Improving Smelt Dissolving Tank TTA Control at Zellstoff-Celgar

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Abstract

White Liquor (WL) variability is detrimental for the cooking process in Kraft mills. Stable Effective Alkali (EA) reduces variability of the physical and chemical properties of cooked pulp. Optimum Raw Green Liquor (RGL) and recausticizing process control is an absolute necessity to achieve these goals.

CAUST-X provides these benefits to help P&P mills reduce variability in WL properties. Smelt dissolving tank process controls is a part of the TEXO CAUST-X APC system and aims at stabilizing the RGL TTA strength with a continuous TTA sensor and controller. Moreover, a TTA saturation algorithm, which is an integral part of this APC, allows the process to run close to the saturation limit in terms of the RGL TTA strength. The achieved results benefit the mills with a stable and increased WL strength at the re-causticizing process, thus reducing green liquor flow, reducing excess water carryover while increasing residence time in the causticizing area.

This paper presents the results of dissolving tank level control, TTA and density control, and TTA saturation override at work. The control performance during line switch is also discussed. The paper concludes this discussion regarding RGL TTA variability.

Background

White Liquor strength stability is an important parameter for producing pulp with stable chemical and physical properties. Variability in white liquor strength affects the pulp Kappa, resulting in increased pulp bleaching costs and poor pulp quality. As an example, a 5% change in white liquor strength can vary the Kappa number by 2% [1].

TTA variability is one of the major contributors to variable white liquor strength since it is a disturbance to the re-causticizing process. Stable raw green liquor TTA ensures stable clarified green liquor composition feeding the Slaker. Stability in the re-causticizing process further results in stable white liquor strength.

The starting point for TTA control should be at the smelt dissolving tank where weak wash is used to dissolve and dilute the hot smelt from the recovery boiler. Specific Raw Green Liquor (RGL) density (in relation to TTA) is maintained to operate the smelt dissolving tank in a safe operating zone. A higher RGL TTA is desirable as Clarified Green Liquor (CGL) has to be further trimmed with weak wash to maintain a stable TTA feeding the slaker for a stable and optimum causticizing reaction to occur. Higher TTA also reduces the volumetric flow of RGL which increases residence times in green liquor clarifier and improves CGL quality.

However, there is a high limit for RGL TTA, above which, the risk of pirssonite deposition and scaling increases. This is known as Saturation TTA (TTA_{sat}) [2]. Therefore, it is advisable to maintain RGL TTA below TTA_{sat}.

CAUST-X SMELT

Smelt dissolving tank process controls is a part of CAUST-X APC solution and aims at stabilizing the RGL TTA strength with a continuous TTA sensor and controller. Moreover, a TTA saturation algorithm, which is an integral part of this APC, allows the process to run close to the saturation limit in term of RGL TTA strength. The achieved results benefits the mills with a stable and increased WL strength at the re-causticizing process, thus reducing green liquor flow, reducing excess water carryover while increasing residence time in the causticizing area.

Existing Control system at Zellstoff Celgar

Figure 1 shows the existing controls at Zellstoff Celgar. Weak wash and green liquor are switched between two lines connected to the smelt dissolving tank to reduce the magnitude of scale formation. Nuclear density analyzers (DI 1302 A and B), installed at each line, provide measurements to the Density controllers (DIC-1302 A and B). The operator specifies the target density setpoint for the green liquor outflow which modulates the weak wash flow into the smelt dissolving tank. Level controller LIC-1301 maintains the level in the smelt dissolving tank by adjusting a variable speed green liquor pump.

Using a specific green liquor density as a setpoint is problematic as the density meter itself is susceptible to scaling which skews the measurement from the true green liquor density. Suspended solids and the presence of ions also affect the measurement [3]. To compensate for these situations, the operator has to make frequent adjustment to the density setpoint based on the TTA lab test.

Proposed Smelt Dissolving Tank TTA control strategy

Figure 2 shows TEXO's CAUST-X Smelt Dissolving Tank TTA controls strategy at Zellstoff Celgar.

A parallel TTA controller (XIC1302) is installed. The FITNIR computer provides periodic TTA measurements of the RGL sample analyzed using Fourier Transform – Near Infra-Red (FT-NIR) spectroscopy technology. The TTA soft sensor uses this periodic TTA measurement to update the TTA-Density relationship model. The resulting TTA prediction from the soft sensor is robust and reliable and therefore stable RGL TTA control is achieved. Additionally, the TTA soft sensor is also adapted to work reliably with manual lab tests, in case the FITNIR computer or the RGL sample stream is out of service for maintenance reasons.

