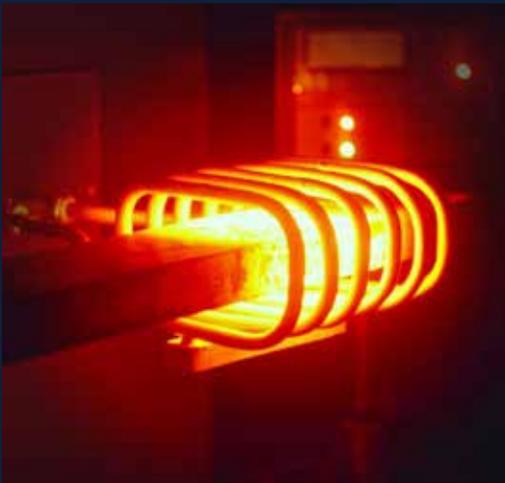
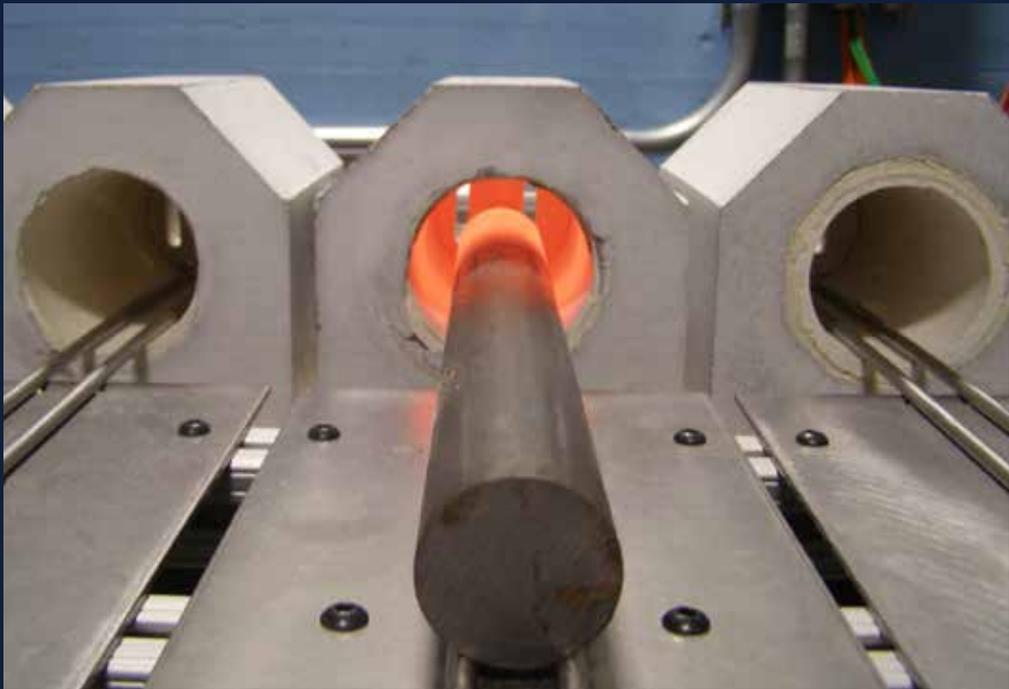


Induction Heating for Forging



Ambrell[®]
INDUCTION HEATING SOLUTIONS
an inTEST Company

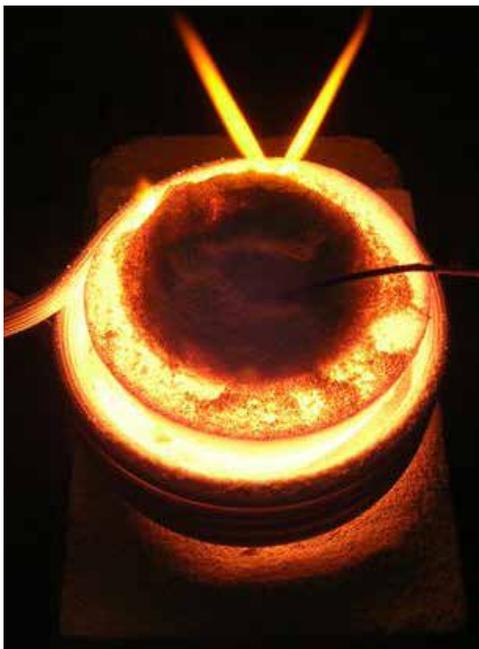


Experience the Excellence.™

Why Ambrell

Ambrell has over 10,000 systems installed in over 50 countries, being used every day worldwide in forging as well as many other industries and applications.

