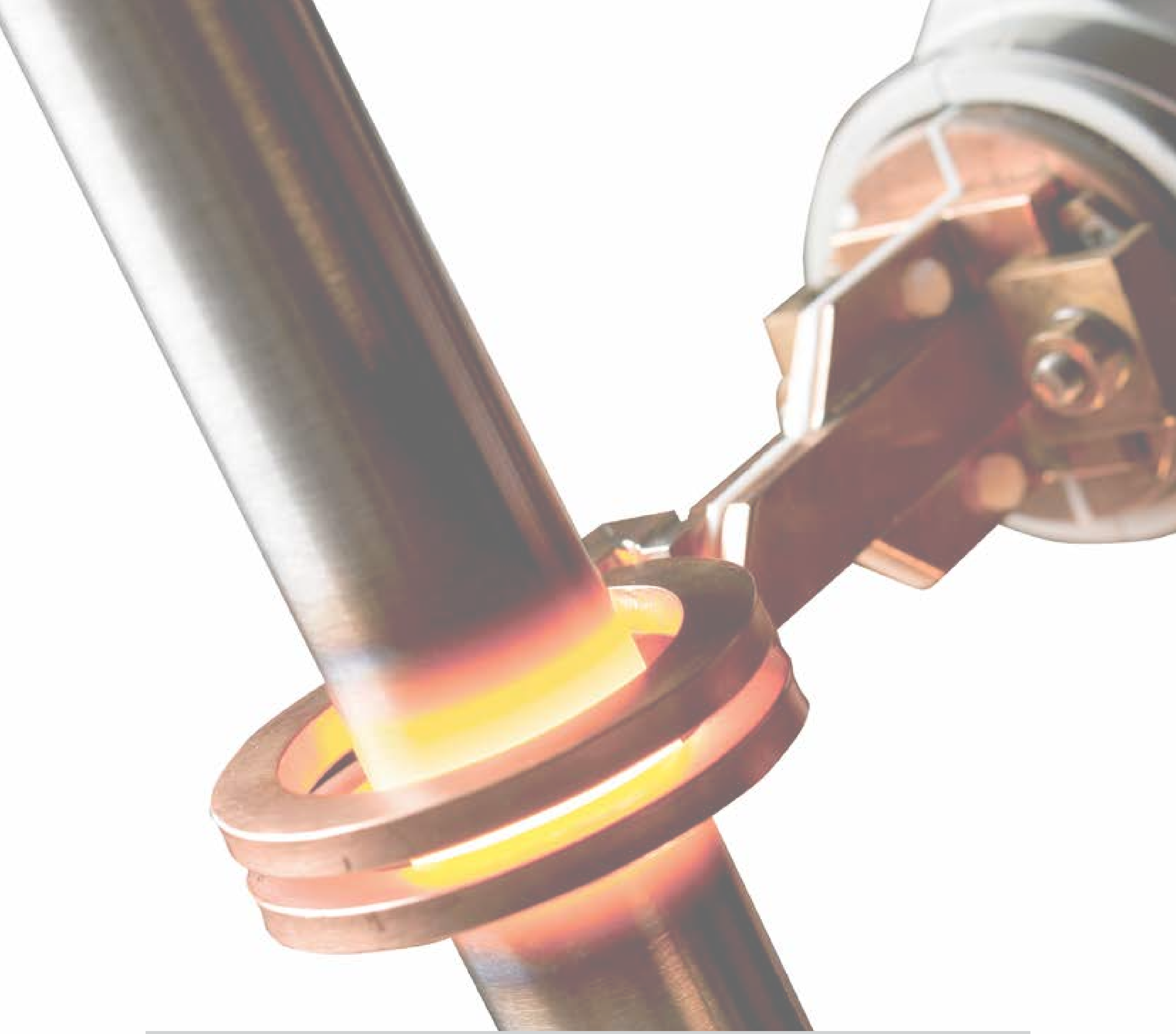
Induction heating applications

The processes, the equipment, the benefits

EFD® INDUCTION



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Introduction

Induction heating is fast, precise, clean, energy efficient, controllable and repeatable. Even more important, at EFD Induction we've figured out how to use this amazing technology for practically any industrial heating application. EFD Induction—putting the smarter heat to smarter use.

EFD Induction was founded in 1996 by the merger of Germany's Fritz Düsseldorf Induktionserwärmung and Norway's ELVA Induksjon. Since then we've grown to become Europe's number one—and the world's number two—induction heating company. To date, almost 20,000 EFD Induction systems have been installed, supported by our worldwide network of factories, labs, offices and agents.

From the start we wanted to extend the benefits of induction to the widest possible range of industrial applications. This led to us pioneering the use of induction for straightening ship decks and bulkheads. As well as using solid state technology to make induction heating equipment smaller, safer, more versatile and more reliable.

Our solutions are today used to make everything from faucets to spaceships; from solar cells to bulldozers. And because many of our solutions are compact enough to be mobile, you'll also find EFD Induction equipment at offshore platforms, wind farms and power stations.

