Novel use of a green beer centrifuge for processing hazy dry hopped beers

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Introduction

Processing hazy dry-hopped beer from the primary fermenter to bright beer tanks in a fully automated brewery posed challenges in quality, productivity, and cost.

Balancing quality (achieving haze correctly), cost (manual hop solid removal and capital investment), and productivity (OEE) was difficult due to hop particle carryover, which blocked filters and strainers (Figure 1) and caused significant downtime in packaging, averaging 300 minutes per week, with peaks of 800 minutes (Figure 5). Performance (filling rate) was also negatively impacted (Figure 2)

The novel use of a green beer centrifuge allowed smaller haze-friendly particles and yeast to pass through while removing larger hop particles, improving both quality and productivity.

Figure 1 Blocked 100µm Strainers en-route to glass and keg line and manual cleaning process required if they block up.

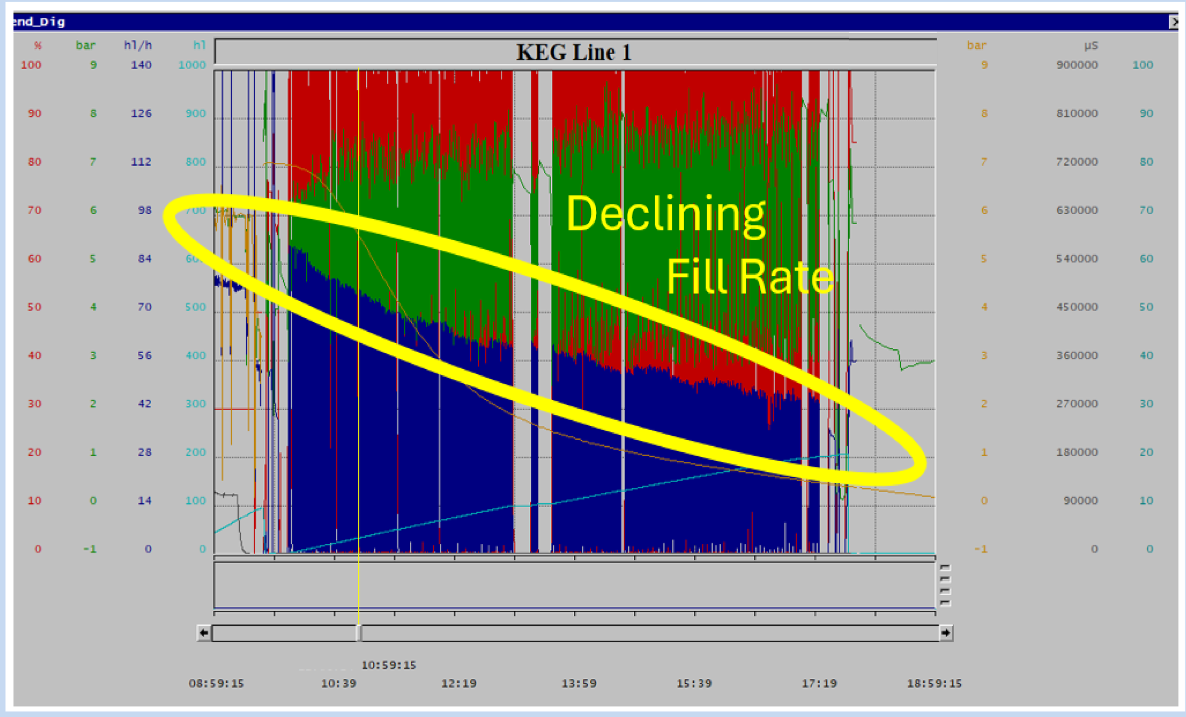

Figure 2 Keg Line filling rates : Starting at standard rate of 90hl/hr (dark blue) followed by a steady decrease in flow rate before stopping line, requiring both a manual and automated clean (CIP).

Methods

Turbidity control was optimized by increasing the permissible and maximum turbidity rise before the centrifuge bowl filled with solids, allowing a "bleed" of solids to overflow, resulting in higher haze clarified beer. Figure 4 shows the turbidity trend of clarified haze (green) vs. bleed haze (red) during the processing run.

