Pot Bypass Arrangement – Lifeline of Potlines

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Abstract

Uninterrupted operation of potlines is a major challenge in aluminium business and this determines the sustainable operation of smelter. The interruption in potline operation shall be due to lack of raw materials, disturbance in DC power supply, potline open circuit, major fire, etc. Many factors evident for operational interruption are external drivers, however open circuit is only due to pot instability of various reasons. Such instability may result in shut down of entire smelter with huge loss of capital and business. The objective of this paper is to demonstrate the various ways of operating potline during any open circuit and to avoid interruption in operation. This concept was developed by considering various categories of open circuit incidents and related control measures were designed for the same. The cases considered are: short circuit bus bar damage of non-corner pot (Type-1), short circuit bus bar partially damaged in pot (Type-2), short circuit bus bar completely damaged in corner pot (Type-3) and several potshells got damaged due to major fire or structural failure (Type-4). To handle all such contingencies, different sets of tools were designed, developed and simulated for performance study. Contingency tool for Type-1, Type-2 and Type-3 were designed, tested and demonstrated in the potline; the result shows restoration of potline operation within 30 minutes for each riser. Type-4 design is in modelling stage and it has been designed in flexible model so as to bypass 'n' number of pots depending on severity of the incident.

Keywords: Interruption in pot operation, open potline circuit, pot fire, contingency tool.

1. Overview of Project

Vedanta Jharsuguda has six potlines of GAMI 320 kA pots, installed in two Plants: Plant 1 has two potlines of 304 pots each, Plant 2 has 4 potlines of which three lines are operating now & one line is under commissioing. The pot has five anode risers and uses pot bypass shunts at the base of each riser to shut down a pot for relining. The uninterrupted operation plays a vital role in defining the reliability and sustenance of potline and so the business deliverables. This paper highlights the pot bypass arrangements which shall act as the lifeline of potlines.

2. Introduction

In potline operation, the major causes for potline interruption are:

a. Shortage in raw materials,
b. Interruption of DC power supply,
c. Interruption in compressed air supply,
d. Natural disaster,
e. Major fire in potline,
f. Open circuit.

The frequency and potentially catastrophic consequences of power interruptions in world smelters are described in [1].

This paper explains all the innovated contingency measures for ensuring uninterrupted operation of potline during ***"open circuit of pot".***

3. Open Circuit Condition of Potlines

Potline design is very similar to number of batteries connected in series. In the series connected batteries, if an abnormality happens at any point of contact/process, the entire circuit will be interrupted. The same scenario is applicable for potline operation as well. 308 pots in each line are connected in series, and any open circuit at one location will result in shut down of entire potline. The open circuit mechanism in a potline is described in detail in [2].

The main causes of open circuit of potlines are:

a. Pot leakage,
b. High voltage anode effect,
c. Anode clad failure,
d. Dead pot voltage not within the desired range.

In all these four cases, in cell technology installed at Vedanta, the result will be ***disconnection of anode riser joints/short circuit bus bar*** (pot bypass shunts) due to high voltage created on a pot by open circuit. The disconnection of riser joints/short circuit bus bar shall be at various locations such as short circuit bus bar damage of non-corner pot, short circuit bus bar partially damaged in corner pot, short circuit bus bar completely damaged and several potshells damaged due to fire/structural collapse.

4. Contingency Plan to Mitigate Open Circuit Condition

To mitigate open circuit condition of potline, the following four types of innovative contingency plan have been designed.

1. Contingency tool - Type 1,
2. Contingency tool - Type 2,
3. Contingency tool - Type 3,
4. Contingency tool - Type 4.

5. Contingency Tool - Type 1

This contingency tool of Type-1 (Figures 1 and 2) is designed for the condition when short circuit bus bar got damaged in non-corner pot.

Five such sets are required in one pot, one per riser. Cross section of aluminium bus bar, design of flex, and all arrangements including the size of bolts and nuts are specified and pre-defined. The flex used here consists of 9 bands and 1 band consists of 9 leaves of 1 mm thickness.

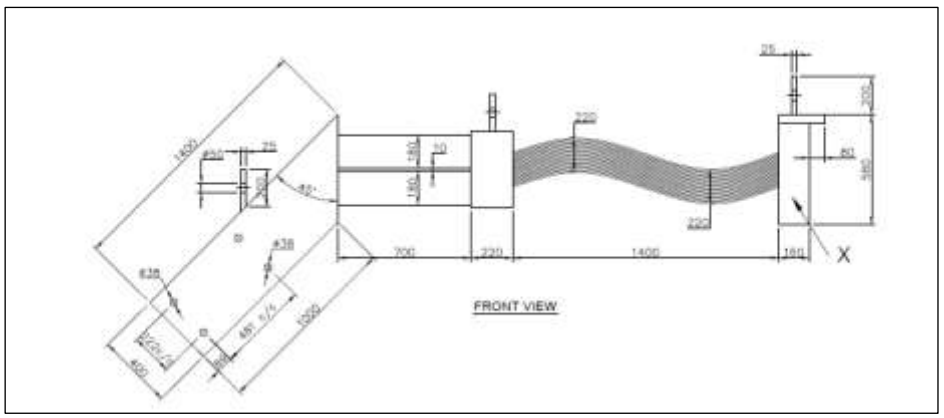

Figure 1. Front view of Type-1 contingency tool.

