DETAILED DESCRIPTION OF ENTRY

Introduction

Propane has long been used as the primary source for projects requiring pipe preheat prior to welding and will continue to be used on some projects for many years. However, using flame heating methods are not without problems. Often, the heating is inconsistent or inadequate, which may lead to crack development in the weld zone due to hydrogen entrapment. Flame heating has also been known to damage pipe coatings, can be difficult to transport into remote areas, and has safety and environmental issues. With the trend in the industry to pursue the use of high strength steels in pipeline construction, the need for a fast, uniform heating method without using flame is desirable.

Induction heating power sources have been used in cross-country applications for decades, primarily for preheat prior to the application of various coatings over the pipe joint area – after welding. The machines are typically very large and require large generators to provide adequate power. The rigid "clam-shell" coil designs are cumbersome to use and are not well suited for preheat applications prior to welding.

Description

Miller Electric has designed and patented new induction heating power sources with durable, flexible coils to facilitate very fast, easy to use, preheat prior to welding instead of using propane burners. The speed and heating consistency makes the system ideal for cross-country, pipeline construction right-of-ways, where production is measured in successfully welded joints per day. Set-up time is measured in seconds and heating time varies from less than 30 seconds for 12" diameter pipe to a few minutes for heavy wall, large diameter pipe. Heating is uniform around the circumference of the pipe end and can be measured by TEMPL sticks, infra red, or thermocouple probe. If required, welding can be done adjacent to the energized coils for situations where constant preheat is needed during welding. Using an optional patented, closed loop temperature control, the Miller induction system has the ability to uniformly maintain a preprogrammed temperature throughout the entire welding cycle.

Due to technological advancements, Miller's inverter-based power sources are much lighter and smaller than conventional transformer-based induction heating machines. Energy efficiency approaches 95% resulting in smaller generator requirements. A 70 KW generator will easily run 2 induction heating machines.

Product Specifications:

Product:	INTELLIFIRE 250
Output:	25 KW at 100% Duty Cycle
Input Requirements:	39 Amps at 460 VAC, 3-phase, 50/60 Hz
Weight:	165 lbs. (75 kg)
Size:	Height: 27.25 in. (692 mm) Width: 15 in. (381 mm) Length: 31.5 in. (800 mm)
Coil Size:	Flexible coils for 12" to 52" diameter pipe
Coil width:	Varies from 10.1 in. (260 mm) for 12" diameter pipe to: 7.5" in. (190 mm) for 52" diameter pipe.
Heating Range:	Up to 400 F. (204 C.)

Note: Special water-cooled coils are available for post-weld, heat treat applications requiring temperatures up 780 C.

Successful Project Use:

Since product field testing on the ALLIANCE Pipeline Project from Alberta, Canada to Chicago in the U.S. in 1999, and on the VECTOR Project in 2000, Miller's induction heating system has been, and is presently being used, on several noteworthy cross-country pipeline projects and for pipeline repair applications. These include:

1. **Ecuador – OCP Project.** TECHINT purchased their first two preheat systems for various pipe diameters in January 2001. Preheat to 121 C. took 2.5 minutes on 36" diameter pipe compared to over 7 minutes using propane. Prior to using the induction heating method, a safety issue became evident when a weld shack started on fire as a result of using open flame to preheat the pipe.

2. **Peru – Camisea Project.** TECHINT purchased three more systems for preheat applications upon start-up of Camisea.

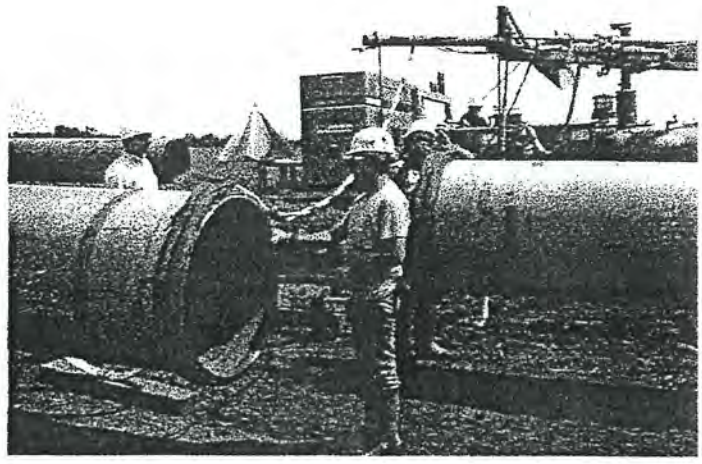
3. **Algeria – In Salah Project.** Bechtel is presently using 6 preheat systems in hot, dusty conditions in Algeria.