All product goes through the centrifuge (no bypassing). The goal is to achieve clarified beer with a turbidity of 50-70 EBC, below the 105 EBC required for bright beer. Turbidity increases until it stabilizes at the "Bleed" haze. Discharge is triggered by a significant turbidity rise or time. About 50% is clarified and 50% is bleed.

Particle size analysis was conducted on the "clarified haze" and "bleed haze" steps. Samples were collected at the inlet and outlet of the centrifuge during a processing run (Figure 4) and analyzed for liquid particle size distribution by HRL Technology Group using a Malvern Mastersizer 2000 with laser diffraction. The measurement gives as a result the average diameter of the particles and the peak values in the diameter distribution.

Results

Over three months of centrifuge processing, The bleed haze accounted for over 50% of the run by volume, with average clarified haze at 64 EBC and bleed haze at 205 EBC. A typical haze trend is shown in Figure 4. The mass balance indicated a theoretical average haze of 137 EBC in the bright beer tanks, while the actual average was 123 EBC.

Comparison of particle size in the clarified pre and post centrifugation samples showed an increase in volume when looking at particles between 200-600nm (ideal haze size, light active but will not sediment) . The 200-600nm fraction for pre-centrifuge was 0.47% of the sample while for post centrifuge was 8.03% of the sample. The change was not so evident in bleed samples at 0.69%.

In the bleed samples, there was a distinct reduction in particle size. This was specifically noticeable when looking at the volume of sample below 50µm. Pre-centrifuge was measured as 88.21% of sample volume being below 50µm in size; comparatively post centrifuge was measured at 99.50%. Indicating only larger particles are being removed.

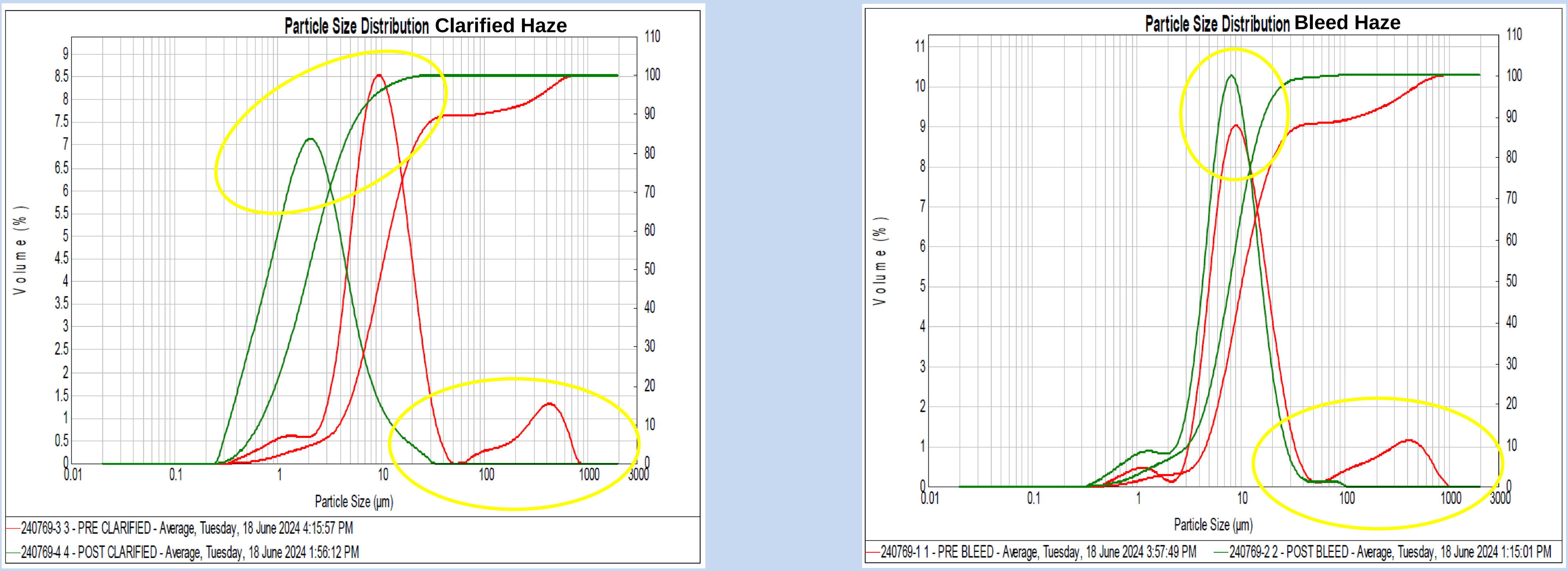

Figure: 3 Particle size distribution charts comparing pre and post centrifuge for clarified and Bleed haze. Key focus are highlighted .