The installed logic automatically defaults to density control from TTA Control, if any fault is noticed in the FITNIR computer or the measurement that it provides. Operators have also been provided with the option to revert back to traditional density controller using a "Density or TTA Selector", if they choose to do so for any reason.

The TTA_{sat} algorithm calculates saturation TTA for RGL using RGL composition measurements provided by the FITNIR computer and the temperature of the RGL. To reduce the risk of pirssonite deposition and scaling, the operator TTA setpoint is overridden by the TTA_{sat} algorithm if the former breaches the limit due to change in RGL properties.

Both the TTA and Density controllers are tuned using TEXO's Tuning Software to decouple with the level controller.

Results

Figure 3 shows RGL TTA soft sensor in its operation providing a continuous TTA signal and comparative graph of FTNIR TTA measured value. As seen from the graph, TTA soft sensor tracks closely with FTNIR measured value. Using signal from continuous online density analyzer, soft sensor detects TTA variation between FTNIR tests. It also makes continuous correction as it receives new FTNIR TTA measurement.

Figure 4 shows TTA control in operation. Initially, the dissolving tank is on density control. It should be noted that TTA saturation is bypassed when on density control and as a result the TTA measurement breaches the TTA saturation limit at times. With the TTA controller on after reference point 598, the TTA measurement is safely below the TTA saturation limit. Moreover, if the operator decides to increase the setpoint above the TTA saturation limit or if the TTA saturation limit drops below the operator setpoint, the TTA controller adjusts the measurement to keep it below the saturation limit. This phenomenon can be observed after reference point 1593.

Also seen in the figure 4 is the performance on control during the line switch approximately near reference point 1195. Although, there is a difference between the density measurements and their relationship to the analyzer measurement, the TTA control in not affected.

Figure 5 shows dissolving tank level controls in operation. Tuning of the level controller affects the performance of the TTA controller. Ideally, the level controller tuning should be fast enough to settle the dissolving tank level disturbance caused by the TTA controller, as implemented in this case. Figure 5 shows that the controller tuning is fast enough to settle any disturbance caused by the TTA controller or a line switch.

Figure 6 shows comparison data between RGL TTA before and after implementation of TEXO's Smelt dissolving tank control strategy. No observable reduction in variability is observed. One of the constraints was process dynamics of the dissolving tank itself. Hydraulic retention time or time constant of the tank was exceptionally high (~90 minutes). Therefore, the fastest possible tuning was installed. Other factors like smelt runoff or fluctuations also affect the response of the TTA controller. These reasons were the limitation for meeting the expected TTA variability improvement. An average increase of approximately 2 gpl in raw green liquor TTA was observed. This was achieved by ability to run smelt dissolving process close to saturation limit for raw green liquor TTA concentration.

Conclusion

TEXO CAUST-X Smelt dissolving tank APC was installed at Zellstoff Celgar. APC was adapted and tuned for smooth operation during line switch. A parallel TTA controller was installed with operator switch to choose between TTA or Density control operation for ease and adaptability for operators. Installed TTA Soft sensor provided a continuous reliable TTA signal to TTA controller, with continuous TTA vs. Density model correction with periodic Lab or FITNIR Green Liquor analysis. This TTA signal along with protection of TTA saturation algorithm provided a robust TTA controller reducing the risk of scaling.

Results achieved show a smooth transition during line switching, irrespective of differences in density measurement between different lines. Moreover, the TTA saturation algorithm allowed operators to run the smelt dissolving process to the highest possible TTA concentration limit. Long process residence time was a major limiting factor preventing reductions to the variability in raw green liquor TTA concentration.

