
CHARACTERISTICS AND PERFORMANCE OF THE CROMPION LLT CLARIFIER

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1 INTRODUCTION

The Crompton LLT Clarifier is a great innovation for the clarification of sugarcane juice. The main feature of our clarifier is that it utilizes turbulence reduction devices that eliminate the turbulent eddies in the flow, enhancing the clarification operation. Additionally, the clarifier has an integrated flash tank, Flash Trough, as we call it, around the equipment's body, providing more degassing area compared to an external flash tank of equivalent capacity while reducing the possibility of air entrainment. These technologies united, allow for shorter retention times, reducing sucrose losses, and providing a juice of higher quality compared to other clarifiers available in the industry.

To reduce maintenance needs and prolong the clarifier's life, we recommend fabricating the equipment with Crompton's Cromgard Specialty Stainless Steel.

2 CROMPION LLT CLARIFIER DESIGN CONCEPTS

The following primary principles are the groundwork for the design of the new Crompton LLT Clarifier.

- The endpoint of each juice feed pipe has a simple turbulence reduction device adapted to cancel the momentum of the liquid jet to reduce the scale of turbulent eddies. Figure 1 shows this effect.
- The feed pipes are designed to maintain a relatively high flow to reduce the potential of scaling and plugging.
- A network of juice feed pipes introduces juice through a series of hydraulically uniform pathways over the cross-sectional area of the clarifier, as shown in figure 2.
- The clarifier receives the clear juice overflow through a series of uniformly distributed channels at the top portion of the clarifier. This feature maintains uniform vertical juice velocity profiles to make full use of the cross-sectional area of the clarifier.
- The Crompton LLT Clarifier has the option to come with a built-in Flash Trough that degasses the juice without the need for an external flash tank. This design provides an additional degassing area compared to an external flash tank of equivalent capacity while reducing the factory's footprint. Moreover, the Flash Trough avoids the necessity of additional piping and flash tank misplacements that lead to poor degassing and clarification problems. Figure 3 shows a top and side view of the Crompton LLT Clarifier design.

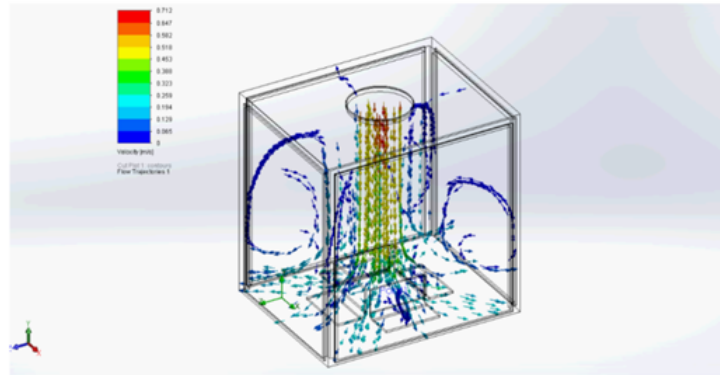


Figure 1: CFD Simulation of the Operation of the Turbulence Reduction Device.

