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POTLINE SHUTDOWN AND RESTART SECURED SOLUTIONS

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Abstract

Today, on any modern technology for aluminium electrolyse reduction, pot shutdown and restart, planned or unplanned, remain an extremely critical operation, because of the level of energy surrounding the process (electrical and mechanical).

Even when using modern reduction technologies, to shut down a pot, the operators have to manually introduce short-circuiting wedges between the electrical conductors to by-pass the current to the following pot and remove them to start the pot. The confined working area located below the floor level puts the operators in an uncomfortable and hazardous situation.
Furthermore, wedge extraction speed is of utmost importance. During the restart phase, the high current density may produce some electrical arcs damaging the conductors if the wedges are not removed fast enough. Rhythm of wedges extraction is also a challenge to not compromise the last one integrity (risks of overheating).

To reduce conductor maintenance costs but above all to put the operator in a safer working environment, ECL™ along with AP Technology™ teams, designed a remotely-controlled wedge extraction system entirely operated from working floor and connected with the Pot Tending Machine.

Introduction

Aluminium production is a continuous process. Each smelter around the world, regardless of the technology used, is based on potlines containing a series of "pots" or large electrolytic cells in which aluminium is made. Each pot is a large rectangular cell, lined with carbon blocks and insulating bricks. The pots are connected electrically in a series so that direct electric current flows through one pot, then on to the next one and so on, to the end of the line. A typical smelter contains anywhere from 300 to 720 pots, each of which producing about a ton of aluminium a day. Needless to say, a power outage, partial or total, can cause large problems with loss of cell life if not managed within short time. Pot shutdown and restart operations are considered as ones of the most dangerous and critical in potline operations especially due to the fact that it still requires human intervention. It is why, ECL™ in close collaboration with AP Technology™, committed to constantly offering to primary aluminium smelters safer solutions, developed and designed reduction pot start-up and shutdown tools.

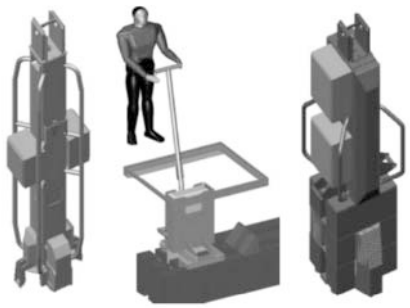
Potline shutdown and restart operations

Whether we are talking about a new smelter or a smelter already in operation, pot start or shutdown operations are performed weekly by operators. In the case of a new smelter, when it's time to put the plant in production, 4 to 5 pots may be daily started. In the case of a smelter already in production, operators and technicians have to shutdown some pots in order to change the cathode. The way to do is the same in both cases. Some short-circuiting wedges are introduced between the conductors in order to by-pass the current to the following pot: the pot is stopped. These wedges are then removed: the pot is restarted. So far, the wedges were introduced and removed more or less manually, using mechanical tools and putting the operator in a very uncomfortable position below ground level and at risk of serious injury due to high current density.

To shutdown the pot, the wedges, are introduced simultaneously using mechanical wedges launchers. This operation is quite delicate but time is not an important parameter. To restart the pot, the wedges are withdrawn one by one. Time is here a crucial parameter as the current density flowing through the wedges increases when the number of wedges decreases. It was quite common for the technicians to go down to unscrew the tie-rod to facilitate the ejection of the last wedge stuck in the conductors due to the current density. Furthermore, this high current density is responsible of the emergence of electrical arc damaging the conductors if the wedges are not removed fast enough but above all technicians have to operate in a dangerous working environment. With the constant amperage increase, from AP 30 to AP 60, it has become essential to deliver safer and cost-savings solutions, to design and provide a tool able to perform these duties remotely while preserving conductors.

The ECL™ reduction Pot Start-up & Shutdown tools

The solution thought, designed and tested by ECL™ and AP Technology™ teams consists in 2 racks composed of: one composed of a set of wedge launchers and one with 1 hammer and handling mast, 1 hydraulic extracting device.



