

Industry 4.0: APC

Industry 4.0 Advanced Process Control – Rendering (Stage 1 Evaluation @ Brooklyn)

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1.0 Abstract

This project evaluated whether an Industry 4.0 Advanced Process Control (APC) system—referred to as CORE—could stabilise rendering operations, improve meal moisture accuracy, increase decanter throughput, and improve tallow and MBM yield consistency at JBS Brooklyn. Rendering is inherently variable, influenced by raw material composition, equipment condition, and operator-driven control decisions. The project explored whether a machine-learning based control platform could reduce this variability and deliver measurable economic benefit.

Early optimisation windows showed promising improvements, including steadier combustion temperature, increased decanter feed rates, and lower burner-load fluctuations. However, sustained performance was not achieved. Independent reviews indicated deteriorating mechanical and feedstock consistency, including air-damper failures, decanter overload events, high torque, unstable differential speeds, and inconsistent feed moisture. Sustained APC performance could not be demonstrated. Nevertheless, the project produced important insights: stable equipment, validated sensors, predictable feedstock, and consistent controller use are prerequisites.

2.0 Executive summary

Australian rendering plants face increasing pressure to stabilise production, reduce labour dependency, and improve yield reliability. Rendering processes involve fluctuating raw materials, variable moisture, and equipment conditions that can shift dramatically across shifts. Labour and skill variability further complicate dryer control, which significantly impacts tallow quality, MBM moisture, and overall energy use. Industry 4.0 APC solutions have been proposed as a pathway to modernise rendering operations.

The objective of this project was to install and evaluate CORE advanced process controllers on the decanters and dryers at JBS Brooklyn. The primary audience includes rendering managers, process engineers, operations leadership, and AMPC levy payers seeking to understand whether APC can deliver measurable improvements in a real-world Australian plant.

Early concept work (CORE APC briefing, 2021) identified significant potential: up to 11.5-month payback, improved moisture consistency, and increased throughput. Mechanical and integration requirements were substantial, including PLC/SCADA modifications, new hardware, and operator training. The project also navigated extensive delays due to IT policy constraints, connectivity issues, and multiple mechanical failures—such as air-damper actuator faults, inconsistent burner load control, and decanter feed instability.

Commissioning in late 2023 produced the strongest performance. The January 2024 Interim Report showed controller usage above 80%, increased decanter feed speed (56% → 63%), and significantly improved dryer temperature stability, particularly around the targeted 600°C combustion temperature. Operators reported better responsiveness to material transitions and more gradual burner adjustments.

However, subsequent operating periods (Feb–May 2024) revealed major regressions. The May 2024 Examination Report showed that CORE decanter controllers were no longer being used due to persistent torque spikes, high differential speeds, unstable process loads, and dryer-temperature deviations. Mechanical constraints—especially feed-rate instability, inconsistent decanter solids dryness, and dryer airflow problems—prevented the CORE system from operating as designed.

Ultimately, the project demonstrated that APC can provide benefits only when rendering plants are mechanically stable and feedstock is predictable. Brooklyn’s variability exceeded APC tolerance thresholds. The project concluded with industry guidance rather than adoption: APC implementation must follow—not precede—mechanical reliability improvements, instrumentation upgrades, and strict operator adherence.

3.0 Introduction

Rendering is one of the most variable processes in the meat supply chain. Variability in raw material composition, moisture, fat, and solids strongly affects decanter loading, dryer performance, combustion temperature, and final meal moisture. Traditionally, operators rely on experience rather than precise, data-driven control. This leads to inconsistent outcomes and lost yield, particularly when labour shortages affect operator skill continuity.

The industry problem addressed by this project was whether an Industry 4.0 APC system could stabilise this variability and automate key controls. Early documentation (CORE APC JBS Briefing, 2021) estimated that uncontrolled process fluctuations—including solids moisture varying between 2% and 15%—could be significantly reduced through predictive, adaptive control. The proposed solution was to apply advanced algorithms to manage decanter feed, burner load, air-damper positioning, and material flow.

