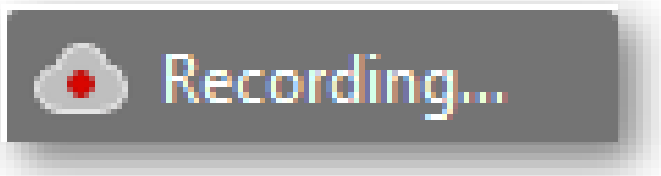
Recycled Paperboard Technical Association

White Water Pre-Treatment

Paul Schutes
RPTA Executive Director

Zoom Webinar Housekeeping

If kicked off, reconnect in a minute.



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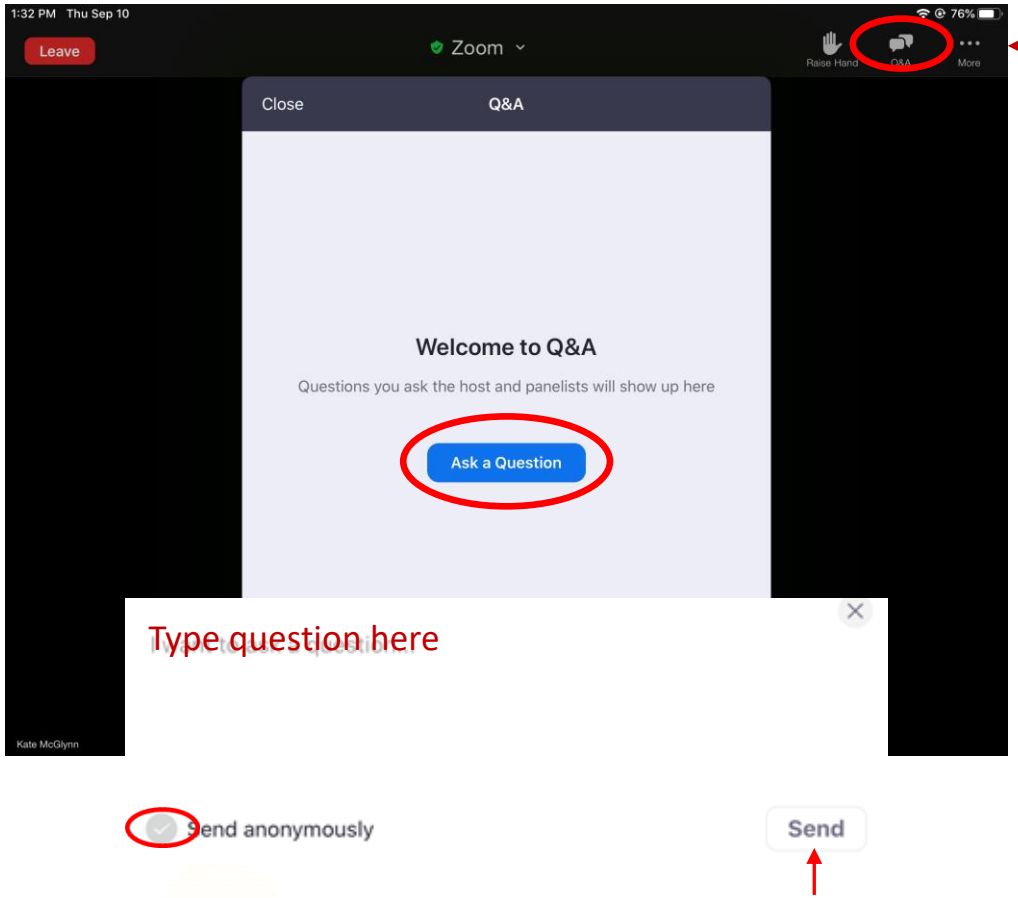
- Attendees cannot be seen or heard

- Presentation slides will be emailed to attendees after the webinar
- ALONG WITH an event feedback form



Q&A

Must wake screen up

- Type question any time
- Speakers will answer after all presentations are completed

Kate McGlynn
RPTA Associate Executive Director

Introduction

Agenda

- Water Loop Separation and Anaerobic Bio-kidney: Effects on Mill Process Water (40 min)
  - Ryan Coda, Voith-Meri
- White Water Treatment and Impact on Product Odor (30 min)
  - Thomas Murphy, Liberty Paper
  - Jamie Cutcher, Greif
- Questions & Answers (20 min)

