guaranteed to be available from the warehouse. Thanks to the flexible manufacturing strategy and agility of ABB Turbocharging in Switzerland, the remaining two percent can, at any time, be manufactured in lots as small as one piece. Even an ABB turbocharger of 1938 vintage has been brought back to effective life thanks to Baden’s standby reproduction capabilities. This spare parts setup is what enables ABB Turbocharging to ensure the highest standards of turbocharger service. And their primary aim: maximum customer benefit.

ABB’s around-the-world service has a single central hub. Supplying new turbochargers to the world functions differently. As well as the production facilities in Baden, Switzerland, ABB Turbocharging has works or joint ventures in China, Japan and India (see map below). And with Hyundai Heavy Industries and Doosan Engine, ABB is represented in...
Korea by licensees. In this way, ABB Turbocharging maintains its proximity to its Asian rail, marine and power generation customers.

Top quality everywhere
Together with the ABB Turbo Systems headquarters in Baden, these manufacturing works form a production network that has been continuously improved and extended for forty years. It is set up to deliver quality. Not all the works make everything. A structured parts exchange process enables materials and components to be moved smoothly around the network. With its specialized mix of machine tools, Baden contributes the majority of rotating components for all turbochargers produced. The whole network profits from this arrangement. The parts exchange process reduces costs, saves time and guarantees the global uniformity of ABB Turbocharging’s products.

Within the network Baden also acts as the design center, which ensures that a turbocharger like the A100-L is absolutely equal in quality, whether from Chinese, Swiss or licensee production, both on the inside and in its outward appearance. Any turbocharger designed by Baden that leaves any ABB works, or the works of a licensee, heading for the customer will fulfill all of its technical specifications in every respect. Wherever the turbocharger is made, customers everywhere can count on the high quality they have a right to expect from a turbocharger bearing the ABB brand.

Only excellence is good enough
Every series-produced turbocharger must be manufactured in line with the network’s prescribed standards. In all its own works worldwide, and at its licensees, ABB Turbo Systems Ltd audits the incoming goods processes, the manufacturing and assembly processes and the machine tools needed specifically for production of ABB turbochargers.

The auditing system goes even further, taking in the sub-suppliers who deliver materials, semi-finished products and components. These must undergo a parts release process: material specifications and component geometry are subject to close and exacting examination – sometimes literally under a microscope. Only those parts and materials that exhibit 100 percent compliance are allowed to be used in the production of ABB turbochargers. The responsible experts at ABB know the critical factors in high quality production and accompany its processes, actively and in a consulting capacity, whether in their own works, at licensees or at sub-suppliers. At any time they are ready to give technical support, from the very first stages of localized production.

Audits assure quality
Professionalism creates quality. This statement sets the overall framework, for example in everything to do with safety at the place of work. As a result, ABB Turbocharging audits its suppliers and its supply chain, not only in a purely technical sense but also in terms of employment law and environmental impact, and by insisting on the ABB Supplier Code of Conduct. Indeed, ABB Turbocharging is subject to exactly this kind of auditing by its customers and invariably gains full approval.

A further quality assurance stage involves gaining approvals from bodies such as the marine classification societies and national authorities and ministries with their criteria for product conformity. These criteria are not only stringent but in many cases identical and internationally valid. They also play their part in ensuring that ABB products attain the same high standards irrespective of where they were manufactured in ABB’s global production network.

The inspection and evaluation of ABB Turbo Systems’ production and sales systems is ongoing. Optimizing production costs while maintaining or improving product quality demands an alert eye. Major investments at all facilities in the past ten years have led to ever more efficient production processes. These things happen for the benefit of the customers. Irrespective of where the order is placed they will always obtain a product representing the latest state of the art, and will never have to forgo the innovation and quality for which the name ABB has always stood.

Only those parts and materials that exhibit 100 percent compliance are allowed to be used in the production of ABB turbochargers.
The new service agreement between ABB Turbocharging and COSCON is now operational.

Text Shengyi Wang, Yongjian Luo, Photography COSCON

In April 2015 ABB Turbocharging signed a five-year Operation Performance Package (OPAC) service agreement with COSCO Container Lines Co., Ltd. (COSCON), which covers 120 ABB turbochargers in 20 COSCON vessels new to operation. This is so far one of the largest service agreements between ABB Turbocharging and a marine customer in China, but it is not the first one sealed between these two parties.
Since 2010, ABB Turbocharging has been providing three COSCON container ships with a customized service package, including condition monitoring of turbochargers, individualized technical support and Original Parts and Original Service at ABB workshops around the globe.

