

OVAKO

**PURITY CREATES
DESIGN OPPORTUNITIES
BQ-STEEL® AND IQ-STEEL®**



YOUR CHALLENGE

More torque. Less weight. More revolutions. Whether you're creating high-performance bearings, durable rock drills or next-generation powertrains, material capabilities are critical. But conventional steel has its limits. And costly remelts or more exotic materials may not be viable. To substantially improve fatigue strength and unlock new design possibilities, a new solution is needed. One that truly delivers cost-effective gains in system performance, weight savings and component lifetime.

More revolutions
with increased
life time

Need to reduce
weight by 12%

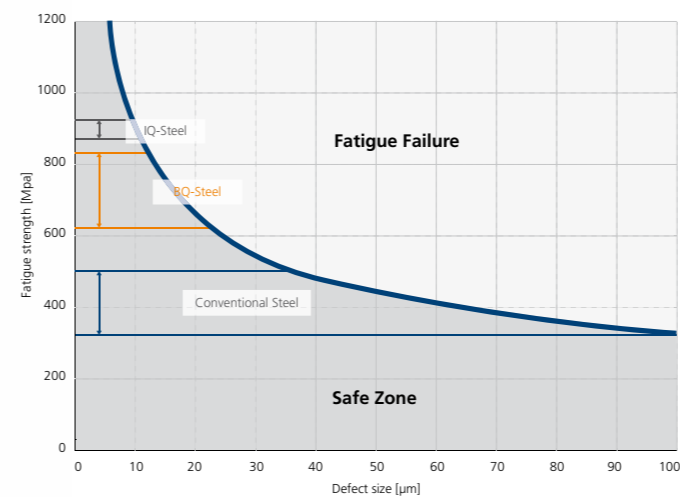
Need to cut
system cost?

Increase torque
by 27%

OUR SOLUTION

The solution can be summed up in three words: Purity creates opportunity. To understand this, take a look at the diagram below. It represents data collected from thousands of tests. As you can see, improvements in purity result in big design opportunities. That's good news for any designer who wants to raise current standards by adding new levels of performance. It means you can economically slim down your gears, bearings and other components to meet new design requirements. All by simply using cleaner steel that consistently delivers smaller-sized impurities, produced with the help of large-scale, air-melt steel production.

ENHANCED FATIGUE STRENGTH WITH IQ-STEEL AND BQ-STEEL



KEY BENEFITS WITH CLEAN STEEL

- Consistent quality level for secure, stable production of end-user components
- Improved bending and contact fatigue strength
- Increased load per weight capacity, e.g. Nm/kg
- Decreased cost per load unit, e.g. €/Nm
- System and component size reduction at fixed torque
- Increased performance for Ultra-High Cycle Fatigue, e.g. high-rpm e-drive

THREE PATHS TO ENHANCED PERFORMANCE

For designers, the advantages of clean steel are becoming increasingly clear. Whether you choose material substitution, partial design changes or a total redesign, IQ-Steel and BQ-Steel can deliver significant performance gains across a range of demanding applications.

Material substitution

Aiming to enhance the performance of an existing design? This is where Ovako clean steel's enhanced fatigue strength comes in. By simply upgrading your existing grades to IQ- or BQ-Steel versions of the same grade, you can boost gearbox power density with little to no design changes.

Partial design changes

Thanks to improved fatigue properties, many components can be downsized to create next-generation powertrains with remarkable gains in power density. Whether you decide to make subtle or comprehensive internal design

changes, you can make room for additional components, giving you a system with superior performance – within the same external system boundaries.

Total redesign

When a major increase in power density is needed, an entirely new powertrain concept may be necessary. Free up space for surrounding systems. Introduce new levels of hybridization. Or extend the range of an electric drivetrain. Whatever your application, the opportunities for new powertrain designs represent the ultimate use of Ovako clean steel.

PUTTING PERFORMANCE TO THE TEST

Because inclusions are much smaller and more dispersed in clean steel, they can be difficult to quantify through conventional test methods. We have responded to this challenge by developing a more comprehensive approach that combines light optical microscopy, scanning electron microscopy, fatigue testing and immersed ultrasonics. The result is a more complete overview of the total inclusion content, which we feed directly into the refinement of

our clean steel production processes. With the help of new methods, we can set precise design parameters that better correlate with the unique properties of clean steel. Typically, this means a fatigue limit improvement of some 30% – or even up to 100% in the heaviest loading directions – when compared with the same grade of conventional steel. Our immersion ultrasonic testing standard is now available for free public use.