4. **Trinidad – BP-Amoco.** BP Specified Miller induction heating for 48" diameter pipe. API Pipeline and DAMUS Mechanical Contractors are using the systems for preheat.

5. **Alaska – Alyeska Pipeline.** Alyeska Pipeline is using several Miller induction systems to maintain heat while welding reinforcement sleeves on the 48" diameter, Trans-Alaskan oil pipeline – with oil flow in the pipe. The method has reduced their costs considerably by allowing them to weld continuously while maintaining a preheat with several induction coils.

Summarizing the benefits of Miller's induction heating system, pipeline construction costs savings are realized by reducing pipe preheat time, improving heat uniformity, and eliminating pipe coating damage due to excessive flame heat. Safety is improved by eliminating large propane fuel tanks and open flame around workers. Environmental impact concerns using open flame and fuel in sensitive areas are also eliminated. Productivity improves in applications where welding while maintaining preheat is desirable.

Photo: Typical cross country set-up with 2 induction systems on 36" diameter pipe.

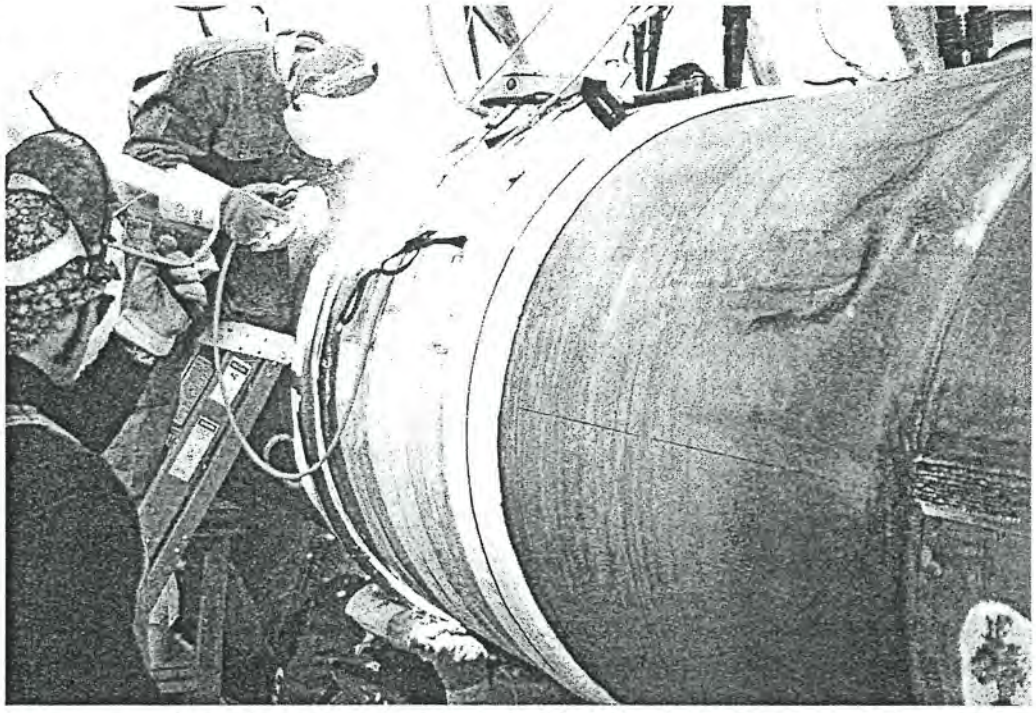


Induction Heating Reduces Pipeline Welding Repair Time By 50 to 66 Percent

Issue:
Keeping pipe pre-heated for welding repairs on Trans-Alaska Pipeline.

Solution:
Miller's Induction Heating System.

Results:
Repair times cut in half despite heat sink conditions.