“The reliable service, including optimized planning of maintenance and spare parts deliveries, well prepare us for unforeseeable incidents in advance, thus allowing us to stay focused on the core of our business. Our operational costs are evidently more predictable and manageable in the long run,” comments Mr. Shi YongXin, General Manager of the Safety and Technology Management Division of COSCON.

“We are always committed to a flexible, reliable, and cost effective approach to turbocharger servicing tailored to the exact needs of our customers. After launching the unique care package here in China over five years ago, we are very pleased that our Chinese customers appreciate the long-term benefits the package has to offer. Their willingness to extend the agreement or to sign another is a mark of trust and faith in our offering and in our ongoing commitment to delivering value for customers,” says Roland Schwarz, ABB Turbocharging China LBU Manager.

China Shipping Container Lines Co. Ltd. (CSCL) is also among those Chinese customers. Since 2009 this global container liner service provider has contracted ABB Turbocharging for servicing 226 units of ABB turbochargers under OPAC service agreements.

Shi YongXin, General Manager of the Safety and Technology Management Division of COSCON: “Our operational costs are evidently more predictable and manageable in the long run.”

Newly signed Original Parts service agreement

Text Alexandra Christie

ABB Turbocharging has signed a service agreement with DFDS and J. Lauritzen Group covering 152 ABB turbochargers under a Maintenance Management Agreement (MMA). The MMA allows for proactive planning of turbocharger maintenance in collaboration with customer requirements. This optimizes the work involved in maintenance and repair of turbochargers, and for customer peace of mind passes the responsibility for managing the service scheduling to ABB.

Under this agreement, ABB will provide service to DFDS and J. Lauritzen Group jointly, collaborating across five countries: Denmark, France, Lithuania, Norway and Sweden.

The turbochargers are installed on a range of vessel types, including Ro-Ro, offshore accommodation rigs, tankers, bulkers and cruise vessels.

According to Jacob Lundholm, Sales Manager ABB Scandinavia, “Customers are increasingly looking to work with OEMs to better manage servicing and overall maintenance of their turbocharging products, for improved cost management, optimum turbocharging performance and increased uptime.” ABB now has over 400 MMAs in place, covering a wide range of customers and applications.
Diesel-electric DF11G dual body locomotive with four VTC254-13 turbochargers in China.
Upgrades optimize loco operational costs

Whether for main line or shunting applications, locomotive engine upgrades have technical and economic benefits guaranteed to boost operator performance. Extended Time Between Overhauls (TBO), increased reliability, durability and flexibility make upgrades a very smart move.

In recent years, ABB Turbocharging has presented to the worldwide railway market a raft of new, innovative solutions based on its tailor-made TPR turbocharger platform. The second frame size of the TPR portfolio, the TPR56, has been introduced in a high pressure version as well as with the option of Variable Turbine Geometry (VTG) to the Chinese market. Parallel to this, its bigger brother, the TPR61, saw the roll-out of serial number 2,000 in India, and many specific variants providing even higher boost pressures have been tested on prototype engines. Plus, there have been a number of radial turbochargers adapted to locomotive engines in Russia and the USA.

With this broad portfolio of specific railway turbochargers available, it goes without saying that not only new engines but also well-proven and reliable engines that are running can benefit from the technological edge TPR is offering. This is possible in two ways: through an upgrade of an existing turbocharging system with only minor changes or by retrofitting an existing air management system in order to enhance engine capabilities, improve emissions and increase the flexibility of the overall power pack.

**DF11G upgrade with a TPR56-F28**

As early as 2001 ABB started to develop a turbocharging solution for the Chinese locomotive DF11G. This locomotive has now been in commercial operation since 2005 on 160 km/h passenger trains between Beijing and Shanghai, marking a first step on the way to a fully developed high-speed connection between these two fast growing centers. The DF11G is a dual body, single cab loco providing 2 x 3,860 kW of engine power for traction by means of two 16V280ZJA engines with four VTC254-13 turbochargers.

*Fig. 1: TPR axial volume flow versus compressor pressure ratio.*

**Coverage of the axial TPR variants**

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Text: Robert Dött, Photography: QSY, Lalain Mandavkar, ABB Turbo Systems Ltd, Michael Reinhard
Reliability is essential on this route and to keep to their tight schedules, maintenance of the DF11G units has been a key factor from the very beginning. ABB offered a tailored service concept for the complete useful lifetime of the turbocharging system up to 3,600,000 km, at which point a mid-life overhaul/rebuild of the complete locomotive is indicated. Systematic bearing inspections and exchange, combined with a carefully chosen time range for the exchange of the rotating components, are at the core of this service concept.