8. Contingency tool- Type 4

This proposed contingency tool of Type-4 (Figure 9) is suitable for the condition when several potshells got damaged due to major fire or structural failure.

The design and development phase have been initiated for this type of contingency tool but they have not been built yet.

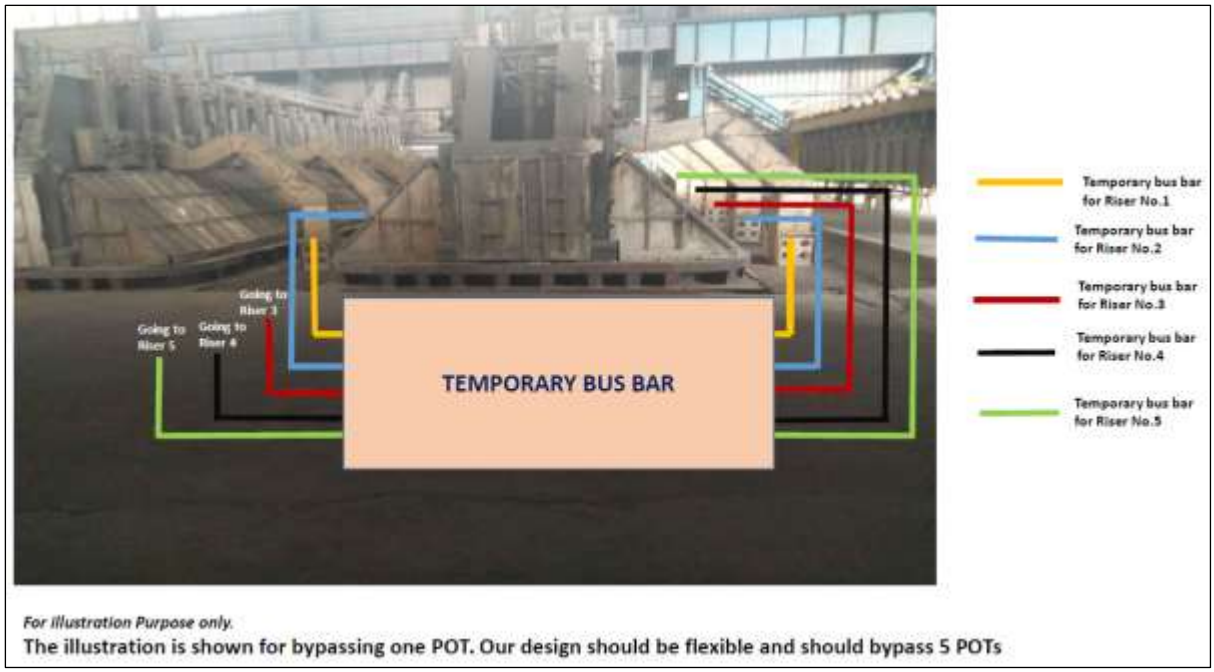

Figure 9. Proposed design of Type-4 contingency tool.

Proposed design as per sketch in Figure 9:

1. Riser-1 of one end will be connected to Riser-5 of another end
2. Riser-2 of one end will be connected to Riser-4 of another end
3. Riser-3 of one end will be connected to Riser-3 of another end
4. Riser-4 of one end will be connected to Riser-2 of another end
5. Riser-5 of one end will be connected to Riser-1 of another end

9. Conclusion

Stable and sustainable operation of the potlines is the key for aluminium business to grow and expand further. Any interruption in operation of a potline is a huge loss or setback for business. The mitigation plan for any interruption should be capable to retrieve the potline operation in minimal time. At Vedanta, the contingency tools are designed in such a way to manage and restore the potline operation to stable within 2 - 3 h maximum in any case of interruption. We designed four types of contingency tools, for different situations that could arise in a potline, of which two have been successfully tested in practice. As an aluminium leader, the thought process is to assure such potline operation to never have an instance to use these contingency tools in our operation. But we are readying for unpredictable.

10. References

1. Alton T. Tabereaux, The high risk of electrical power interruptions to the continuous production of aluminum smelters, Light Metal Age, October 2018, 24-30.
2. Dominique Duval et al., Potline open circuit protection, *Light Metals* 2012, 913-916.