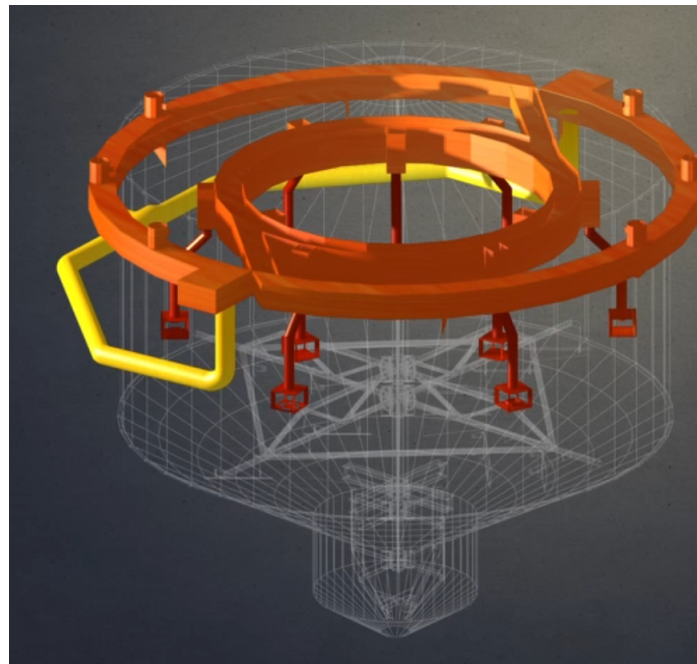


Figure 2: Layout of the TRDs inside the Clarifier.

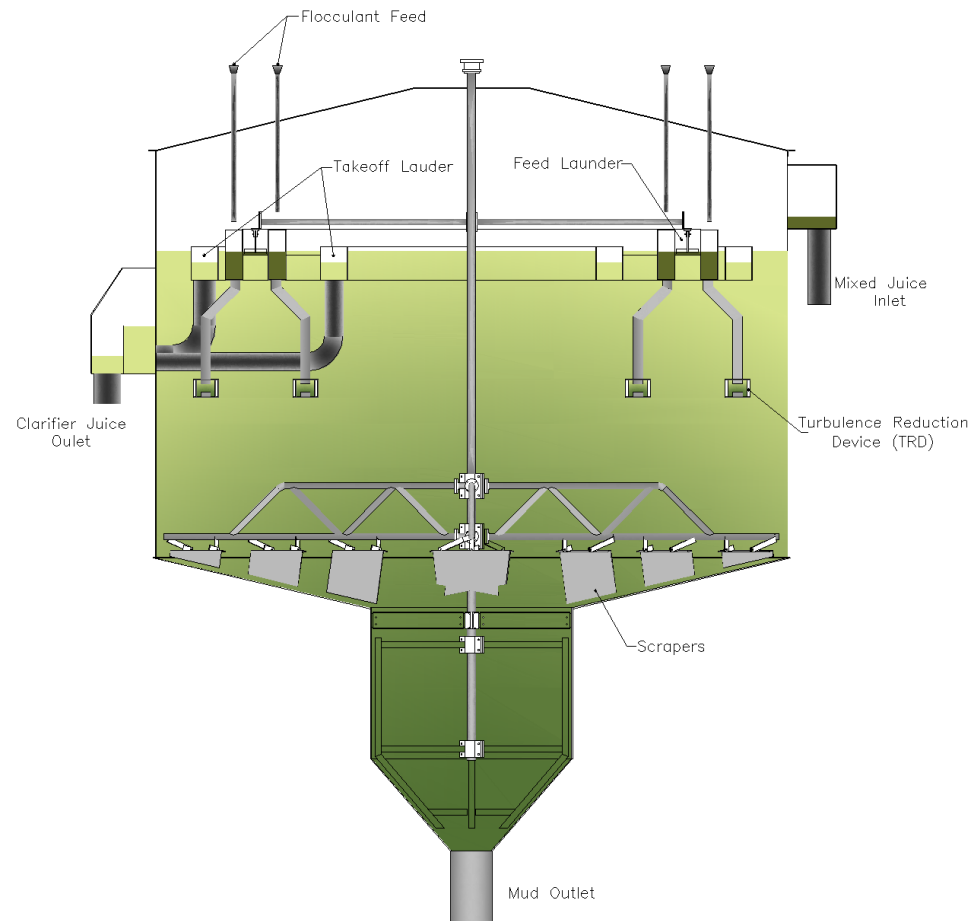


Figure 3: The Crompton LLT Clarifier.

Table 1: Sugar Inversion Estimate in Different Types of Clarifiers.