Dana Pelletier
RPTA Operating Board Chair
General Manager, Greif - Fitchburg

Water Loop Separation and Anaerobic Bio-kidney

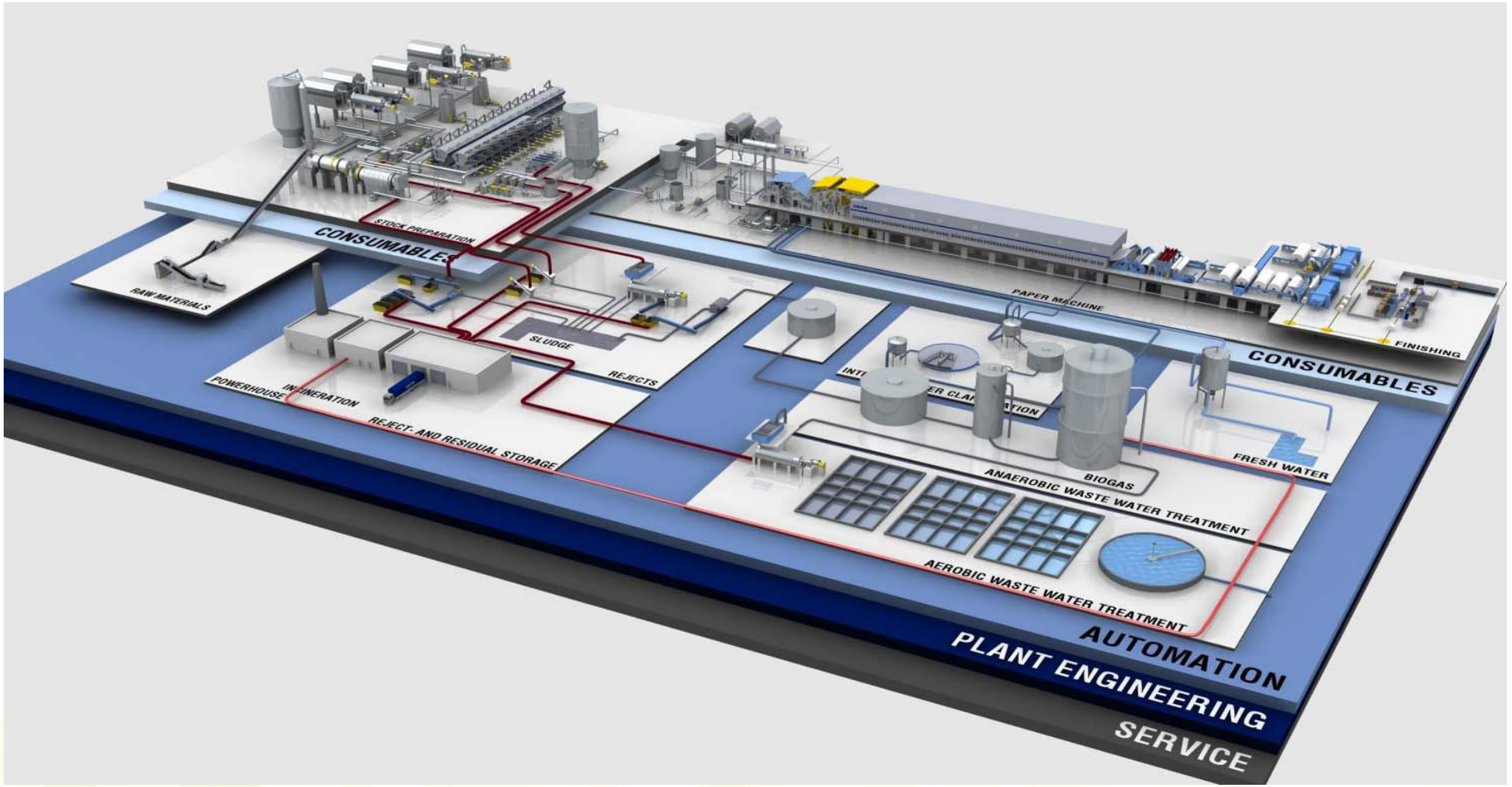
Effects on Mill Process Water

Ryan Coda

Sr. Applications Engineer

Voith Meri Environmental Solutions

What is a Complete Mill?



1. What is Chemical Oxygen Demand (COD)?
2. Impact of Water Loop Separation on COD
3. Anaerobic Bio-kidney
4. Basics of Anaerobic Treatment
5. Summary

1.What is Chemical Oxygen Demand (COD)?

Chemical Oxygen Demand (COD): Definition

- COD is a test used to measure the Oxygen equivalent of the organic material in Wastewater that can be oxidized chemically using Dichromate in an Acid solution (*Wastewater Engineering: Treatment and Reuse*, Metcalf & Eddy)
- The COD test is a 2-hour test and can be used as an indirect indicator of the Biological Oxygen Demand (BOD)

Biological Oxygen Demand (BOD): Definition

- Biological Oxygen Demand (BOD) is one of the most common measures of pollutant organic material in water. BOD indicates the amount of Putrescible Organic Matter present in water.
- Therefore, a low BOD is an indicator of good quality water, while a high BOD indicates polluted water. Dissolved Oxygen (DO) is consumed by Bacteria when large amounts of organic matter from sewage or other discharges are present in the water.
- Typically reported as BOD_5 as the most common BOD test is a 5-day test

BOD:COD Ratio

- The ratio of BOD to COD describes the ratio of readily biodegradable and non-biodegradable substances.
- The higher a BOD/COD ratio is the easier it is to degrade.
- This ratio also relates to the possible Biological Degradation Efficiency that can be achieved with a Wastewater.
- Typical ratios for OCC Mill wastewater are in the range from 0.4 to 0.6

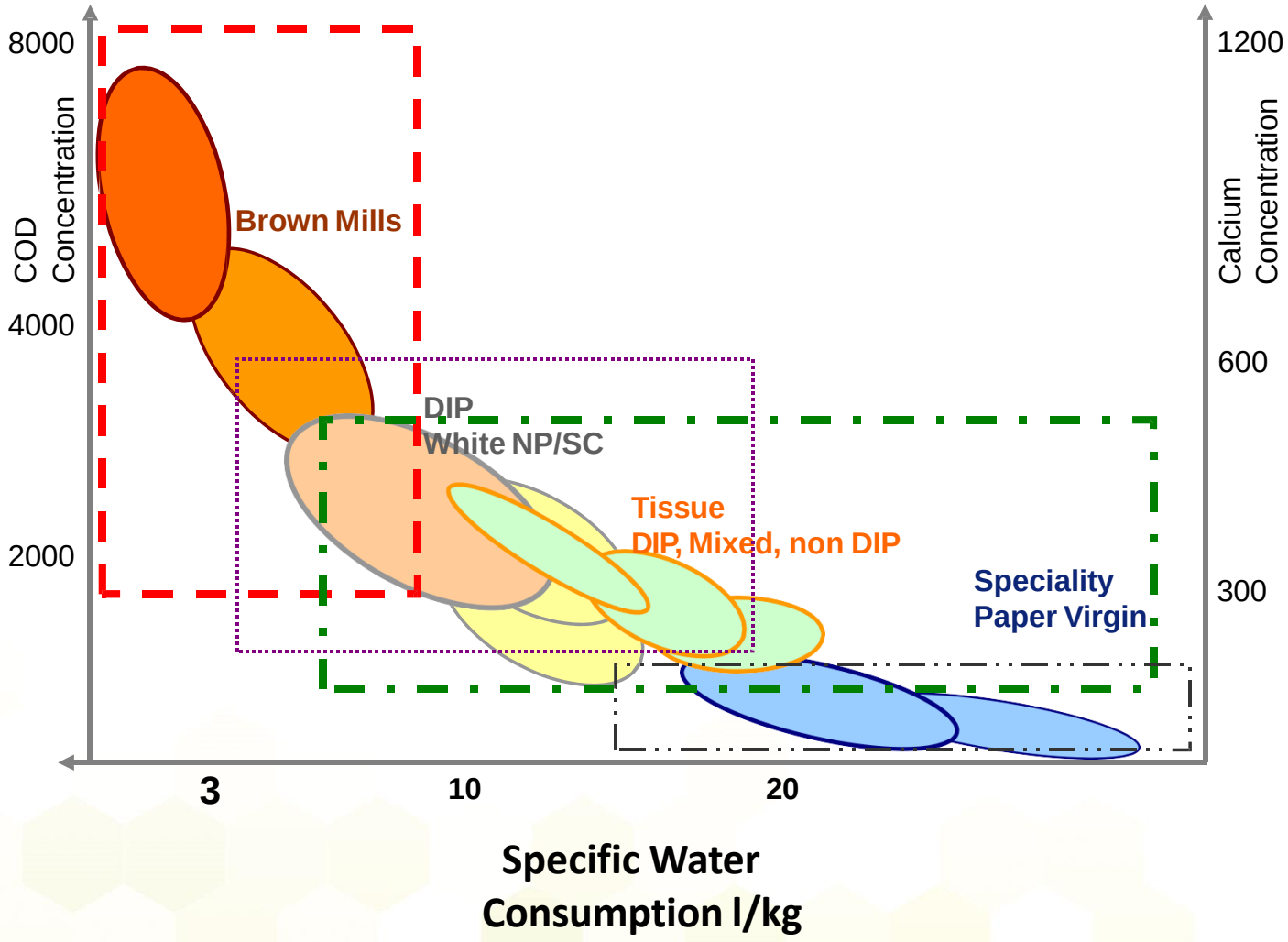
Chemical Oxygen Demand (COD)

COD is the parameter for the evaluation of the dissolved organic load of the water loops and an indicator for the realisation of the counter flow principle

High values equate to:

- High consumption of process additives
- Deposits at the paper machine
  - Leads to breaks, reduce runnability, and quality issues
- Problems with microbiological activity (acidification, slime, odor)
  - Biocide dosing necessary

Effect of Water System Closure on COD



1. What is Chemical Oxygen Demand (COD)?

2. Impact of Water Loop Separation on COD

Consistent Water Loop Separation

Goal:

Reduce carryover of dissolved/colloidal disturbing substances (microstickies, anionic trash, COD,…) from stock preparation to PM