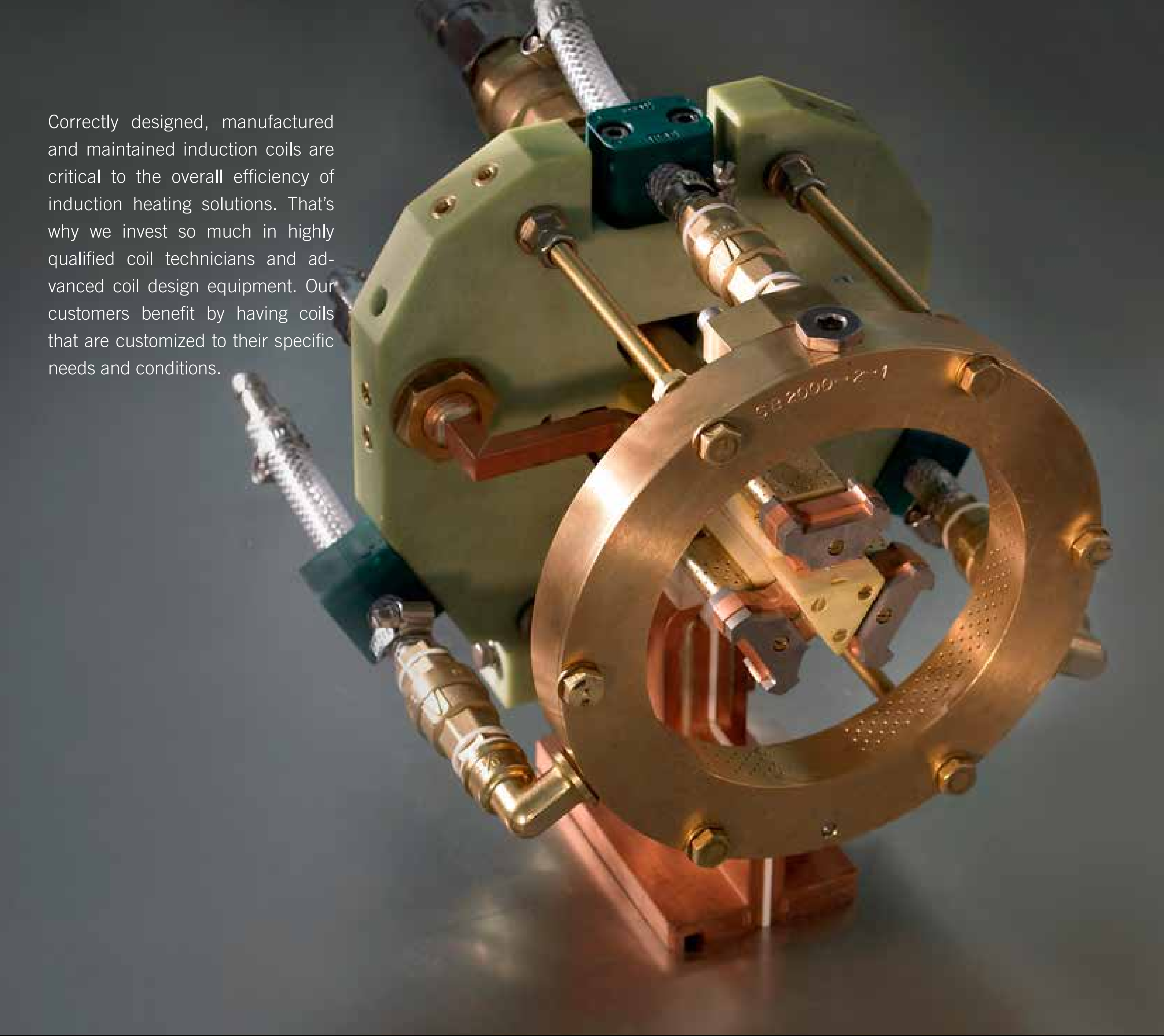
The following pages give a brief overview of the main application areas for our equipment. But of course, a document like this cannot cover everything. If you'd like to know more—about us, or the technical and commercial benefits of induction heating—just get in touch. You'll find our website address on the back cover.

Induction coils

The induction coil, also known as an 'inductor', is essential to the induction heating process. Many factors contribute to a coil's effectiveness: the care taken to make it, the quality of the materials used, its shape, its maintenance, its correct matching with the power source, etc. That's why it's so important to insist on professionally made and maintained coils—preferably from the same people who made your induction system.

EFD Induction has perhaps the world's most advanced coil making and coil care programs. We not only design and make customized coils for all materials and applications, we also have preventive maintenance and coil logistics solutions. These initiatives ensure you always use the right coils, and that their working life is maximized.

The details of every single EFD Induction coil are entered into a constantly updated database. As a result we can quickly and smoothly replace or repair any coil, anywhere—without compromising quality or productivity.



Correctly designed, manufactured and maintained induction coils are critical to the overall efficiency of induction heating solutions. That's why we invest so much in highly qualified coil technicians and advanced coil design equipment. Our customers benefit by having coils that are customized to their specific needs and conditions.

EFD INDUCTION COILS

Our in-house coil expertise and facilities let us make bespoke coils for virtually any specialist application. And as the photo on the left shows, we are also experienced in building exceptionally dimensioned coils.

Induction hardening

What is induction hardening?
Induction hardening uses induced heat and rapid cooling (quenching) to increase the hardness and durability of steel. Induction is a no-contact process that quickly produces intense, localized and controllable heat. With induction, only the part to be hardened is heated. Optimizing process parameters such as heating cycles, frequencies and coil and quench design results in the best possible outcomes.