Hammer/handling mast, Launcher, Extractor

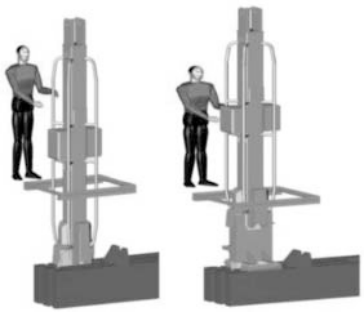
The wedge launchers

Manipulated by the handling mast, the wedges are first clamped automatically in the launchers ensuring the good positioning in its slot. Each launcher is very compact and electrically insulated. The

launchers are equipped with a push and pull system avoiding unintentional release of the wedge during transfer. Once the launcher is positioned on the conductor, the operation is totally safe for the operator as it is completely performed remotely from the hammer/handling mast.

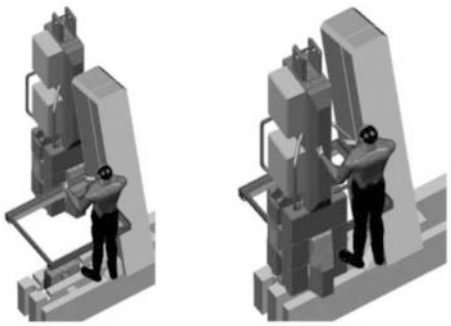
Hammer and Handling Mast

Once set in position in between the bus bars, it is sometimes needed to hit the wedges to have good contact with the conductors in order to reduce voltage drop. This operation was usually performed manually by the operator using a sledge hammer. The hammer is now dedicated to this former painful and difficult task. Energized directly by the PTM (24 VDC & 5,5 Bars air pressure), the hammer controls the hitting of the wedge avoiding thus the over sinking of the wedge which results in no excess hitting and obviously less damages on the wedges and consequently conductors. Therefore manipulation and operation on wedges are totally under control, performed remotely from working floor protecting the operator from all risk of external moving part, falling, back pain, electrical shocks.



Hydraulic extracting device

If pot shutdown has been facilitated but above all made safer, the same is true and even more with pot restart. As already mentioned time is an essential parameter and complete cycle must be over within 20 minutes (AP Technology™ requirements).



To date, it was not unusual, even common rather, to have the three last wedges to be removed blocked between the conductors due to the increasing current density. Operators were forced to go down loose conductor tie-rods. The design and functions of ECL™ hydraulic Extracting Device put a stop to this high-risk practice. Now the operator safely positioned on the tool rack-platform will:

- Connect the extractor to the PTM
- Remotely pre-position the extractor above with the first wedge to be removed using a laser pointer.
- Control the extractor position on the wedge (self centering of the extractor thanks to mechanical guides)
- Remotely order the extractor to clamp the wedge. The cooling system starts-up automatically.
- Perform last step and begin extraction of the wedge

The wedge is ejected in a couple of seconds thanks to the 50 ton hydraulic extraction and the pneumatic ejection. The extraction is totally safe as the wedge is guided and kept in the extractor at all time and then dropped directly in its rack. The operation is repeated for the 5 following wedges resulting in a safe and smooth restart of the pot.

HSE & cost-savings targets

Tested on several occasions on aluminium production line in operation, the pot start-up and shutdown solutions greatly improve the safety of the operators and the smelter and contribute to cost-savings targets.

The tools were qualified as very ergonomic. The complete cycle is totally performed remotely from working floor, therefore limiting risk of falls, burns, back injuries, hard work (hitting, handling…). Now, for most of the time of the complete operation only two operators are needed to achieve shutdown and restart which contributes to have a better visibility to perform operations (more operators are still needed to launch the wedges). The wedges are always under control by one of the tool avoiding external moving part.

If HSE is the most important concern of any smelter, cost-savings is probably the second one. In a time when energy suffers from high costs, smelters are seeking for all kinds of savings and the pot shutdown and start-up tools address doubtless this concern. Damages on conductors and wedges are greatly decreased. The amperage does not have to be decreased for removing the last wedge which does not disturb the entire potline and its production.

Conclusion

The reduction pot start-up & shutdown solution designed by ECL™ and AP Technology™ teams is an innovation that significantly contributes to both HSE efforts and costs-savings while ensuring reliability, efficiency and rapidity of the process.

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