ELECTRICAL STEEL FOR GENERATORS

Shape the future – with isovac® by voestalpine

Domenico Marchese, Key Account Manager
Future energies require the highest quality standards. Companies who provide their customers with the highest quality standards must also ensure that their partners achieve their best performance.

Particularly in the field of renewable energies, high-quality isovac® electrical steel and pole sheets contribute substantially to increased efficiency. isovac®, our non-grain-oriented electrical steel and our hot- and cold-rolled pole sheets stand for best electromagnetic properties and highest energy efficiency. That is why so many of our products are found, for example, in generators for wind and hydro power generation.
To find out more about isovac®, visit us on our website at www.voestalpine.com/isovac/en
SEE FOR YOURSELF WHAT isovac® CAN DO!

Tailored solutions for individual demands

On the following pages you will find out more about isovac®, our electrical steel for generator manufacturing. Discover what added value it can bring to your business in the following fields of application.

» Hydroelectric power plants
» Concentrated solar power plants
» Thermal power plants
» Wind power generation plants

We set new standards with isovac®, an innovative electrical steel with excellent properties that leads to high performance as well as unsurpassed sustainability and meet much more than merely standard requirements.
isovac® – electrical steel for the highest energy efficiency, and our pole sheets. isovac® is combined with our unique services and innovative materials to provide you with a comprehensive package of benefits. Because of its excellent property profile, isovac® is a leading product worldwide.

isovac® high-perm – The specialist with the highest permeability
The optimum adjustment of textures increases magnetizability and reduces core losses. This increase in efficiency makes it possible to maintain the same level of performance while reducing component size and saving material, weight and costs. This means that a higher level of performance can be achieved with the same component size.

» Increased performance achieved by increasing torque based on higher magnetizability
» Cost optimization through less material usage, less weight and less space requirement resulting from downsizing while maintaining the same level of performance.

isovac® high-frequency – The specialist for high frequencies
The use of isovac® HF (high-frequency) grades guarantees optimum utilization of machinery at higher frequencies. High-precision adjustment of the microstructure and adaptation of the alloy content make it possible to keep losses low in the high-frequency range.

» Application in fast-turning machines with low core loss at high rotational speeds.
» Greater freedom of design and motor size optimization based on higher strengths

isovac® high-conductivity – The specialist with high thermal conductivity
The high thermal conductivity of isovac® HC (high-conductivity) grades ensures rapid heat dissipation in combination with higher polarization while maintaining low specific total losses. Innovative design strategies made possible for electrical machinery

» Potential cost savings in electric machinery based on lower component sizes and lower material usage based on higher polarization than the standard
» isovac® grades
» Cooling power reduced by up to 20% as a result of higher thermal conductivity
isovac® high-strength – The specialist for high mechanical requirements

Both magnetic and mechanical properties play an important role in many modern high-speed motors or large electric machinery. The electrical steel in the rotor is especially subject to high mechanical stress, which requires the use of high-strength material. isovac® HS (high-strength) grades combine good magnetic properties with high strengths.

- Reduced air gap between rotor and stator as a result of higher strength or reduced rotor ridge widths in permanent synchronous motors
- Larger freedom of design in electric machinery
- Possibility of partial subsequent annealing treatment at the customer in order to improve magnetic properties, e.g. in the stator

<table>
<thead>
<tr>
<th>Products</th>
<th>isovac®</th>
<th>Pole sheets and web plates</th>
<th>Insulating varnishes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fully processed</td>
<td>cold-rolled</td>
<td>hot-rolled</td>
</tr>
<tr>
<td>Maximum width</td>
<td>1.600 mm</td>
<td>1.600 mm</td>
<td>1.620 (1.750) mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.3 - 1.0 mm</td>
<td>0.7 - 1.5 mm</td>
<td>2.0 - 12.0 mm</td>
</tr>
<tr>
<td>Cut shapes</td>
<td></td>
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<tr>
<td>Hydro generators</td>
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<tr>
<td>Wind generators</td>
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<td></td>
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<tr>
<td>Turbo generators</td>
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<td></td>
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<tr>
<td>Universal generators</td>
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</tbody>
</table>

Technical consultation and customized product properties: Do you have special requirements? Our technical experts will be happy to assist you with all of your concerns and work with you in developing customized solutions.

