Data Acquisition Precision for the Chloralkali Process

The following paper focuses on data acquisition precision for equipment used to measure cell voltage in the chloralkali process and how precision is at the heart of EMOS functionality.

MODA Precision – Laboratory Measurements

To evaluate the precision of all MODA analog input channels, a voltage source is connected to each channel one at a time; the voltage source is then measured and compared with the value shown in the EMOS software. To ensure signal stability and minimize noise, the voltage source used is a 3V battery pack. A 6-digit, high precision Agilent multimeter is used to measure the voltage source.

The experiment yields the following results.

Channel	Multimeter	EMOS	Delta	Delta
	V	V	V	mV
1	3.22840	3.22866368	-0.000264	0.263680
2	3.22840	3.22866368	-0.000264	0.263680
3	3.22840	3.22866368	-0.000264	0.263680
4	3.22840	3.22866368	-0.000264	0.263680
5	3.22840	3.22866368	-0.000264	0.263680
6	3.22840	3.22866368	-0.000264	0.263680
7	3.22840	3.22866368	-0.000264	0.263680
8	3.22840	3.22866368	-0.000264	0.263680
9	3.22840	3.22829747	0.000103	0.102530
10	3.22840	3.22848058	-0.000081	0.080580
11	3.22840	3.22829747	0.000103	0.102530
12	3.22840	3.22848058	-0.000081	0.080580
13	3.22840	3.22829747	0.000103	0.102530
14	3.22840	3.22829747	0.000103	0.102530
15	3.22840	3.22829747	0.000103	0.102530
16	3.22840	3.22829747	0.000103	0.102530
17	3.22840	3.22848058	-0.000081	0.080580
18	3.22300	3.22371984	-0.000720	0.719840
19	3.22350	3.22353673	-0.000037	0.036730
20	3.22370	3.22426915	-0.000569	0.569150
21	3.22370	3.22390294	-0.000203	0.202940
22	3.22370	3.22426915	-0.000569	0.569150
23	3.22370	3.22390294	-0.000203	0.202940
24	3.22370	3.22426915	-0.000569	0.569150
25	3.22390	3.22408605	-0.000186	0.186050
26	3.22390	3.22426915	-0.000369	0.369150
27	3.22390	3.22408605	-0.000186	0.186050
28	3.22390	3.22426915	-0.000369	0.369150
29	3.22390	3.22408605	-0.000186	0.186050
30	3.22410	3.22445226	-0.000352	0.352260
31	3.22410	3.22426915	-0.000169	0.169150
32	3.22410	3.22445226	-0.000352	0.352260

From these measurements, it can be seen that the MODA has an average difference of 0.250 mV from the measured voltage. In essence, this error margin is within the analog-to-digital converter resolution of ±0.180 mV.

To achieve this precision, the circuit topology of the MODA is designed to simplify the manipulations required for calibration and these are automated to minimize human error. Parameters are stored in a database for traceability and self-tests are used to ensure that the calibration has been performed adequately.

Importance of Filtering

The process voltage sampled by the MODA also contains a significant amount of noise generated by the rectifier. This noise needs to be removed from the measurement in order to obtain a precise cell voltage measurement. The MODA incorporates sampling algorithms that synchronize to the fundamental rectifier frequency, for example 50Hz in Europe or 60Hz in North-America, and removes this unwanted noise. This synchronization has the benefit of providing fast data acquisition compared to standard filtering and averaging techniques. Without this advanced filtering, overall precision would be affected by several millivolts.

The MODA is also designed to be installed directly on the electrolyzer in order to minimize wire length, therefore reducing noise pickup and contributing to greater precision.

How Temperature Influences the Measurements

Most available off-the-shelf data acquisition components advertise precision without consideration for temperature drift. For a typical ±0.1% measurement class component with a 10V input measuring range, the room temperature precision will be of ±10 mV. Over the usable temperature range, the added temperature drift can exceed ±20 mV.

The MODA is thermally compensated over the practical operating temperature found in cell rooms in order to provide a total precision within ±1.5 mV.

Why This Precision is Necessary

The primary reason behind this required precision is for plant safety. Early detection of some of the hazards is only possible with this range of precision. For instance, early detection of injector blockage is seen in a change of cell behavior within a range of about 20mV. A precise reading provides time to perform corrective action and avoid build-up to its point of no-return resulting in the emergency shutdown of the electrolyzer.

Similarly, with older plants or when an element degrades prematurely, a decision may be taken to operate with higher voltage values in order to keep the elements until the next planned maintenance. With a precise reading, a realistic trip limit can be set without putting the plant at risk. With other systems, imprecision may require the engineer to consider a greater error margin (high or low) that requires a constant attention due to increased risk and more frequent shutdowns.

Precision has an inherent benefit, a precise individual voltage reading allows you to perform selective maintenance, and realize substantial economy. The individual voltage reading is THE ONLY on-line direct indication of the cell condition.

Under normal condition, the aging of the cell component has an impact of about 35-50 mV that is shared between membrane (10 to 20 mV) and coatings (25 to 30 mV). With EMOS precision and R2's unique expertise, it's possible to evaluate the condition of the cell, determine the current efficiency of the individual membranes and the specific energy consumption of each individual cell. This is used to identify under performers and elaborate a maintenance plan.

Without precision, this is not possible. For example, a 30 mV imprecision on the dynamic range will result in a 60 month resolution in the aging evaluation of the membrane and 30 months for the coating. When determining the current efficiency for each element, an imprecision of 30 mV results in an error of 1.5%, equivalent to 35kWh/t on the specific power consumption. Overall, without precision, underperformers are kept too long and it is not possible to make a correlation analysis between elements, resulting in considerable loss for the plant.

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