Pulsed Technology Increases Cladding Travel Speed

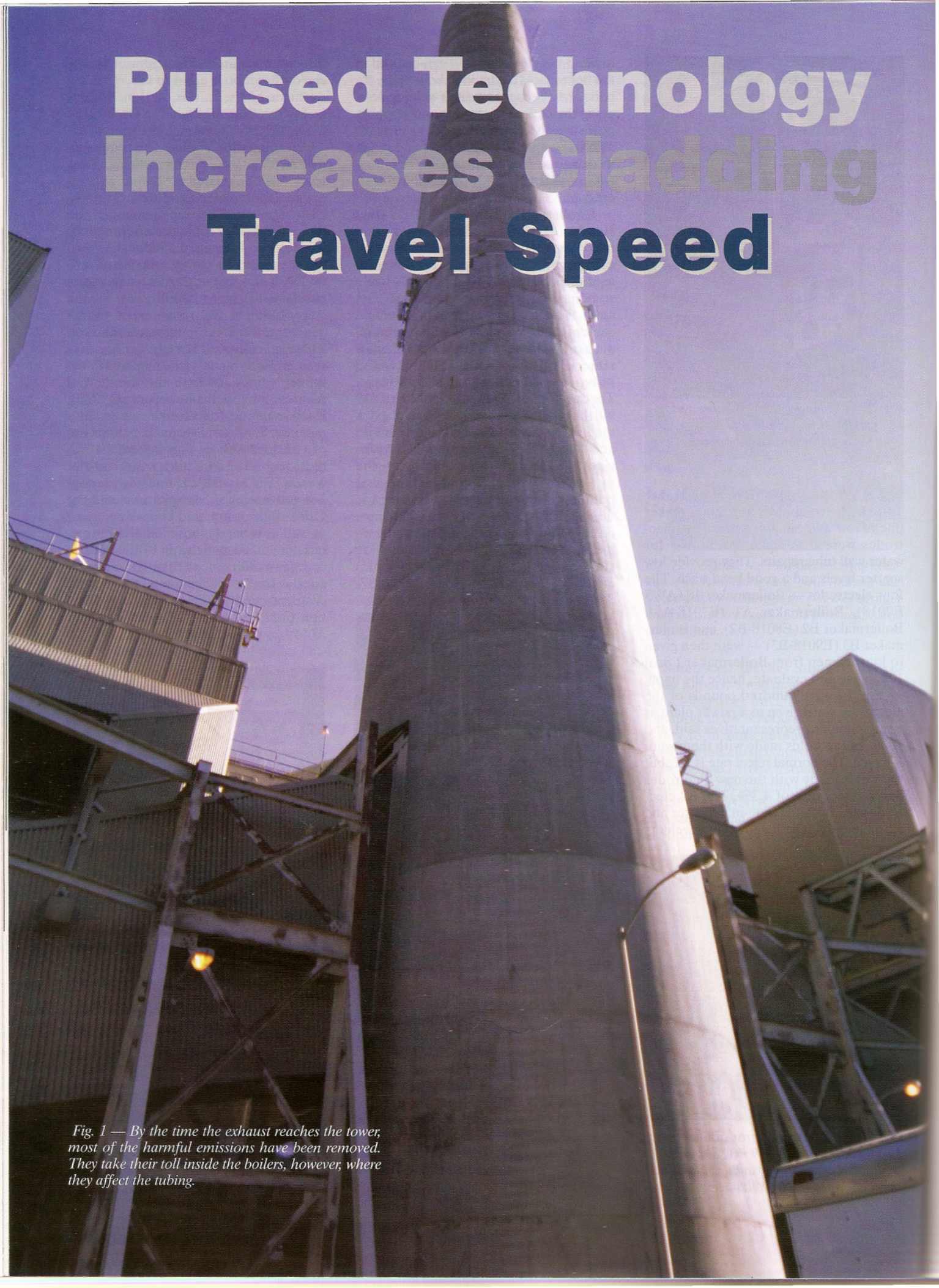

Fig. 1 — By the time the exhaust reaches the tower, most of the harmful emissions have been removed. They take their toll inside the boilers, however, where they affect the tubing.