What are the benefits?
Induction hardening boosts throughput. It is an extremely fast and repeatable process that integrates eas-ily into production lines. With induction it is usual to treat individual workpieces. This ensures each separate workpiece is hardened to its own precise specifications. The optimized process parameters for each workpiece can be stored on your servers. Induction hardening is clean, safe and typically has a small footprint. And because only the part of the component to be hardened is heated, it is extremely energy-efficient.

Where is it used?
Induction is used to harden numerous components. Here are just a few of them: gears, crankshafts, camshafts, drive shafts, output shafts, torsion bars, rocker arms, CV joints, tulips, valves, rock drills, slewing rings, inner and outer races.

EFD Induction hardening solutions are used by many of the world's leading carmakers and their suppliers. High throughput, short leadtimes, assured quality and worker/environmental safety are key reasons why they choose our solutions.

What equipment is available?
HardLine is the EFD Induction family of hardening systems that offers vertical, horizontal, rotary table and centerless equipment. At the heart of our hardening solutions are Sinac generators, available with output power ratings and frequencies ranging from 5–2000 kW and 0.3–350 kHz. EFD Induction can also deliver turn-key hardening plants that include handling equipment, washing/straightening processes, process devel- opment and service and support programs.

Induction hardening is faster than all other alternatives. At the same time it is highly controllable and repeatable—making it perfect for integrating into automated production lines.

Induction tempering

What is induction tempering?
Induction tempering is a heating process that optimizes mechanical properties such as toughness and ductility in workpieces that have already been hardened.

What are the benefits?
The main advantage of induction over furnace tempering is speed. Induction can temper workpieces in minutes, sometimes even seconds. Furnaces typically take hours. And as induction tempering is perfect for inline integration, it minimizes the number of components in process. Induction tempering facilitates quality control of individual workpieces. Integrated induction temper stations also save valuable floor space.

Where is it used?
Induction tempering is widely employed in the automotive industry to temper surface-hardened components such as shafts, bars and joints. The process is also used in the tube and pipe industry to temper through-hardened workpieces. Induction tempering is sometimes performed in the hardening station, sometimes in one or several separate temper stations.

What equipment is available?
Complete HardLine systems are ideal for many tempering applications. The chief benefit of such systems is that hardening and tempering are performed by one machine. This delivers significant time and cost savings in a small footprint compared to alternative technologies. With furnaces, for example, one furnace often first hardens the workpieces, with a separate furnace then being used for tempering. Stand-alone EFD Induction Sinac and Minac systems are also used for tempering applications.

A shaft moving at high speed through an induction coil. Induction tempering is unrivalled for its speed and precision.

A complete EFD Induction tempering typically includes power sources, coils, handling mechanisms and control software. Training, maintenance and service options are also available.

Induction brazing

What is induction brazing?

Brazing is a materials-joining process that uses a filler metal (and usually an anti-oxidizing solvent called flux) to join two pieces of close-fitting metal together without melting the base materials. Instead, induced heat melts the filler, which is then drawn into the base materials by capillary action.

What are the benefits?

Induction brazing can join a wide range of metals, even ferrous to non-ferrous. Induction brazing is precise and quick. Only narrowly defined areas are heated, leaving adjacent areas and materials unaffected. Correctly brazed joints are strong, leak-proof and corrosion resistant. They are also very neat, usually requiring no further milling, grinding or finishing. Induction brazing is ideal for integrating into production lines.

Where is it used?

EFD Induction brazing systems can be used for virtually any brazing task. To date, our systems are typically used in the electrotechnical industry to braze generator and transfomer components like bars, strands, rings, wires and SC-rings. They also braze fuel pipes and AC and brake parts for the automotive industry. The aeronautics sector uses induction to braze fan blades, blades for casings, and fuel and hydraulic systems. In the houseware industry our systems braze compressor components, heating elements and faucets.

What equipment is available?

Our brazing solutions usually include an EFD Induction mobile Minac or stationary Sinac system. Both product families offer a wide range of output powers and frequencies, together with automatic matching and robot compatibility.

Brazing with an EFD Induction system. Note how the heating zone is fully visible, something that is practically impossible with flame brazing.

An EFD Induction Minac brazes generator windings. Minac's mobility and the handheld transformer let operators access hard-to-reach areas.

Induction bonding

What is induction bonding?
Induction bonding uses induction heating to cure bonding adhesives. Induction is the main method for curing adhesives and sealants for car components such as doors, hoods, fenders, rearview mirrors and magnets. Induction also cures the adhesives in composite-to-metal and carbon fiber-to-carbon fiber joints. There are two main types of automotive bonding: spot-bonding, which heats small segments of the materials to be joined; full-ring bonding, which heats complete joints.

What are the benefits?
EFD Induction spot bonding systems ensure precise energy inputs for each panel. Small heat affected zones minimize total panel elongation. Clamping is not needed when bonding steel panels, which reduces stresses and distortion. Each panel is electronically monitored to ensure that energy input deviations are within tolerances. With full-ring bonding, a one-size-fits-all coil reduces the need for spare coils.

Where is it used?
Induction is the preferred bonding method in the automotive industry. Widely used to bond steel and aluminum sheet metal, induction is increasingly employed to bond new lightweight composite and carbon fiber materials. Induction is used to bond curved strands, brake shoes and magnets in the electrotechnical industry. It is also used for guides, rails, shelves and panels in the white goods sector.