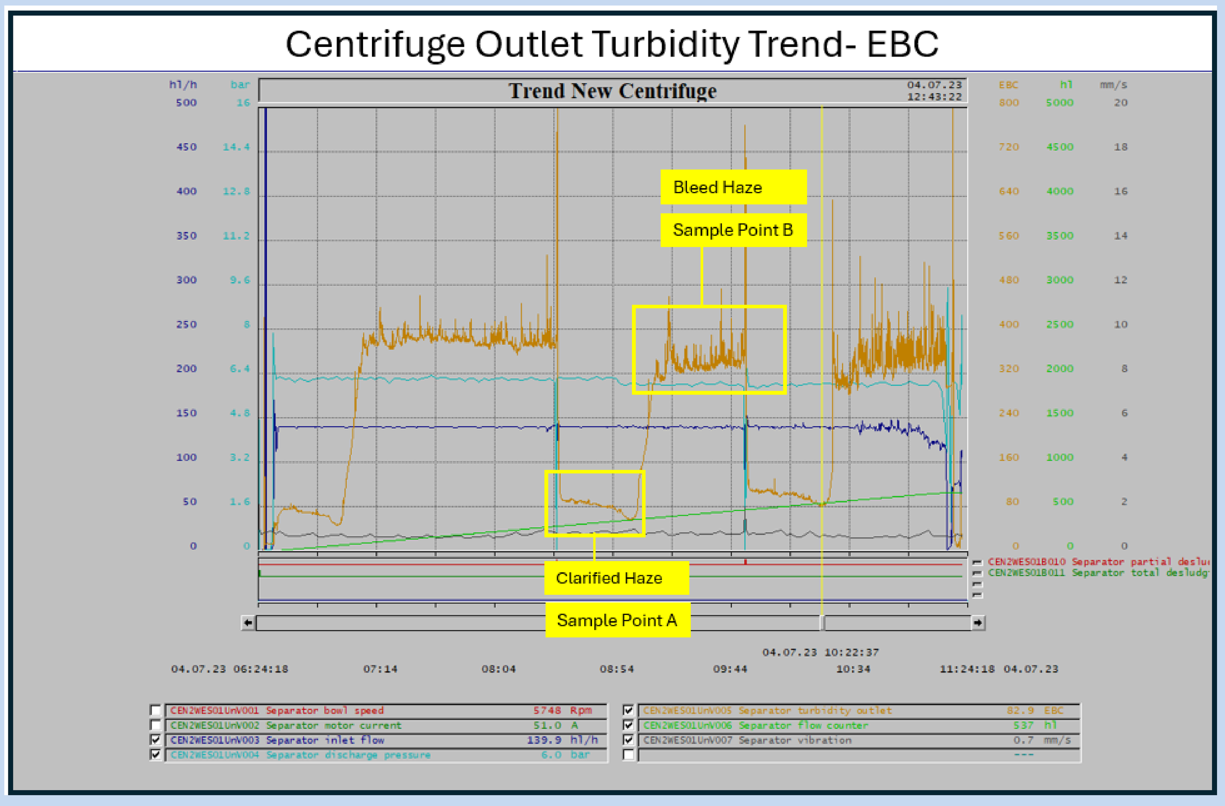

Figure 4 Turbidity trend on centrifuge outfeed showing Clarified Haze vs Bleed Haze across a processing run. 100% of the product goes through the centrifuge (No Bypassing)

Sample ID	Peak (µm)	Vol Weighted Mean (µm)	"Large" Particle Spread (µm)
Pre-centrifuge clarified haze	9	47	20 to 900
Post-centrifuge clarified haze	2	3	None Detected
Pre-centrifuge bleed haze	9	50	50 to 1000
Post-centrifuge bleed haze	8	9.5	None Detected

Table 1 : Key measures of particle size in the clarified vs bleed haze steps.

Discussion

During the clarification steps, we observe the removal of large particles (as shown in the table and figure), with the volume-weighted mean shifting to smaller particle sizes,. This is somewhat expected from a green beer centrifuge where an optimized green beer centrifuge would remove all particles over 3 micron [2].