A company that converts trash to energy achieved faster welding speeds when it began utilizing newer pulsed gas metal arc power sources

BY JIM RAPPL

That can of garbage sitting in your kitchen might not be worth its weight in gold, but it contains enough energy to power a light bulb for 24 hours — at least it could once Covanta Energy gets a hold of it.

At its more than 30 plants around the world, Covanta takes municipal solid waste — trash that would otherwise fill landfills — and turns it into energy. For every 10 tons of waste received, Covanta

- Reduces it to ash that is 10% of its original volume
- Recycles 500 lb of metal
- Generates 5200 kWh of power.

According to Covanta, every ton of municipal solid waste converted to energy avoids the need to import one barrel of oil or mine one-quarter ton of coal.

The company feeds the waste into combustion chambers constructed of steel tubes (Grades 28, 213, A213) that contain water. The burning waste turns the water into steam, which then spins turbines. Unfortunately, the gases emitted during the process can corrode mild steel within a few years — Fig. 1. That's where Brad Hooper and his team come in. Hooper is supervisor for the NorthEast Regional Maintenance cladding program for Covanta Energy.

To extend tube life by up to 15 years, Hooper's team uses the pulsed gas metal arc welding (GMAW-P) process to clad the tubes with Inconel™ 625, a high-nickel-content alloy known for its combination of high-temperature corrosion resistance, toughness, and strength — Fig. 2. Because Hooper's team operates during scheduled shutdowns, and because the team moves from one Covanta facility to another, they must adhere to tight schedules. Any lost time can throw off months of planning and affect several facilities.

The cladding process leaves little room for error. Maintaining the proper amount of metallurgical dilution between the mild carbon steel tubes and the Inconel cladding demands controlling the total heat input created by the welding process. Pulsed GMAW helps the company achieve high productivity while controlling heat input.

Extending Service Life

During regularly scheduled maintenance shutdowns, every inch of tubing is ultrasonically measured. The tubing starts with a 0.235-in. wall thickness. When it thins to 0.140 in. thick, the company clads it with a 0.070-in. layer of Inconel 625, which extends tubing life up to 12 to 15 years, according to Hooper. Without cladding, the tubes would last a couple of years before needing replacement.

During the cladding process, the molten Inconel partially melts the base metal and combines with it.

"Maintaining the proper dilution rate is critical when applying Inconel," Hooper said. "When you apply it to the carbon steel, you need a dilution rate that keeps it from wanting to fall off the tube. However, the dilution rate needs to be low enough so that it doesn't either pull the iron up into the face of the weld or impact the free chromium content and reduce Inconel's corrosion-resistant properties. To get the desired dilution rate (7 to 10% of the base metal) and keep it from cracking, you need to use a pulsed GMAW arc."

With GMAW-P, the power source switches between a high peak current and a low background current. The peak current pinches off a spray transfer droplet and propels it toward the weld. The background current maintains the arc, but is too low for metal transfer to occur.

"Pulsed GMAW helps to control the heat," Hooper explained. "A straight (spray transfer) GMAW process adds too much heat to the molten metal, which reduces chrome content in the finished product. With too much heat, you get a higher iron dilution rate and decreased corrosion resistance."

Complicated Problems

Although GMAW-P provides a solution, older technology complicated the process of establishing and maintaining pulsing parameters. Some combinations of base metals and welding wires required an engineer to set all of the parameters.

"Some contractors thought all you had to do was buy a pulsed GMAW machine," Hooper said. "But there was more to it. We had to program the trim (arc length), the actual pulsed frequency, delay time of the pulse (pulse width), and other parameters for every individual wire size and type. Our previous power sources weren't very user-friendly. It took somebody who had been around them a long time to be able to set them to weld Inconel. You couldn't just send in a new kid to turn a machine on and set it for Inconel. You had to know exactly what button to push or you'd be welding with the wrong processes or wrong parameters."

Fig. 2 — Inconel cladding protects the tubes that make up the boiler, extending their lives from 3 to 15 years. To maintain the proper dilution rate, GMAW-P is used.

The difficulty in dialing in the previous machines led to lengthier training periods and required Hooper to closely monitor machine settings with most of his operators.

For a solution to this problem, Hooper and Gregg Pruett, Covanta regional maintenance manager, sought out new pulsed GMAW technology.