Advantage:

- PM cleaning downtime minimized
- Better chemical performance → lower chemical consumption
- Reduced odor in the final product

Counter Current Principle

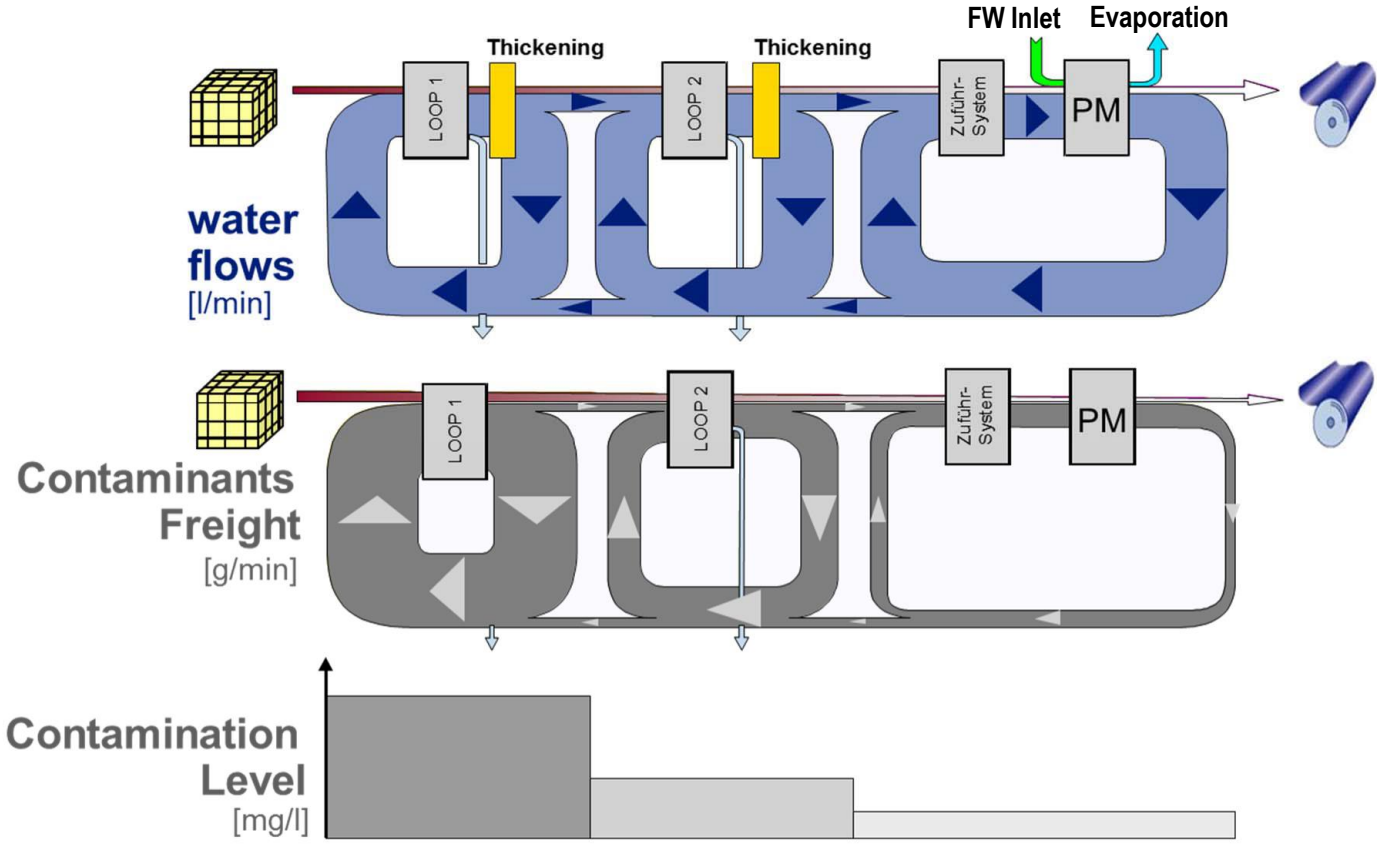
Definition:

Fresh water is fed at the PM on one hand and recycled paper with a high load of contaminants is fed to the stock preparation. The fresh water flows through the different process loops against the main stock flow with increasing load.

The washing water of the 1st loop with the highest load of colloidal and dissolved matter (with disturbing behaviour) is discharged from the paper mill.

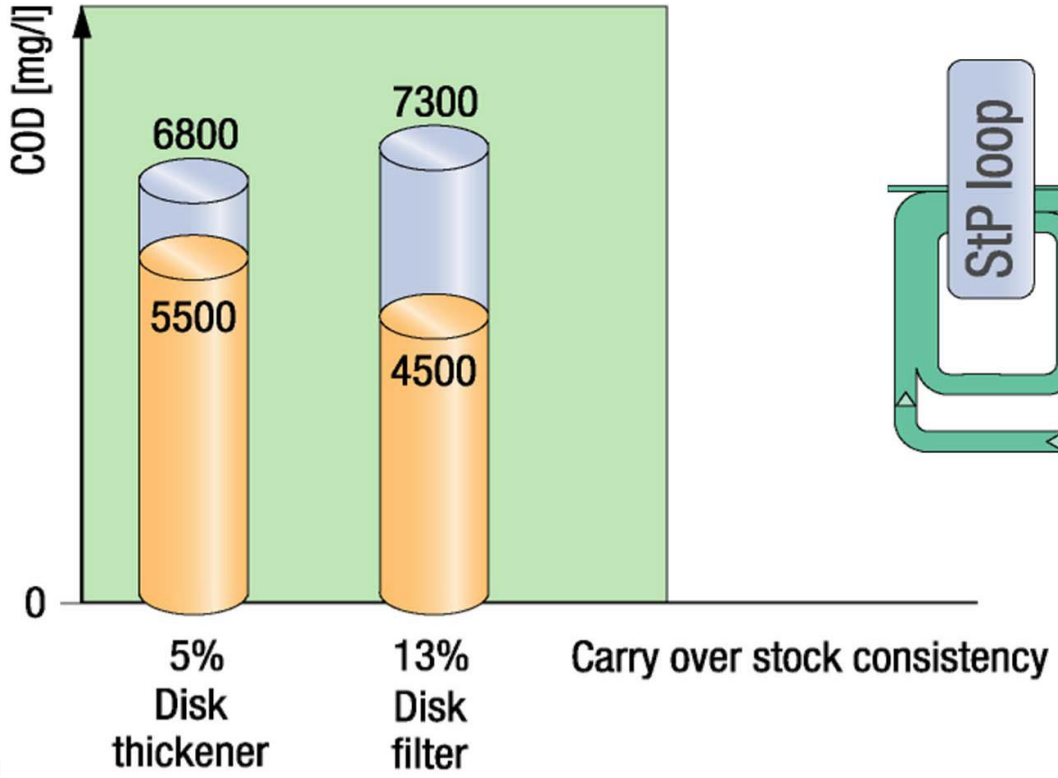
The effect of the counter current principle is determined by the outlet consistency of each thickening stage separating one loop from another.

