Ackumen™ MCA-i™ – The safer, smarter monochloramine offering

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INTRODUCTION:

From super cruise control that allows hands-free driving of a vehicle to smart watches that tell us how much sleep we get, monitor our health statistics and track our exercise, we are becoming more connected every day. So is chemistry! With this evolution Buckman is stepping up the mill visibility of our monochloramine chemical systems with cloud connection and actionable insights responding to the ever-changing mill processes.

Monochloramine Overview

Monochloramines (MCA) are formed in situ by mixing the monochloramine precursor (MCAP) with industrial grade sodium hypochlorite in water. The general chemical equation is:

$$NH_3 + NaOCl \rightarrow NH_2Cl + NaOH$$

This reaction must occur at the proper pH (>7) and at the proper molar ratio of MCAP to sodium hypochlorite. If the sodium hypochlorite is overfed, the reaction is pushed to the formation of dichloramines.

$$NaOCl + NH_2Cl \rightarrow NHCl_2 + NaOH$$

Monochloramines are considered weak oxidizers when compared to the other oxidizers used in the paper manufacturing process such as chlorine dioxide, hypochlorous acid, hypobromous acid, and peracetic acid. Because they are considered to be a "combined" form of chlorine, monochloramines react to a much less degree or not at all with other wet-end additives such as dyes, optical brighteners, starch, retention aids, and sizing agents. They are highly specific to the microbial contamination in a process. Because of these attributes, MCA chemistry has become one of the major oxidant biocides used in the paper industry.

Taking Your MCA Program to the Next Level

Reducing freshwater usage, increased use of and rising contamination in recycled furnish and greater reliance on anaerobic digesters for effluent treatment can mean adding more chemistries to supplement final product specifications and effluent efficiency. This can lead to increased process variability, unscheduled shutdowns, lower quality product and additional costs. In response to these challenges, Buckman offers a new monochloramine program called Ackumen™ MCA-i™, a breakthrough chemical-digital solution that uses artificial intelligence with actionable insights that automatically and promptly stabilize your process.

MCA-i™ combines Buckman's best-in-class monochloramine chemistry with state-of-the-art sensing technology, cloud-based data analytics, 24/7 expert monitoring and analysis, and accurate predictive modeling to take the work – and the guesswork – out of you managing your paper machine microbicide programs and their impact on your effluent system. One significant feature of the MCA-i unit is a hypochlorite sensor which measures the activity of the sodium hypochlorite. It is well known that sodium hypochlorite's stability is greatly impacted by storage temperature, storage time and exposure to sunlight. As noted above, to produce a stable MCA molecule, the sodium hypochlorite and MCAP must be mixed in water at a precise molar ratio. The hypo sensor measures the sodium hypochlorite concentration continuously, adjusting the sodium hypochlorite flow rate to maintain that precise molar ratio.

MCA-i is Buckman's newest MCA generator that utilizes data to produce actionable insights. It is capable of monitoring multiple sensor data, combining them with mill process data to automatically adjust your treatment program. Your microbiological control program is pro-actively managed. The generator adds significant safety features, including Buckman's patented reaction temperature technology. Its improvements in automation and technology allow usage reductions of not only the microbial control chemistries; you will also benefit from better system/process performance, leading to significant savings in functional chemistry, improved machine runnability and improved final product quality. As mill personnel, you can view key operational parameters of the unit and Key Performance Indicators (KPIs) from your computer or smart phone.

To prevent disruptions to your process, the MCA-i unit will alert the Buckman representative of routine maintenance and potential problems with the unit or the treatment program. The unit can "learn" to change dosage rates as your process experiences changes or system upsets, such as high freshwater usage at start-up or increased broke usage after a break. This learned insight can lead to better control and chemical cost savings to you.

MCA-i connects to the cloud and allows Buckman's Remote Services Innovation (RSI) lab and global subject matter experts to remotely monitor the unit and hundreds of process parameters – nearly 1000 data points – and notifies the Buckman representative of significant changes to mill processes, such as increased biocide demand. It works with edge computing and cloud storage to securely collect and store data, which can then be used to develop historical patterns. This allows the quick detection of process anomalies. Benchmarking data with context can be used to help you plan continuous improvement projects or your new machine/mill. Critical to achieving the best-in-class performance is linking the "what, where, when and how".

Case History

MCA-i technology has allowed for significant performance increases. Recently, MCA-i was benchmarked against Buckman's previous generation MCA equipment on a paper machine in North America.

