Safer, More Efficient Water-Cooled Power Cable Changeout – FINAL REVISED

Karl Schwenk, Partner & Director, I^2r POWER

I^2r POWER
4300 Chamber Avenue SW, Canton, Ohio, USA 44706
330-588-3000
Karl.Schwenk@i2rPower.com

Keywords: water-cooled EAF power cables, electric arc furnace power cables, LMF power cables, ladle metallurgy power cables, EAF power cable installation, EAF power cable storage, EAF power cable lifting options, EAF barrel terminals, LMF barrel terminals, EAF cylindrical terminals, LMF cylindrical terminals

INTRODUCTION

Within the USMCA (United States-Mexico-Canada) steelmaking industry, an estimated 170 electric arc and ladle metallurgical furnaces utilizing more than 20 MVA are operating daily–actively using an estimated 1,500 power cables. Approximately 500 EAF and LMF power cables are replaced annually. The installation and removal procedure is customarily performed in less-than-optimal circumstances. Cable changeouts are conducted in awkward, elevated production environments and depend on the skills of personnel performing the task. Safety managers, plant engineers, operations, and maintenance personnel must explore options to increase personnel and equipment safety, and reduce downtime.

DISCUSSION

EAF and LMF power cable changeout require that maintenance personnel wrestle with the weight of the cable against the effects of gravity while in a man lift 30 to 40 feet off the melt shop floor. The cable is inherently not rigid and its flexibility contributes to potentially unpredictable movement. Additionally, cable connection points can be difficult to access further complicating the removal and installation. Experienced, skilled personnel are required for a successful power cable changeout.

Additional considerations are whether the removal and installation is occurring during a planned outage or shut down, or if the power cable changeout is an emergency procedure. If the latter, the safety of the changeout and the quality of the installation may be compromised if the threat of reduced production is overshadowing the procedure. Under all conditions, safety protocol and advance preparation for power cable changeout is paramount.

Physical risks to personnel and operating equipment are abundant during EAF power cable changeout. Safety planning and careful selection of operating parts are essential. Innovative and practical terminal designs, proper storage, and lifting options exist to improve safety, ease of installation, and to reduce downtime.

Innovative, practical terminal designs for safer installation procedure

Traditionally, EAF and LMF power cables have blade terminals that can be 10 to 12 inches in length, with eight through holes. Precise alignment of all eight bolt holes on each end is required. Most traditional installations begin with one terminal end at a time. The second terminal connection is typically more difficult. In many instances, the terminal is manually forced into bolt hole alignment.

Cylindrical terminals eliminate the time-consuming bolt hole alignment effort. To accept the cylindrical terminals, the load-end and furnace-end connection points are retrofitted with adapter plates that provide a hinged closure, clamping the cylindrical terminal into position. The hinged closure can be a single- or double-hinged design, and can be made of copper or brass. Captive hardware reduces the risk of losing nuts, bolts, and disc spring washers.

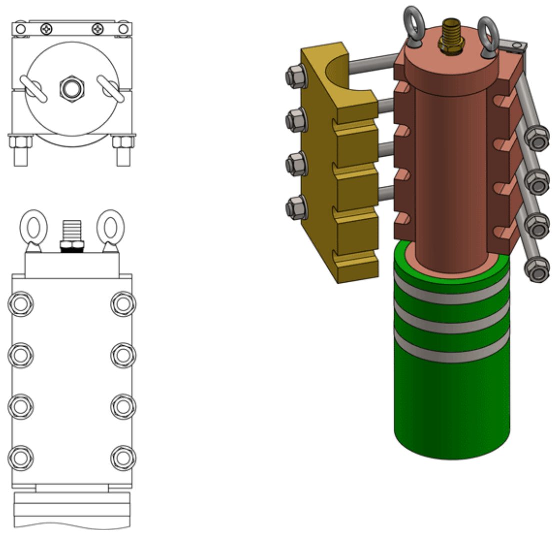

Figure 1. An EAF/LMF cylindrical terminal design.

Implementation of the cylindrical terminal design can be accomplished in two methods. Steel makers can employ the cylindrical terminal on both cable ends, providing the most safety and time-saving benefits. Retrofitting both cable terminals, as well as the required adapter connection plates, is a greater investment. Alternatively, retrofitting only one cable terminal is a more cost-effective approach and allows steel makers to test the cylindrical terminal design. In this latter scenario, the 8-hole traditional blade terminal would be connected first and the cylindrical terminal would be installed next.