	LLT Clarifier	SRI/SRT Clarifier	Multi-Tray Clarifier
Sugar Price [¢/lb]		21	
Retention Time [min]	30	60	120
Sugar Inversion [g/100 g of sucrose]	0.04	0.09	0.18
Juice Purity [%]	85	85	85
Total Sucrose Lost [t/million t of cane]	93.5	187	373.9
Total Loss [\$ /million t of cane]	43,281	86,563	173,127
Total Gain [\$ /million t of cane]	-	43,282	129,847

3 SUGAR SAVINGS WITH THE CROMPION LLT CLARIFIER

The typical retention time of the Crompton LLT Clarifier is 25-30 minutes. Compared to multi-tray clarifiers, the LLT has 350-400% less retention time. Furthermore, compared to a Short Retention Type (SRT) Clarifier with 30 to 60 minutes retention time, the Crompton LLT clarifier is 50 to 100% faster.

Consider that the longer the retention time in the clarifier, the higher the inversion of sucrose. Table 1 shows an estimate of the sugar inversion generated in each of the previously discussed clarifiers.

The Crompton LLT Clarifier can save approximately \$43,282 per every million tons of Cane grounded compared to the SRT type clarifiers. Furthermore, this value triples when we compare the Crompton LLT to the multi-tray type clarifiers, saving up to \$129,847 per every million tons of Cane.

4 PERFORMANCE OF THE CROMPION LLT CLARIFIER

We compared the performance of the Crompton LLT Clarifier while operating simultaneously with other clarifiers in sugar mills in Louisiana. Louisiana's sugar cane season characterizes by its high mud content in the cane due to heavy rainfall. The first industrial implementation of the LLT clarifier was in 2010 at Sterling Sugars in Franklin, LA. During this season, a 6.1 meters diameter LLT Clarifier with 25 minutes retention time operated in parallel with an SRI/SRT clarifier of 12 meters diameter and an average retention time of 74 minutes. The average grinding rate for this factory was 12000 TCD.

The SRI/SRT had twice the retention time, leading to higher sucrose losses, compared to the Crompton LLT Clarifier. Additionally, when we compared the clear juice turbidity, we observed that the Crompton LLT Clarifier showed, on average, 30% lower turbidity than the SRI/SRT clarifier as shown in figures 4 and 5. This evidence demonstrates that the Crompton LLT Clarifier can handle high throughputs and manage wide process variations without sacrificing the quality of the clear juice, and reducing sugar

