by Al Sherrill, induction heating specialist, Miller Electric Mfg. Co.

Debunking four common myths about induction heating in pipe welding applications.
Preheating and stress relieving parts are necessary steps in many welding applications, including pipe welding, but the heating process can sometimes present challenges. Various applications and materials have different requirements, from preheat to post-weld heat treatment (PWHT). In addition, pipe and other parts range in size and shape, and may be located in the shop or in the field. All these factors make it important to choose a heating system that offers flexibility to meet a range of heating requirements.

When a welding application requires any type of heat treatment, induction heating is a method that offers many benefits, including greater heating consistency, faster time to temperature of the part, ease of use and safety in operation.

However, there are some misconceptions about how and when induction heating can be used in pipe welding that may hold people back from realizing the improvements it can provide. This article discusses common myths regarding induction and provides information about how to overcome challenges operators may encounter in some applications.

**MYTH NO. 1**  
**INDUCTION HEATING CAN’T BE USED ON P91 PIPE**

Induction can be used to preheat and stress relieve (through PWHT) P91 and other chrome moly pipe. Preheat on these pipes is no different than on any other carbon steel pipes, though it does involve addressing the specific challenges of heat treating the material.  

Debunked Myth: Induction heating can’t be used on P91 pipe.
P91 is a type of creep strength enhanced ferritic (CSEF) alloy, which are steels designed to retain strength at extremely high temperatures. While CSEF alloys are designed to maintain strength as the environmental temperature rises, one of the biggest challenges in welding P91 is the material’s sensitivity to heat changes during the welding process. This makes it critical to properly control the temperature before, during and after welding.

When heating a thick piece of pipe, high heat is necessary to get a stabilized temperature throughout the inside of the pipe, and P91 typically has higher temperature requirements during welding. For example, with many carbon steels, it is common to require soak temperatures of 1,150 to 1,250 degrees F. But with many grades of P91 material, the necessary soak temperature range typically starts at 1,350 and may extend to 1,410 degrees F.

Metal that is heated to a certain point loses its magnetic properties. The temperature level at which this happens, which can vary slightly, is called the Curie point. With many grades of P91 material, the Curie point typically occurs around 1,380 degrees F, so when the application calls for the material to be heated to 1,410 degrees, the induction heating process changes. As a result, heating from hysteresis losses goes away, the output parameters of the induction unit change, and part temperature heating rates may slow down or stall out before they reach the soak temperature level.

This issue can be overcome with some corrective actions. First, proper setup is important to help ensure the material heats up well. Using proper PWHT insulation for the size of pipe being heated and tightly winding the coil turns onto the insulation are important steps to maintain proper coupling distance from the part to the coil.

Second, because output characteristics will change at the Curie point, it’s important to wind an appropriate coil setup for this change. Because heating hysteresis losses go...
away at the Curie point, Joule heating becomes the only source of adding heat to the part.

To ensure reaching the desired soak temperature past the Curie point on larger pipe, consider coil windings that run at lower voltage and current levels. The easiest solution to achieve this is to use a longer cable to get four to eight more turns on the part. A better solution is to wind two coils in parallel, which results in less voltage and better utilization of the current available from the unit.

Lastly, make sure the unit’s kilowatt level is enough to heat the part to the desired soak temperature. For larger parts, a second unit can be added to reach the necessary heat levels. Cable length is not generally an issue that causes limitations in induction heating, but kilowatt range can be.

This makes it important to consider the power density necessary to heat the part and the capacity of the unit. It all comes down to how much time the operator has to wait; heating up something extremely large can take

Induction heating is a commonly used method for heat treatment in pipe welding.
MYTH NO. 2

INDUCTION HEATING CAN’T BE USED WITH NONFERROUS METALS
This misconception ties back to the earlier discussion about the two types of heat produced by induction: Joule heating and hysteresis heating. Nonferrous metals are not magnetic and, therefore, have extremely low permeability. This means the hysteresis heating portion of induction is lost with this material, and the process relies strictly on Joule heating. As a result, there must be a stronger magnetic field to achieve heating.

This can be accomplished by winding more turns with the solenoid or pancake coil, which produces stronger magnetic fields that will induce enough eddy currents to get full power out of the units. For instance, on a ferrous material an operator might be able to get full power from the system with five to seven coil turns around a pipe. With nonferrous material, it may require 20 turns to get full power from the unit. This may require a longer coil, or the operator may need to run two coils in parallel.

While this may require slightly more setup time, the benefits of induction heating help offset this through faster time to temperature and more consistent heating throughout the pipe. In addition, the ability of an induction system to heat ferrous and nonferrous materials results in a greater ROI since it can be used to complete more heating jobs.

MYTH NO. 3

INDUCTION HEATING CAN’T BE USED IN MULTIPLE ZONES
Because induction uses one control zone for heating, it’s a common belief that induction can only heat one pipe joint or zone at a time. However, multiple zone preheating and stress relief with one induction unit is possible, even...
though the system uses only one control zone.

When completing stress relief on a pipe, it’s important to make sure the temperature is within tolerance (typically, ±25 degrees F in pipe codes) all the way around the pipe. Heating up one side more than the other can cause expansion, which can lead to stress-induced cracking. There are code requirements aimed at preventing this.

For example, if a large pipe must be heated to 1,300 degrees F, one side of the pipe cannot be 1,200 degrees and the other side 1,300 degrees; both need to be within 25 degrees of the 1,300 degree set point.

If set up properly, induction heating supplies equal energy to the entire soak zone. Small variances in temperature due to convection currents or environmental conditions can be easily compensated for with coil placement on the part. While induction power sources typically have one output, thermocouples can be placed in several locations in the soak zone and be used to control output.

Using several control thermocouples allows the hottest thermocouple to control the output during ramp up, monitor all control thermocouples during the soak, and use the coolest thermocouple to control the ramp down. This does not allow the pipe to exceed maximum temperatures or allow the process to proceed unless all temperatures are within tolerance.

Depending on the part size and geometry, induction heating systems can use various components to induce heat, including blankets, cables and the Rolling Inductor from Miller, which is designed for rolled pipe applications.

Induction heating offers a much faster time to temperature compared to open flame heating. With induction, the part becomes its own heating element, heating from within, which makes induction very efficient since little heat is lost in the process.
Because induction heating systems offer various types and styles of components to induce heat in parts, induction is a flexible option for many applications and a wide range of part sizes and geometries. Contacting an induction system manufacturer can help answer questions about the needs and requirements for a specific application.

The bottom line is that induction heating is the best choice in many welding applications, providing significant benefits that include more consistent heating, faster time to temperature and improved safety.

**MYTH NO. 4**

**INDUCTION HEATING CAN’T BE USED ON PLATE**

While induction is a commonly used method for heat treatment in pipe welding, it offers great flexibility to be used for other part geometries as well, including flat plates. Various induction coil configurations are available, including some that sit on top of a plate and don’t have to be wrapped around the piece. Induction blankets are another option that can be used with flat plates.

In induction coil design, a solenoid or helix coil is typically wrapped around the part, while a pancake coil – which is similar in shape to a stovetop heating element – can lay flat on the part and be stretched out to cover a large area.

It’s also important to note that induction coil configurations can be used to heat from one side of the part – and heat the entire part – in flat plate welding applications. So, for example, if the welding operator is working on one side of the plate, the induction coil can heat from the opposite side – saving time in setup and in moving on to the next part.

With Miller’s rolling heat inductor, applications that would typically require hours to heat can be done in minutes.

Rolling induction heating technology improves fabricating efficiency compared to flame heating because the heat is generated within the part.