Reference

1. Truett, H. D., *Optimizing the controls of a batch digester house with an integrated distributed control system,* TAPPI Journal P 133-140 (1991)

2. Frederick, W. J., Ayers, R., Krishnan, R., *Pirssonite deposits in green liquor processing,* TAPPI Journal P 135-139 (1990)

3. Allison, B., Halvorson, B., Pawson, D., *Model Predictive Controls of Smelt Dissolving Tank using FT-NIR liquor composition analyzer,* International Chemical Recovery Conference Proceeding (2010)

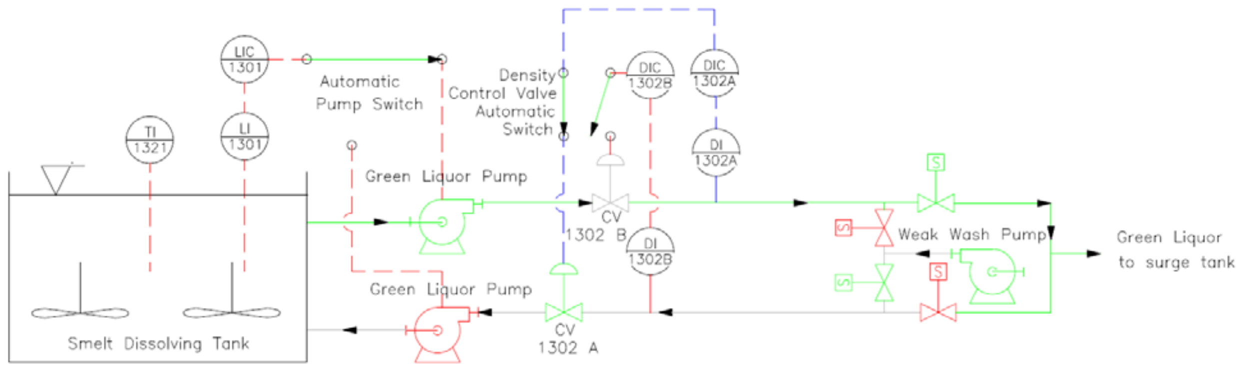