International standards used to quantify inclusions – such as ASTM E45, ISO 4967 and blue fracture testing – are only capable of analyzing a relatively small area. To accurately capture the “true inclusion distribution”, Ovako's in-house testing procedures include testing of larger areas and/or volumes. The information gained by these methods helps to predict final component properties while providing relevant data for further development of clean steel.



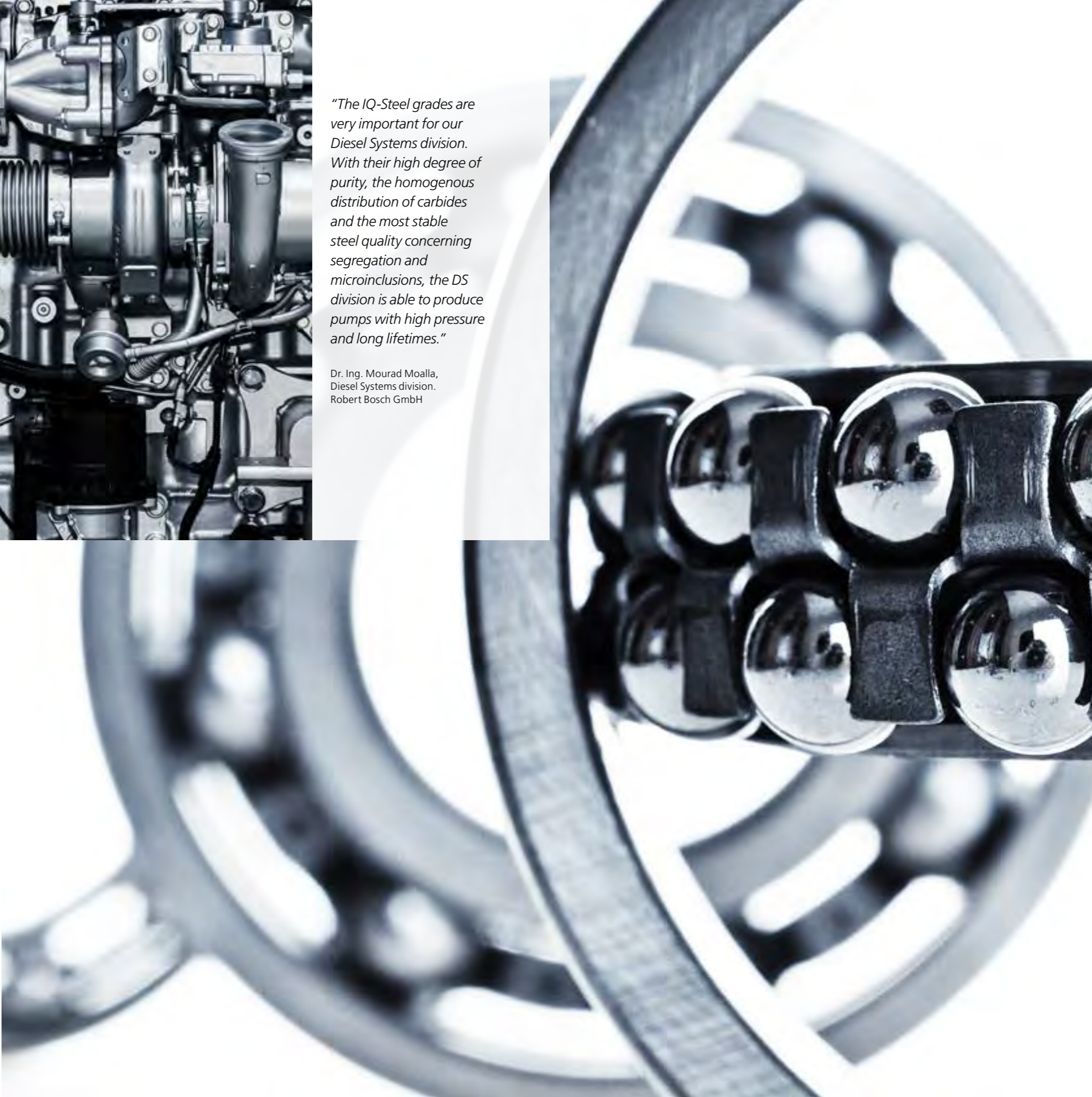


"The IQ-Steel grades are very important for our Diesel Systems division. With their high degree of purity, the homogenous distribution of carbides and the most stable steel quality concerning segregation and microinclusions, the DS division is able to produce pumps with high pressure and long lifetimes."

