Integrated Power Outage Restoration Capability System (IPORS) in Potlines

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Abstract

Power outages and poor recoveries are costly, damaging for environment and cell life and are also stressful for the personnel involved in the recovery. It is fundamental to strengthen the power-outage restoration efficiency while minimizing relapses and production losses as well as sustaining the reliability of the cells and safety of the staff affected. In this paper, we report the enhancement of the power outage-recovery agility through computerized capabilities. We recommend Integrated Power Outage Restoration Capability System (IPORS), a comprehensive, cost-effective outage-recovery management system that helps reduce the recovery duration and enhances the coordination by providing adequate information for directing responses. The IPORS is an advanced prediction and coordination capability that allows power outage recovery in a more informed and efficient manner.

Keywords: Power outage, power recovery agility, aluminium reduction potline.

1. Introduction

Whether caused by aging assets, extreme weather, natural calamity, shortage of energy, or open circuit, power outages are increasingly challenging to manage by potline personnel due to an increasingly high cooling tendency of modern aluminum cells. For instance, unplanned power outages could be particularly difficult to recover due to lack of companies' readiness and electrolytic cell preparedness to such thermal variation. Admittedly, as modern aluminum cells are designed to have a high heat loss capability, recovering from a prolonged power outage may be challenging and potentially damaging to the power plant utilities, if the personnel fails to control the recovery rate and efficiency.

Outages are costly, damaging for the environment and cell life and are stressful for the personnel involved in the recovery. It is essential to minimize the power outage relapses and costs while sustaining the reliability and safety of the cells and staff affected. In this paper, we aim to improve critical situation management and the recovery agility from a power outage through computarized capabilities.

In the event of a planned or an unplanned power outage, the cells lose heat rapidly, which results in the electrolyte cooling and beginning to freeze beyond the reasonable limits. During power restoration, multiple faults, abnormal voltages, and anode effects often occur. These occurrences are a burden to fix during the line load ramp-up phase. The amount of information facing the decision makers can be overwhelming to digest and interpret. Too often, some of the information might not be needed for decicion making to ensure rapid recovery. The following questions usually come to mind of managers: Which faults should the personnel attend first? How do operational and technical teams decide to move forward? When to increase the line load given the voltage capacity limits? How to minimize pot failure? How to avoide power outage relapse? Each operational decision may have a significant or detrimental impact on the business. As the reaction time is critical for success, reduction personnel need to act fast and coordinate activities cost-effectively.

To best manage the recovery efficiency and avoid pot loss, we propose Integrated Power Outage Restoration System (IPORS), a comprehensive, cost-effective outage-recovery management system that helps reduce the recovery duration by providing better information for directing responses. The IPORS is an advanced coordination capability to power restoration in a more informed and efficient manner. It tracks historical and real-time information such as cell voltages and age, anode effects, cathode voltage drop, iron and silicon content to predict cells at high risk of failure. Based on this information, operations personnel could make accurate decisions by evaluating how to prioritize responses, assign crews, and better determine possibilities for power creeps. IPORS also allows high agility recovery, minimizing the restoration time and improving communication with the power plant personnel. The remainder of this paper is organized as follows: first, we provide the purpose, the research question and the methodological framework of this study. We then outline a succinct background and the motivational framework for writing this paper. Next, we focus on three critical perspectives of the power outage and restoration; we describe the power outage and provide some knowledge of the currently available practices. Second, we discuss the challenges in high amperage cells; finally, we define the value proposition of IPORS and demonstrate how the system could maximize potential benefits.

2. Purpose

The power interruption and restoration in the aluminum production are addressed. Response to a long-term power outage involves two operational concurrent efforts; the efficient restoration of power and the prevention of collateral damages of a company's assets. The purpose of this paper is to describe the integrated power outage restoration capability function and illustrate the extent to which it increases the restoration agility through computerized capability. The scope of this paper applies to response and recovery capabilities of the pot line personnel in the event of a long-term power interruption.