Now that the mid-life time of the locomotives is about to be reached, a system upgrade using the next generation of turbocharging technology, namely the TPR56-F28, is planned. The procedure foresees a complete drop-in solution, so that all the existing interfaces on the engines can be matched – see fig. 2. The new solution will provide a genuine benefit in terms of performance that translates into fuel savings, while, as a matter of course, the engine will comply with all mandatory emission regulations now in force.

Another substantial benefit of the rebuilt locomotive will be the new service scope. This will stretch out the lifetime of individual components, compared with the former VTC254 turbocharging solution. The result is minimization of the Total Cost of Ownership (TCO) – ranging from the cost of upgrading and overhauls to the beneficial effects of the extended service intervals, and the attendant increase in durability and fuel saving.

Upgrading from VTC to TPS on ALCO 6-cylinder engines

India has many shunting locomotives equipped with 6-cylinder ALCO engines running on railways or in the yards of private operators of steel mills, ports and other industrial plants. Hundreds of these locomotives, for example types WDS6 and YDM4, are in operation and remain a popular choice for shunting tasks. Their engines, ALCO 6L251Ds, deliver 1,350 hp and have been boosted by VTC214 turbochargers for ten years. In order to move to the next technological step and at the same time reduce operational costs, ABB proposed equipping the 6L251D engine with the next generation of turbochargers i.e. the TPS52.

To this end, ABB has developed a drop-in concept. First tests have been conducted and the results indicate several additional benefits over the former turbocharging solution. One is the higher performance compared with the VTC214, resulting in a fuel saving for operators.
Another benefit is the increased time between overhauls (TBO). This will give operators an additional TCO advantage by extending the TBO from three years for a VTC 214 to four years for the TPS 52.

**Upgrading an ALCO engine to Miller timing**

Another project currently under way in India involves the upgrade of a turbocharging module that focuses more on fuel savings and emissions reduction. Most of the 5,200 diesel locomotives running in India are equipped with ALCO 16-cylinder engines, rated at 3,100 and 3,300 hp. After 18 years of operation, these locomotives are undergoing an extensive rehabilitation program and the engines are being upgraded to the latest technical standards. As part of this process ABB has proposed introducing so-called Miller timing on the rebuilt engines, using turbochargers able to deliver higher boost pressures to compensate for the reduced opening periods of the engine intake valves of the so-called Miller cycle.

Performance tests are scheduled and it is expected that they will show the benefit of a two percent reduction in fuel consumption over the standard duty cycle of the locomotives. Given that the fuel cost makes up the largest part of the operational costs of locomotives, the TCO of these units’ second life span of 18 years will, as a consequence, be substantially reduced. In addition, Miller timing will reduce peak temperatures of the combustion cycle and subsequently bring NOx emissions down, which is very welcome in view of the forthcoming, stricter emission regulations.

**Upgrades on rail: Benefits at a glance**

- Improved reliability
- Increased operational flexibility (ambient temperature and altitude variation)
- Extended durability
- Fuel saving
- Emissions compliance
- All benefits reduce Total Cost of Ownership (TCO)

The operational costs of the ALCO locomotives’ second life span will be substantially reduced.
Upgrades from fix to VTG have strong potential benefits

Recently, ABB broadened its application of Variable Turbine Geometry (VTG) technology to railway engines. Serial production has become a standard for high-horsepower locomotives. VTG could also be a smart way to upgrade an existing engine, with a focus on fuel economy and flexibility in operation. Whether as part of a locomotive’s mid-life rebuild or as an interim upgrade project, a change-over to VTG offers major benefits to the operators.

A one-to-one comparison on a traction engine has confirmed a potential of two to four percent fuel saving for a typical duty cycle. Fig. 3 illustrates these benefits and emphasizes the advantage VTG offers in part load. Additionally, the flexibility demanded of a rail engine in terms of temperature fluctuation and altitude variation is well covered, allowing full load to be made available up to 2,500 m above sea level.

Indian Railways have expressed their interest in VTG being used on their ALCO locomotives, as has the Russian JSC Kolomna Plant, which has taken delivery of first test units and started testing the VTG on a new engine platform.

Summary

Upgrading traction engines offers a number of key advantages to operators. Depending on the operator’s focus, an upgrade can improve fuel economy, extend TBOs, increase reliability and operational flexibility or enhance the emissions compliance capabilities of the power packs. In each and every case, however, it leads to lower Total Cost of Ownership.