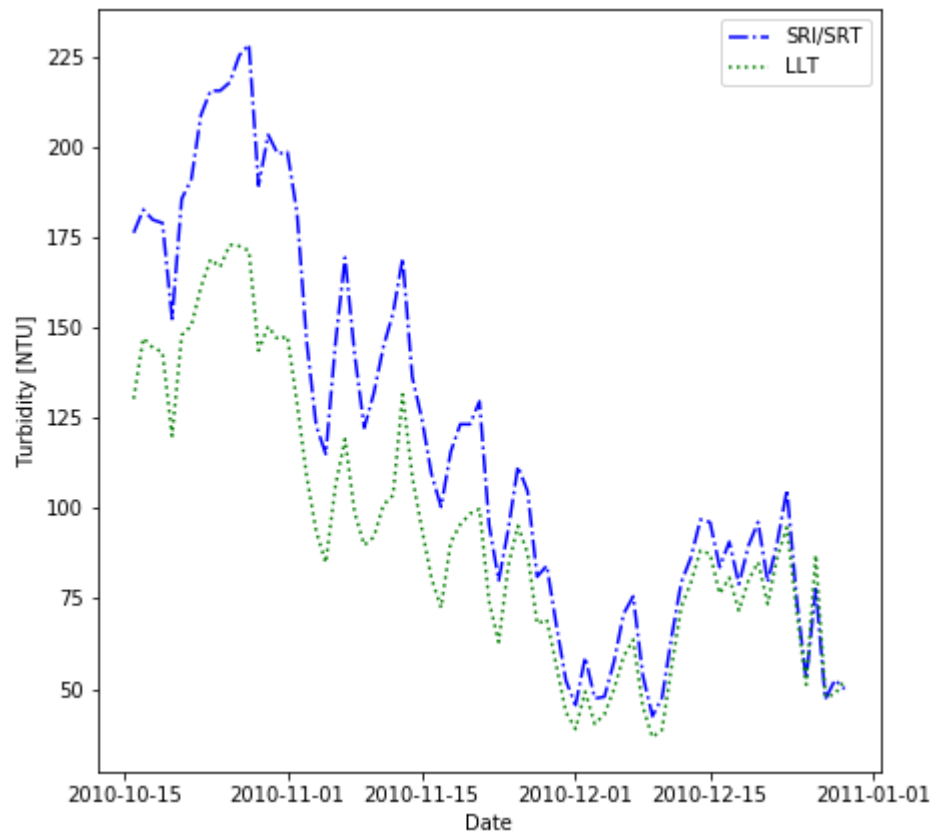


Figure 4: Clear Juice Turbidity Profile During the 2010-2011 Harvest Season in Louisiana.

loss [KGR11, GK13]. During the 2013-2014 harvest season, we observed a similar turbidity profile, as shown in figures 6 and 7. This time we compared three clarifiers operating simultaneously. One SRI/SRT Clarifier, one LLT Clarifier with Flash Trough, and one LLT Clarifier with a conventional flash tank. We measured the turbidity of the clear juice by absorbance using the ICUMSA Standard Method.

Furthermore, the Crompton LLT Clarifier has been in operation since 2011 at Andhra Sugars in India. A follow-up of the turbidity and color removal in a Crompton LLT Clarifier and a Graver type clarifier showed that the Crompton LLT Clarifier removed approximately 90.42% of the turbidity and 33.34% of the color in approximately 37 minutes retention time. In comparison, the Graver type clarifier attained comparable results but with a significantly higher retention time (137 minutes)[NL11].

During the performance assessment of the Crompton LLT Clarifier in India, researchers observed that the temperature of the clear juice leaving the clarifier was 3 degrees centigrades higher than the Graver type clarifier [NL11]. We developed an