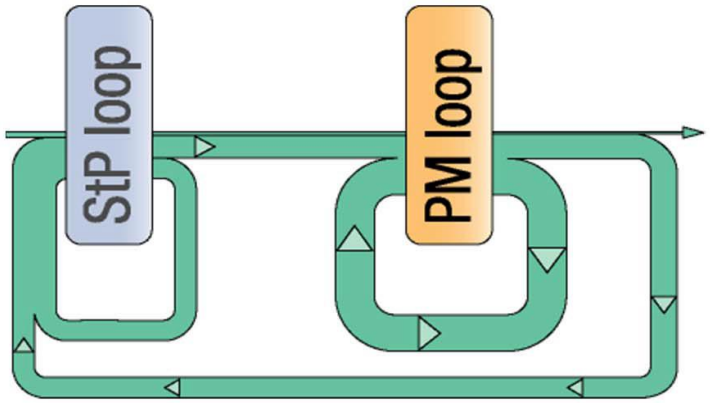
Water Loop Separation and Counter Current Flow



COD level as a function of carry over stock consistency

(effluent 3.5 l/kg)

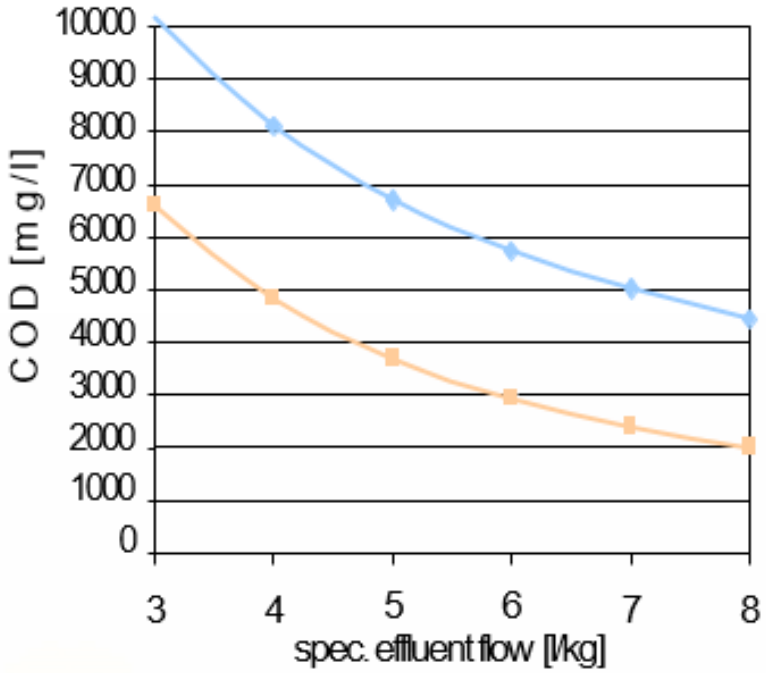


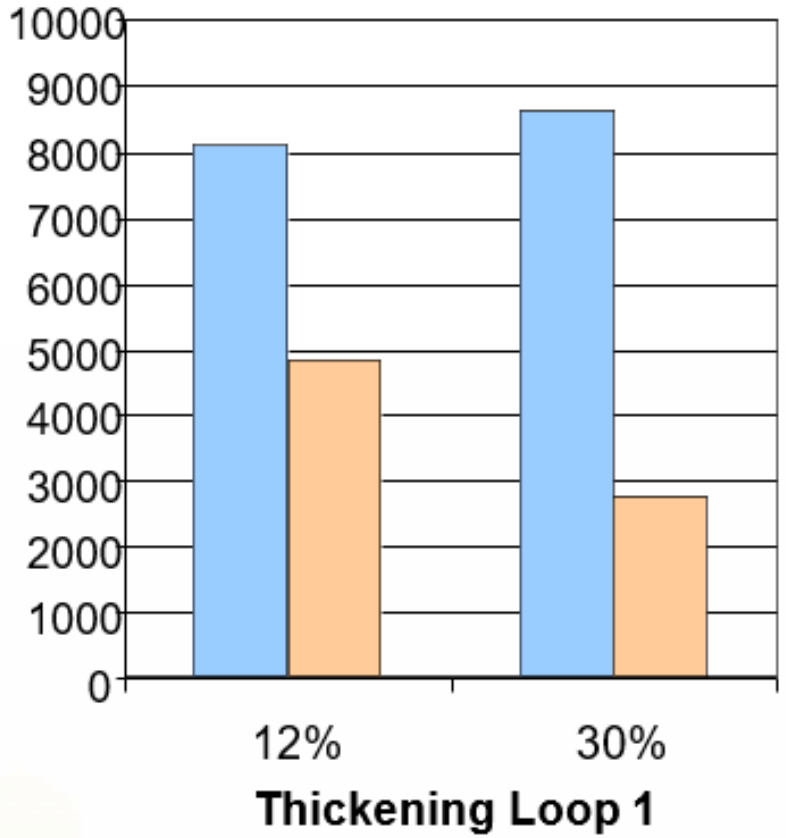


Low carry-over to PM loop thanks to high carry over stock consistency

VPR Chapter 16 No 2251 Ed 01

COD level as a function of carry over stock consistency





1. What is Chemical Oxygen Demand (COD)?
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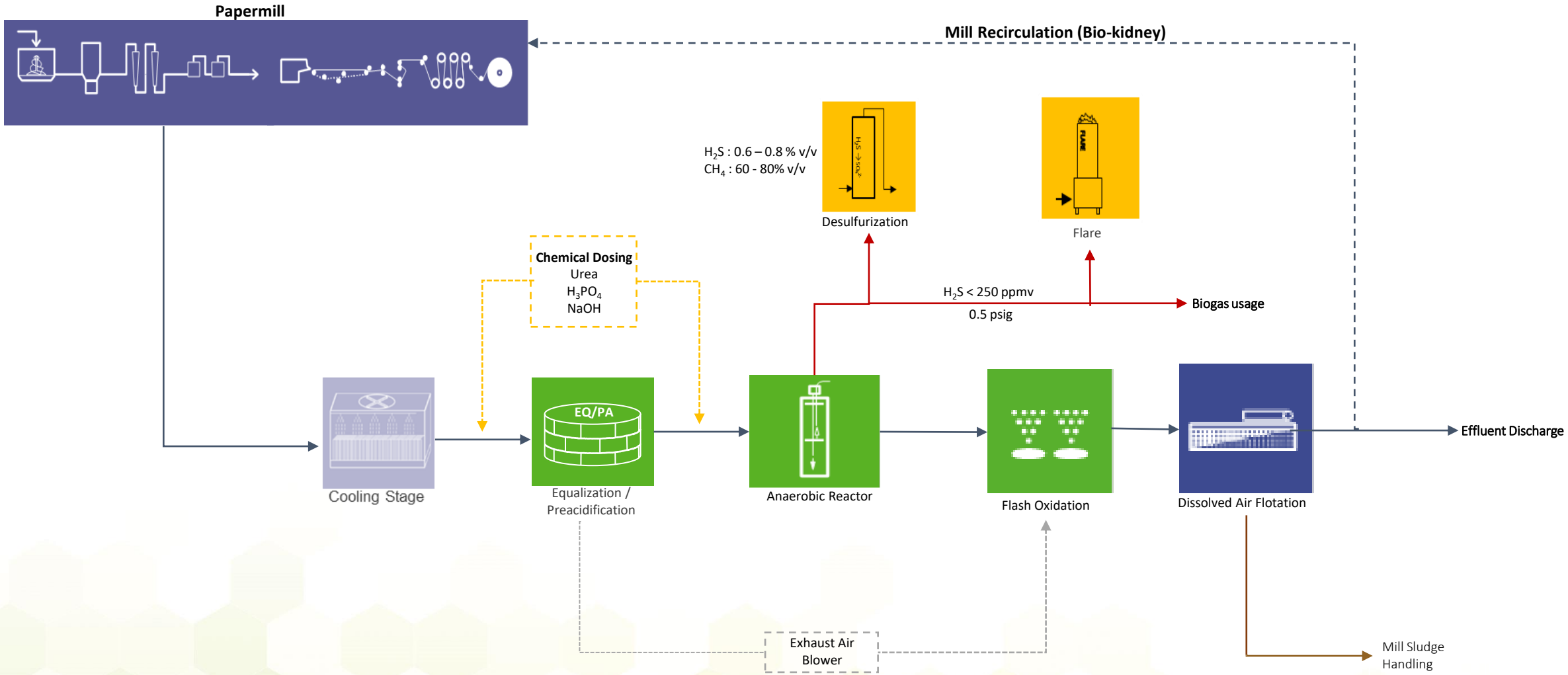
3. Anaerobic Bio-kidney