What equipment is available?
EFD Induction is the world's largest induction curing specialist. In fact, we invented induction spot curing. We also invented the U-Coil® process, the most advanced hem bonding system on the market. A self-aligning and 100 per cent repeatable system, U-Coil® ensures uniform heating with the lowest possible distortion risk. The equipment we deliver ranges from individual system elements such as power sources and coils, to complete and fully supported turn-key solutions.

Two of our induction bonding systems. The left photo shows a solution for full-ring bonding. The right photo shows spot-bonding, a method invented by EFD Induction.

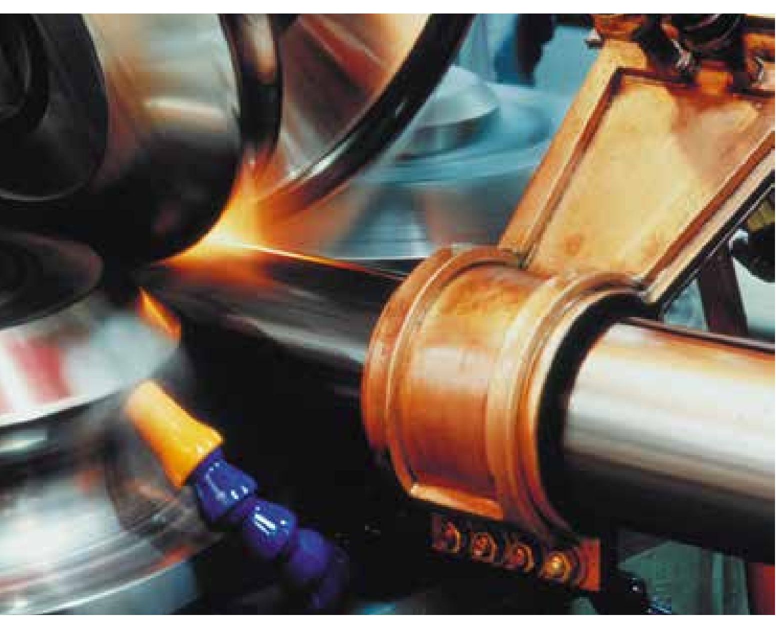
Induction welding

What is induction welding?
With induction welding the heat is electromagnetically induced in the workpiece. The speed and accuracy of induction welding make it ideal for edge welding of tubes and pipes. In this process, pipes pass an induction coil at high speed. As they do so, their edges are heated then squeezed together to form a longitudinal weld seam. Induction welding is particularly suitable for high-volume production. Induction welders can also be fitted with contact heads, turning them into dual purpose welding systems.

What are the benefits?
Automated induction longitudinal welding is a reliable, high-throughput process. The low power consumption and high efficiency of EFD Induction welding systems reduce costs. Their controllability and repeatability minimize scrap. Our systems are also flexible—automatic load matching ensures full output power across a wide range of tube sizes. And their small footprints make them easy to integrate or retrofit into production lines.

Where is it used?
Induction welding is used in the tube and pipe industry for the longitudinal welding of stainless steel (magnetic and non-magnetic), aluminum, low-carbon and high-strength low-alloy (HSLA) steels and many other conductive materials.

What equipment is available?
Weldac is EFD Induction's range of solid-state welders. A high-efficiency system (>85%), Weldac is virtually short-circuit proof thanks to rugged IGBT transistors. Weldac's low ripple results in clean weld beads—making the system particularly suitable for aluminum and stainless steel welding.



Weldac can be fitted with various induction coils or with quick-lifting contact heads.

The high-speed throughput and reliability of induction welding makes it perfect for the tube and pipe industry.

Induction annealing/normalizing

What is induction annealing?
This process heats metals that have already undergone significant processing. Induction annealing reduces hardness, improves ductility and relieves internal stresses. Full-body annealing is a process where the complete workpiece is annealed. With seam annealing (more accurately known as seam normalizing), only the heat-affected zone produced by the welding process is treated.

What are the benefits?
Induction annealing and normalizing delivers fast, reliable and localized heat, precise temperature control, and easy in-line integration. Induction treats individual workpieces to exact specifications, with control systems continuously monitoring and recording the entire process.

Where is it used?
Induction annealing and normalizing is widely used in the tube and pipe industry. It also anneals wire, steel strips, knife blades and copper tubing. In fact, induction is ideal for virtually any annealing task.

What equipment is available?
Each EFD Induction annealing system is built to satisfy specific requirements. At the heart of each system is an EFD Induction Sinac generator that features automatic load matching and a constant power factor at all power levels. Most of our delivered systems also feature custom-built handling and control solutions.

The control system helps meet the challenges posed when normalizing weld seams on the new generation of API-standard pipe.

Orbital movement of the coils on this EFD Induction normalizing system means accurate tracking of the weld seam. Normalizing is essential for pipes used in the oil and gas industries.

Induction pre-heating

What is induction pre-heating?

Induction pre-heating is a process where materials or workpieces are heated by induction prior to further processing. The reasons for pre-heating vary. In the cable and wire industry, cable cores are pre-heated before insulation extrusion. Steels strips are pre-heated prior to pickling and zinc coating. Induction pre-heating also softens metals before bending, and prepares tubes and pipes for welding. Mobile pre-heating solutions facilitate onsite repairs of bearing assemblies.

What are the benefits?

EFD Induction pre-heating systems are extremely efficient, resulting in major energy savings. When pre-heating steel strips and cable and wire, diode rectifiers ensure a constant power factor of 0.95, thus eliminating reactive power costs. Cycle times are short, too. And continuous automatic matching means a single coil can handle wide production ranges. Induction pre-heating systems are compact and easy to integrate into existing or planned production lines.