A secondary aim was to determine what foundational conditions must exist before any processor can adopt APC technology. As the project evolved, mechanical issues, installation challenges, SCADA deficiencies, and feed inconsistencies revealed critical dependencies that define the feasibility of rendering automation.

This project is unique because it represents one of Australia’s first full-scale attempts to apply machine-learning-based APC to rendering—generating valuable insights for broader industry adoption planning.

4.0 Project objectives

The objective of this project were to evaluate if advanced process control on older PLC driver equipment could improve operational efficiencies.

1. Installation of APS module to evaluate the improvements to process outputs (and draw on non-meat inputs)
2. Evaluation of any reduction in operator supervision required to optimum plant operation
3. Change management required (do staff enable the system to function)
4. ROI determination
5. Value added opportunities (including additional modules and staff training)

5.0 Methodology

The methodology was a systematic installation, learning, evolving and review of the system. This included:

- CORE APC System Deployment: Installation of PLC modules, communication units, and remote connectivity using Secomea.
- Integration: Programming with JBS automation teams and contractors (GPSE), including implementation of CORE on/off toggles, faceplates, signal scaling, alarms, and bumpless transfer logic.
- Operator Manuals: Development of v0 (Nov 2023) and v1.0 (Jan 2024) operator manuals to standardise usage.
- Commissioning:
 - I/O testing
 - Dry-run testing
 - Controller activation
 - Trend analysis
- Data Collection:
 - Combustion temperature, burner load, air-damper positions
 - Feed speeds, torque, differential speeds
 - Temperature stability
- Benchmarking & Reporting:
 - Commissioning report

6.0 Results

6.1 Early performance (late 2023 – early 2024)

- Controller usage exceeded 80% for Decanter 2 and both dryers.
- Feed speed increased from 56% to 63% while maintaining torque levels (Interim Report).

- Dryer combustion temperature stabilised around 600°C with significantly less time above 650°C.
- Operators confirmed smoother burner and damper adjustments.

6.2 Mechanical & integration challenges

- Dryer 1 air-damper actuator failure (Sept 2023) required replacement.
- Burner load handover logic required modification to prevent instability.
- Upstream variability caused torque spikes and forced manual override of decanter control.

6.3 System regression (Feb – May 2024)

- CORE decanter controllers were largely abandoned by operators.
- High differential speeds indicated a heavier, more variable feed mix.
- Dryer combustion temperature dropped, then spiked, due to poor raw material consistency.
- Air-return valve positions drifted out of optimal range.
- No meal moisture data was available for final confirmation of yield impacts.

6.4 Overall system performance

- APC required stable mechanical conditions that were not present.
- Controllers performed well in isolation under stable conditions but failed under real-world variability.
- No sustained yield or energy benefit could be verified.

7.0 Discussion

Throughout the duration of the project, the technology showed strong performance, suggesting that the control logic is fundamentally sound. However, rendering variability at Brooklyn exceeded APC tolerance limits.

7.1 Key insights:

- Mechanical reliability is prerequisite, not optional.
- Air-damper faults, decanter overload, torque spikes, and burner variation all prevented sustained control.
- Operator consistency is critical.
- Despite training and manuals, operator reluctance to trust automated control led to inconsistent usage.
- Raw material variability is a fundamental barrier.

- Feed composition variability (e.g., higher bone content) destabilised the system.
- Data gaps reduced optimisation potential.
- Lack of MBM moisture and detailed yield data prevented final quantification of benefits.

These insights explain why early promising results were not sustained and form the foundation for industry guidance on future APC attempts.

8.0 Conclusions

CORE APC can improve rendering stability when mechanical conditions are sound and feedstock is consistent. At JBS Brooklyn, high variability in equipment condition and raw material composition prevented sustained APC control. Mechanical upgrades must precede any APC implementation. From JBS Brooklyn's perspective, APC is not yet feasible in rendering environments with high upstream volatility. However other companies and locations may have a different experience based on their ecosystem environment.