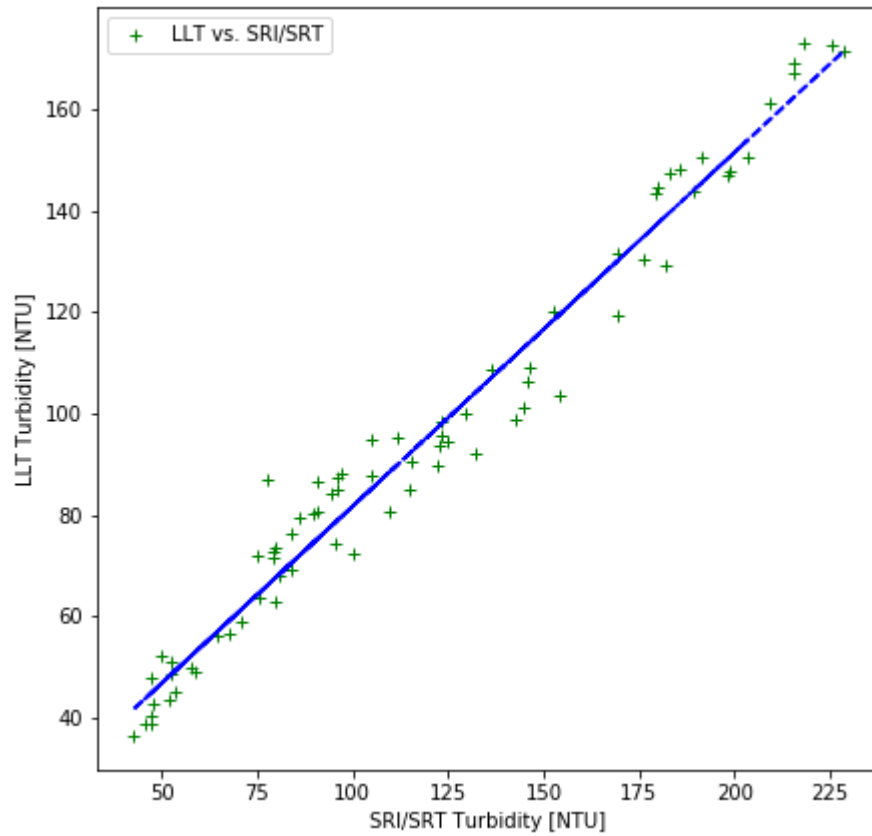


Figure 5: LLT Clear Juice Turbidity vs. SRI/SRT Clear Juice Turbidity During the 2010-2011 Harvest Season in Louisiana.

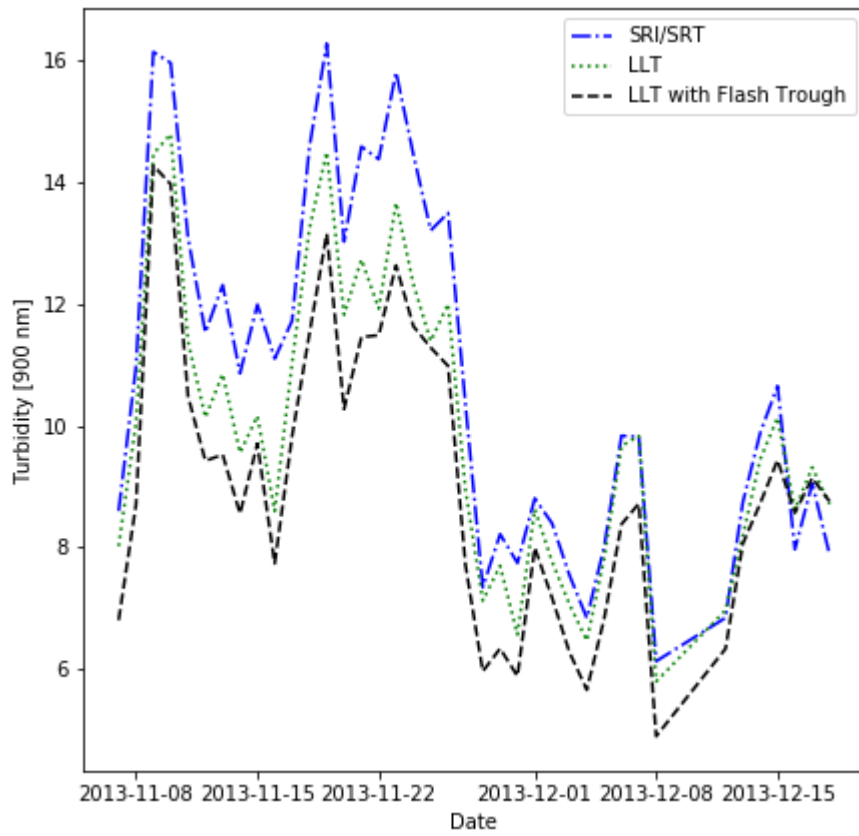


Figure 6: Clear Juice Turbidity Profile During the 2013-2014 Harvest Season in Louisiana.