Phase 1 - Trial

Phase 1 of this evaluation was to compare the performance of MCA-i with the older generator, a Gen 4. In order to accomplish this, application points and dosing strategies were not changed during this phase. A primary goal was to maintain a similar MCA residual at the headbox while maintaining KPIs such as machine runnability. Manual testing included both total chlorine and MCA residuals and adenosine triphosphate (ATP) analysis to measure microbial contamination. Data collected via digital platforms (Buckman OnSite® for the Gen 4 and Ackumen™ for MCA-i) included application flow rates, pump flow rates from water, MCAP and sodium hypochlorite, and pH. The hypochlorite concentration was also monitored by the MCA-i unit.

Results of Phase 1 are shown in Figures 1-2 and summarized in Table 1. With MCA-i, slightly higher headbox MCA residuals (13.3%) were easily maintained (Figure 1) while a reduction in both the MCAP (12.0%) and sodium hypochlorite (14.7%) chemical usages was achieved (Figure 2). With regards to controlling microbial activity, headbox ATP remained well below the customer's upper limit of 500 relative light units (rlu) (Figure 3). The outliers (above 100 rlu) occurred after an unscheduled down and correlate to lower headbox MCA residuals (Figure 1) during the same time period.

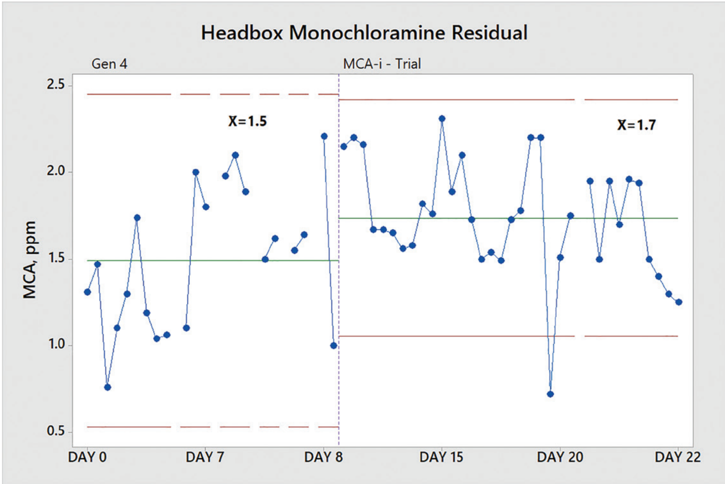


Figure 1: Phase 1 Trial Evaluation of Headbox MCA Residual. When comparing the performance of MCA-i with the Gen 4, slightly higher MCA residuals (13.3%) were achieved.

Table 1. Summary of key findings from Phase 1 Trial Evaluation

	Gen 4	MCA-i	Difference	% Change
Headbox MCA Residual (ppm)	1.5	1.7	+0.20	13.3
MCAP Flow Rate, LPH	13.3	11.7	-1.6	-12.0
Sodium Hypochlorite Flow Rate, LPH	33.4	28.5	-4.9	-14.7