9.0 Recommendations

The end of project recommendations from JBS include Brooklyn, include:

- Undertake mechanical upgrades to dryers, air-damper systems, decanter feed pumps, and steam/airflow systems.
- Standardise raw material handling to reduce volatility in solids load and moisture content.
- Strengthen instrumentation and data availability, especially meal moisture and energy usage.
- Reassess APC feasibility post-upgrade through short, controlled validation trials.
- Share findings across industry to inform realistic expectations and reduce adoption risk for other processors.

10.0 Project outputs

The outputs from this project mainly comprise of knowledge and recommendations for any other processor considering this possible value lift to older equipment. They include:

- CORE hardware installation and PLC integration.
- Two operator manuals (v0 and v1.0).
- Commissioning report, Interim Report (2024), Examination Report (2024).
- Trend data logs, optimisation datasets, and parameter histories.
- Pre-commissioning meeting summaries and troubleshooting reports.

- Industry guidance for APC adoption and prerequisites.

11.0 Bibliography

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12.0 Appendices

12.1 Appendix 1 - Operator Manual

- Filename - JBS Brooklyn - CORE Operator Manual V1_0

12.2 Appendix 2 – Data, Insights and Trend Graphs

The implementation of CORE control for the decaners and dryers in the render facility at JBS Brooklyn commenced in the Spring of 2022. The project has faced significant delays due to IT restrictions, internet connectivity issues, installation difficulties and automation work to update existing control and SCADA systems. The controller commissioning began in October 2023 and the project has progressed well since with a commissioning report and operator manual delivered on November 24th, 2024, and a subsequent status meeting on November 28th.

The CORE controller for each machine is activated individually from the SCADA screen once the production process is up and running. The expected use of the controllers is specified in the provided CORE operator manual which also includes information on the relevant setpoints and limitations. Table 1 summarises the main goals and process variables for each controller type.

Controller	Primary goals	Target variables	Control variables
Decanter	High, stable flow of line taking dryer capacity into consideration	- Torque - Dryer capacity	- Feed pump speed
Dryer	Temperature stability through gentle and gradual control, reducing production issues and maintenance	- Burner exit temperature - Combustion temperature	- Burner load - Air damper

Table 1: Summary of controller goals and key process variables.

Following the controller commissioning and resolution of mechanical issues in the beginning of December, the controllers have been used most of the production time as seen in Figure 2. The week starting December 25th saw reduced controller runtime, however, the total production time was also significantly lower due to holidays. Decanter 1 has hardly run during the considered period and meaningful controller runtime has therefore not been attained.