Fig. 3: Test results: fixed geometry versus VTG on a traction engine.
ABB turbochargers chosen once again to power record holding ship

Record. ABB turbochargers are set to power what will be the world’s largest cruise ship, currently under construction and scheduled for completion in the first half of 2016. Harmony of the Seas is owned by Royal Caribbean International and is the third vessel to join the Oasis class of ships. On completion the vessel will be 362 m long.

ABB has received an order to deliver two different sizes of its highly efficient TPL series turbochargers designed for two- and four-stroke engines. ABB turbochargers are also on Royal Caribbean’s three largest cruise ships to date: Allure of the Seas, Oasis of the Seas and Quantum of the Seas.

Oasis of the Seas – one of Royal Caribbean’s largest cruise ships with ABB turbochargers.

MSC Oscar’s sister ships

Record. This is not the first time ABB has been associated with world record holding ships. The two container vessels announced as the largest in the world earlier this year, with over 19,000 TEU (CSCL and MSC), have turbochargers designed by ABB installed on their main engines. In 2015, two of MSC Oscar’s sister ships, MSC Oliver and MSC Zoe (19,224 TEU), also powered by ABB designed turbochargers, were taken into operation. The fourth and fifth box ships in this so-called Olympic series are scheduled for the end of 2015. All are expected to be fitted with ABB designed turbochargers.

Service network growth in 2015

Network. Already with an extensive network of more than 100 fully owned service operations around the world, ABB Turbocharging this year has further developed this network by opening another six service locations across Africa, the Middle East and South America. In addition, the Kyushu Service Station in Japan relocated within the Kyushu area to offer customers faster and more efficient service in a more convenient location. This service network expansion meets the need for large shipping companies to work more closely in partnership with their suppliers.
The importance of keeping the compressor side clean

A properly working turbocharger compressor is a key element in good engine performance. This tip shows what needs to be maintained, and how.

Text Peter Schellenberg, Photography Michael Reinhard, ABB Turbo Systems Ltd

Let’s first define the system: The compressor side is more than just the rotating impeller; in fact, it starts at the air intake section and ends after the engine cooler.

Air inlet

Every pressure loss at the air inlet will result in a reduction in the pressure of the compressed air after the turbocharger. This can be explained using a simple example: If the compressor ratio is 5 and the ambient pressure is 1 bar, there will be 4 bar of compressed air relative to the ambient condition after the turbocharger ($5 \times 1 \text{ bar} = 5 \text{ bar absolute, or 4 bar more than ambient}$). If there is a loss of e.g. 0.1 bar somewhere in front of the turbocharger it will simply be multiplied in the compressor ($5 \times 0.9 \text{ bar} = 4.5 \text{ bar absolute or 3.5 bar more than ambient}$). For the engine, this means 0.5 bar less receiver pressure. Higher exhaust gas temperatures can be the result, or the turbocharger could tend to surge.

ABB Turbocharging provides turbochargers fitted with a silencer with a grid around the silencer to prevent larger foreign objects reaching the impeller. As many customers also install filter mats around the silencer, it is only a matter of time before these mats become clogged. This clogging will inevitably lead to an increase in pressure loss across the silencer and to the described effect. ABB therefore recommends frequent checking of the silencer losses by means of a U-type manometer and that the condition of the silencer be checked when the pressure losses exceed the limit of 30 mbar. To prevent such conditions arising in the first place, ABB recommends washing or replacing the filter mats.

For turbochargers without a silencer and which are connected to an air filtration system on the installation side, the same applies. The filters must be kept in good condition to prevent any losses.
Tips for the operator

Heavily contaminated static parts of a compressor stage.

In 1999 Peter Schellenberg received a bachelor’s degree in science from Fachhochschule Nordwestschweiz FHNW, Switzerland, followed by a master’s degree from the Berner Fachhochschule, Switzerland (2004). He joined ABB Turbo Systems Ltd in 2000, starting in the turbocharger engineering division where he led several development projects. In 2008 he was appointed head of design, medium size turbochargers. Since October 2013 Schellenberg is Team Manager Technical Service for turbochargers.

Washing or replacing the filter mat is recommended.