Where is it used?

Induction pre-heating is employed in the automotive, mechanical, aeronautical, electrotechnical, white goods and shipbuilding industries. A major area of use is pre-heating for welding. Our mobile Minac systems are used in the offshore sector for onsite weld pre-heating. Minac units are also frequently flown to oil platforms and air-ports to perform repairs and maintenance.

What equipment is available?

EFD Induction designs and builds specialized systems for steel strip and wire and cable pre-heating. These systems typically feature our Sinac equipment, and offer horizontal or vertical coil layout designs. Customized layouts are also available. Mobile and compact EFD Induction Minac units are used for onsite pre-heating.

A medium-frequency EFD Induction Sinac pre-heats seamless offshore pipe prior to coating.

No dust, no fumes, no noise. An EFD Induction heater gets to grips with 170mm anode stubs.

Induction post-heating

What is induction post-heating?
Induction post-heating refers to any process where induction is used to heat workpieces or materials that have already undergone significant processing. Metal components and welds, for example, must often be post-heated to relieve internal stresses caused by a previous process. Induction post-heating is also used to heat cable cores following extrusion.

What are the benefits?
The speed, versatility, precision and controllability of induction make it ideal for numerous post-heating tasks. Our cable and wire post-heating systems, for instance, induce localized heat directly in the cable core. This results in extremely fast cross-linking of the insulation's polymers. At the same time, induction minimizes the risk of cable deformation. While our mobile Minac systems bring the benefits of induction to flame-free sites such as offshore oil and gas platforms.

Where is it used?
Our post-heating solutions are mainly used in the cable and wire, tube and pipe, electrotechnical and aviation industries. In the automotive industry they post-heat rings, shafts, joints and gears; and cure corrosion-resistant brake disc covers. Induction is also used for tin re-flow applications.

What equipment is available?
Stationary EFD Induction Sinac systems—together with numerous options and control and handle features—are widely used for cable and wire and other high volume applications. Mobile Minac systems bring induction solutions to offshore platforms, wind farms, power stations, etc.

Onsite post-heating for the oil and gas industry is a growing application area for EFD Induction. These photos show a mobile Minac (left) and a stationary Sinac being used to treat pipelines.

Induction forging

What is induction forging?
Induction forging uses induction to heat metal parts before they are shaped, or 'deformed' by presses or hammers.

What are the benefits?
Induction forging has several key advantages over furnace forging. The speed and controllability of induction ensures high throughput. Induction also minimizes oxidation and helps maintain metallurgical integrity. And since induction delivers precise, localized heat, it saves energy. The consistency and repeatability of induction make it ideal for integrating into automated production lines.

Where is it used?
Induction forging is widely used in the metal and foundry industries to heat billets, bars and bar ends. Metals commonly forged with EFD Induction systems include aluminum, brass, copper, steel and stainless steel.

What equipment is available?
Three families of EFD Induction equipment can be used for forging applications: HeatLine, Sinac and Minac. However, HeatLine includes various models that are specially designed for high-output forging of billets, bars, handlebars, bar ends, bolts and pre-formed components.

Above, an EFD Induction vertical partial heater. These systems can be fitted with any number of induction coils, and are available in IGBT and thyristor versions.

A heated steel billet in an EFD Induction forging station.

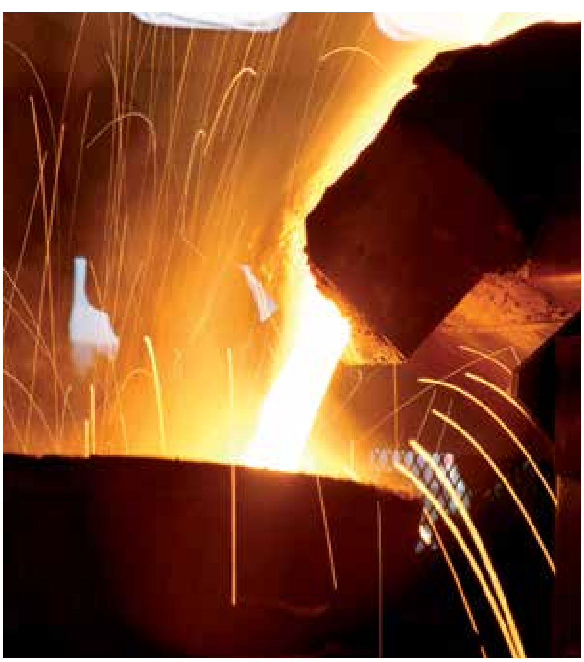
Induction melting

What is induction melting?
Induction melting is a process where metal is melted into liquid form in an induction furnace's crucible. The molten metal is then poured from the crucible, usually into a cast.

What are the benefits?
Induction melting is extremely fast, clean and uniform. When correctly performed, induction melting is so clean that it is possible to skip the purification stage necessary with other methods. The uniform heat induced in the metal also contributes to a high-quality end result. EFD Induction melting systems have advanced ergonomic features. They not only make workplaces safer, they increase productivity by making the melting process faster and more comfortable.

Where is it used?
EFD Induction melting systems are used in foundries, universities, laboratories and research centers. The systems melt everything from ferrous and non-ferrous metals to nuclear material and medical/dental alloys.