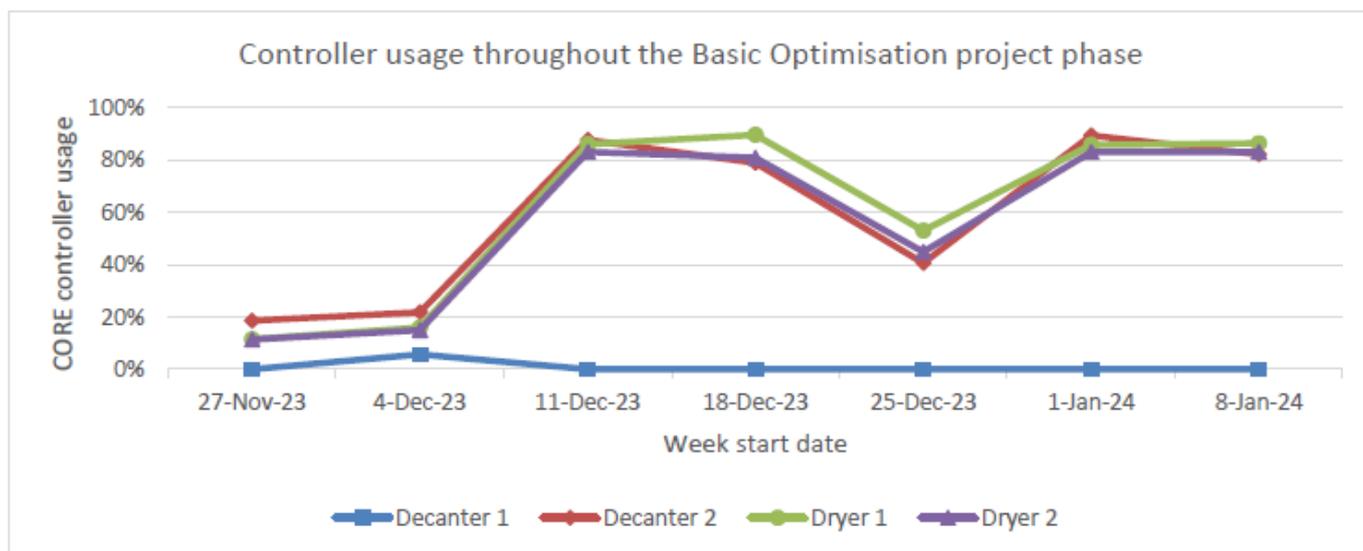


Figure 2: Weekly CORE controller usage during the Basic Optimisation phase.

Data collection and analysis method

The results in this report are based on data collected by Haarslev in the period October 9th, 2023, to January 21st, 2024. The considered data partitions are detailed in the table below. In the specified *Basic Optimisation* data period,

the first two weeks of the corresponding project phase have been omitted to only consider weeks with substantial controller usage.

Requested production data including meal analysis results and energy usages have not been provided during the *Basic Optimisation* phase and the analysis is therefore based solely on the process data logged by Haarslev. The goals for the dryer control have consequently been revised to relate to process temperatures rather than meal moisture and energy efficiency directly. The KPI document has been updated accordingly.

Table 3 shows the total logged production for each machine in the two data periods along with the average CORE controller usages in the *Basic Optimisation* period. On average, the CORE controllers for Decanter 2 and the two dryers have been used around 80% of the time from December 11th to January 14th.

<i>Production hours and controller usage</i>		Decanter 1	Decanter 2	Dryer 1	Dryer 2
Benchmark	Logged production	2 hrs	432 hrs	479 hrs	483 hrs
	CORE usage	0%	80%	84%	78%
Basic Optimisation	Logged production	4 hrs	436 hrs	439 hrs	497 hrs
	CORE usage	0%	80%	84%	78%

Table 3: Logged production time and CORE controller usage for each machine.

Preliminary results and discussion

As shown in Trend graph 1, the CORE controller will attempt to keep the decanter feed speed at the maximum set by the operators while ensuring that the torque is around the chosen setpoint. The local decanter control adjusts the differential speed according to the torque reading. Towards the end of the period shown in the trend graph, the torque level drops due to either a reduction in material flow from the render vessel or a change in material type. The CORE control is running at maximum speed as expected.