We offer exceptional customer service before and after the sale. Your specific forging application will be analyzed and tested in the nearest Ambrell Applications Lab. There is no charge, and you will receive a system recommendation designed to deliver the best possible solution for your forging requirements. Ambrell delivers the expertise, innovation and system quality to give your company a competitive edge.



Forging a Better Solution with Induction Heating

What is forging?

Forging is a process where metal is formed into shape using pressure applied by an impact hammer or press. It is one of the oldest known metalworking processes. Metals can be forged cold, warm or hot. Cold forging is used for forming softer materials and smaller steel parts, but this process hardens the material making it brittle and difficult to process after forging.

Hot forging is when a part is heated above the material recrystallization temperature before forging, typically 1100 °C (2012 °F). Hot forging allows a part to be formed with less pressure, creating finished parts with reduced residual stress that are easier to machine or heat treat. Warm forging is forging a part below the recrystallization temperature, typically below 700 °C (1292 °F).

Some processes require a whole part to be forged, called billet heating, such as manufacturing automobile crankshafts. In other applications, only one end of a part needs to be forged, called bar end heating, such as manufacturing automobile steering components or hot heading fasteners.

Why Induction Heating?

A superior alternative to furnace heating, induction heating provides faster, more efficient heat in forging applications. The process relies on electrical currents to produce heat within the part that remains confined to precisely targeted areas. High power density means extremely rapid heating, with exacting control over the heated area. Recent advances in solid-state technology have made induction heating a remarkably simple and cost-effective heating method.

Benefits of using Induction for forging are:

- Rapid heating for improved productivity and higher volumes
- Precise, even heating of all or only a portion of the part
- A clean, non-contact method of heating
- Safe and reliable – instant on, instant off heating
- Cost-effective, reduces energy consumption compared to other heating methods
- Easy to integrate into production cells
- Reduced scaling

Induction Heating for Forging

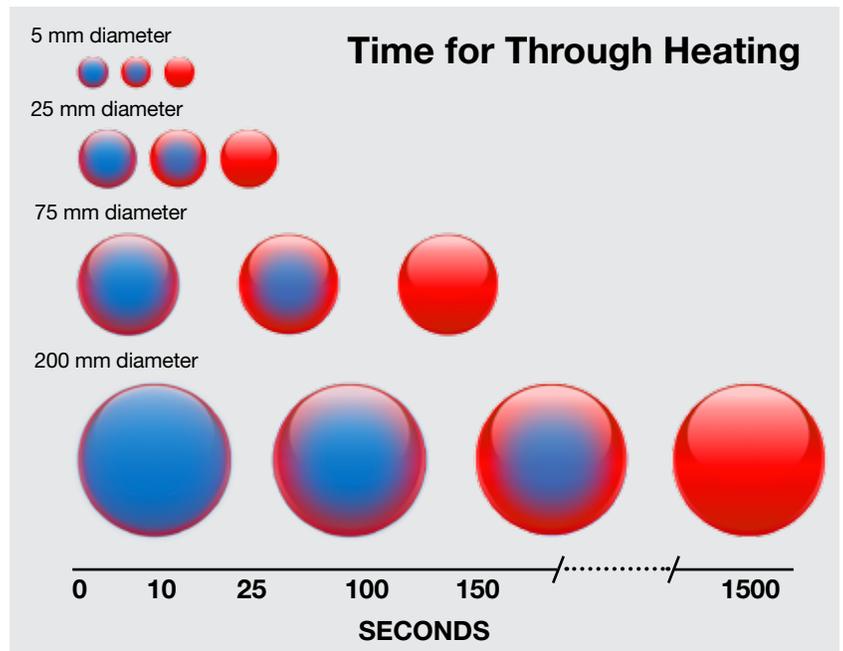
Induction heating is commonly used for heating bar ends and metal billets prior to forging. There are several critical considerations when using induction heating for forging.

Size of the Heated Part

In addition to the amount of energy required to heat the part to the forging temperature, the size of the part will also dictate the required operating frequency of the induction system to optimize operating efficiency.