Dr. Ing. Mourad Moalla,
Diesel Systems division.
Robert Bosch GmbH

"We identified a need for a high-quality gear steel to be used on a critical high-load timing gear application for one of the most powerful mining engines in the world. Ovako responded rapidly, providing technical support on material selection and helping to develop, cast and roll the steel ahead of schedule – at a guaranteed cleanliness level."

Global Supply Quality Leader
Fortune 500 Engine Manufacturer



"Ovako has been a driver in the development of clean steel. Twenty years ago, subsurface fatigue cracks due to internal defects and inclusions generally determined performance and bearing life. Today, thanks to the development of cleaner steels, these failures are rare. Cleaner steel grades now delay the onset of sub-surface failures and extend life, so the most common challenges are generally surface related. The focus of our research has thus moved on."

Alan Begg,
Former Senior Vice President,
Group Technology Development, SKF



HANDLE HIGHER LOADS WITH CLEAN STEEL

The advantages of clean steel have already led to years of performance gains for demanding components in bearing and diesel injection applications. Now major automotive manufacturers are taking the next step, using clean steel to rethink the future of powertrain components including gears, final drive units and engine designs.

Rising to meet new demands

In recent decades, we've seen an exponential rise in power density for both light- and heavy-duty vehicles. Engine torque levels well above 600 Nm, once unimaginable, are now common. These higher torque loads create completely new fatigue conditions for steel components – particularly for rotating parts. With IQ-Steel and BQ-Steel, available as upgraded versions of all conventional steel grades, now there's a cost-effective way to meet these demands by guaranteeing vastly higher and more predictable fatigue strength.

Overcome the limitations of conventional steel

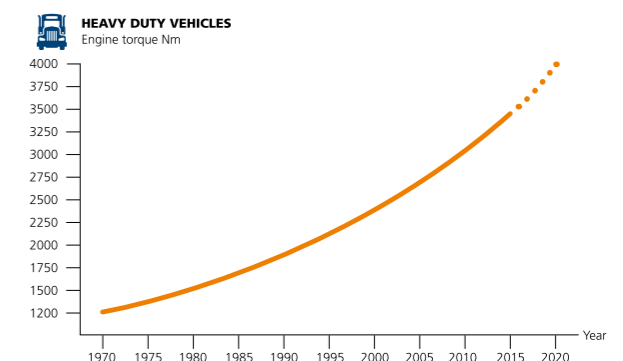
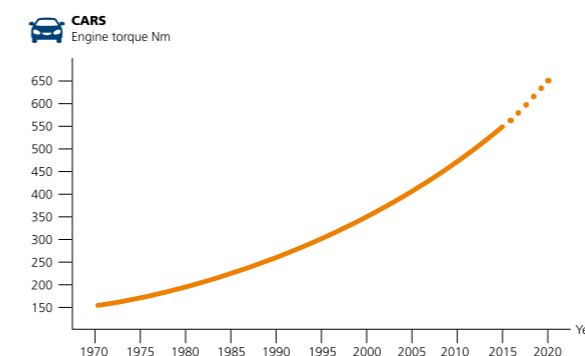
IQ-Steel is already well proven for use in high-pressure diesel injection systems, advanced bearing and transmission components, as well as for gears and hydraulic applications. Its ability to withstand extreme stress levels and highly complex loads make it uniquely suited for a

wide range of critical components ranging from highly loaded gears, axles and shafts to small internal pump components. As conventional steel components face higher torque stresses and cyclic fatigue, it's little wonder that some of the world's most demanding OEMs are now using IQ-Steel grades to handle higher and more complex loads.

Stronger, smarter gearbox components

Of course, more powerful engines lead to higher stresses on gears and other components. This often makes previous transmission designs obsolete, necessitating costly platform redesigns. By upgrading to clean steel, you can extend the life of your gearbox into the next generation by taking advantage of IQ-Steel and BQ-Steel's enhanced fatigue strength. You can even open up new downsizing possibilities for your next design, allowing you to both save space and increase power density.