Operators use induction heating to pre-heat the girth weld of a 6-inch STOPPLE fitting. Induction maintains desired pre-heat temperature throughout the welding process.

by: Jeff Thomas, product manager, Miller Electric Mfg. Co.

ALONG THE TRANS-ALASKA PIPELINE SYSTEM'S 800 mile length pulses roughly one quarter of the United States' life blood — a river of crude oil from Prudhoe Bay on the Arctic Ocean to waiting supertankers at the southern Alaska terminal of Valdez.

To preserve their $8 billion investment, six petroleum companies rely on Alyeska Pipeline Service Company, which designed, built, operates and maintains the 24-year-old conduit. With its seven operating pump stations, countless valves controlling oil flow, and its journey above and below hundreds of miles of rugged terrain, the Trans-Alaska Pipeline presents ongoing repair challenges. Major facets of the South Fairbanks-based company's pipeline maintenance activities include STOPPLE® plugging operations. These entail welding special fittings to enable in-service line tapping, and welding full encirclement repair sleeves around the line's 48 in. diameter girth to shore up weak spots. Most pipe material for the main line is API 5L Grade X60 or X65 (0.462 in. or 0.562 in. wall thickness) with some X70 (0.562 in. wall thickness), depending on pressure gradients related to a pipe section's elevation above sea level or position upstream or downstream from a pump station.

Heat Sink Sinks Productivity

Until 2000, these welding activities consumed extraordinary amounts of time. While Alyeska can make many repairs without having to stop oil flow or drain it from the pipe, the presence of the crude itself hampers welding efficiency.

"Flowing crude at 68 degrees Fahrenheit creates a major heat sink that removes heat from the pipe," says Alan Beckett, senior welding engineer. "If you're trying to pre-heat the pipe to 125 degrees Fahrenheit using conventional methods, you can't put enough kilojoules of energy into the pipe that the oil is not taking away."

Since Beckett joined Alyeska in 1991, he has seen the problem of heat sink worsen, as the depletion of the Prudhoe Bay oilfield gradually reduces the volume of crude flowing through the system. Nine years ago, the Trans-Alaska Pipeline conveyed 1.85 million barrels a day, whereas today's volume is approximately one million barrels a day. Lower oil volumes mean lower oil and pipe temperatures, therefore, a more daunting pre-heating challenge.

The Induction Heating Alternative

Fortunately, a little inspiration on Beckett's part and Miller Electric Mfg. Co.'s Induction Heating System has resulted in dramatically reduced repair welding times despite the heat sink.

In two projects in 2000, Alyeska leased and used Miller's Intellifire™ 250 (25kW output) induction heating power sources and patented induction heating blankets. The induction blanket consists of a special cable surrounded by insulation and sewn into a high temperature fabric. The power supply creates a rapidly alternating (10 to 50 kHz) electromagnetic field inside the blanket. This field excites the molecules of the part (i.e., pipeline, hot tap fitting), raising its energy level and causing the steel material to heat from within.

Pre-heating through heat induction made Alyeska's former methods seem crude by comparison.

"The process involved two or more pipefitters on either side of the 48 in. pipeline using turbo torches to heat the pipe as hot as they could and then back away," he explains. "Then four welders, two on either side, would jump in, get ready, check the pre-heat with contact pyrometers and then start welding. Usually, because of the rapid decline of the pre-heat due to the cooling effect of the flowing oil, they had to back away after having welded for only 30 to 60 seconds.

"We're talking about 11 to 15 passes around the 150 in. circumference to complete a minimum 3/4 in. fillet weld on just one end of a STOPPLE fitting," Beckett notes. "That's a tremendous linear footage of weld for a four-man crew that can weld for only up to one minute at a time before pulling away to pre-heat the weldment again. It made an old man out of you."

Joining one end of an encirclement sleeve to the underlying 48 in. diameter pipe used to take as long as 8 to 12 hours, and 12 to 18 hours for a STOPPLE fitting. "This was totally unacceptable," he remarks. "Miller's induction heating technology establishes a minimum pre-heat temperature and maintains a consistent, non-fluctuating pre-heat condition. This allows us to weld one 48 in. repair sleeve girth weld in just four hours."