What equipment is available?
EFD Induction offers five different furnace ranges to suit a wide variety of melting needs: single-axis tilt-pour, dual-axis tilt-pour, moving coil, rollover and laboratory.



An EFD Induction single-axis tilt-pour furnace. Such systems can melt ferrous and non-ferrous metals (copper and aluminum alloys). Several models are available to suit all capacity needs. They are available with easy-to-change pre-fabricated crucibles or rammed linings.

Molten brass in a moving-coil melting furnace. The pre-fabricated (clay graphite) crucible remains static during the full melting cycle. Instead, the coil moves around the crucible without touching it. Dedicated crucibles—which also act as pouring ladles—eliminate inter-alloy contamination.

Induction straightening

What is induction straightening?

Induction straightening uses a coil to generate localized heat in pre-defined heating zones. As these zones cool they contract, 'pulling' the metal into a flatter condition.

What are the benefits?

Induction straightening is extremely fast. When straightening ship decks and bulkheads, our customers often report minimum 50% time savings compared to traditional methods. Without induction, straightening on a large vessel can easily consume tens of thousands of man-hours. The precision of induction also boosts productivity. For example, when straightening truck chassis there is no need to remove heat-sensitive components. Induction is so precise it leaves adjacent materials unaffected.

Where can it be used?

Induction heating is widely used to straighten ship decks and bulkheads. In the construction industry it straightens beams. Induction straightening is increasingly used in the manufacture and repair of locomotives, rolling stock and Heavy Goods Vehicles.

What equipment is available?

EFD Induction Terac systems are specially designed for ship straightening. Each Terac includes a frequency converter, cooling system, operator panel and deck-heating unit. A handheld unit replaces the deck unit when straightening bulkheads. Mobile Minac heaters are used for non-ship straightening tasks.

Terac works just as well on bulkheads and other vertical structures as it does on decks. For added ergonomic comfort, the handheld transformer pictured above can be attached to a balancer and suspended from a magnet or wire rope.

An EFD Induction Terac system ensures fail-safe operation—it makes it impossible to overheat magnetic steel. Moreover, Terac does not produce toxic gases from the heating source. And there is no acoustic noise.

Specialist applications

This document gives you an overview of the main application areas for EFD Induction systems and solutions. However, our equipment is used for a vast array of other applications in industries as diverse as power generation, food packaging and apparel manufacturing. Below is a very partial list of some of these applications.

Shrink fitting

Our systems are used in the automotive industry to shrink fit gears and rings. They are also employed to repair planes, trains and trucks. Our mobile systems are used for shrink-fitting tasks on offshore platforms. And are increasingly used to remove the giant nuts and bolts in power stations' turbines.

Glass wool fiberizing

Induction is used to generate the heat needed in the fiberization stage of glass wool manufacturing. This application involves applying heat to molten glass as it is extruded in the form of fibers through the orifices of a centrifugal spinner.

In-line chain heat treatment

EFD Induction builds custom-designed chain hardening and tempering systems. These systems minimize handling, while ensuring the chain is treated according to its specific parameters. Induction heating is ideal for producing high-quality, fine-grained chains.

Giant slewing ring hardening

An EFD Induction patented solution is used to harden the giant slewing rings used in wind turbines. In the past, induction hardening of such rings left a 'soft zone' that rendered the ring unfit for many tasks in wind energy generation. EFD Induction solved the problem with a multi-coil system that hardens such rings without leaving any unwanted soft zones.

An example of shrink fitting—EFD Induction equipment removes large nuts and bolts in a fraction of the time needed by traditional gas or resistance heating.

A large ring being hardened by an EFD Induction vertical scanning hardening machine.

It doesn't get hot. It doesn't touch the component. So how can a coil heat metal cherry red in a few seconds?

How induction works

Induction is a flame-free, no-contact heating method that can turn a precisely defined section of a metal bar cherry red in seconds. How is this possible?

Alternating current flowing through a coil generates a magnetic field. The strength of the field varies in relation to the strength of the current passing through the coil. The field is concentrated in the area enclosed by the coil; while its magnitude depends on the strength of the current and the number of turns in the coil. (Fig. 1)

Eddy currents are induced in any electrically conductive object—a metal bar, for example—placed inside the coil. The phenomenon of resistance generates heat in the area where the eddy currents are flowing. Increasing the strength of the magnetic field increases the heating effect. However, the total heating effect is also influenced by the magnetic properties of the object and the distance between it and the coil. (Fig. 2)

The eddy currents create their own magnetic field that opposes the original field produced by the coil. This opposition prevents the original field from immediately penetrating to the center of the object enclosed by the coil. The eddy currents are most active close to the surface of the object being heated, but weaken considerably in strength towards the center. (Fig. 3)

The distance from the surface of the heated object to the depth where current density drops to 37% is the penetration depth. This depth increases in correlation to decreases in frequency. It is therefore essential to select the correct frequency in order to achieve the desired penetration depth.