Figure 1. Existing RGL Density Controls at Zellstoff Celgar

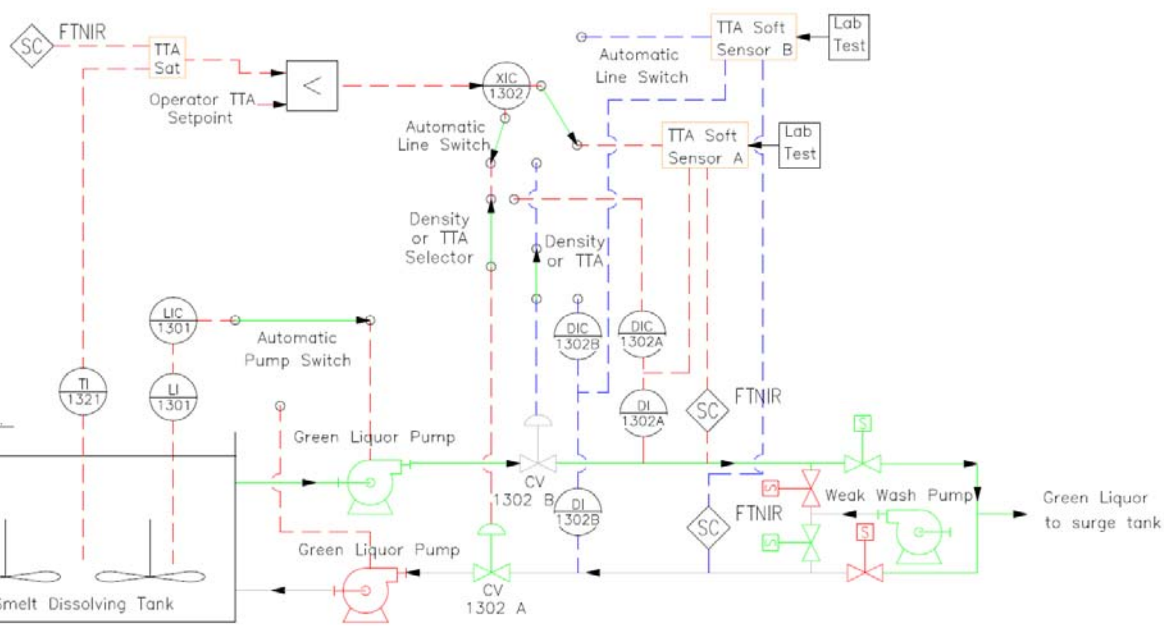

Figure 2. Proposed RGL TTA Controls at Zellstoff Celgar

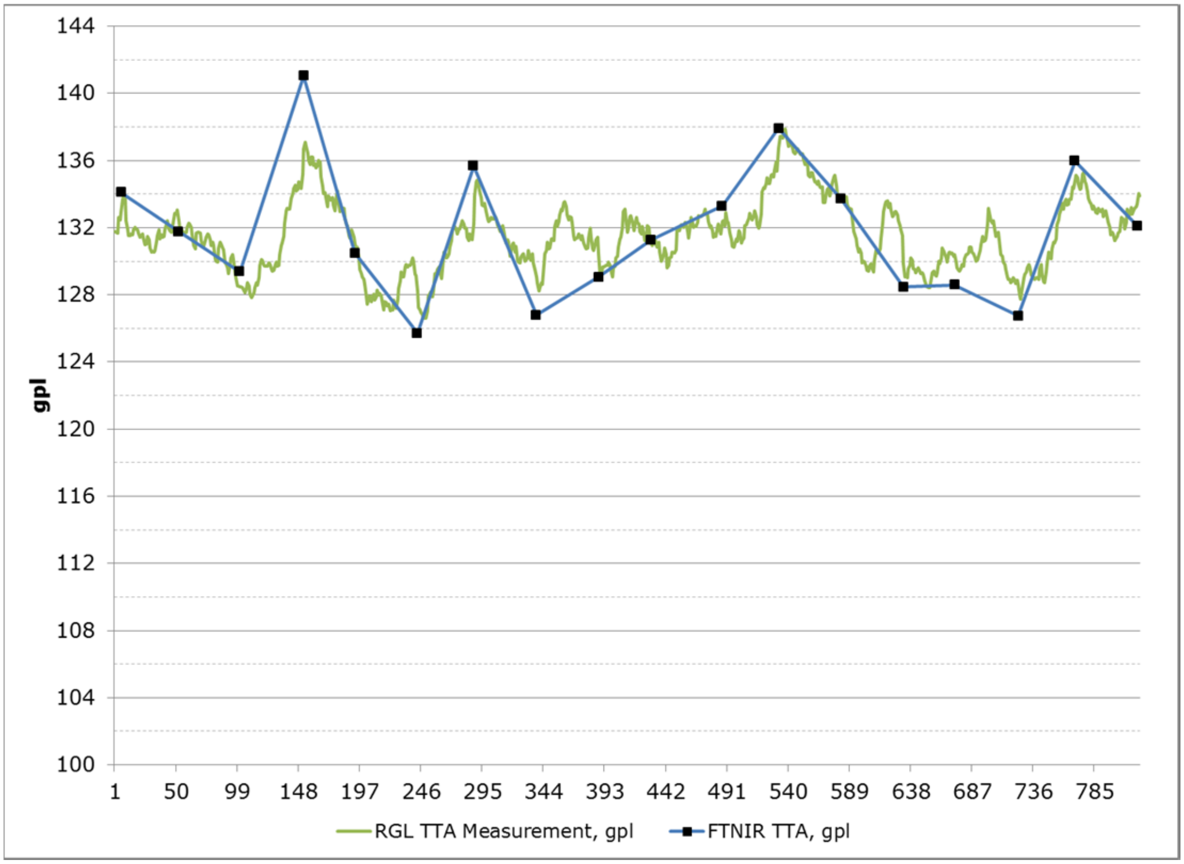

Figure 3. RGL TTA Soft Sensor comparison with FTNIR TTA measurement