RISING TORQUE LEVELS DEMAND HIGHER FATIGUE STRENGTH



DESIGN FREEDOM WITH ISOTROPIC QUALITY STEEL

Are you still designing steel components according to traditional standards? With conventional steel you may get your costs down, but strength and fatigue properties will be lacking. Remelted steels are a safer choice, but they are costly. What do you do?

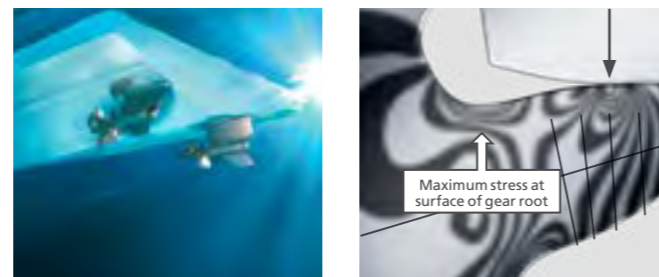
Fortunately, there is a smarter way: IQ-Steel. Developed specifically to meet the stress demands of high-performing mechanical components, this isotropic-quality steel is ideal for gears, shafts and other highly stressed components. Due to a unique metallurgical design, the inclusions in IQ-Steel are small and spherical, ensuring high resistance to stresses in all directions.

High-performing gear designs

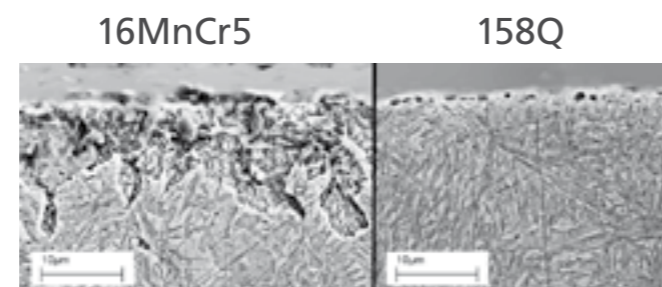
Volvo Penta is just one manufacturer that has leveraged these enhanced fatigue properties to optimize the design of critical components – in this case, for a unique IPS pod drive system. Thanks in part to an improved gear design utilizing IQ-Steel, Volvo IPS delivers significant performance gains over traditional systems. Compared to inboard shafts, the advantages of Volvo IPS include 40% longer cruising range, 20% higher top speeds and a 30% reduction in both fuel consumption and CO₂ emissions.

Put our expertise to work

As customers in the marine, light and heavy vehicle, and wind power sectors become increasingly aware of the design possibilities of IQ-Steel, our experience in cutting-edge new applications continues to grow. Wherever complex loads and high torque stresses are a challenge, Ovako can provide a range of state-of-the-art tests to ensure that your next-generation design can withstand the pressure and elevate performance to new levels.



When Volvo Penta developed its new IPS “pod drive” system with counter-rotating forward-facing propellers, it needed superior steel. Our IQ-Steel offers equal strength in all directions, enabling optimized powertrain performance.



As-carburized surface region of a standard carburizing steel and Ovako 158Q.

“As a premium brand, Volvo Penta produces systems for extremely demanding marine and industrial applications. The load cases, combined with design demands, have to be optimized and always in the frontline of technology. When it comes to gear steel material, our clear view is that the cleanliness and in particular the inclusion control is crucial in determining design possibilities. The isotropic properties of IQ-Steel provide just those conditions and is thus our gear material of choice.”

Johan Wiklund, Gear Development Engineer
Volvo Penta

WORLD-CLASS PERFORMANCE, LIGHTWEIGHT DESIGN

In the world of rallycross racing, every kilo counts. Which is why leading teams depend on lighter, stronger transmission components to gain a crucial competitive edge. For Mats Karlsson, founder and lead engineer at Unic Transmissions, IQ-Steel from Ovako makes it possible to create drive shafts, gears and spline parts that are lighter and with longer life spans – compared with designs based on conventional steel.

As a supplier to several World Championship rallycross teams, few understand the advantages of clean steel like Mats Karlsson. “IQ-Steel enables a lighter, stronger, more compact transmission design. This lightweight powertrain has two major benefits. The first is that the lower rotational mass means faster acceleration and a more responsive feel for the driver. The second is that the car’s weight distribution can be optimized for improved handling.”