Time for Through Heating

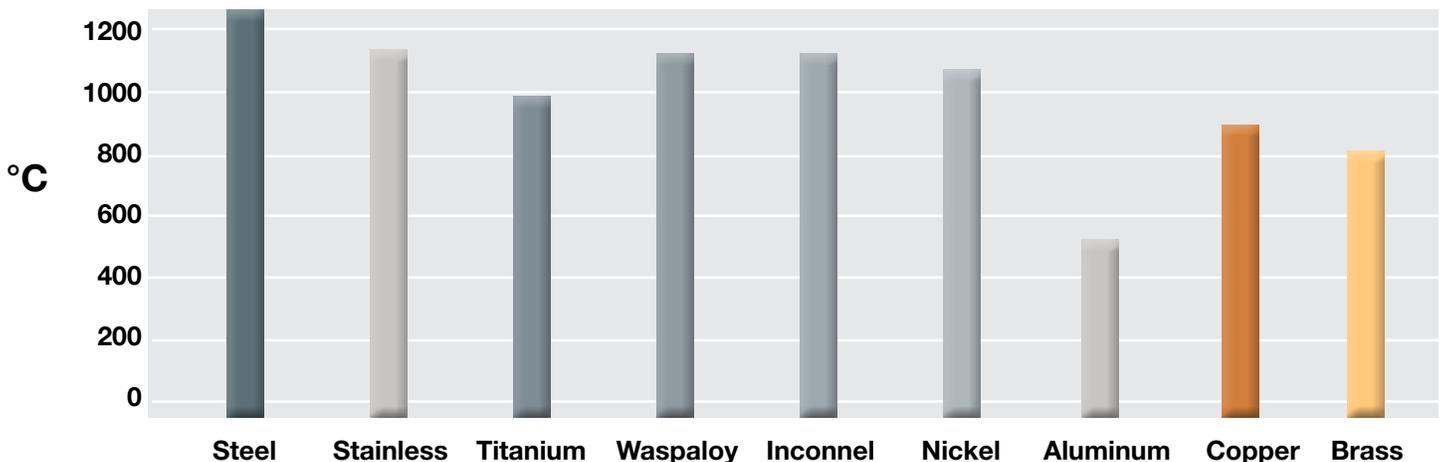
The induction process produces heat within the part, but the heat is generated near the outside surface and will take time to conduct to the center of the part. Typically, bar ends up to 20 mm in diameter through-heat in less than 10 seconds, whereas a 75 mm diameter bar will take 150 seconds to heat to the center.



Radiation Loss

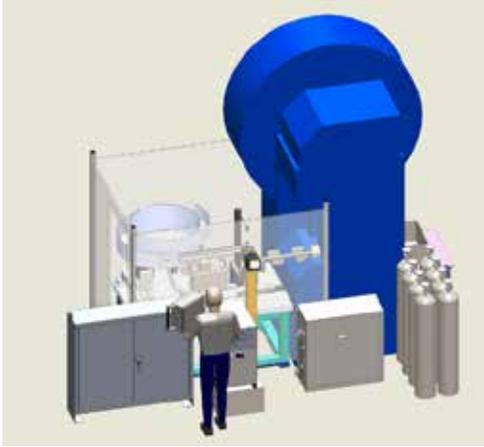
Energy loss due to radiation from the hot part becomes significant with forging temperatures in the 1000 °C (1832 °F) to 1200 °C (2192 °F) range and can be controlled by using thermal insulation during the manufacturing of the induction coil.

Required Temperature for Hot Forging Different Materials



Bar End Heating

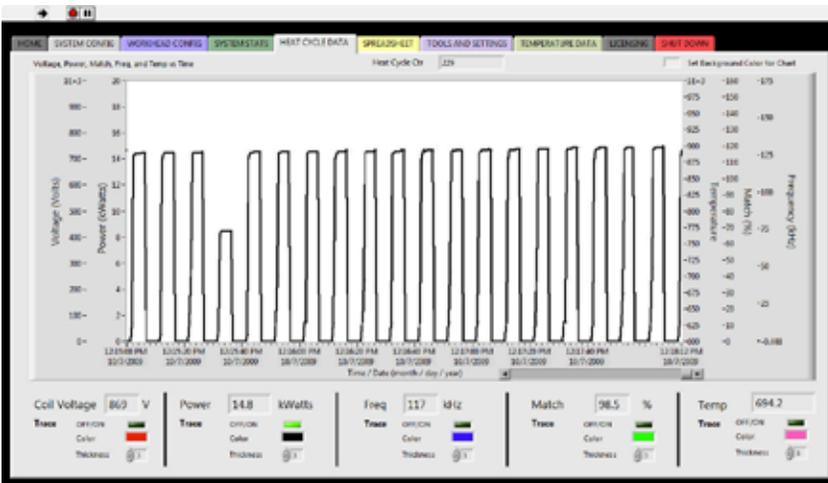
Ambrell manufactures an extensive line of induction heating products for bar end heating. Our systems provide operating frequencies up to 400 kHz for hot heading of small diameter fasteners and down to 2 kHz for larger cross-section beams or bars. We also offer heating process expertise for high-volume manufacturing of consistent, high quality parts.