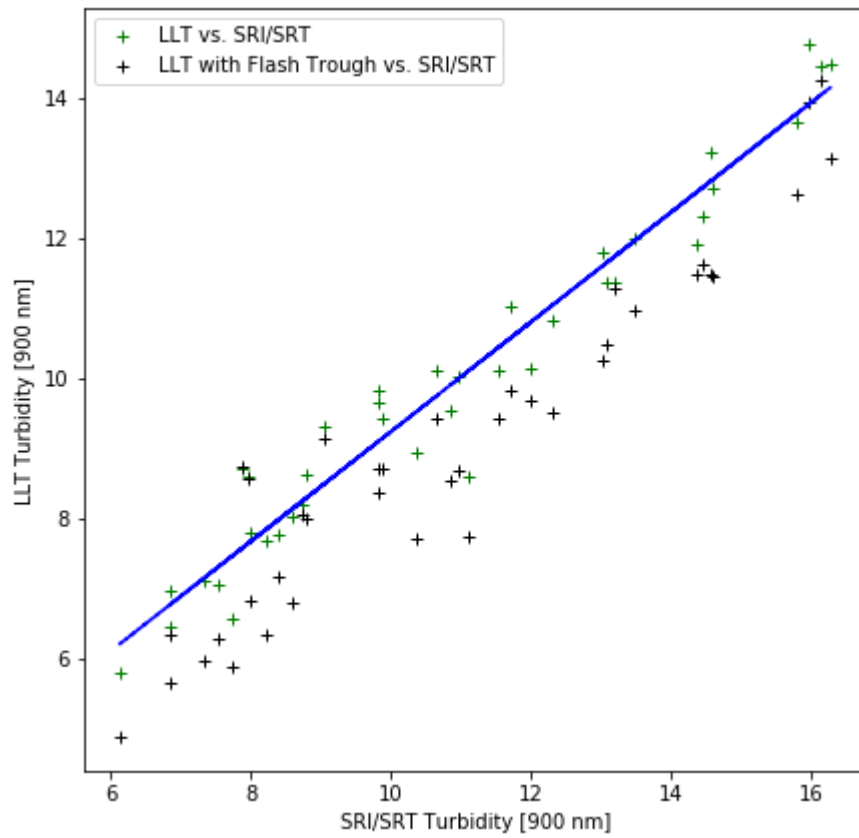


Figure 7: LLT Clear Juice Turbidity vs. SRI/SRT Clear Juice Turbidity During the 2013-2014 Harvest Season in Louisiana.

estimate of the energy and money savings of the effect of this temperature increase showing that the sugar factory saved approximately 3000 metric tons of bagasse per every million metric tons of cane grounded. Dollars-and-cents, this means approximately 78,000¹ dollars saved per every million metric tons of Cane grounded. Bagasse savings with the Crompton LLT Clarifier can be especially attractive for co-generating factories or other processes where the bagasse is the raw material.

5 CONCLUSIONS

- Different studies show that the Crompton LLT Clarifier provides juice with low turbidity and color with a short retention time compared to other clarifiers while reducing the sucrose losses.
- The Flash Trough & TRD technologies of the Crompton LLT Clarifier are key differentiators of our equipment. These devices provide additional degassing area compared to a conventional flash tank and dissipate the turbulent eddies of the flow, respectively. By eliminating these two problems, we can achieve excellent clarifier performance.
- The design of the Crompton LLT Clarifier is simple, making it easy to fabricate and maintain.
- The Crompton LLT Clarifier showed excellent energy efficiency by providing a clear juice with higher temperatures compared to other clarifiers.

6 REFERENCES

- [GK13] C Gaudet and V Kochergin. Design and Industrial Applications of Louisiana Low Turbulence (LLT) Clarifiers. *International Sugar Journal*, 115(1377):628–632, 2013.
- [KGR11] V Kochergin, C Gaudet, and M Robert. A Juice Clarifier with Turbulence Reduction Devices: Results of first Industrial Trials. *International Sugar Journal*, 113(1349):348–354, 2011.
- [NL11] M Narendranath and R Lionnet. Performance of the Louisiana Low Turbulence (LLT) Juice Clarifier, 2011.

¹Assumptions: one metric ton of bagasse generates 1 metric ton of steam. We considered the calorific capacity of bagasse and coal as 9740 kJ/kg and 25000 kJ/kg, respectively. We considered the price for bagasse and coal as 26 and 68.5 dollars per ton, respectively.