POLE SHEETS FOR UTMOST RELIABILITY

Best electromagnetic and excellent mechanical properties in our pole sheets guarantee the narrowest shape tolerances, even at high rotational speeds. Size and application determine whether cold-rolled or hot-rolled pole sheets are used.

- Hot-rolled pole sheets are thermomechanically rolled and combine good electromagnetic properties with high strength.
- Cold-rolled pole sheets are characterized by high polarization while maintaining the same high yield strength. They are preferred in large, fast-turning machinery such as electrical exciters and hydro-electric generators.
Additional treatment to extend the functionality of our electrical steel. We offer the highest quality in our insulating varnish systems. In close cooperation with leading European varnish producers, we supply insulating varnishes that meet specific customer requirements. The varnishes do not contain any toxic, carcinogenic or mutagenic substances.

<table>
<thead>
<tr>
<th>C3</th>
<th>Inorganic/organic insulating varnish system</th>
<th>C6</th>
<th>Inorganic/organic insulation system</th>
<th>Backlack for efficiency in electrical steel packages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Best weldability and resistance to annealing (under protective gas up to 850 °C) Excellent suitability to pressure die casting.</td>
<td>Pressure-resistant and improved punchability Thermal rating up to 420 °C and suitable for burn-off repair.</td>
<td>Backlack technology is an innovative joining technique used in the production of electrical steel packages. A controlled chemical process is used to cleanly and compactly join coated laminations. The technology is characterized by a number of efficiency and processing advantages when compared to conventional joining techniques.</td>
<td></td>
</tr>
</tbody>
</table>

100% Green Power
We offer insulating varnish systems free from chromium and formaldehyde. We guarantee freedom from chromium using our new high-resolution and quantitative verification method for electrical steel insulation systems. We comply with all pertinent EU directives (RoHS Directive 2011/65/EC).
Note
As a water-based varnish system, our backlack-v® is also extremely environmentally compatible.
SAMPLE TAKING AND TESTING METHODS

Highest quality standards. Our accredited testing laboratory measures all the samples according to the required standards, e.g. EN 10106 (electrical steel) or EN 10265 (pole sheets) using an Epstein or bending test. We can perform tests to customer specifications upon request.

INTEGRATED CATS MEASURING SYSTEM

Our continuous annealing testing system (CATS) is an in-house development and automatically tests samples taken from our product range. Testing is conducted on the varnish coating thickness, paint curing, insulating resistance and residual curvature. Samples are prepared for mandrel bending and crosscut testing.

With more than 100,000 samples tested annually, our CATS measuring system contributes considerably to our high success in meeting the most stringent customer demands.
**DEVELOPMENT EXPERTISE**

For sustainable product innovations. Industry-specific material and manufacturing expertise coupled with reliability and relationships based on trust make us the European center of competence for non-grain-oriented electrical steel.

Intense development, research partnerships with university organizations, our use of the most modern technologies and continuously implemented quality control systems guarantee optimum product quality.

**Wind power - typical grades**

**indirect operation:**
isovac 250-50 A through 350-50 A, isovac 310-65 A through 470-65 A

**direct operation:**
isovac 1000-100 A through 1400-100 A

**Hydroelectric power - typical grades**

1. Web plates 900-VA-175, 700-TG-178, 750-VA-175
2. Pole sheets 350-TF-181, 450-TF-179
3. Stator sheets isovac 250-50A, isovac 210-35A

**Technical consultation**

Our technical experts will be happy to assist you with any of your concerns. We will also be happy to provide consultation services for the optimization of prematerial widths and will gladly assist you in the creation of nesting diagrams.
**CUSTOMIZED AND PERSONAL.** With a total of 500 subsidiaries and locations in more than 50 countries, we are represented on all five continents of the world and are a global player. This is how we meet all the local requirements of our customers in their own country. In the generator market segment, we count many renowned companies as our customers.