A work cell with an automated feed to a hot header for large bolts. Ambrell works with expert integrators to provide a turnkey solution to customers.



Heating a 75 mm diameter bar to 1100 °C (2012 °F) for hot heading. An eight-position coil was used to provide one hot bar end every 20 seconds to the robot for loading into the press.



A screen view of eVIEW software monitoring a fastener hot heading process showing one part heating to only 750 °C instead of the correct process temperature of 900 °C.



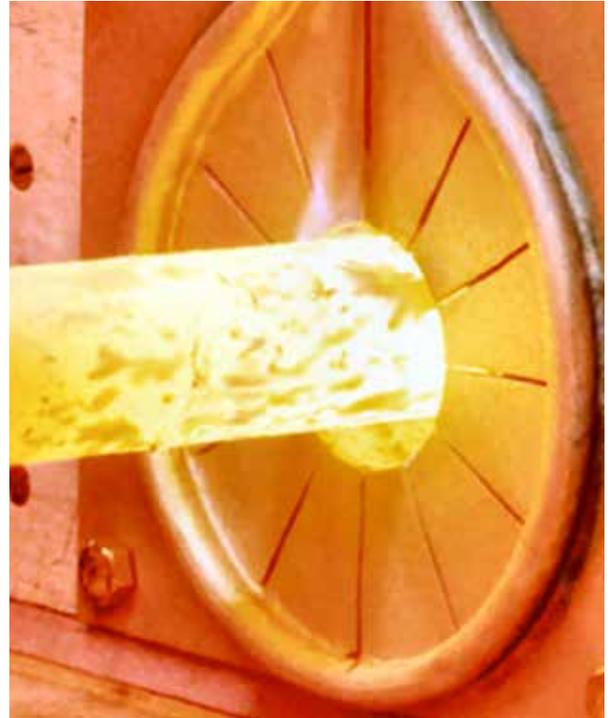
Ambrell eVIEW Software

In some industries, such as aerospace fastener manufacturing, part quality, reliability and the repeatability of the manufacturing process is critical.

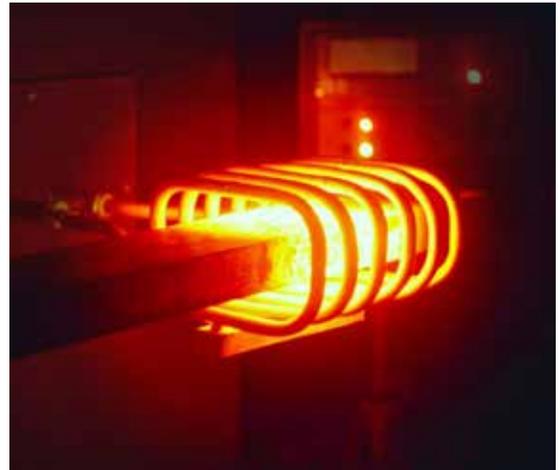
To help identify and record a part-by-part process, Ambrell's eVIEW software is utilized to capture the process data for each heated part. Our eVIEW software records the operating details of the induction system as well as the temperature and other critical process parameters.

Billet Heating

Ambrell manufactures an extensive line of induction heating systems for billet heating operating at frequencies down to 2 kHz and up to 15 kHz. The modular design allows a versatile approach to each customer's application giving a much finer and accurate control over the billet temperature. Modular building blocks are available in power levels from 125 kW up to 500 kW.



A billet heater for heating 48 mm diameter x 350 mm long steel billets producing a billet every 12 seconds. Ambrell works with expert integrators to provide a turnkey solution to customers.



Small or large, Ambrell can build a system that will meet your fastener application needs and exceed your expectations.

Ambrell Induction Heating Systems at a Glance



EASYHEAT™ **4.2, 6, 9, and 10 kW**

Typically used in many small wire applications in the fastener industry.



EKOHEAT® **30 and 45 and 50 kW**

Typically used at operating frequencies of 20 to 125 kHz for the fast heating of wire up to 25 mm in diameter for fastener hot heading.