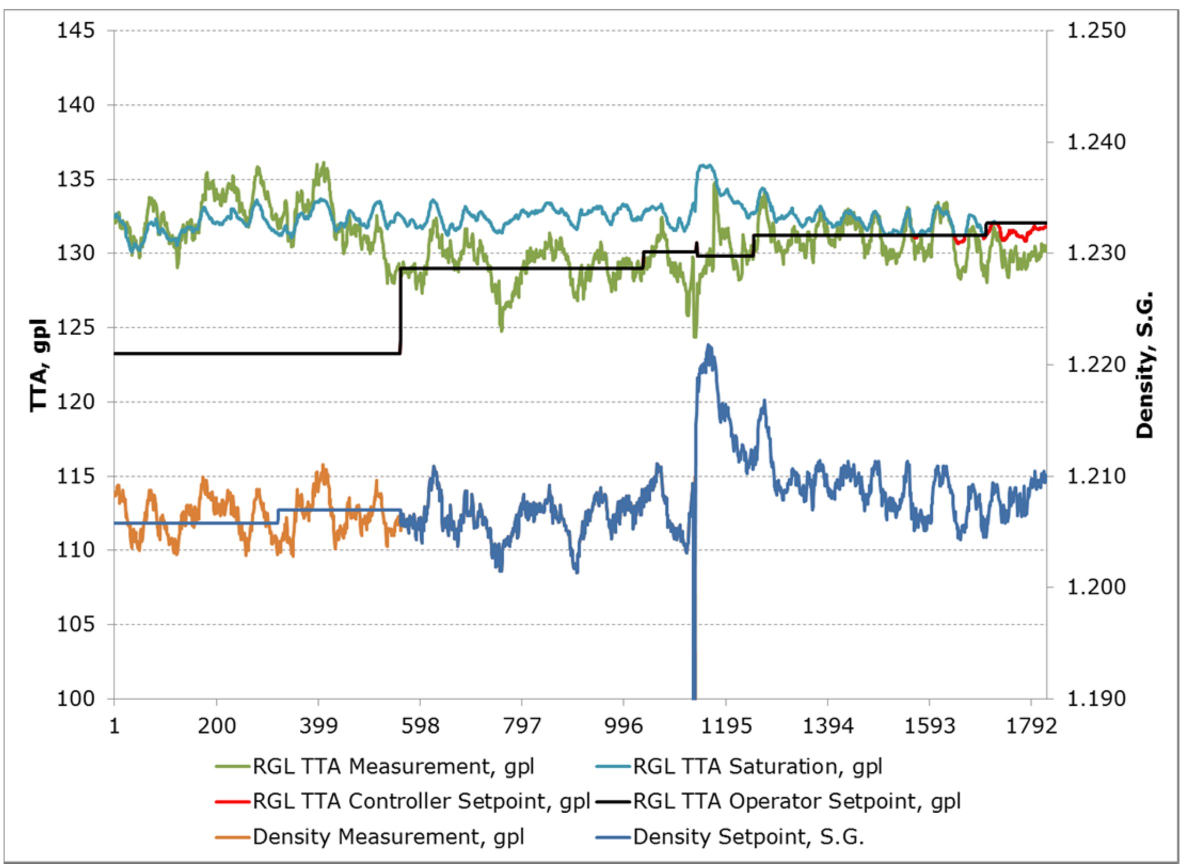

Figure 4. TTA and Density Controls

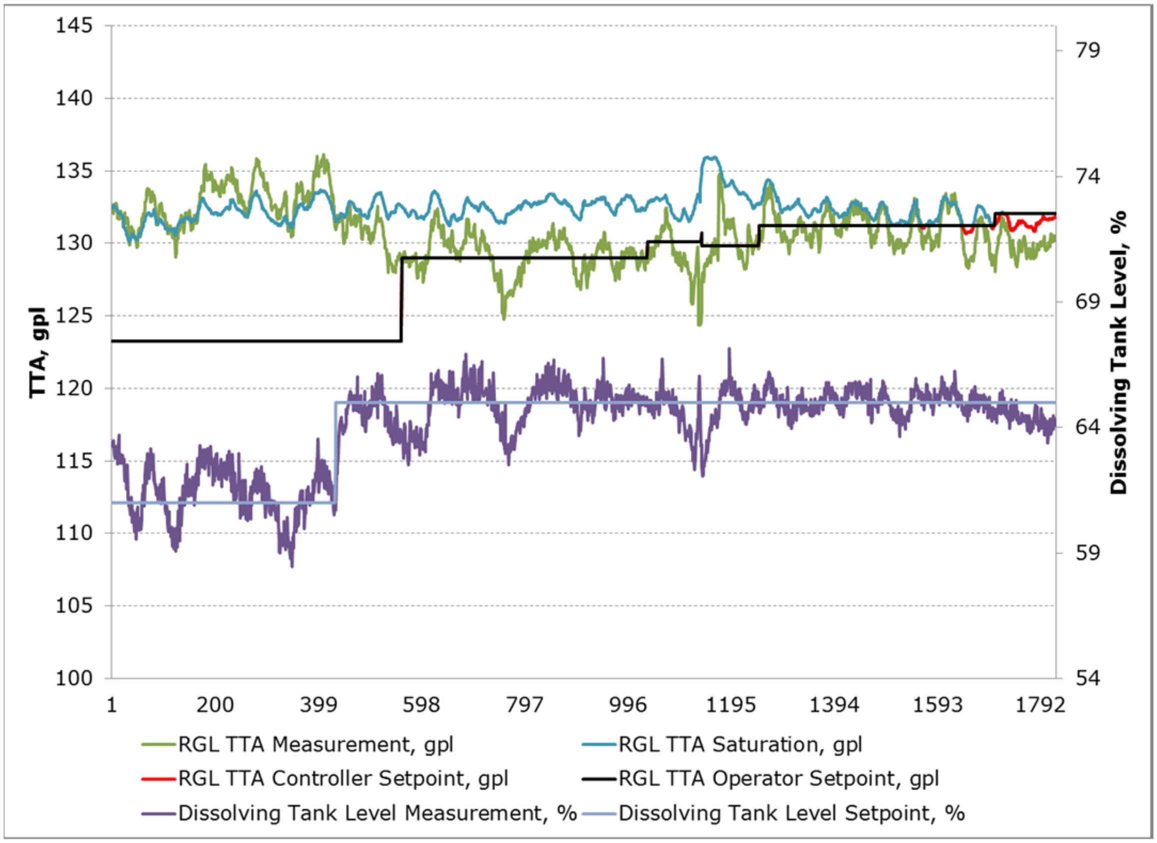

Figure 5. Dissolving Tank Level Control

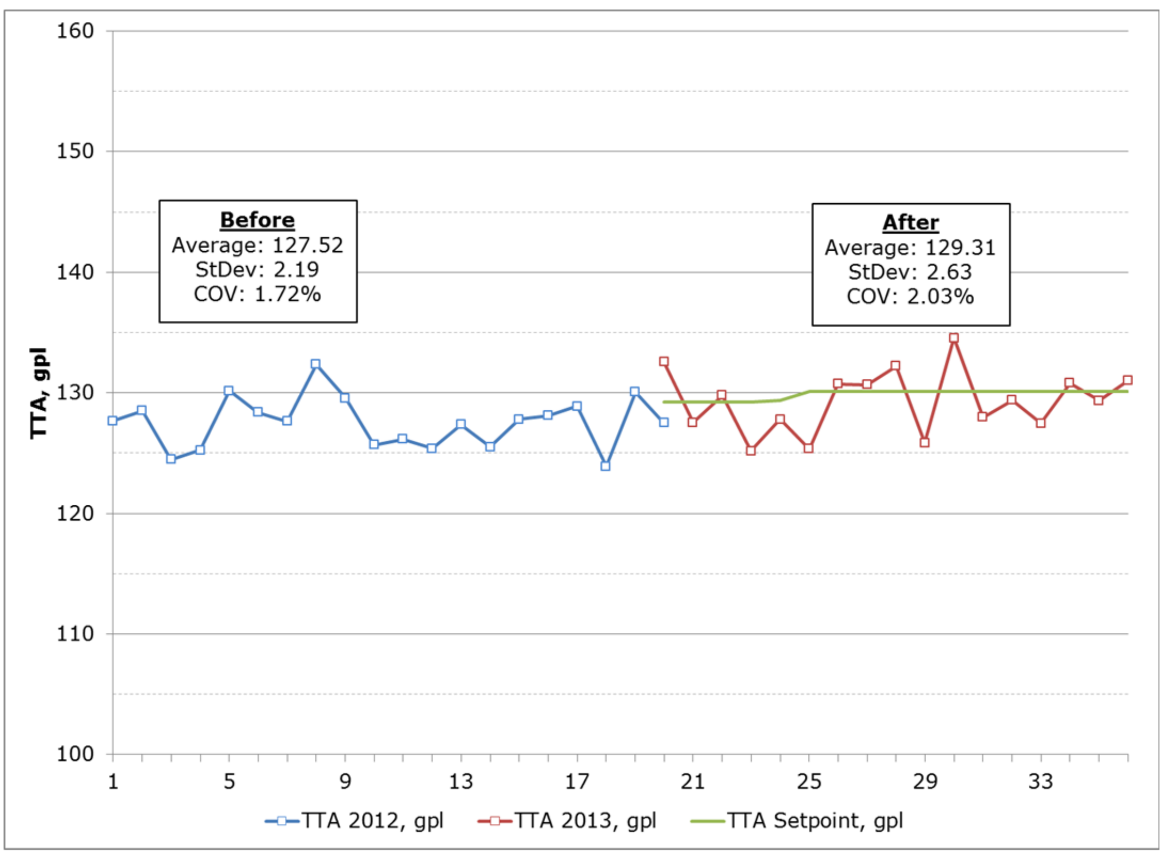

Figure 6. RGL TTA Comparison