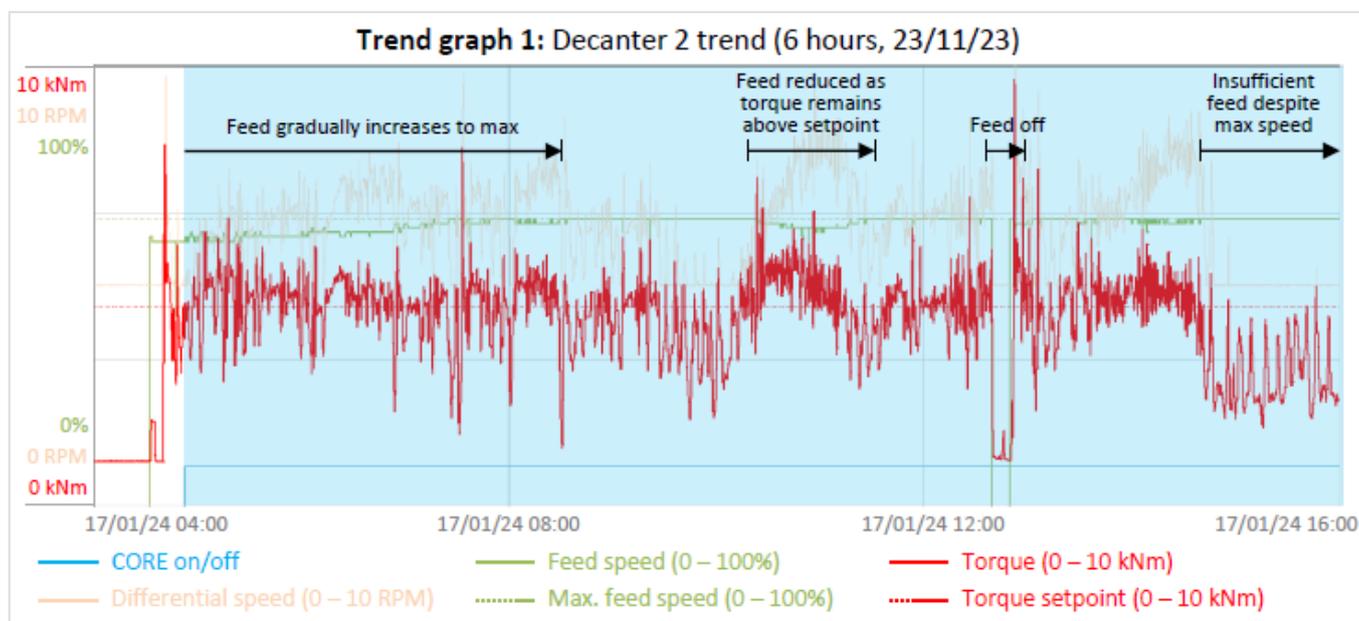


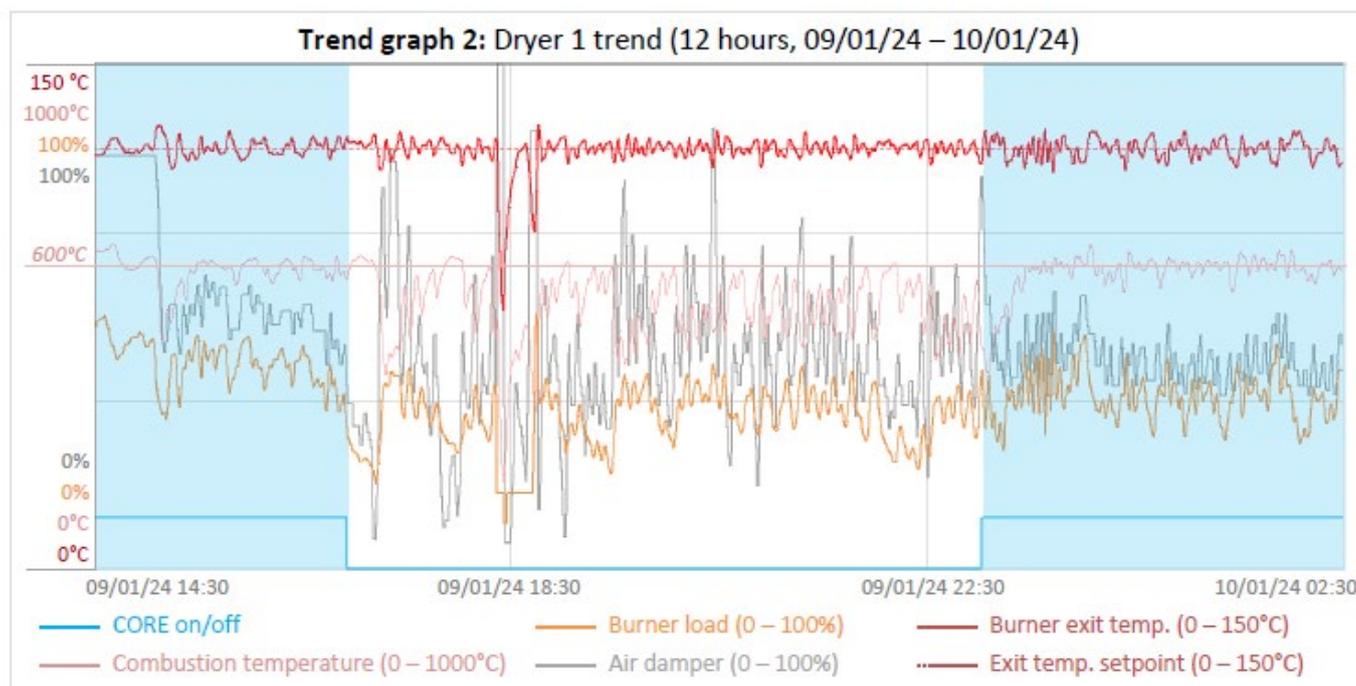
Table 4 shows the key process statistics for the two decaners with Decanter 2 of main interest due to the low usage of Decanter 1. The table suggests a significant increase in the decanter feed speed during the period of CORE