EKOHEAT® **125, 250 and 400 kW**

Typically used at operating frequencies from 2 kHz up to 15 kHz for bar end heating and small billet heating.



EKOHEAT™ **500 kW**

Typically used at operating frequencies from 2 kHz up to 15 kHz for bar end heating and billet heating.

With our EASYHEAT and EKOHEAT induction heating systems we offer a wide range of power and frequency. Whether you're forging large or small parts, Ambrell can help you maximize cost efficiencies and productivity.

Our EKOHEAT systems can be configured to operate at the correct frequency for your forging process and can be cascaded to allow for the correct soak-through time. They can be configured for stage heating in 50, 125, 250 or 500 kW steps, and in single shot heating up to 500 kW.

Ambrell's systems are versatile with multiple capacitor and tap transformer configurations. They offer efficient power conversion that will minimize your energy costs. Our systems are user-friendly, offer agile frequency tuning for repeatable heating, and can be easily integrated into your existing process.

Systems Include:

- **Ease of integration into production processes with small workheads – easily located in the work area**
- **Wide frequency ranges allowing forging of different part sizes with the same power supply**
- **Multiple capacitor and tap transformer configurations for a more versatile heating tool**
- **Agile frequency tuning for accurate, repeatable heating**
- **Efficient power conversion minimizes energy expenses**
- **Expert coil designs that maximize power delivery and save production time**
- **User-friendly operator interface in five languages (EN, ES, FR, DE, IT)**

Free Application Testing From THE LAB



With a Reputation for Delivering Extraordinary Results, Our Applications Laboratory is the Gold Standard in the Industry.

Our Applications Laboratory – known in the industry as THE LAB – is where we solve our customers' most challenging heating applications every day.

Dr. Girish Dahake, Sr. Vice President of Global Applications, leads a worldwide team of elite engineers who are uniquely qualified to assist you with your heating process needs. Under the guidance of Dr. Dahake, our engineers have evaluated thousands of applications in THE LAB, so it's likely we have already assessed an application similar to yours.

Ambrell's team of engineers is world-renowned for producing extraordinary results. Our innovative and effective induction heating solutions consistently deliver performance excellence in one application after another. It's why THE LAB is the gold standard in the industry.

Have our team of expert engineers design and test the optimal solution for your application, free of charge. All it takes are three easy steps:

- 1. Send us your parts and process requirements**
- 2. Our engineers will analyze your process and heat your parts to develop the right solution for your specific application**
- 3. You will receive your parts back for inspection as well as a video of the heating process of your parts, and a laboratory report with a system recommendation**

We also invite you to visit THE LAB where you can experience our state-of-art testing facility, which is fully equipped with Ambrell induction heating systems and hundreds of proven coils. In addition, you can interface with our engineers and see first-hand how they design prototype coils and develop effective solutions to maximize the efficiency of your heating process.



"Induction heating is a precise, repeatable and efficient method of heating. However, in order to maximize the benefits of induction, it's critical to have the correct system and coil design. Our global team of highly-skilled engineers look forward to assessing your application and making the right

recommendation for your process."

**Dr. Girish Dahake,
Sr. Vice President, Global Applications**

**For more information, contact
us today at +1 585 889 9000
or visit thelab.ambrell.com**



About Ambrell

Founded in 1986, Ambrell Corporation, an inTEST Company, is a global leader in the induction heating market. We are renowned for our application knowledge and engineering expertise. In addition, our exceptional product quality and outstanding service and support are at the core of our commitment to provide a superior customer experience.

We are headquartered in the United States with additional operations in Europe including the United Kingdom and the Netherlands. All Ambrell products are designed, engineered and built at our manufacturing plant in the United States, which is an ISO 9001-certified facility. Over the last three decades we have expanded our global reach through an extensive distribution and OEM network, and today we have more than 12,000 systems installed in over 50 countries.



Ambrell[®]
INDUCTION HEATING SOLUTIONS
an inTEST Company

www.ambrell.com

Ambrell Corporation
United States
Tel: +1 585 889 9000
Fax: +1 585 889 4030
sales@ambrell.com

Ambrell B.V.
The Netherlands
Tel: +31 880 150 100
Fax: +31 546 788 154
sales-eu@ambrell.com

Ambrell Ltd.
United Kingdom
Tel: +44 1242 514042
Fax: +31 546 788 154
sales-uk@ambrell.com