For more than a decade, Unic has leveraged the superior material properties of clean steel to contribute to the world’s top competitors, including two recent world champions. And the same opportunities, Karlsson sug-

gests, could hold significant potential for the automotive industry at large. “Today’s modern automotive industry places extremely high demands on high-performance steel and weight reduction,” says Karlsson. “IQ-Steel is well suited to these applications, where an initial focus on heavier parts like crown wheels could lead to massive weight reductions and design freedom.”

In fact, our own validations, carried out through years of rotating bending fatigue tests, support this conclusion. By combining design and material properties, the result is a lighter system with dramatically enhanced service life.

“These systems have to withstand the most extreme forces: acceleration from zero to 100 km/h in less than two seconds, hard braking, and even harder turns. So the fact that I can reduce the weight of my components has huge spin-off effects. It enables a design with a lower center of gravity and opens up to other lightweight systems.”

Mats Karlsson Founder and Lead Engineer, Unic Transmissions

THE EV RANGE EXTENDER

Electric vehicles share the same goal as internal combustion and hybrid electric systems: to achieve the best possible range on a given energy input. With clean steel you can explore entirely new possibilities in overall system efficiency by combining increased fatigue resistance with smart new design and manufacturing methods.

Spin faster, go longer

Electric vehicles are entering into a new world of system design. Because of higher rpms, fewer gear steps and a demand for longer service life, components need to be designed with Very High Cycle Fatigue (VHCF) conditions in mind. In this challenging environment, clean steel offers an ideal replacement for commonly used steels, due to improved fatigue life.

Give new life to critical components

Several possibilities make clean steel a cost-efficient alternative. One is the option of upgrading the material in critical components to remove your transmission system’s weakest links, while maintaining the same design generation. In other cases, it can help solve immediate challenges when components need to be replaced due to premature failure.

Consistent quality for optimized designs

IQ-Steel and BQ-Steel combine higher fatigue strength with consistent performance due to reduced variability. This makes it possible to stay much closer to the design limit for extended time periods, compared with commonly used steels.





HIGH-PERFORMANCE BEARING SYSTEMS WITH BQ-STEEL

Longer performance. Higher loads. Zero defects. As a bearing maker, you've no doubt seen how design requirements are getting tougher. The good news is that there is a wide range of Ovako bearing quality steel so reliable and fatigue-resistant it's causing the industry to rethink what is possible.

Meeting global standards and local needs

Today, our range of tube, bar and ring is ideal for all the main components of a rolling bearing – and we meet all international quality standards. As a result of tight collaboration with our key customers, we've also been able to establish long-term business agreements and customize our logistical and EDI solutions. All of our services are underpinned by a detailed understanding of the industrial applications of our products, ensuring that our entire supply chain can be optimized to meet your requirements.

As a former division within one of the world's largest bearing manufacturers, Ovako has played a central role in improving the performance of bearing systems for nearly a century. Our latest generation of bearing quality steel, BQ-Steel, is the result of this deep experience in material performance and manufacturing economy. Ideal for applications where fatigue strength is critical, BQ-Steel allows bearing system and component manufacturers to rethink their design solutions.

Leading the way in bearing steels

In recent years, BQ-Steel has proven its potential in a wide array of demanding applications outside the bearing industry. These include gears, mining tools, hydraulic cylinders and wear-resistant details such as grinding wheels for coffee and textile manufacturing. Wherever long performance or higher loads are required, BQ-Steel makes it possible to dramatically increase fatigue strength in order to further downsize components or handle higher loads. Today we can offer a very wide range of BQ-Steel grades, based on either ingot cast or continuous cast qualities.

Total control from first melt to final product

It is the clean and consistent properties of our steel grades that customers tell us they value most. We achieve this by securing high-quality raw materials and ensuring purity and consistency across the entire production chain – from melt to rolling and finished component. As part of the process, our extensive testing verifies that the quality of the BQ-Steel will result in consistently superior fatigue properties.

ADD MORE VALUE IN MINING & CONSTRUCTION

In production and in the field, clean steel can add significant value to your mining and construction components. The advantages all boil down to one word: **predictability**. Because of consistent steel properties, you get more predictable performance all along the value chain – from repeatable processing to a superior end product.