control while the torque levels are maintained or even slightly increased. It should be noted that the feed pump for Decanter 2 has recently been replaced which might also have contributed to improved performance.

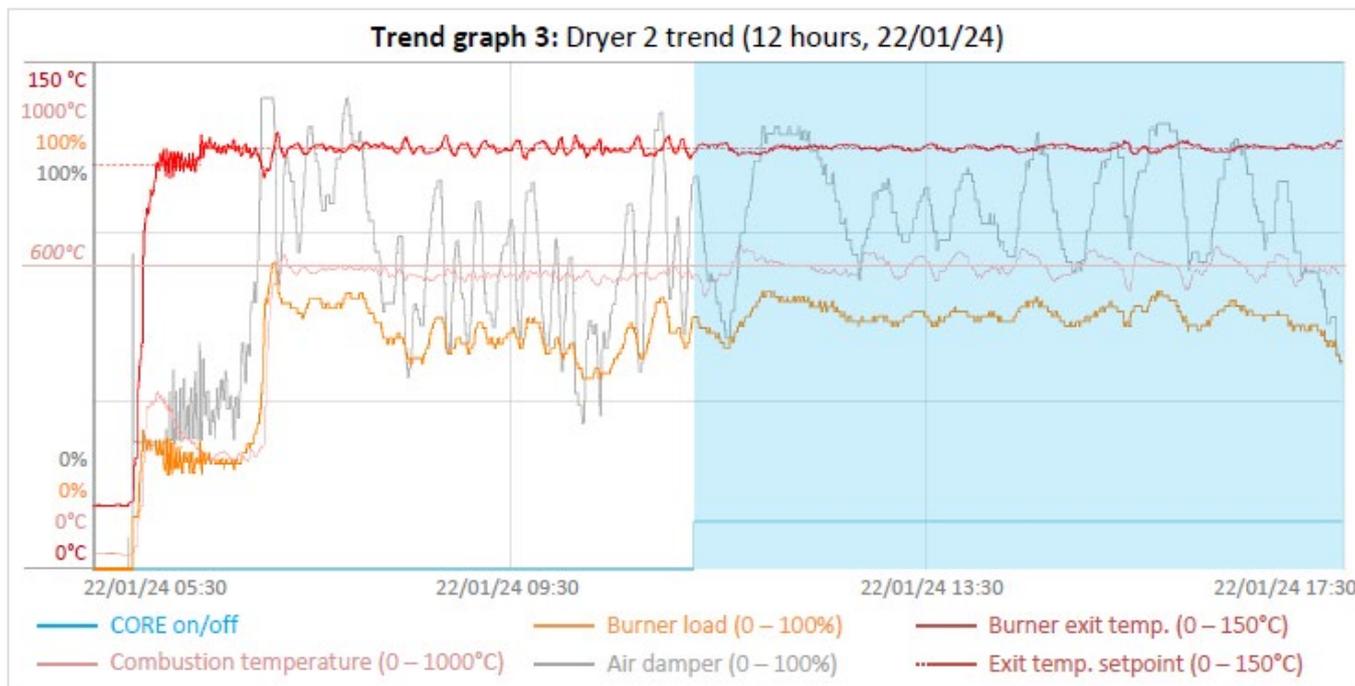
Decanter process statistics	Decanter 1			Decanter 2		
	Feed speed	Torque		Feed speed	Torque	
Benchmark	65%	969 rpm	3.6 kNm	56%	845 rpm	4.2 kNm
Basic Optimisation	68%	1014 rpm	3.7 kNm	63%	952 rpm	4.3 kNm

Table 4: Process statistics for the decanters before and after CORE controller implementation. Note that Decanter 1 has only run for very few hours and the figures are not necessarily representative of actual performance.