Typical Components of Anaerobic Systems With Bio-kidney



The Bio-kidney Effect

- Reduce dissolved organics in process water by returning anaerobically treated effluent back to process
- Reduced odor
- Easier pH control
  - Reduces Volatile Fatty Acids that drop pH
  - Increases process water alkalinity (pH buffer)
- Reduced biocide usage
- Improved drainage (increase capacity of wet end limited paper machines!)

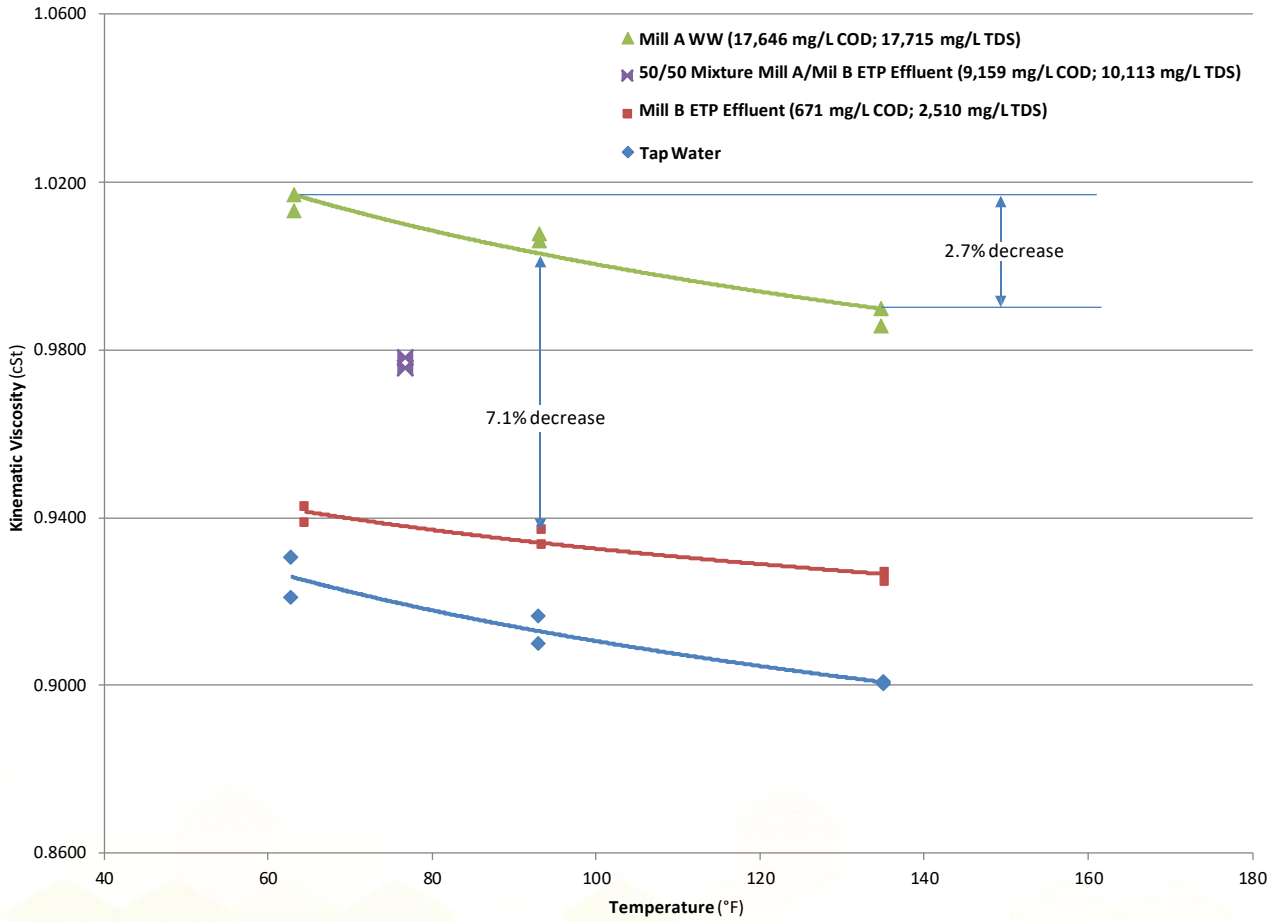
Increased Drainage?

- The concentration of dissolved organics in process water has a direct impact on drainage
- Water loop separation helps keep dissolved levels as low as possible around the paper machine
- A bio-kidney can reduce dissolved organics to a level even lower than achievable through loop separation alone
- Faster machine speeds and reduced drainage aid addition!

Increased Drainage?

- Mills strive for high temperatures to improve drainage (energy input)
- The effect of temperature on drainage is due to changes in water viscosity
- High concentrations of dissolved organics have greater impact on viscosity (and therefore drainage) than temperature
  - A temperature increase of ~70° F in a mill whitewater sample reduced viscosity by 2-3%