Simple Pulsing Solutions

The newest generation of pulsed GMAW welding systems use advanced technology to do the following:

- Reduce training time to a few hours for experienced welders.
- Simplify machine setup to the point where an operator is ready to weld within 30 s after turning on the machine.
- Relieve operators and engineers from the burden of setting complex pulse parameters.
- Use simple controls that enable welders to customize arc length and arc cone width to match their personal preferences and/or application requirements.
- Increase travel speeds and eliminate arc restrikes (unintended short circuits).

For simple operation, Covanta selected a system that featured factory-set pulsing programs. While several such

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Fig. 3 — Brad Hooper walks through the four-step setup for setting pulsed GMAW parameters on the XMT 350 MPa. The units retain settings for each process, so they can easily be switched from GMAW-P to SMAW and back with a simple turn of the knob.

models are available, the company selected a model (the XMT® 350 MPa from Miller Electric Mfg. Co.) that included programs for the wire types (nickel alloy) and diameters (0.035 and 0.045 in.) used for cladding.

When using the unit's factory-set programs, operators use the process selector control knob to select from available welding processes (gas metal arc welding, pulsed gas metal arc welding, shielded metal arc welding, and gas tungsten arc welding). Additionally, a mode is available for operators using voltage sensing wire feeders for gas metal arc or pulsed gas metal arc welding.

After selecting a process, the operator then uses a single pushbutton and control knob to scroll through menus to select the preferred arc shape for weld pool control and desired bead appearance, wire diameter and type, and shielding gas for the application at hand — Fig. 3. The system only provides correct options, preventing such errors as selecting 100% argon shielding gas for a steel wire.

The operator then sets the desired wire feed speed on his or her remote control wire feeder, and the power source tells him the best voltage/arc length setting to achieve optimal results. The operator, however, can adjust this setting for any wire feed speed and tailor the arc length as desired.

For the most part, the company's operators set welding parameters once, accounting for the dilution rate, penetration, and their preferences, and that's the only time they touch the controls.

The Long and Short of It

When performing the cladding process or when using highly alloyed metals, operators need to tailor the arc length to suit their needs, shortening the arc to reduce heat input and help the operator "push the (pool) around and get the desired tie-in," Hooper explained — Fig. 4. Shortening the arc with the older pulsed GMAW units would often lead to short circuits that would cause inclusions in the weld bead or other defects that would require reworking. As a result, welders held a longer than desired arc. Longer than desired arc length can cause more heat to be applied to the weldment.

Hooper said that with the older technology, the company's welders couldn't weld faster than 300 in./min without experiencing a lot of shorts. With the newer power sources, they average 350–400 in./min and can even weld 500–540 in./min in some applications.

When he mentions "tailoring the arc," Hooper is referring to two additional controls available on newer GMAW-P systems. When switching from standard GMAW to pulsed GMAW, the control knob that operators think of as "voltage control" instead enables them to adjust arc length to match their personal preference or joint configuration.

This arc length control helps set optimum welding parameters, reducing unintended short circuits and flare-ups, such as when the operator needs a long electrode extension to reach into a tight space.

The other control adjusts the width of the arc cone. Using a lower setting results in a wider arc cone that has greater wetting action, increased weld pool fluidity, and a flatter weld bead. A higher setting narrows the arc cone, which produces a narrower, faster-freezing weld bead with less heat input.

Lastly, as Hooper noted, with today's microprocessors, software at the heart of pulsed GMAW technology also addresses the issue of short circuits and subsequent arc re-strikes. Newer systems sample arc characteristics thousands of times per second and include feedback loops that can react to changing arc conditions and clear short circuits before they adversely affect the weld pool or throw unmelted wire and/or spatter.

In addition to benefiting other types of cladding, the newer GMAW-P technology can address productivity and quality issues in other pulsed GMAW/alloy metal applications requiring portability, notably those in power piping, petrochemical, and shipbuilding.

Easier training, more operator control, eliminating inclusions and rework, 30% faster travel speeds, and freeing the maintenance technician have important ramifications for Covanta.

"We try to minimize downtime in the facilities as far as boiler availability. Time to us is money, Pruett said." New pulsed GMAW systems help Covanta achieve that goal.◆

Fig. 4 — Operators need to be able to hold a short arc length for maximum weld pool control.