Improving Reliability and Reducing Electric Energy Losses in the 'Rod–Yoke' Connections

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Abstract

In recent years, the most important strategic goal of the global aluminium producers has been to intensify existing technologies in order to minimise electricity consumption. Globally, some companies are gradually implementing technical solutions to achieve the ultimate goal of electricity consumption of less than 12 000 kWh/t Al. One of the main areas in achieving high energy efficiency is to reduce the voltage drop in the connections. The most important connection, on which the operation of the aluminium pot depends, is the 'aluminium rod–yoke' connection through a Fe-Al bimetallic coupling.

During the operation of aluminium pots, approximately up to 35 % of the heat is removed through the top of the anode array, the 'aluminium rod–bimetallic plate–yoke' connection is constantly in the high temperature zone. The passage of high current density leads to heating up the contact up to 300 – 400 °C. As a result, corrosion occurs in places where the joint is poorly welded, and under the influence of high voltage and the presence of the joint breakdown failure source, eddy currents arise, which under the high temperatures provoke electrocorrosion. Over time, the process of the breakdown failure of a welded joint accelerates: the larger the centre of failure, the faster the overall process of joint corrosion. The area of the source of the breakdown failure increases, and the area of the joint decreases. Under its own weight, the lower part of the anode, that is, steel yoke with prebaked anode blocks, breaks off, which leads to an emergency condition in the pot.

This article proposes using a new approach of mounting the yoke to the anode rod through several Fe-Al bimetallic couplings of various configurations and designs. Based on results in terms of reliability and energy efficiency, this technical solution has been included in the technology package of RA-400 and RA-550 technologies.

Key words: RA-400 pot, RA-550 pot, Fe-Al bimetallic coupling, anode rod assembly, energy efficiency.

1. Introduction

Current in the pot is distributed over many parallel branches, the number of which depends on the size and design of the pot. In turn, the parallel branches consist of a number of resistances in series and in parallel. Electric connections exist between the individual elements of different parallel branches, due to which equalisation currents arise.

In the course of operation, the process parameters of the pot vary: the anode is consumed, metal is accumulated, alumina is consumed, anodes are replaced, etc. The above factors, as well as a number of design features of the pot, lead to a continuous redistribution of the current. Uneven

and unstable current distribution in the pot leads to internal mechanical stresses, local heat-up, changes in the geometric dimensions and the state of the individual units, as well as increased energy losses.

The purpose of this work is an attempt to eliminate the causes that affect the uneven distribution of the current through the pot, and to assess the impact of the current distribution on the technology and the technical and economic indicators of electrolysis.

2. General

Production of aluminium requires large amounts of electrical energy, and the reduction of its consumption is one of the most important issues in the aluminium industry. This is why it is necessary to know in which parts of the pot there are losses of electrical energy, and what the reasons for this are. The current in all parts of the pot is not the same and the losses of electrical energy are directly proportional to the voltage drop in these parts. Thus, voltage drops in all parts can be calculated or measured directly on the operating pot.

The main area where voltage drops and as a consequence, the uneven distribution of current along parallel branches occur is the 'anode bus to rodded anode' connection. Figure 1 shows a diagram of typical voltage drops in the anode assembly of the RA-400 pot. The voltage distribution in the anode is shown in Fig. 1.

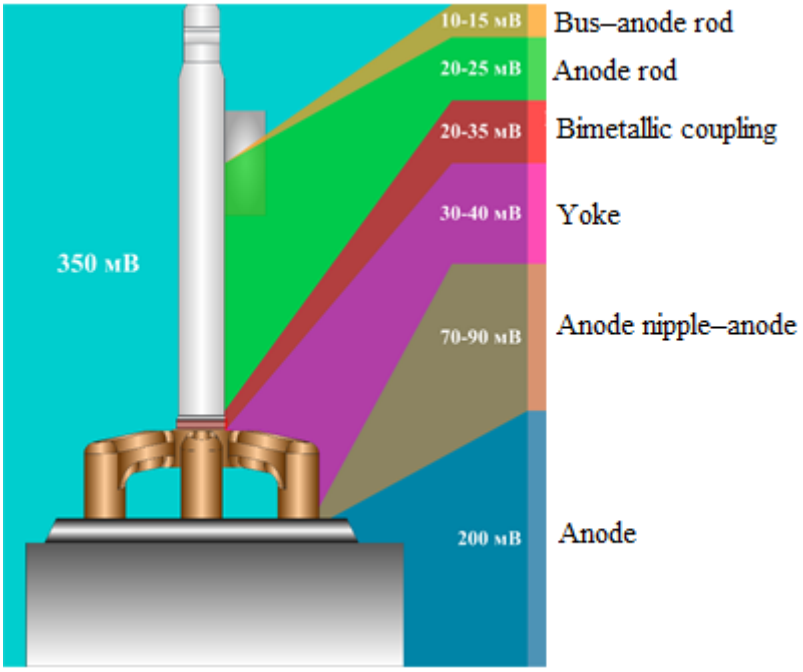

Figure 1. Typical voltage drops in the middle of the service life of an anode of the RA-400 pot.

Voltage drop in the 'bus–rod' connection is due to the design features of the connection, surface contact, as well as the preparation of the surfaces before installing the anode. Over time, due to high temperatures, intermetallic compounds form in this connection, leading to an increase in resistance and, as a result, in a voltage drop. High voltage drops can be eliminated by tapping the joint and tightening the clamp.