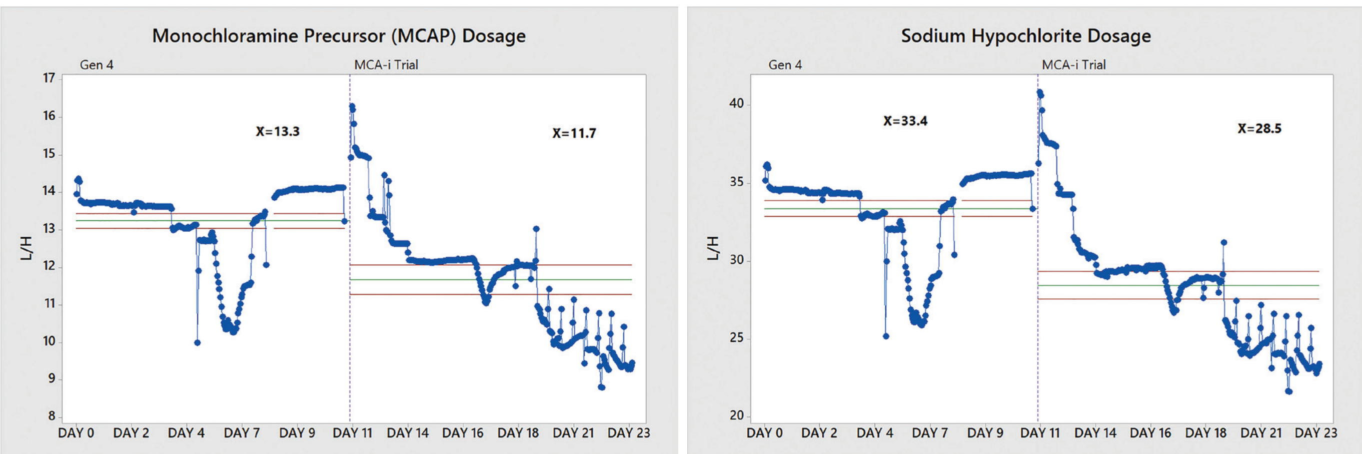
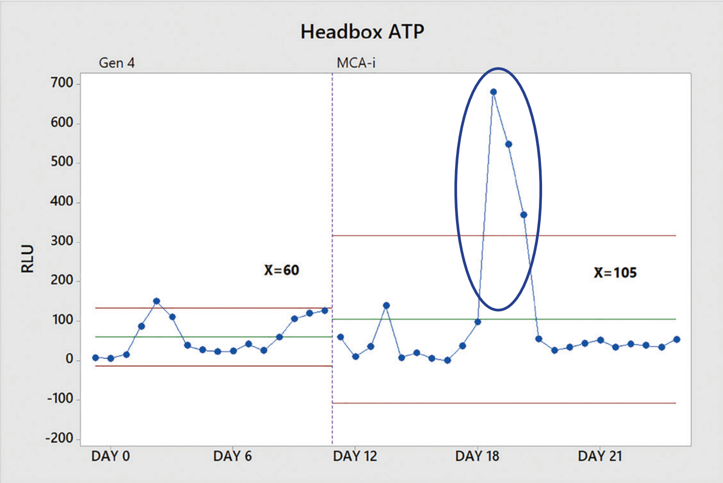


Figure 2: Phase 1 Trial Evaluation of MCAP and Sodium Hypochlorite Dosage Rates. For the MCA-i trial, both chemical flow rates were reduced while maintaining a slightly higher headbox MCA residual (Figure 1) as compared with the Gen 4.



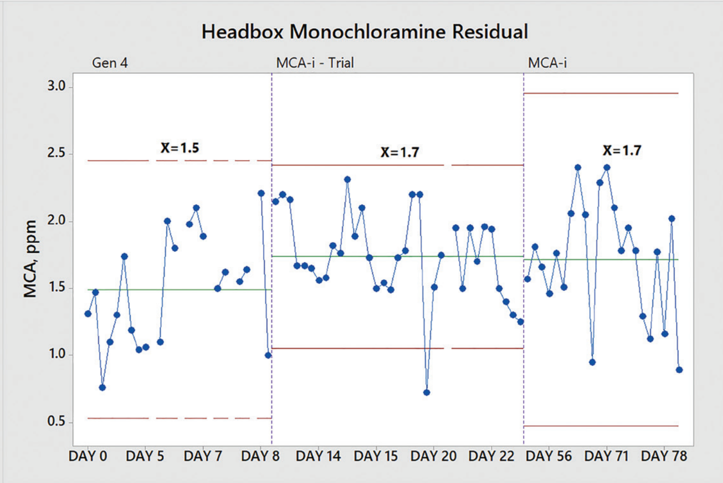


Figure 3: Phase 1 Trial Evaluation of Microbial Control via ATP Analysis. With the Gen 4 unit, ATP numbers were well below the customer's upper limit of 500 rlu. MCA-i produced similar results. The three outliers (encircled) occurred after an unplanned down and correlate to slightly lower MCA headbox residuals during the same time period (Figure 1).

Figure 4: Phase 2 Trial Conversion Evaluation of Headbox MCA Residual. The headbox residuals were maintained during the conversion.