Whatever the load case of your component, IQ-Steel and BQ-Steel make it possible to push the limits of fatigue. In most cases of percussive drilling, such as top hammer or DTH, the immediate result is more drilled meters per tool. It also means less risk of breakage, which can otherwise lead to extremely costly tool retrieval and re-drilling. As the industry moves toward more automation and remote operation, this ability to achieve a longer and more predictable tool lifespan is becoming increasingly critical.

Tailored for your processing route

Clean steel's consistent composition brings the same level of predictability into your manufacturing process. Heat treatment, welding and automated machining can all be carried out with high consistency. And a wide range of grades, shapes, formats and services are available to ensure a delivery that neatly matches your planning and processing routes.

Your cost savings

This uniquely integrated supply chain gives you total control from initial order to finished product. All to guarantee that your investment in clean steel is a profitable one: a combination of minimal total tool production costs and optimal end product performance. In short, the best of both worlds, from an efficient factory floor to a longer life in the field.

PROCESSING NEEDS

The right grade for your processing needs

In the manufacturing stage, you want a steel that suits your existing processing route and results in the optimal end-product properties. This is why we pride ourselves on our wide range of grades including steels with higher carbon content for induction hardening, quenched and tempered steels, and steels with lower carbon levels for case carburizing and additional alloying to support nitriding. Based on your current processes, we can optimize all of these properties and more to maximize the productivity of your operations.



LOAD CASE

The right material properties for every load case

Ovako offers a wide variety of grades engineered for the specific load cases of each individual component. This means you get the right wear resistance and the right fatigue strength for high-frequency impact. For several grades, we also offer the option of dual sourcing from both ingot cast and conicast routes. All to give you a wider range of price and performance choices tailored exactly to the load requirements of your components.

COST SAVINGS

The right cost savings

Our broad capabilities mean that we can go beyond your precise steel requirements to ensure that your investment pays off every step of the way. With minimal alloy variation, your processes can become more repeatable and automated. And thanks to high steel cleanliness and precise load case analysis, your component's strength, toughness and fatigue properties are guaranteed. The end result is a superior end product that minimizes all unnecessary supply chain costs and performance risks.

THE ENVIRONMENTAL BENEFITS

At Ovako, all of our products are manufactured with recycled steel and a Nordic energy mix with an extremely low CO₂ footprint. This means our products are world-leading in their low cradle-to-gate carbon footprint. As a result of our sourcing and production methods, your IQ-Steel and BQ-Steel products already have significantly lower CO₂ emissions when they arrive at your facilities.

The difference versus other steel products can be as much as 80%, meaning that every kilogram of Ovako steel can amount to some 2 kilograms in CO₂ reduction, compared to the alternative. This is a difference that remains in your end products.

When you design more efficient, stronger and lightweight systems, you're passing on additional environmental benefits to all of your customers. This low carbon footprint is inherent in the steel we produce, enabling us to build a better steel cycle together – for a better engineered future.



STEEL NAVIGATOR YOUR SHORTCUT TO THE OPTIMAL CLEAN STEEL

Ovako offers IQ-Steel and BQ-Steel in an extensive range of grades, properties and formats. To explore our full range of clean steel products by property, application or end product, or to calculate which steel grade composition is best suited to your needs, visit our easy-to-use online Steel Navigator.

With Ovako's Steel Navigator, finding the right clean steel has never been easier. Search by material properties, applications or end products. Compare with standard steels. And calculate machine settings to save time and increase tool life. Our digital Heat Treatment guide even helps you save time and money by predicting how a

specific steel grade composition will perform after heat treatment. Whatever your application, our web-based steel selection tools let you explore hundreds of high-quality steel products to find the right match for your specific needs.

Find out more at steelnavigator.ovako.com

Ovako develops high-tech steel solutions for, and in cooperation with, its customers in the bearing, transport and manufacturing industries. Our steel makes our customers' end products more resilient and extends their useful life, ultimately resulting in smarter, more energy-efficient and more environmentally-friendly products.

Our production is based on recycled scrap and includes steel in the form of bar, tube, rings and pre-components. Ovako has around 2,700 employees in more than 30 countries. Ovako is a subsidiary of Sanyo Special Steel and a member of Nippon Steel Corporation group, one of the largest steel producers in the world with more than 100,000 employees globally.

For more information, please visit us at www.ovako.com, www.sanyo-steel.co.jp and www.nipponsteel.com.

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