**A PROVEN TRACK RECORD WHEN IT COMES TO QUALITY**
The companies of the voestalpine Steel Division meet the highest standards of quality management and are certified pursuant to Lloyd’s Register QA Ltd. in the United Kingdom as well as ISO 9001. We focus continually on this pursued path as well as on the consistent implementation of all our quality standards.
isovac®
RANGE OF SUPPLY

As individual as the customer. Our isovac® product range includes conventional international standards as well as special grades with special properties.

<table>
<thead>
<tr>
<th>Wide strip (coil)</th>
<th>Thickness [mm]</th>
<th>Width [mm]</th>
<th>Inner diameter [mm]</th>
<th>Outer diameter [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>isovac®</td>
<td>0.3 - 1.0</td>
<td>1.000 - 1.600</td>
<td>ca. 600</td>
<td>max. 2.000</td>
</tr>
<tr>
<td>Cold-rolled pole sheets</td>
<td>0.7 - 1.5</td>
<td>1.100 - 1.600</td>
<td>ca. 600</td>
<td>max. 2.000</td>
</tr>
<tr>
<td>Hot-rolled pole sheets</td>
<td>2.0 - 12.0</td>
<td>1.620 (1.750)</td>
<td>ca. 600</td>
<td>max. 2.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slit strip (slit)</th>
<th>Thickness [mm]</th>
<th>Width [mm]</th>
<th>Inner diameter [mm]</th>
<th>Outer diameter [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>isovac®</td>
<td>0.3 - 1.0</td>
<td>19 - 1.600</td>
<td>500 / 600</td>
<td>850 - 2.000</td>
</tr>
<tr>
<td>Cold-rolled pole sheets</td>
<td>0.7 - 1.5</td>
<td>19 - 1.600</td>
<td>500 / 600</td>
<td>850 - 2.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sheet (cut-to-length)</th>
<th>Thickness [mm]</th>
<th>Width [mm]</th>
<th>Length [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>isovac®</td>
<td>0.3 - 1.0</td>
<td>300 - 1.550</td>
<td>300 - 5.000</td>
</tr>
<tr>
<td>Cold-rolled pole sheets</td>
<td>0.7 - 1.5</td>
<td>300 - 1.550</td>
<td>300 - 5.000</td>
</tr>
<tr>
<td>Hot-rolled pole sheets</td>
<td>2.0 - 12.0</td>
<td>900 - 1.620 (1.750)</td>
<td>1.250 - 14.000</td>
</tr>
</tbody>
</table>

Indicated values are standard references. Limitations are possible depending on thickness.

Supply options, special widths and thicknesses
Customer-specific widths and thicknesses can be quickly produced and supplied without any complications with the help of our integrated production process and high-performance logistics. Our supply capabilities are dependent on steel-grade-specific dimension limitations.

Note
Our electrical steel and pole sheets are generally supplied pursuant to the conventional standards (EN 10106, EN 10303, IEC 404-8-4, JIS C2552, GOST 21427.2, ASTM A677, AISI, IS 648, GB/T2521). The precise limit dimensions available for each grade are found in the respective data sheet.

Maximum widths can be found in the data sheet for each grade here
**ELECTRIFY TOMORROW**

**100% PERFORMANCE**

Are you ready for the package deal?

isovac® electrical steel for highest energy efficiency. We combine isovac® with our unique services, innovative materials, logistics, commercial advise and technical consultation in order to provide you with a comprehensive package of benefits.
Maximizing performance
Low eddy-current and hysteresis losses in electrical steel is of decisive importance in order to be able to efficiently utilize the energy used in the operation of electrical machinery. The most modern production facilities guarantee the production of electrical steel for the highest performance of electrical machinery.

