RUSAL's Digital Tools for the Proactive Control of Cells and Cell Lines

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Abstract

RUSAL Engineering & Technology Center has always paid attention to the development of digital control systems to enhance the performance and environmental indicators of cells and cell lines.

In 2022, the center introduced ELTM (Electrolysis Technology Monitoring System), an electrolysis technology monitoring system. The system, which continuously processes data from cells, precisely detects problems in cells and cell lines in real time and immediately warns personnel to urgently remedy a problem. The system has been successfully used by all potroom managers and process engineers.

Moreover, RUSAL continues to upgrade its existing high-amperage cell control systems. As an example, Virtual Cell, a digital twin, has been integrated in RUSAL's conventional SAAT process control system, which allows optimizing cell operation by means of virtual sensors and predictive analytics.

Plans are to supplement control systems with AI (Artificial Intelligence) algorithms in order to enhance control quality and prediction accuracy, and adapt them to different cell types. Pilot tests showcase improvements in operational efficiency and environmental indicators, and cost savings.

Keywords: Digital cell control systems, ELTM, Virtual cell, Digital twin, Artificial intelligence.

1. Introduction

Aluminum reduction cells and cell lines represent quite complex systems that are characterized by a multitude of stationary states and that are capable of operating in a wide range of parameters, i.e., in operating windows. Not all stationary states are energy – efficient or economically feasible. Now, it is the potline personnel who search for energy-efficient states or "select parameters"; they use their personal experience and various control tools, including digital ones: automated process control systems (APCS), MES (Manufacturing Execution System), video monitoring systems, etc. Such systems generate a huge amount of data that need to be used in cell control. Considering the growth of cell amperage, global deterioration in the quality of raw materials and the shortage of process personnel, the development of digital control systems has lately become a key element of the process of transforming the industry.

Since the mid-1990s, RUSAL's smelters have been replacing the outdated *"Aluminium"* process control system with the new generation "*SAAT"* systems, which are based on Siemens controllers and which are integrated with the upper-level *ELVIS* automated control systems. In the late 1990s, a proprietary Manufacturing Execution System (MES) – an automated workstation – was developed to collect and analyze process data, as well as the *Virtual Cell*, a dynamic model to solve analytical issues during aluminum production and train process engineers.
These products have been continuously improved and enhanced since then.

In the meantime, RUSAL's facilities have additionally created a number of their own software (in various programming languages and with different interfaces) to address the growing need for software at all management and control levels. The problem is, such products are all different, and there are extremely weak connections, if any, between them. Therefore, it was a logical step for RUSAL, when developing digital control tools, to start combining all the software into ALECSYS, a uniform digital eco-system.

The purpose of this paper is to review the experience of deploying across RUSAL a uniform eco-system of digital tools to manage and control aluminum reduction technologies, as well as to present a strategy for its further enhancement and up-scaling (based on the two main components: ELVIS WEB and MES ELTM).

2. Development of RUSAL's Uniform Digital Eco-System

When developing the uniform digital eco-system, the objectives were as follows:

1. Integration of all the Web applications developed by RUSAL, so that there is a single access point, uniform services, and a single information space. Figure 1 shows a single point to access ALECSYS.
2. The eco-system development should involve up-to-date approaches to the designing and development of software.

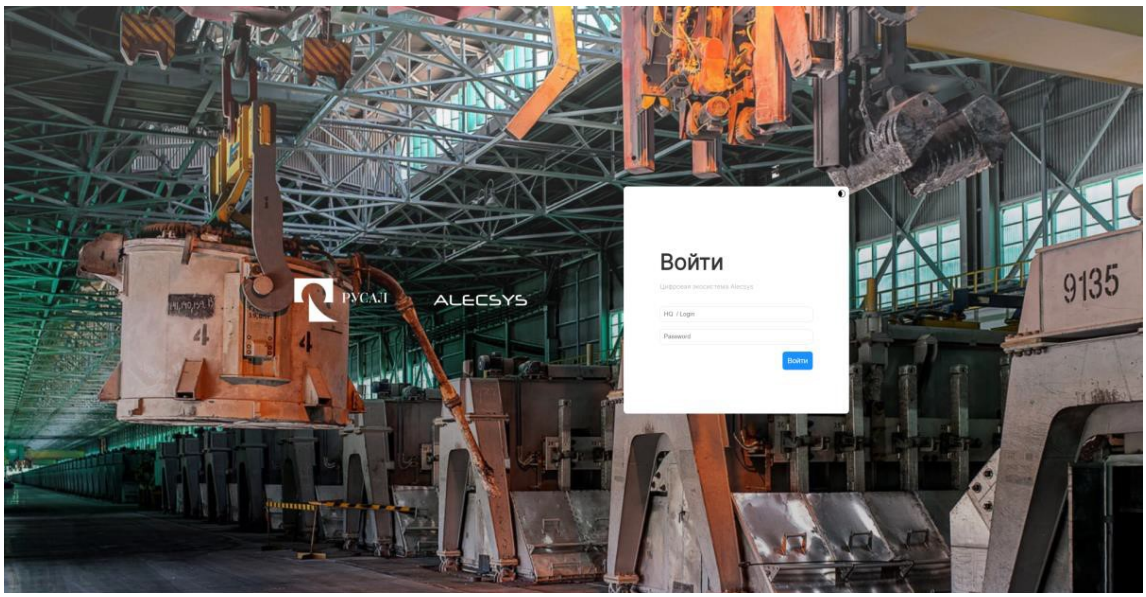

Figure 1. Single point of access to ALECSYS.

The single information space ensures the following advantages:

1. The ability to integrate data between different production facilities,
2. The increase in the period of storage of process data (for their further analysis); data can be stored for more than a year (instead of a current period of 1 month),

- Predict disturbances with an accuracy of 90 %, and higher. This allows us to be aware of possible problems in advance, which reduces the risk of equipment downtime;
- Detection of hidden disturbances. In the past, it took 5–14 days to detect a problem before it appeared, and now it takes only 3–9 days, i.e., twice as fast;
- Identification of problems with automated control systems (ACS); and
- Prediction of anode effects (AEs) before they occur.

The information & analytical system (IAS) is also currently integrated into the ALECSYS eco-system, which improves performance indicators.

3. Conclusions

The deployment of ALECSYS, a uniform digital eco-system, allowed RUSAL to increase the stability and efficiency of cell operation control. Automated monitoring and AI tools open up new prospects for reducing the time of response to abnormalities and increase process transparency.

Prospects for improvement and enhancement are associated with a deeper implementation of AI algorithms (based on Big Data analysis) into cell control, the use of digital sensors and the expansion of functionality.

RUSAL's experience confirms that digitalization is an integral element of competitiveness in the context of the global transition to a low-carbon economy. Further enhancement of ALECSYS will allow the Company to reduce its carbon footprint, reduce emissions and provide for fully autonomous production lines in the future.

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