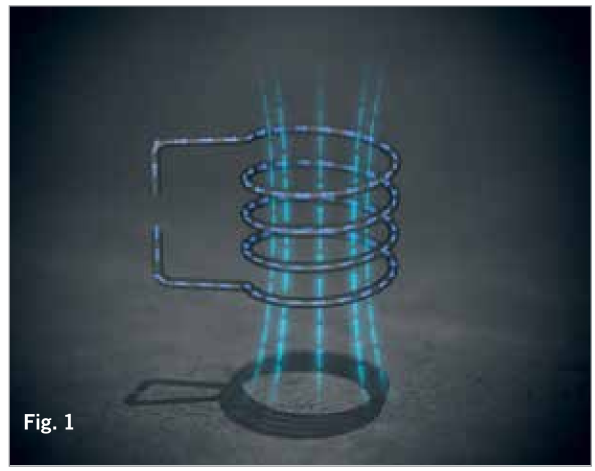


Fig. 1

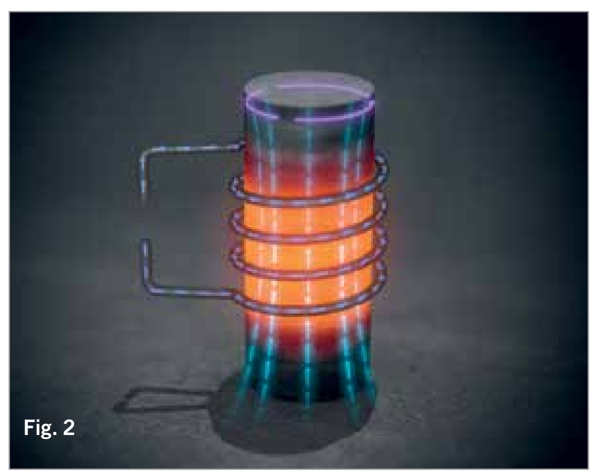


Fig. 2

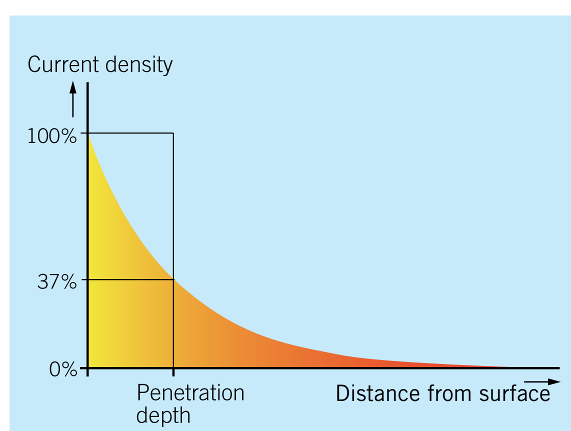


Fig. 3

The smarter heat—induction exploits basic electromagnetic laws to generate controllable heat directly in the workpiece. At no time does the coil touch the workpiece.

Selecting the best solution

Just how efficient is induction heating? What frequencies are best suited to your applications? The guide below will give you some idea of induction's potential. To learn more, just contact your nearest EFD Induction office or representative.

How much energy do you need?

Before calculating your energy requirements you first need to know:

- **The type of material (steel, copper, brass, etc.)**
- **Workpiece dimensions**
- **Desired hourly production**
- **Desired final temperature**

Calculate your energy requirements

Step 1 First determine the material's energy absorption rate. Fig. 1 shows rates for some common materials.

Step 2 Multiply the energy absorption rate by your desired hourly production (kg/hour). The result is your specific power requirement.

Step 3 You can now ascertain the overall efficiency level of the induction equipment. Some typical induction heater efficiency levels for common materials are listed in Fig. 2. Divide the calculated specific power need by the equipment efficiency rate. This gives you the total power requirement.

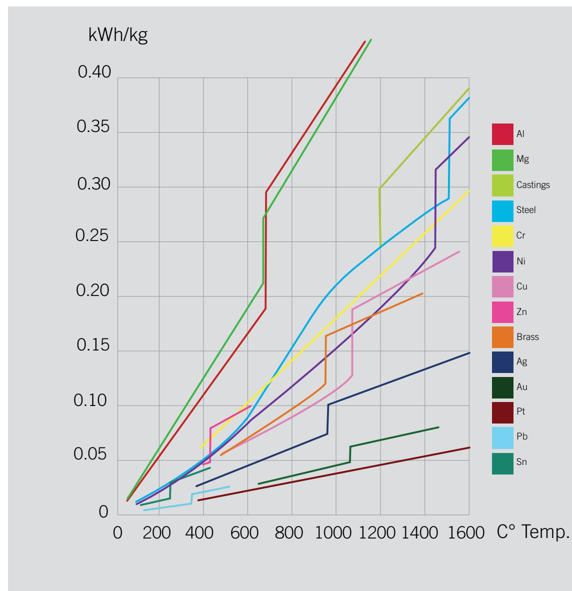


Fig. 1. Energy absorption rates for different materials

Material	Final temp.°C	Efficiency
Carbon steel	1250	0.65
Carbon steel	700	0.80
Stainless steel	1250	0.60
Brass	800	0.50
Copper	900	0.40
Aluminum	500	0.40

Fig. 2. Typical induction heater efficiency levels. The above values assume the use of enveloping multi-turn coils. Different coil designs may affect efficiency levels. For instance, the efficiency rate for copper is, because of the coil type normally used, usually 0.1-0.2.

Selecting the right frequency

The choice of frequency is crucial when using induction heating, as frequency determines the heat's penetration depth. Fig. 3 shows approximate frequencies for through-heating some common materials.