COD Concentration, Temperature, and Viscosity



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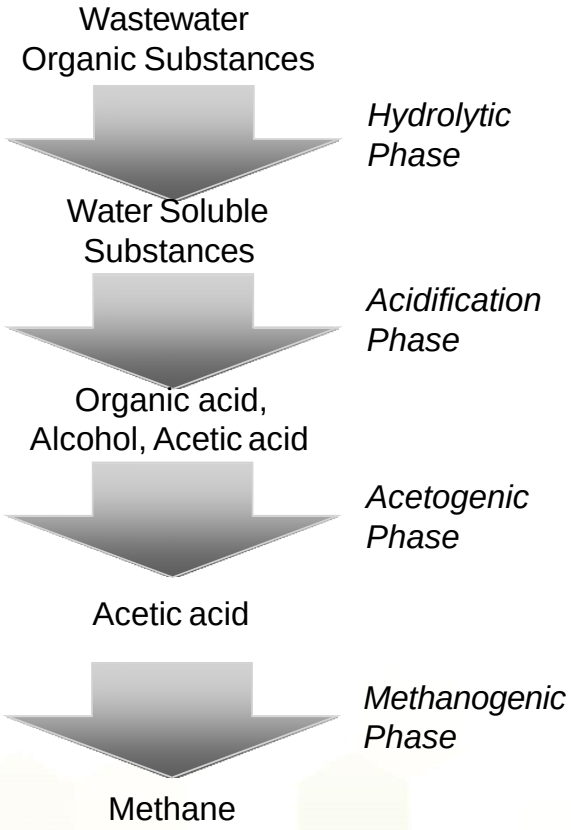
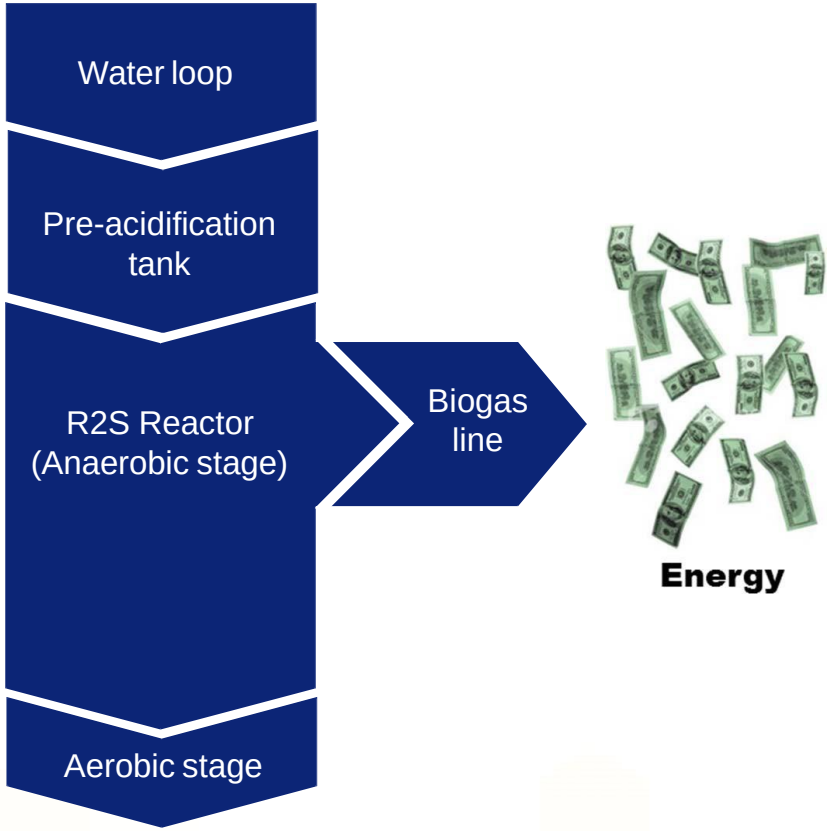
4. Basics of Anaerobic Treatment

Anaerobic Treatment Phases





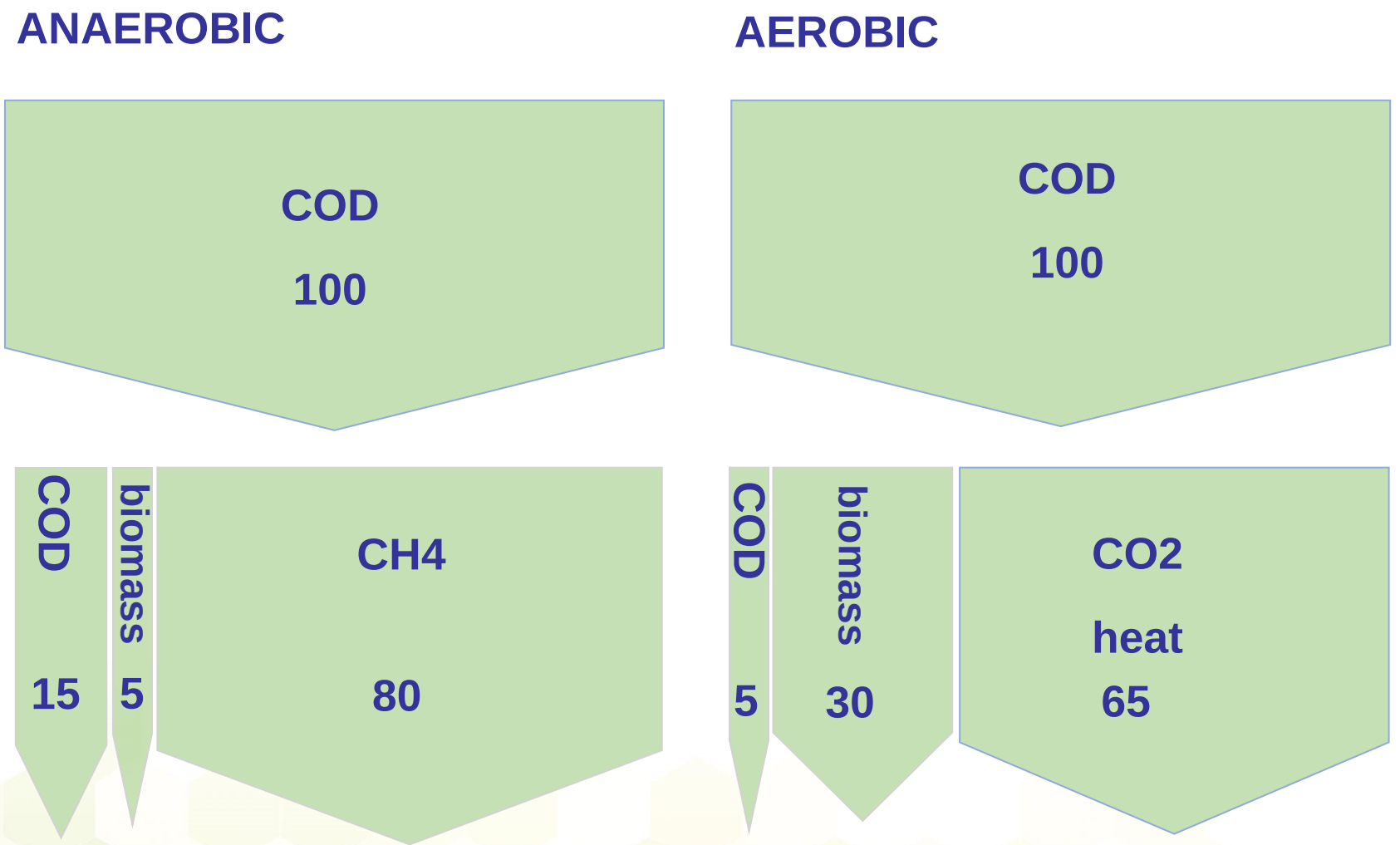
Anaerobic biomass in granular form

Why Anaerobic?