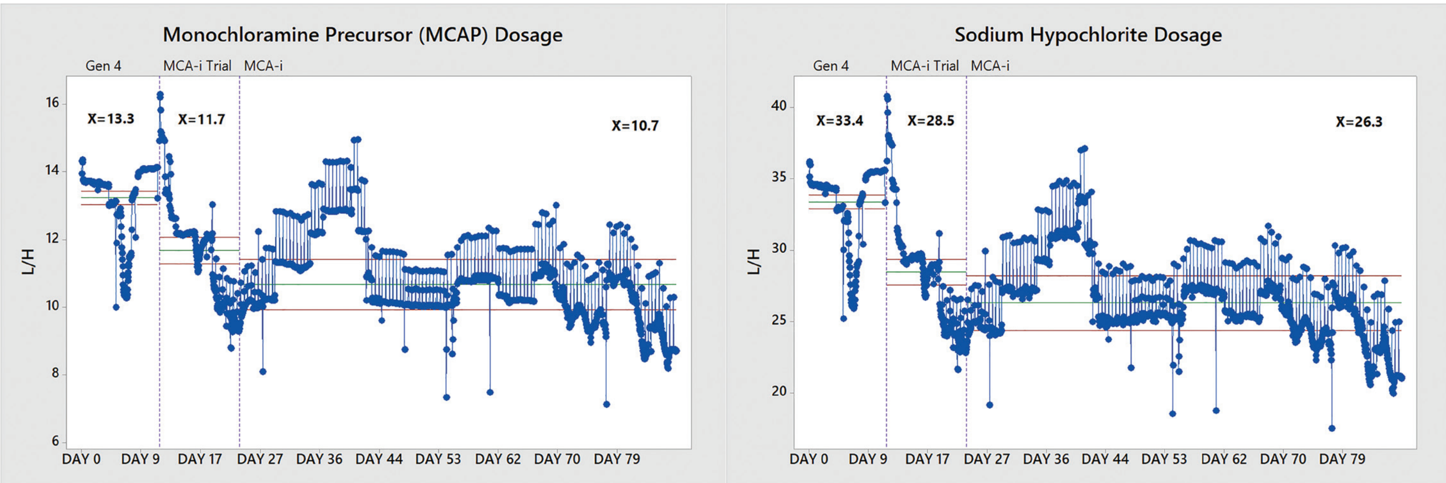


Figure 5: Phase 2 Trial Conversion Evaluation of MCAP and Sodium Hypochlorite Dosage Rates. Both chemical dosage rates were reduced further while the MCA headbox residuals noted in the trial phase were maintained (Figure 4).

Phase 2 – Trial Conversion

For phase 2, the biocide program was further optimized utilizing MCA-i's features. Results are shown above in Figures 3-4. The MCA headbox residuals were maintained at 1.7 ppm (Figure 4) while the flow rates of both MCAP and sodium hypochlorite were further reduced (Figure 5).

The speed of response with MCA-i provided a more consistent biocide dosing, less variation in monochloramine residual and reduced variability throughout the process, resulting in a higher level of efficacy and a reduction in chemical usage. Features of the MCA-i unit that contributed to these results include the hypochlorite sensor and the use of PID (proportional–integral–derivative) flow control valves. In the past, the sodium hypochlorite activity was tested manually and then the MCAP : sodium hypochlorite molar ratio was also adjusted manually. Because the sodium hypochlorite activity was monitored continuously, MCA-i was able to automatically adjust the MCAP : sodium hypochlorite ratio to the proper molar ratio. Figure 6 shows an example of the change in sodium hypochlorite activity over a 24-hour period. As a new delivery was transferred to the run tank, the sodium hypochlorite concentration increased from 8.5% to 12.5%. MCA-i automatically adjusted the chemical ratios to continue to produce a stable MCA solution. This ensured that the sodium hypochlorite was not being overfed, which would have led to the formation of dichloramines. The addition of PID flow control valves eliminated drifts which can occur with the use of manual flow valves. A comparison of the water booster pump variation over a 12-hour period between the Gen 4 unit and MCA-i is shown in Figure 7. With the PID flow control valves in MCA-i, the flow variation was reduced by 75%. This translates to having the right amount of MCA chemistry in the process at the right time.