In certain instances, converting to a cylindrical terminal may not be possible. When overhead furnace and structural facility components make access to connection points limited, a rotating terminal design can offer benefits beyond a traditional stationary terminal. A rotating terminal can facilitate bolt hole alignment during changeout. Rotating terminals also mitigate stress on the cover hose, and strain on the internal conductor package, when the furnace lid opens and closes. Installation time, and the time personnel spend elevated in a man-lift, can be reduced by using a rotating terminal design.

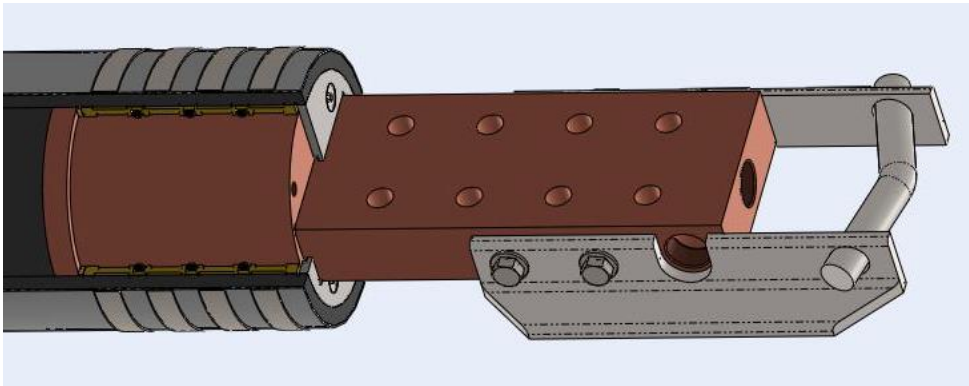

Figure 2. An EAF/LMF rotating terminal design with lifting device.

Innovative, practical terminal designs exist to help solve safety and downtime challenges for steel makers. Newer terminal designs can streamline the cable changeout process. When utilizing state-of-the-art designs, terminal orientation becomes simplified, personnel spend less time in bucket or man-lift equipment, and more time is spent on safer ground.

Importance of proper cable storage and lifting options for easier alignment

Proper cable storage and use of equipment and fixtures engineered specifically for water-cooled EAF and LMF cable handling will enhance the safety of the changeout process. Alignment and orientation challenges in a traditional changeout can be mitigated with proper storage and handling. Storage and lifting options exist to improve safety and reduce downtime.

Figure 3. Newly manufactured spare cables stacked in trays for safe, portable and flat storage.

The environment in which power cables are stored impact their condition. EAF and LMF power cables should be stored indoors, out of the elements, and at a reasonable ambient temperature. Power cables should not be stored in a coiled state for a prolonged period because this promotes embrittlement of the outer hose covering and the inner core hose. Additionally, it is not the ideal state for the internal conductor package. Cables left coiled may retain this spiral shape and hinder the installation process, making it difficult to align the bolt hole pattern. EAF and LMF cable spares should be stored in a flat state–either hanging vertically or in stackable storage trays. Proper cable storage will safeguard spares and ensure they operate correctly when needed most.

Figure 4. Newly manufactured spare EAF cables stacked in trays and fitted with custom handles for lifting and/or hanging.

Safe handling of EAF and LMF cables can be improved with proper lifting fixtures. Often there are furnace and facility components directly overhead of terminal connection points–in close proximity to one another–forcing maintenance personnel to work around less-than-optimal conditions when handling cables using an overhead crane. There are a number of Euip

Proper care of your replacement cable is critical for safer, easier installation. Store EAF or LMF cables–either lying flat or hung vertically–to maintain integrity of the outer hose and internal conductor package. Keep spares dry and at a moderate temperature to ensure they work properly at the time they are critically needed. Review procedures and assess equipment and lifting fixtures to ensure safe control and alignment, and to reduce duration of risky elevated changeouts.

CONCLUSION

Approximately 500 EAF power cables are replaced within the North American steelmaking industry annually. Advance safety planning, preparation, and careful selection of operating parts are essential for these changeouts. Equipping power cables with innovative terminal designs and custom lifting fixtures will facilitate handling–improving safety and reducing downtime. Proper flat storage of power cables is essential to prolonging the life of the cable and easing alignment challenges. It is imperative safety managers, plant engineers, operations, and maintenance personnel research cable changeout procedures to reduce personnel and operating equipment risk, and minimize lost production time.