Customized product properties
The exclusive manufacturing of prematerial in our integrated metallurgical facilities makes it possible for us to unceasingly monitor and ensure the high quality of all processing parameters. This results in a tailor-made product that meets the highest quality standards.

High magnetic polarization and permeability
Magnetic polarization and permeability are essential values in the engineering of electric machinery. Only high induction allows efficient utilization of available energies.

Material homogeneity
High process reliability and low tolerances through continuous rolling and annealing processes guarantee homogeneous material in the interest of mechanical, magnetic and geometric properties. This leads to stable material processing, low tool wear, less scrap accumulation and rejects as well as high dimensional accuracy of the stamped part.

High thermal conductivity
High thermal conductivity permits further optimization of performance. The innovative alloy design and the high chemical degree of purity of isovac® grades significantly increases thermal conductivity.

Highest energy efficiency thanks to intense research and development

HIGHEST ENERGY EFFICIENCY
THANKS TO INTENSE RESEARCH AND DEVELOPMENT

100% Performance

Are you ready for the package deal?

0% Troubles 100% Green Power 100% Performance
Are you ready for a green future?

The question of sustainable conservation of resources can only be whether our world will be a livable place tomorrow. Set a new standard with our innovative isovac® electrical steel and contribute to a more sustainable and environmentally compatible future.
OUR WORLD WILL BE A LIVABLE PLACE TOMORROW

100% recyciability
Our isovac® electrical steel is 100% recyclable. When calculating costs across the entire product lifecycle, steel shows substantial advantages in eco-balance when compared to other materials.

Lowest emissions
Our optimized production processes guarantee the lowest emissions. This reduces the environmental impact and sustainably increases the quality of life for future generations.

Recycled materials
67% of all incurred recycling materials and wastes are returned to the production process. This recycling process requires few natural resources and minimizes waste.

Free from chromium and formaldehyde
In collaboration with leading European varnish manufacturers, we supply insulating varnishes that contain no toxins, carcinogens, mutagens, formaldehyde or chromium compounds. The coatings meet all applicable EU directives.

Low energy consumption
Intelligent utilization of released energy and optimized selection of process parameters in the production of isovac® leads to substantially lower overall energy consumption than in conventional manufacturing processes.

Most ecological steelmaking plant in the world
We assume holistic responsibility for our products, continually optimize our production processes and develop our environmental management systems. We see environmental protection as the responsibility of each employee.
We will never be satisfied with excellent product quality alone. Comprehensive services and unlimited dedication to your challenges are at the core of our philosophy.

Are you ready for a careless package deal?

0% TROUBLES
WE THINK IN TERMS OF SOLUTIONS

The foundation of our partnership is based on solutions.

Development advantages
Our experience and continued research activities make it possible for us to develop innovative steel grades that help you more effectively meet your challenges in the future and provide you with a decisive competitive advantage.

Technical consultation and support
Our experts will support you with their excellent knowledge of the industry and materials and will be pleased to answer your questions. They guarantee comprehensive technical consultation pertaining to materials and applications.

Always close to you
Our international sales organization creates a direct connection between the customer and the production companies. Our sales organizations and representatives guarantee worldwide best consultation and expert solutions from a single source.

Precisely tailored to your needs
Each of the plants required for the production of high-quality steel strip is located in our modern steel works next to related facilities and is highly integrated into the production process. This makes it possible for us to react quickly and personally to your specific product requirements and to provide you with customized solutions.

Supply-chain management and logistics
We work together with you to devise the most optimized route, the best means of transport and, where necessary, comprehensive logistics strategies in order to guarantee availability and on-time delivery at the desired destination.

Process support
We support you throughout the entire process from placement of the order to delivery of the material. Whether it be in annealing trials, the adjustment of a stamping tool or assistance in making the transition to a new grade, our highly professional employees offer their expertise to you each step of the way.

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