To keep the compressor stage clean, good air filtration is essential. What is more, contaminated air will affect all the equipment after the turbocharger. By following these points you can help to prevent the compressor stage from early fouling:
- Make sure the air surrounding the turbocharger is clean.
- Prevent exhaust gas from entering the air suction side.
- Avoid oil in the air as this will act like a glue for any dust to stick to.
- Follow the washing instructions in the operation manual and use pure water.
- If the air inlet is removed by the crew, clean the impeller and the wall insert with a soft rag and water; this will help to keep the compressor stage clean.

Air cooler

The compressed air after the turbocharger is cooled down in the air cooler. If the air cooler is dirty, the pressure loss in the cooler will increase and the receiver pressure will be lower as a result. Further, the cooling efficiency will be reduced. This translates into a loss of valuable work done by the turbocharger, with the following consequences for the engine:
- Lower receiver pressure.
- Higher exhaust gas temperatures.
- In the worst case, surging of the turbocharger.

Compressor stage

A clean compressor stage is a guarantor for reliability and high performance. Contamination in the compressor stage will reduce the performance of the turbocharger, leading to:
- Reduced receiver pressure.
- Higher turbocharger speed.
- Higher exhaust gas temperatures.
- Reduced scavenging of the engine.
- A reduced control margin (gas engines).

Losses in front of the turbocharger can lead to:
- Reduced receiver pressure.
- Higher turbocharger speed.
- Higher exhaust gas temperatures.
- Reduced scavenging of the engine.
- A reduced control margin (gas engines).

Heavily contaminated static parts of a compressor stage.

ABB therefore recommends frequent checking of the engine cooler losses. Regular cleaning of the cooler can prevent these losses becoming higher than those recommended by the cooler manufacturer and the resulting possibility of severe problems.

A turbocharger that is maintained properly, including those parts on the cold air side, helps to save money.

The better the turbocharger performance, the lower the fuel consumption and the lower the exhaust gas temperatures. Also, the equipment will suffer from less thermal fatigue. Note: In the troubleshooting section of the operation manual you will find more hints on keeping your turbochargers top fit. This will support reliable operation of the engine.

Washing or replacing the filter mat is recommended.
Today’s international recipe No. 10, Mandarin fish, is a homage to Shanghai, the host city of this year’s major marine trade show Marintec, and to the abundant fish in the waters off its coast.

But first consider this quaint little story. According to legend a restaurant in the southern region of the Yangtze River served Emperor Qianlong of the Qing Dynasty (1711 – 1799) Mandarin fish. The cook had put in a great effort not only to cook an excellent meal but also to make the dish look like a sculpture. So he formed the fish into the shape of a squirrel. Not only was the aromatic dish very much to the Emperor’s liking; from that day on the recipe has also been called the “squirrel-shaped Mandarin fish”.

Good things stand the test of time. Mandarin fish is still widely cooked in the region around Shanghai and counts as a dish for special occasions. It has two auspicious semiotic meanings. The fish is in red tomato sauce, a color which is a symbol for joy and good fortune in China. And: 鱼 (yu, which means fish), in Chinese, is a homophone for another character 余 (yu), meaning abundance. To have fish on special occasions is a wish for health, wealth and happiness.
Mandarin fish

for two people

Ingredients
ca. 600 g Mandarin fish
A handful each of pine nuts, corn
kernels and petits pois
150 – 200 g tomato sauce
2 dl rice wine
5 g ginger
1 – 2 green shallots
1 tbs. starch
Sugar and salt to season.

(Quantities can be varied as required)

Preparation
1. Slice open the Mandarin fish
from head to tail along its spine,
remove the spine and small
bones on the sides, and cut the
flesh into skin deep strips.
2. Marinate the fish in salted rice
wine with ginger and the green
shallots for about an hour.
3. Coat the marinated fish with
starch before frying it in hot oil
until the fish turns golden brown.
4. Warm the tomato sauce, oil, salt
and sugar according to your per-
sonal preference.
5. Add water to the sauce and
cook the corn kernels, pine nuts
and petits pois until soft.
6. Pour the sauce all over the
cooked fish.

Enjoy your Mandarin fish with our
best wishes for the future.
Turbocharging Service. Secure your investment.

Assuring the availability of your application is a critical part of securing your business. The right service reduces downtimes and increases your application’s performance and lifetime. You also save costs by preventing repeat maintenance and redundant spare part purchases. Getting your service plan from ABB Turbocharging guarantees dependable delivery of results and lower total cost of ownership of your turbocharger. We are dedicated to providing our customers a comprehensive turbocharging service offering 24/7, 365 days a year at any one of our 100+ ABB-owned Service Stations in 50+ countries across the globe. Get the right service. www.abb.com/turbocharging