In the novel "bleed haze" steps, large particles (>100 microns) are reduced, but the particle distribution remains similar around 10 microns. (Table 1)

In terms of quality (haze), both steps result in the favorable presence of smaller particles in the bright beer2 , while large particles (>100 microns), which negatively affect productivity (OEE), are effectively removed. The similarity in peak distributions between the bleed haze steps suggests that the bleed of particles up the clarification process is controlled, with large particles typically removed by the green beer centrifuge. This resembles a bypass effect without the associated negative consequences.

Additionally, vibration analysis and annual servicing and inspections serve as key indicators for maintaining centrifuge reliability, both showing clean and balanced centrifuge operations.

Overall, packaging OEE across a glass and keg line improved. Downtime caused specifically from blocked strainers (Figure 5) virtually disappeared after implementation of centrifuge changes.

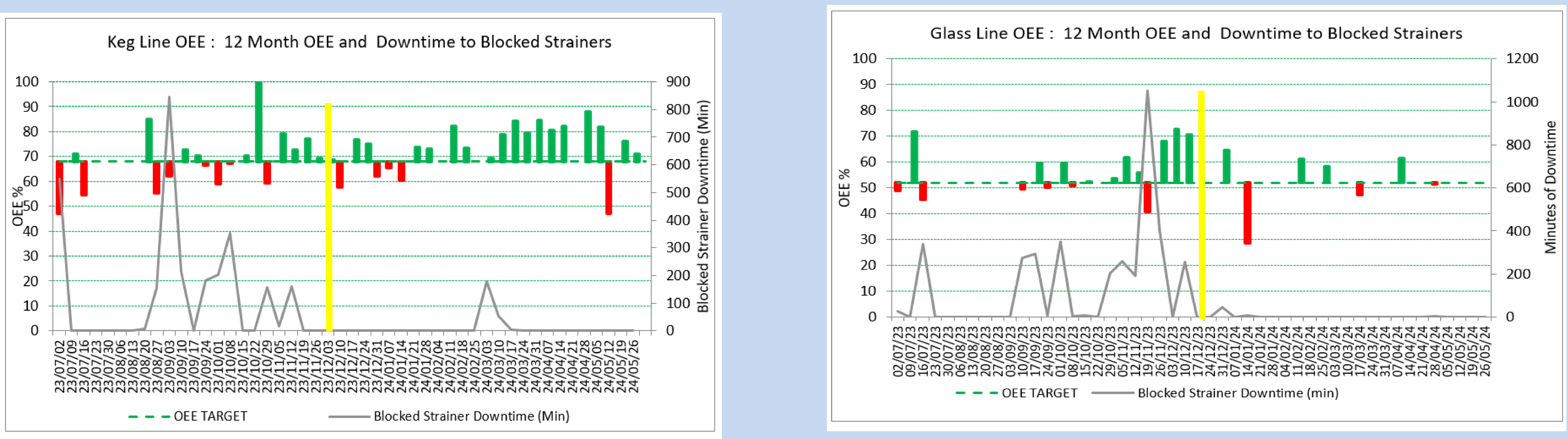

Figure 5 OEE of keg and glass lines overlayed with downtime allocated to blocked strainers. Vertical yellow line indicates completion of significant improvement work as discussed in this poster.

Summary & Conclusion

By de-optimizing our green beer centrifuge through turbidity controls, we enabled a controlled bleed across the centrifuge in a safe and reliable way.

This approach successfully produced bright beer with in specification haze targets, eliminating the need for green beer transfer and mixed tanks.

The outcome of this approach has been an improvement in quality by achieving haze in specification right first time, in a sustainable way. We also achieved increased productivity (reducing downtime in packaging), and cost savings (avoiding the need for capital investment or additional processing) by staying in our uni tank process.

There is further work required to leverage improving the baseline haze in the clarified beer using traditional brewing levers and consideration of flash pasteurization[3] and how it can stabilize the ideal haze we create.

Acknowledgements

Many thanks to the team involved at the frontline who continued to strive for results all the way through, kept open minded, and worked as a team. This includes, but it is not limited to Karl, Cam, Dennis, Jeremy, our packaging and brewing team.

References

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