Material					**Frequency**
Steel non-magnetic	Steel magnetic	Brass	Copper	Aluminum and aluminum alloys	
Final temp. 1,200°C Ø mm	700°C Ø mm	800°C Ø mm	850°C Ø mm	500°C Ø mm	Hz
150–500	27–75	110–	50–	50–	50
60–250	8–35	35–440	22–800	22–800	500
40–175	6–25	30–300	15–600	15–600	1,000
25–100	3.5–14	15–180	9–350	9–350	3,000
20–85	2.5–10.5	10–130	7–260	7–260	5,000
14–60	2–8.5	8–100	5–180	5–180	10,000
10–40	1.5–5.5	6–75	3–125	3–125	20,000
5–22	0.7–3.0	3.5–40	2–75	2–75	60,000
4–17	0.5–2.0	2.5–30	1.5–60	1.5–60	100,000
1.8–8	0.2–1.0	1.2–15	0.6–20	0.6–20	500,000

Fig. 3. Some economically beneficial ranges of dimensions for common materials at different frequencies. The frequencies shown are approximate guides only. The shortest heating time for specific materials and dimensions is achieved by operating close to the lowest possible frequency limit.

International certifications

EFD Induction is the international induction heating specialist, with production plants in Norway, Germany, France, China, India, the USA and Romania. And sales and services offices in Sweden, Denmark, Finland, Italy, Austria, Spain, Japan, the UK, Russia, Poland, Brazil, Thailand and Malaysia.

Key to EFD Induction's growth has been an ability to meet the tough quality demands set by our customers—many of whom operate in the world's most competitive and quality-conscious industries. We boast numerous certifications, but examples from three areas (China, India and Germany) give some idea of the range of quality approvals achieved by EFD Induction.

Germany

EFD Induction's production center in Freiburg, Germany is icertified to DIN EN ISO 9001 standard.

China

In China, our Shanghai facility is certified by Det Norske Veritas to conform to ISO 9001:2000. The hardening systems manufactured at our Shanghai plant are certified to EN ISO 12100-1:2003, EN ISO 12100-2:2003 and EN 60204-1:2006 standards, thus qualifying for the CE marking.

India

Our production facility in Bangalore satisfies the technical specification ISO/TS 16949:2000. The facility also has an occupational health and safety management system that is certified to OHSAS 18001:1999 standard. And in addition to its ISO 9001:2000 certification, the facility has an environmental management system that fulfills the requirements of the EN ISO 14001:2004 standard.

Some of our customers

EFD Induction equipment has been used to build and maintain everything from tin cans to the engines on the European Space Agency's Ariane 5 launch vehicle. Below is a partial list of EFD Induction customers. Case stories and customer testimonials from around the world are available from your nearest EFD Induction representative.

ABB
Alcatel
Alstom
Andritz Hydro
Ansaldo
Ashok Leyland
Aston Martin
Audi
Autocam
Avesta Sandvik Tube
Baosteel
Bartell Machinery
Benteler
BHEL
BMW
Bodycote
Boehler
Bombardier
Borg Warner
Bosch
BPW
Brakes India
Burseryds Bruk
Busatis
Caterpillar
Changzhou XD Transformer
Chrysler
Citroen
DAF
Daimler
Danfoss
Delphi
Deutsche Bahn
DEUTZ
Dongfang Electrical Machinery
Dongying Dongyi
Doosan
Dreister
Dörrenberg Edelstahl
Edelstahlwerke Südwestfalen
EMD Curtiss Wright Electro-Mecha. Corp.
FAG
Fardis
Federal-Mogul
Ferrovaz
Fiat
Fincantieri
Ford
Fraunhofer-Institut
Gamesa
Gearbox del Prat
Geislinger
Gelenkwellenwerk Stadtilm
General Electric
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Haldex Garphyttan
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Heidelberger Druckmaschinen
Hilti
Hitachi
Hoerbiger Antriebstechnik
HQM Haertetechnik
Hydro Aluminium
Hyundai
Hörmann Industrietechnik
I.S.R.
Indar
ISI Airbag
Jaguar Land Rover
John Deere
Johnson Control
Joseph Vögele
Jos L. Meyer
KBP Kettenwerk
KmB Technologie
KME
Komatsu
Kongsberg Automotive
Koni
KS Kolbenschmidt
Lankhorst Indutech
Linamar Antriebstechnik
Linde
LUK
Läpple
Magna
Mahle Migma
Maillefer
MAN
Mannesmann
Marcegaglia
Mercedes Benz
Metalor
Miba
Mitec
Mitsubishi
MTU
Nexans
NTN
OAO 'Electrosila'
Opel
Otto Meyer
Peugeot
Pratt & Whitney
PSA
Renault
Retezarna
Rieckermann
Rockinger
Roctool
Roth Technik
Rothe Erde
Rover Group
S.N.R.
Saint Gobain
Sandvik
Sauer Sundstrand
Savoilor
SCANIA
Schaeffler
Schneeberger
Shanghai Baosteel
Shanghai Turbine Generator
Showa
Siemens
SKF
Skoda
SNR
Sona Koyo Steering
Splintex
Sprimag
Stabilus
Stihl
STX Europe
Sumitomo
Suzlon
Suzuki
Swarovski
SAAB
Thermotite Bredero Shaw
Thyssen Krupp
Tianjin Pipe International
Timken
Toshiba
Toto
TRW
Vallourec
VEG
Vestas
Visteon
Voestalpine
Voith
Volkswagen
Volvo
Vyksa Steel Works
Wanxiang Qianchao
Weigl Antriebstechnik
Whirlpool
ZF
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