Rogue Inspection Pig Prompts Use of Induction Heating

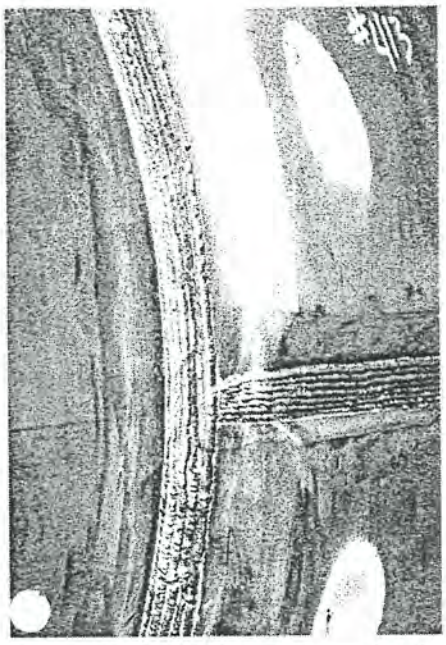
Cleaning and inspection pigs are in-line inspection devices equipped with brushes or measuring devices, and have been highly useful to the pipeline industry to perform in-line cleaning, detect wall loss or corrosion and measure pipe curvature. However, in an unlikely scenario, an Alyeska inspection pig did something extraordinary.

"The pig was traveling a section of pipe measuring curvature and it took out one of the seat rings in a 48 in. check valve and carried it down the pipeline," Beckett recalls. "The pig actually broke it out and left us with a non-functioning check valve."

Check valves spaced at increments along the pipeline prevent oil from gushing out of the entire line in the event of a guillotine cut or other accidental rupture of the line. Without seat rings, check valves won't seal correctly.

Alyeska engineers located which valve

Induction heating allows operators to work in close proximity of the blankets without the risk of heat exposure or burns.



Sample of a finished longitudinal and girth weld on 48" STOPPLE fitting. The stopple fitting is 2-inches thick, requiring multiple passes to complete the welds.

the seat ring had been removed from and determined they needed to perform a valve replacement, entailing a STOPPLE plugging operation. Using STOPPLE® Plugging Machines and STOPPLE Fittings, Alyeska isolates a section of line for repairs or additions without having to drain a long stretch of pipeline and while maintaining full or nominally reduced line pressure.

"We put a line plug upstream and downstream of a section of the pipeline containing the check valve, removed the oil in that section through a drain down process, and replaced the valve and entire section," he explains.

STOPPLE fittings are welded to the pipeline in much the same way full encirclement sleeves are joined. The difference is STOPPLE fittings are usually longer than sleeves and have a considerably greater wall thickness (2.5 in. versus .562 in.). The most significant difference is a full 48 in. size branch connection on top of the STOPPLE fitting to enable a 48 in. diameter tapping of the pipeline using a tapping machine. A STOPPLE Plugging Machine attached to each of the two STOPPLE fittings hydraulically forces a plugging head of the same diameter into the line on either side of the isolated section, effectively plugging the line upstream and downstream.

The entire process is much more involved than a simple sleeve repair. "Installation of the STOPPLE fittings is done weeks ahead of the line shutdown and repair work, and it takes weeks of preparation. Everything is staged and rehearsed for the shutdown day. A lot of time is spent draining down the oil between the STOPPLEs, cold cutting the line, line removal, line up of new pipe, tie-in welding and inspection during the shutdown. Inserting the STOPPLE plug into its sealing position only takes about 20 minutes and the same amount of time to remove them," Beckett explains.

Miller's Induction Heating Power System proved indispensable in efficiently pre-heating the robust STOPPLE fittings while they were being welded to the pipeline. Because of the STOPPLE fitting's greater wall thickness, pre-heating is more difficult, taking more time and more passes to complete the girth fillet welds. However, use of the induction technology greatly reduced the usual time needed to weld a STOPPLE fitting using other methods.

Beckett sees the Alyeska and Miller collaboration as a benefit to the entire oil and gas industry. "It's not only Alyeska using Miller equipment, it's Alyeska and Miller joining together to pioneer a new application for an established technology. This area of in-service welding has tremendous ramifications within the oil and gas industry and opens up opportunities for pre-heating during in-service welding that haven't been considered before. Miller had been building induction heating products for one application, but through our desire to apply it somewhere else, the company has found another application to develop for this equipment. That will be good for the entire industry." ◆