Industrial Internet of Things Based Measurement Instrument in Potroom

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Abstract

With the achievement of major milestones in big data analytics, cloud computing, internet of things, artificial intelligence and machine learning, industries are transgressing the traditional manual systems and leaning toward data driven optimal solutions for better and accurate results. In line with the vision of Industry 4.0, Aluminum industry is also transforming itself from taking intuitive decisions to making data centric proactive and predictive decisions.

Vedanta Aluminum Limited has brought Industrial Internet of Things (IIoT) concept into the potroom for digitalization of measurements of critical pot parameters like – side shell temperature (SST), collector bar temperature (CBT), anode current density (ACD) and bath temperature (BT). A digital measurement device has been developed in association with an electric mobility solutions start-up. It is a sensor-based instrument and uses cloud-computing platform to store, read and introspect the data. This device will capture and record the readings in the central server with a single click and thus a reliable data bank will be created consisting of critical values of different pot parameters. It will enable data integrity in process parameters, reduction of manual involvement in measurement, resulting in a significant decrease in human error. Key benefits that can be achieved utilizing this device are – On time data capturing with time stamping for error proof logging, self-identification of abnormality in parameters and generation of automatic alarms and detection of pre-pot leakage condition.

Keywords: Industry 4.0, digitalization, IIoT, pot-leakage.

1. Introduction

Vedanta Aluminium, a subsidiary of Vedanta Limited, is a prominent global producer of aluminium, often referred to as the 'Metal of the Future'. It holds the distinction of being the largest aluminium producer in India, operating in the states of Odisha and Chhattisgarh. The Vedanta Jharsuguda plant has the annual production capacity of 1.8 million tonnes of primary aluminium. Such extensive production necessitates a vast infrastructure, a substantial workforce, and continuous monitoring of operational processes. From the importation of raw materials to the production of finished goods, every aspect of the process is meticulously recorded as data. Some steps involve manual data entry, while others utilize digital data collection. The accurate information and thorough analysis of this data are crucial for maintaining stable operational practices and consistent processes.

The industrial production of aluminium follows the Hall-Héroult process, which involves the electrochemical decomposition of alumina or aluminium oxide (Al_2O_3) dissolved in an electrolyte, composed mostly of cryolite (Na_3AlF_6) with 8-12 % excess AlF_3, and 4-7 % CaF_2, also known as the bath. This process occurs at temperatures ranging from 950 °C to 970 °C. Direct current (DC) is used to reduce alumina to molten aluminium, which is then deposited at the cathode. Oxygen generated during the electrolysis process reacts with the carbon anode to produce carbon dioxide (CO_2).

$$2Al_2O_3 + 3C = 4Al + 3CO_2 \quad (1)$$

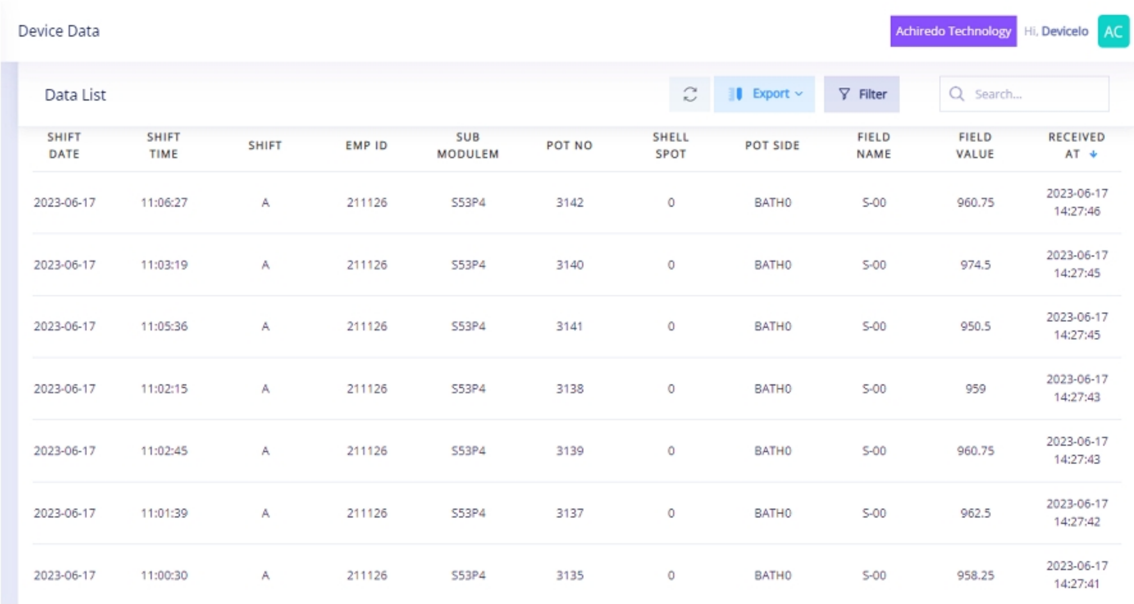
By implementing the Hall-Héroult process, the industrial production of aluminium becomes feasible on a large scale. The molten aluminium collected at the cathode can then be further processed and used in various industries for manufacturing purposes.
The aluminium smelting process encompasses numerous critical parameters, including alumina feeding, bath temperature, anode current density, cathode type, cathode voltage drop, aluminium fluoride feeding, side shell temperature, and more. All these parameters are not digitally monitored, leading to potential manual errors during data collection. Incorrect entry of vital parameters can result in severe consequences such as red-shell formation, anode clad failure, significant increases in energy consumption, and in extreme cases, pot tap-outs or leaks.

To transition from manual data entry to digital integration, Vedanta has undertaken several initiatives. Embracing the principles of Industry 4.0, Vedanta has placed significant focus on big data analysis and process digitalization. The initiatives involve the development of IIoT-based digital measurement instruments, aligning with the latest advancements in technology.

2. Industry 4.0 and IIoT

The first three industrial revolutions are characterised as being driven by mechanical production relying on water and steam power, use of mass labour and electrical energy and the use of electronic, automated production respectively. Industry 4.0 refers to the ongoing phase of digitalization in the manufacturing sector, driven by data, advanced analytics, automation and advanced manufacturing technologies. It has a broader scope, which includes IIoT, digital transformation, and business sustainability.

Figure 1. Industry 4.0 technologies [1].



SHIFT DATE	SHIFT TIME	SHIFT	EMP ID	SUB MODULEM	POT NO	SHELL SPOT	POT SIDE	FIELD NAME	FIELD VALUE	RECEIVED AT
2023-06-17	11:06:27	A	211126	S53P4	3142	0	BATH0	S-00	960.75	2023-06-17 14:27:46
2023-06-17	11:03:19	A	211126	S53P4	3140	0	BATH0	S-00	974.5	2023-06-17 14:27:45
2023-06-17	11:05:36	A	211126	S53P4	3141	0	BATH0	S-00	950.5	2023-06-17 14:27:45
2023-06-17	11:02:15	A	211126	S53P4	3138	0	BATH0	S-00	959	2023-06-17 14:27:43
2023-06-17	11:02:45	A	211126	S53P4	3139	0	BATH0	S-00	960.75	2023-06-17 14:27:43
2023-06-17	11:01:39	A	211126	S53P4	3137	0	BATH0	S-00	962.5	2023-06-17 14:27:42
2023-06-17	11:00:30	A	211126	S53P4	3135	0	BATH0	S-00	958.25	2023-06-17 14:27:41

Figure 11. Real time monitoring of SST and BT with timestamping.

7. References

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