Hydraulic Wedge Puller Device "Quick Start" for Removing Wedges when Energizing an Electrolysis Cell in Aluminium Smelter

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Abstract

In the aluminum electrolysis, the electrolytic cells need to be replaced at old age with newly relined cathodes. The shutdown and restart of these electrolytic cells remains to be a very important and extremely critical part of the process. In EGA cell technologies, wedges are installed between busbars of a pot to be shut down and busbars of an adjacent upstream pot to by-pass electrical current and stop a particular pot. The wedges are extracted during the cell restart. The extraction of these wedges should be quick and accurate in order to prevent arcing on the conductor contact faces and avoid possible overheating/fusing of the last wedge left in the process. The execution of wedge extraction/pulling is a laborious task involving a lot of manpower and movement in a congested hazardous area considering heat, fumes and other equipment. The hydraulic wedge puller is part of a wedge extraction device. It is a jacking system used to remove up to ten inserted wedges. It uses a single hydraulic tank unit coupled with three pneumatically operated high-pressure hydraulic pumps of which two pumps are operated at a time and a standby pump ready to kick in case of any failure. This device is fitted with two operating stations to start and stop the system. The pressures exerted on the ten jacks are equal at all times in order to balance the forces exerted on the wedges to separate them. The quick isolation valve isolates the jack(s) on wedges already pulled out and diverts the pressure to other jacks pulling the remaining wedges. High pressure hose reels dedicated to each jack are installed for easy pull-out, pull-retract of the hoses. This newly developed hydraulic wedge puller system addresses the problems and issues faced by operators in the conventional jacking system and improves the safety of the startup process and equipment operation.

Key words: Cell start-up wedge puller device, hydraulic wedge jacking device, jacking device, cell bypass removal device, electrical short circuit removal device.

1. Introduction

Aluminium production is a continuous process. An aluminium smelter consists of large number of pots connected electrically series so that the same DC electric current flows through one pot, then on to the next one and so on to the end of the line. Continuity of the current path has to be guaranteed, otherwise an open circuit will be created and will cause a lot of damage unless the potline current is quickly shut down. A typical potline has from 300 to over 400 pots (EGA Al Taweelah Potline 3 is the longest in the world with 444 pots). When a pot is shut down the current has to bypass it; for this special short circuiting either wedges or some kind of bypass shunts are used. In EGA cell technologies, wedges are installed between busbars of a pot to be shut down and busbars of an adjacent upstream pot. An example is shown in Figure 1 for DX+ Pot Technology. The wedges have to be extracted during the cell restart and this is done with equipment called wedge puller, which is the subject of this paper.

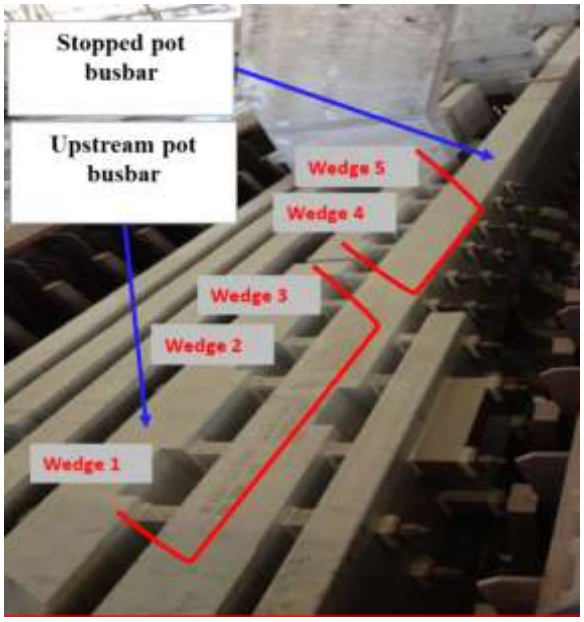

Figure 1. Wedge positions for cutting out a DX+ pot (one half of pot is shown). A total of 10 wedges are used per pot.

Pot shutdown and restart operations are among the most dangerous and critical operations in a potline in any pot technology especially due to the fact that it requires human involvement. The cutout can be either planned or un-planned. To cut out the pot the operators have to manually drop short-circuiting wedges between the electrical conductors of two adjacent pots and hammer them in position for good contact in the wedges. However, to remove the wedges for pot cut-in a lot of power and high speed of removal are needed and this can only be provided with a machine, a wedge puller. The extraction of these wedges should be quick and accurate in order to prevent arcing in the contacts between wedges and busbars and avoid possible overheating/fusing of the wedge pulled out last. The working area between the pots with wedge operations puts the operators in a tough and hazardous situation. The operator is exposed to the harsh environment of potrooms i.e., heat, high current, noise, fumes/dust and magnetic field.

In this paper we describe a new innovative hydraulic wedge puller system which solves the problems and issues faced by operators in the conventional jacking system and improves the safety of the startup process and equipment operation.

2. Pot Cut-out and Restart

In most aluminium smelters pot start-up or cutout operations are performed every week and in some every day when pot replacement is taking place. In a new smelter four to five pots are typically started per day and sometimes even more. There are planned shut-downs when a pot is designated to be shut down by pot replacement schedule or some specific problem known ahead of time and un-planned, such as tap-outs. The actions for an unplanned shut down must be very rapid.

During the restart of the pots, the wedges are withdrawn one by one and speed of the extraction is a vital parameter as the current density flowing through the wedges increases when the number of wedges still in place decreases. It was quite common for the operators to help in the removal of the last wedge, stuck to the busbars due to the high current and thermal expansion of the wedge. This can be avoided with good equipment design and enough power.

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Figure 14. Certification of the wedge puller.

8. Health, Safety and Environment (HSE) and Cost-Reducing Targets

The new semi-automatic wedge pulling device "Quick Start" minimized the manual intervention and eliminates failures in potlines. This reduces employees' exposure to the harsh environment of potrooms including heat, high current, noise, fumes/dust and magnetic field. The risk of exposure to residual energy was eliminated as there was no need to depressurize the hoses in the line as independent pumps were incorporated and spare hoses/jacks were considered. Hazards of laying hoses on the floor which earlier led to damages were eliminated by introducing retractable hose reels concept, even helping in eradicating tripping hazard. Manpower spent in wedge extraction was drastically reduced by introducing "Quick Start" unit. The number of operators involved is reduced to three, who typically spend 30 minutes in the activity.

9. Conclusion

The reduction pot start-up and shutdown solution designed by EGA Al Taweelah Reduction Maintenance team is an innovation that significantly contributes to HSE of the operators and is costs-effective, while ensuring reliability, efficiency and rapidity of the wedge extraction process.