Trend graph 2 exemplifies the difference between the CORE dryer control and the local dryer control. The CORE control is predictive and adaptive, allowing it to achieve a good temperature stability with a more gradual control of the burner load and air return valve. The erratic nature of the local air damper control in the middle part of the shown trend makes the control more volatile and prone to dramatic variations upon changes of material as well as increasing wear on the mechanical equipment.



The combustion temperature is also a lot more stable during CORE control and is constantly kept around the 600°C value set as controller parameter. Maintaining a stable combustion temperature helps in transitions between material types and ensures a consistent drying process.



An example of the stable exit temperature provided by the CORE dryer control is seen in Trend graph 3 where the gradual nature of the control is again illustrated with slower adjustments of both burner load and air damper.

Table 1 and Table 2 summarise key temperature related performance statistics for the dryers. They show that the burner exit temperature is maintained while the combustion temperature is very consistent. The major increase in production time around the desired combustion temperature of 600°C gives a more consistent production with improved handling of different material types and changes between these. The reduced time at very high combustion temperatures also prevents an unnecessarily high energy usage.

<i>Dryer 1</i> <i>process statistics</i>		Avg. Burner exit temperature	Combustion temperature		
			Average	Time in 550°C – 650°C	Time above 650°C
Benchmark		125.3°C	544°C	33%	16%
Basic	Total	124.0°C	588°C	89%	1%
Optimisation	CORE control	124.1°C	600°C	98%	1%

Table 5: Dryer 1 process statistics.

<i>Dryer 2</i> <i>process statistics</i>		Avg. Burner exit temperature	Combustion temperature		
			Average	Time in 550°C – 650°C	Time above 650°C
Benchmark		124.2°C	523°C	44%	8%
Basic	Total	124.3°C	558°C	83%	3%
Optimisation	CORE control	124.2°C	597°C	93%	3%

Table 6: Dryer 2 process statistics.

Benefits and savings

The examples and results presented above show improved feed to the decanter and vast improvements in the dryer temperature control. The implementation of the CORE control is thereby yielding the following benefits and savings:

Higher production rate through higher decanter feed speed The CORE decanter control will maximise the feed speed within the relevant processing restraints such as decanter torque levels, dryer capacity and the maximum feed speed set by the operators. This ensures that the rendering process is pushed continuously and helps make the most of the available processing capacity.

Improved dryer capacity and reliability by better control of combustion temperature Keeping the combustion temperature at a constant, high level enables the dryer to handle sudden changes in the incoming material flow such as an unexpected influx of wetter material without the risk of consequent loss of temperature.

Reduced wear and maintenance need with more consistent and gradual control The gradual nature of the CORE controllers puts less pressure on the burner load and air return valves as they are not required to change as quickly. It also helps prevent large oscillations stemming from overreaction in the control variables.

Conclusion

The CORE controllers for Decanter 2 and both dryers have been used consistently since the middle of December while Decanter 1 is not currently utilised in the production and the controller consequently not run. The project has transitioned from the *Basic Optimisation* phase, where the controllers are tuned and production scenarios requiring specific operator or controller action are identified, to the *Benefits & Savings* phase where results are documented.

This report summarises intermediate results and shows the effect of the controller implementation. Most notably, the decanter feed speed is higher than prior to CORE control and the dryer temperature stability has increased significantly, especially in terms of a more stable and reliable combustion temperature. The gradual adjustments provided by the CORE controllers have also been highlighted by the production team as beneficial and improving the process stability.