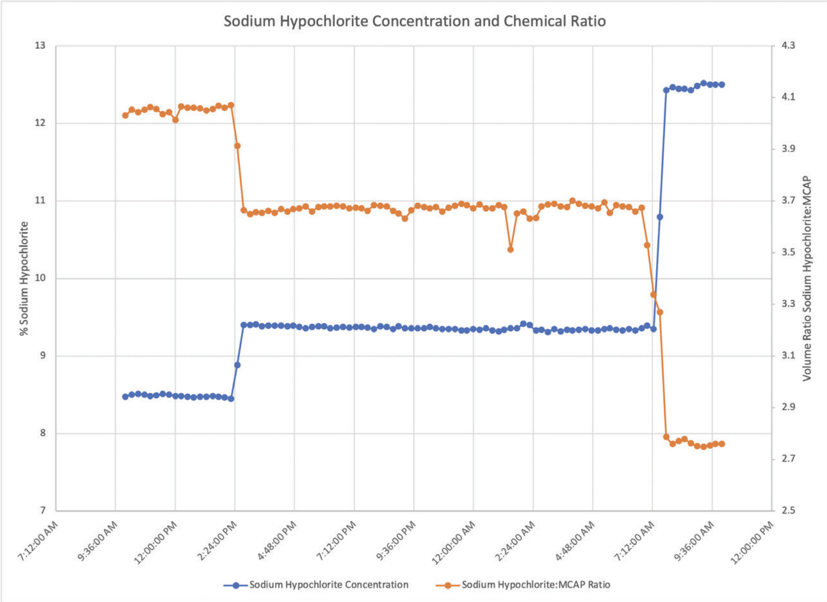


Figure 6: Phase 2 Trial Conversion Evaluation of Hypochlorite Sensor. The sodium hypochlorite activity over a 24-hour period is shown. As a new delivery was transferred to the run tank, the concentration increased from 8.5% to 12.5% and the MCA-i unit automatically adjusted the MCAP : sodium hypochlorite ratio to maintain a stable MCA solution.

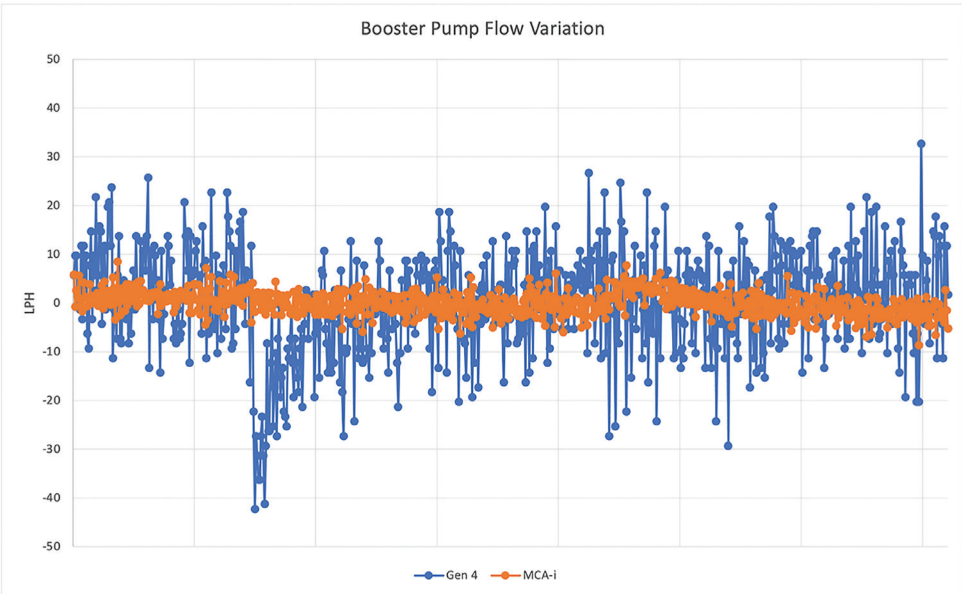


Figure 6: Phase 2 Trial Conversion Evaluation of the PID Flow Control Valves. The water booster pump variation over a 12-hour period was compared between the Gen 4 unit and MCA-i. The flow variation was reduced by 75% due to the use of the PID flow control valves in MCA-i.

Phase 3- Continued Optimization

The next phase in optimizing the customer's biocide program is utilizing the variety of control modes that MCA-i offers. One step is to combine the machine production data with a total chlorine probe at the headbox for tighter control of the program. This and other control modes will continue to ensure that the right amount of chemistry is used at the right time.

CONCLUSION

The Gen 4 dosing unit at this customer site produced a good, stable MCA solution that provided more than adequate biological control to the process. To take this MCA program to the next level, Buckman was allowed to trial MCA-i. Data from the initial trial and conversion to MCA-i have shown that the MCA residuals were maintained and thus biological control maintained while both the MCAP and sodium hypochlorite dosage rates were reduced. Several of the key features of MCA-i, e.g., hypochlorite sensor for chemical ratio control and PID control flow, provided the customer with significant chemical savings.