- De-couple the dependence on municipal treatment plants
- Low operating costs compared to aerobic
  - Minimal, if any, aeration involved
  - No difficult to handle biosludge (sludge that is produced can be stored and sold)
- Small footprint
- Energy from biogas

These factors make it easy to include anaerobic treatment as an actual part of the mill water system rather than simply end-of-pipe

Anaerobic vs Aerobic Treatment



Anaerobic vs Aerobic Treatment

	Anaerobic	Aerobic
Energy of Substrate	Converted into Methane	Converted into Biomass and CO_2
Energy	Net renewable energy production in form of Biogas	Energy consumption due to Aeration and Sludge Handling
CO_2 Emissions	CO_2 Emission Equivalents reduced, replacement of fossil fuel	CO_2 Emission Equivalents produced, use of fossil fuel for Aeration
Removal Efficiency	±80%	±95%
Organic Solids	No Removal possible	Removal possible
Volumetric Loads	High Volumetric Loading Rates 10-40 kg COD/m^3/d	Low Volumetric Loading Rates 1-6 kg COD/m^3/d
Sludge Production	Low Sludge Production	High Sludge Production
Nutrients Removal	No Nutrients (N,P) are removed	Nutrients (N,P) removal possible

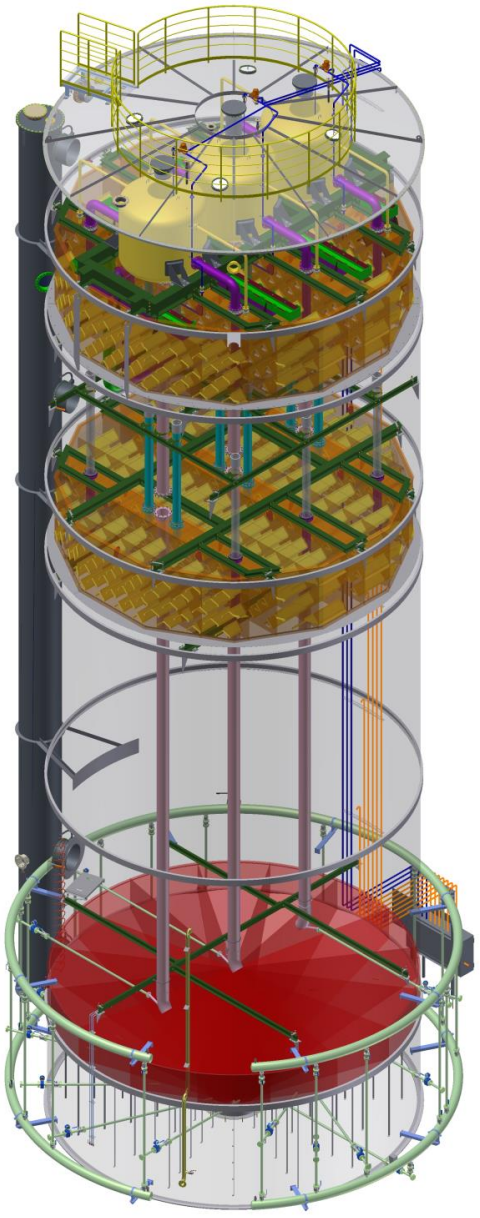
Anaerobic vs Aerobic Treatment (example)

Wastewater Data (an example)	
Flow	833 gpm
COD	4500 ppm
COD load	45,000 lbs/day
BOD load	22,500 lbs/day

	Anaerobic	Aerobic
Energy Balance	+ 195 MMBTU/day*	- 37 MMBTU/day**
Tank Volume required	96,000 ft^3	446,000 ft^3
Net Tank Surface Required	6,600 ft^2	77,000 ft^2

* Energy produced by Biogas Generation
** Energy Consumed by Aeration

High-Rate Anaerobic Reactor – Overview

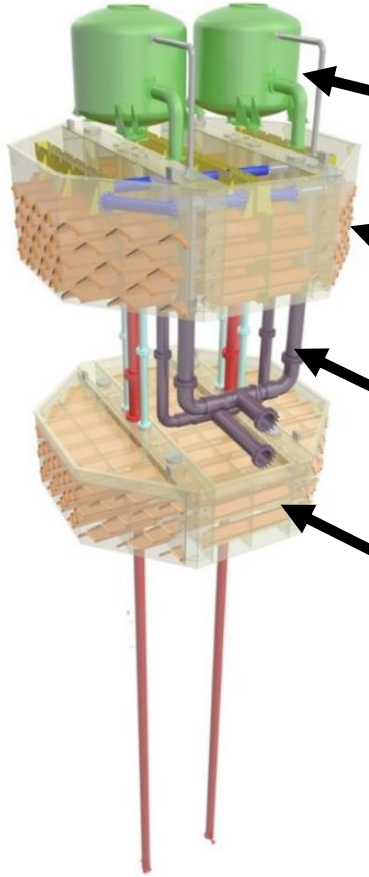


Key Factors:

- **Advanced type of EGSB Reactor**
- **High volumetric load** leads to compact reactor tanks
- **Conical bottom** for discharge of sediments / heavy sludge during operation via unique **Heavy Sludge Removal**
- **Combined internal/external recirculation** for always constant hydraulic flow, even in case of inlet fluctuation or mill shut down
- **Improved fluidization** of the granular sludge bed and optimized distribution of inlet flow
- Design features to **avoid clogging of the reactor internals** / Simple feeding system
- 3-phase separators supplied in segments for onsite assembly

High-Rate Anaerobic Reactor – Overview

Tank



Internals

Small Footprint

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Summary

- Proper water loop separation critical to maximize quality, runnability, etc.
  - Higher consistency at the end of a water loop creates a greater drop of contaminants going into the next water loop
- Anaerobic effluent treatment is increasing in popularity
  - Municipal discharge rates increasing
  - Significantly lower operating costs than aerobic
  - Significantly smaller footprint than aerobic
  - No bio-sludge to dewater
  - Energy from biogas
- Benefits of anaerobic technology make it an attractive option as an actual part of the papermaking process and not just end-of-pipe treatment
  - Bio-kidney
  - Improved drainage, reduced odor, reduced biocide, easier pH control

Thank you for your attention!

Mill Experiences

Now, we will learn about the experiences at two different mills from

- Tom Murphy, Technical Manager, Liberty Paper, Inc.
- Jamie Cutcher, Environmental Manager, Greif

White Water Treatment and Impact on Product Odor

Recycled Paperboard Technical Association

Jamie Cutcher
Environmental Manager
Greif

Thomas Murphy
Technical Manager
Liberty Paper

100% Old Corrugated Containers (OCC) Used to Make New Linerboard and Medium

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LIBERTY PAPER INC.
an LDI Company

- Linerboard and coated products manufacturer
- Operates year round
- 163 employees
- Owned by Liberty Diversified International

