More and more companies today are looking at using the induction process for preheat and postweld heat treating (PWHT) in the mechanical industry. Inspectors are often responsible for verifying that preheats are performed to code as well as reviewing postweld heat treatment charts to verify that the PWHT was performed to code. Many of these inspectors have questions about the process, including what is the gradient falloff away from the area that is being stress relieved with the induction. Knowing the amount of gradient falloff helps to ensure that the stress the welding process created is not merely moved to another area in the pipe but is being relieved from the material being welded. This article addresses this question as well as provides other information that was discovered during a study of induction PWHT.

Understanding Induction Heating

First, we should understand the basics of how induction works. In induction heating, a liquid-cooled braided hose is wrapped around the material to be heated, and a magnetic field is created. The magnetic field excites the molecules in the material, which creates heat that radiates from the center of the material outward in all directions. Knowing that the material heats from the center of the material out to both sides, and understanding that a thermocouple reads the surface temperature of the material being heated, we can conclude that using this induction process, the inner wall of pipe or other side of the material would be the same temperature as the surface where the thermocouple is attached. This effect gives a more even heat at the area to be preheated or postweld heat treated. This differs from the electric process in which the heat is transferred from a heating coil to the outer wall of the material where the thermocouple is attached then has to migrate through the material to the opposite side.

Studying Gradient Falloff

A study of the induction heating process was conducted in February at the Icon Mechanical fabrication facility in Granite City, Ill. Icon Mechanical is a fabricator and mechanical contractor providing services to the power piping, petrochemical, heavy industrial, and commercial industries. This study was performed using a Proheat 35 induction machine from Miller Electric Mfg. Co. The material used was a piece of 8-ft-long A106 pipe with a wall thickness of 0.322 in. Six thermocouples were placed in a line. The first thermocouple was placed ¾ in. from the center of the weld, then the next five were placed at 4-in. intervals — Fig. 1. The thermocouples were placed in this way to determine the gradient falloff of heat through the wall of the pipe away from the area to be stressed relieved. The control rates used were as described in ASME B31.1, paragraph 132.5 as well as Table 132 for P1 material.

Figure 2 shows the six thermocouple readings of the test throughout PWHT of the material. Note that there is a temperature difference between each thermocouple. That is expected because the heat slowly and evenly transfers linearly out from the area of PWHT. The falloff of heat between the thermocouples is gradual with no significant drop due to the induction process. The biggest drop in temperature was between thermocouple 2 and thermocouple 3. This was due to the fact that the reusable insulating blanket that goes between the coils and the

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pipe wall measured 18 in. and was centered on the weld. This placed thermocouple 3 at the edge of the blanket, where the pipe wall was exposed to atmospheric temperature. If you study Fig. 2, you will notice the ramp up and down of all the thermocouples, which follows the gradual rise and fall for the maximum temperature each thermocouple reached during the process. It was expected that as we moved out from the insulating blanket and farther from the area where the magnetic field was being created that we would see a fall in temperature.

It is hoped that this study answers some of your questions as to the gradient falloff of temperature using induction for preheat and postweld heat treatment for stress relief of pipe welds.

Fig. 2 — Readings from the thermocouples throughout PWHT of the material.

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