3. Research Question

What computarized capability would the reduction personnel appreciate in the middle of the power outage restoration to increase recovery agility and minimize relapses and faults?

4. Motivational Framework and Background

Nearly all aluminum smelters experience power outages and power restoration at any given time of their lifespan. The power outage often results in a temporary loss of power and shutdown of reduction lines. For instance, from 2008 to 2017 most aluminium smelters in the Gulf Cooperation Council (GCC) countries - Ma'aden, EGA, Sohar and Aluminum Bahrain had major power outages ranging from partial to complete shutdown of the potlines. The power outage and restoration failure are primarily the result of the complexity of the Hall-Herault process as well as the lack of some companies' readiness and preparedness to such emergencies. For example, while most companies focus on reducing cost through utilizing rationalization and cheap labor, they often fail to align long-term contingency plans to power interruptions and restoration. Estimate of annual production losses due to power outages might amount 3 % to 10 % of the total production in many cases. The restoration efficiency affects the magnitude of the production loss. Modern aluminum plants now have an annual production of more than 1 - 2 million tonnes [1]. The loss of the 10 % of production could have a detrimental impact on a company's revenues and fixed costs. Aging assets, natural calamities, rising appetite to business productivity through amperage increase, lack of experienced personnel, and open-circuit incidents are situations that contribute to the power outage. In the meantime, there is limited ability in managing power outages restoration in most aluminum production companies; this paper suggests that adequate preparedness through competently trained personnel and technological capabilities may allow preventing the occurrence and mitigating the restoration duration, which is the principal cause of production and asset losses and the most challenging step of power interruptions.

Select Pots to Show: Potline Submit

POT	AGE (Days)	COMBINED DROP (mV)	IRON (%)	SILICON (%)	TEMPERATURE (° C)	BEAM POSITION (mm)	METAL HEIGHT (cm)	BATH HEIGHT (cm)	POT STAT
5001	356	446	0.050	0.023	956	226	26.0	18.0	
5002	1701	568	0.058	0.031	955	229	27.0	17.0	
5003	1618	548	0.054	0.026	967	96	27.0	18.0	
5004	1543	566	0.417	0.031	960	198	26.0	17.0	
5005	16	515	0.023	0.081	955	92	27.0	13.0	
5006	1907	548	0.281	0.045	972	234	27.0	17.0	
5007	1671	581	0.054	0.041	954	118	27.0	17.0	
5008	1802	632	0.303	0.091	973	189	25.0	22.0	
5009	1839	591	0.043	0.025	960	118	26.0	19.0	
5010	213	521	0.060	0.023	965	140	28.0	13.0	
5011	1517	580	0.063	0.059	950	113	26.0	17.0	
5012	285	571	0.361	0.027	973	112	26.0	17.0	
5013	170	565	0.051	0.021	956	185	27.0	17.0	
5014	103	574	0.051	0.021	960	188	26.0	17.0	
5015	1608	569	0.087	0.027	963	241	26.0	17.0	
5016	1508	552	0.058	0.029	954	192	28.0	17.0	
5017	1782	573	0.089	0.035	976	220	26.0	14.0	
5018	1663	774	0.072	0.085	958	208	28.0	17.0	
5019	1638	626	0.169	0.034	980	108	25.0	19.0	
5020	1804	569	0.190	0.091	975	116	26.0	21.0	
5021	1627	557	0.052	0.026	965	94	25.0	13.0	
5022	203	535	0.062	0.024	960	82	25.0	19.0	
5023	311	546	0.077	0.025	960	127	26.0	13.0	
5024	1521	558	0.058	0.038	980	111	27.0	17.0	
5025	970	555	0.049	0.027	955	164	26.0	18.0	
5026	1368	556	0.162	0.028	975	141	26.0	16.0	
5027	1817	581	0.070	0.029	978	163	26.0	15.0	
5028	711	557	0.064	0.026	963	162	26.0	18.0	

Figure 11. Critical historical variables for a cell cut-out decision-making.

13. References

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