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1995 Paper Machine Startup

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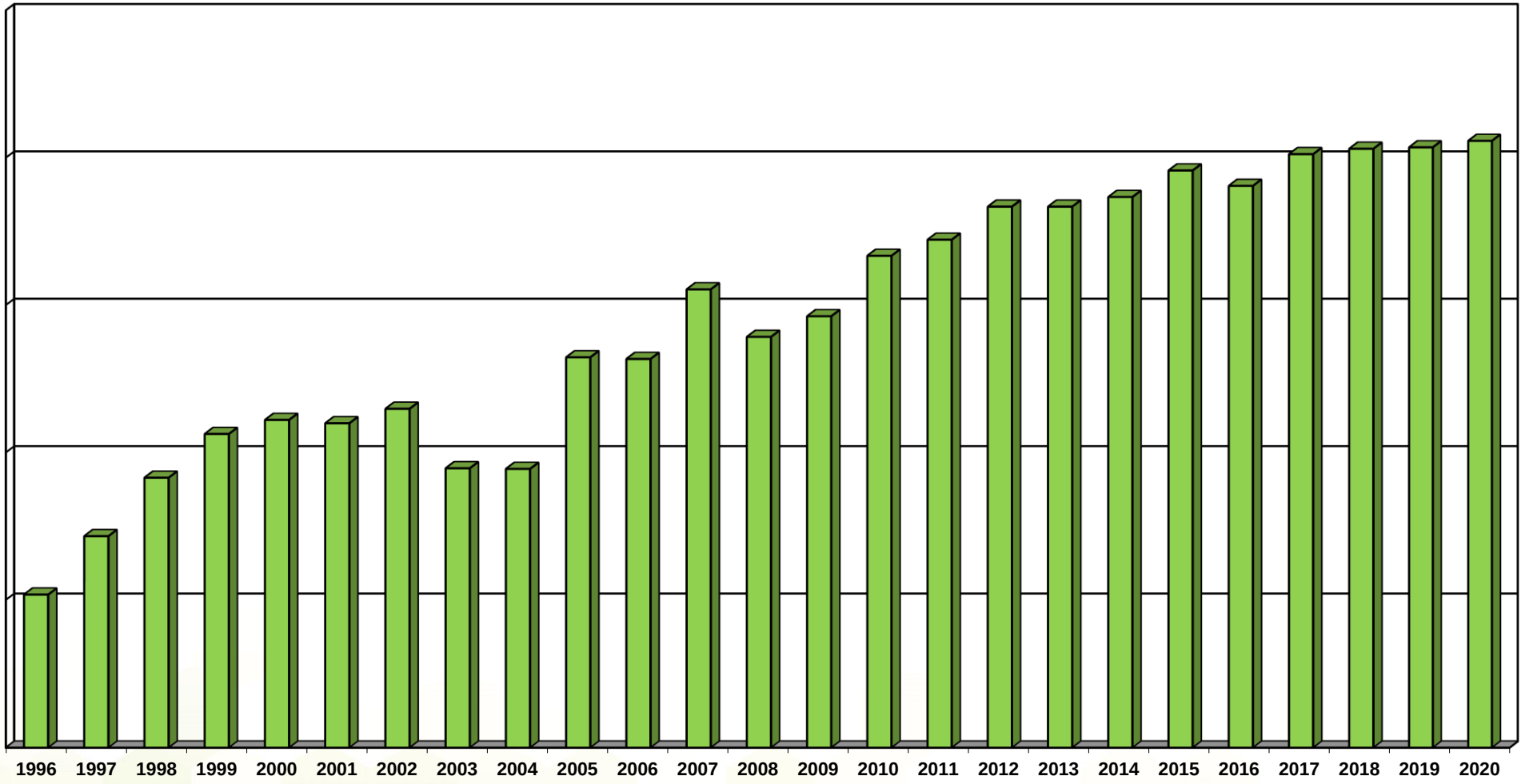
Paper Machine - Tons Produced



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Problems with Increasing Production

- Wastewater flows from LPI to City of Becker for Final Treatment
- Causing BOD issues at Becker City Treatment Plant
- Papermill reduced wastewater flow
  - Excess wastewater was trucked to MCES
  - 5000 gal wastewater truck/hour for 2 years
  - Very high trucking and disposal cost
  - Justification for Anaerobic Treatment Plant

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LPI Anaerobic Treatment Plant

- $MM Capital Investment
- High water cleanliness (90% less contaminants)
- Eliminated trucking costs

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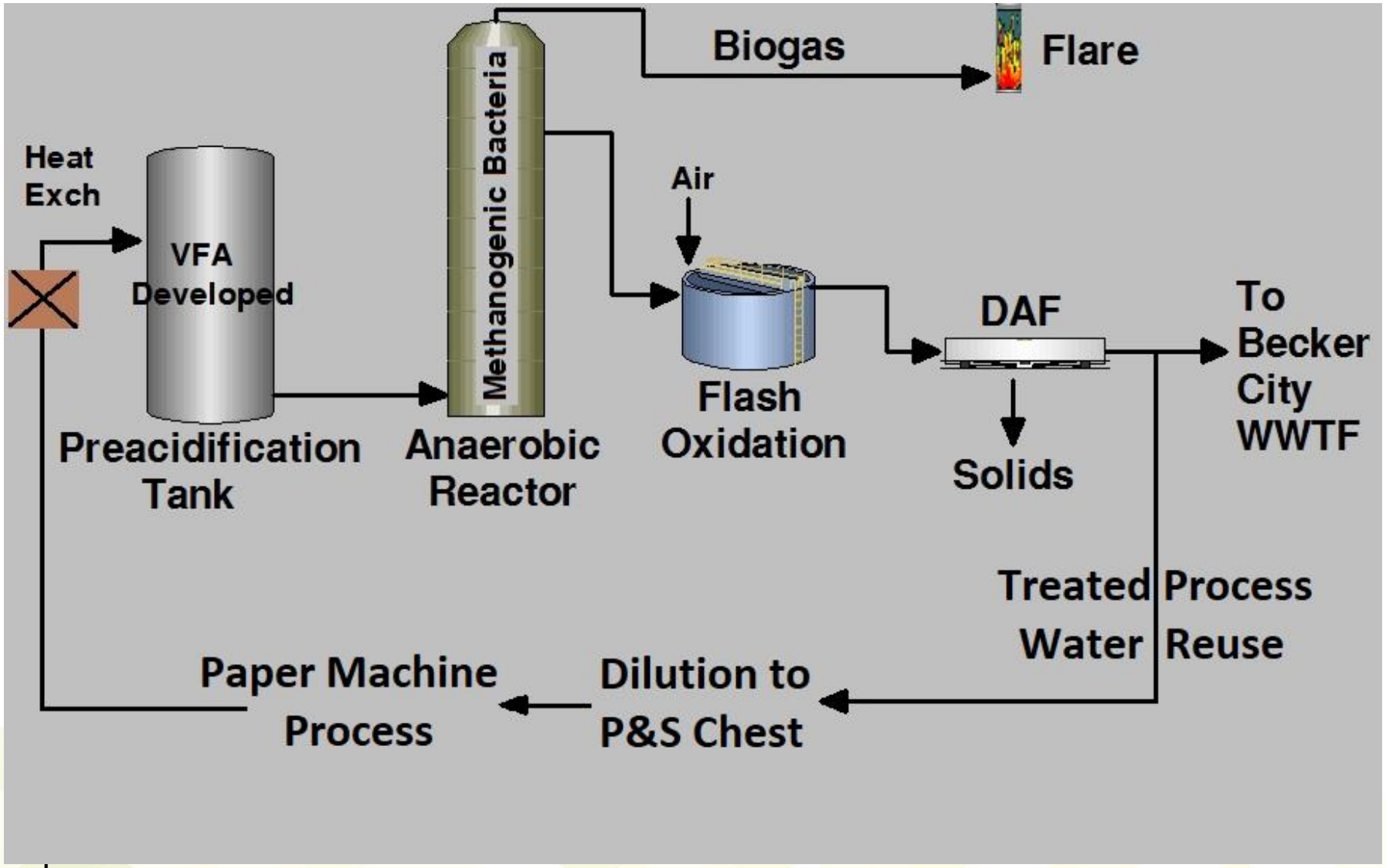
Simplified Drawing of the Process



Greif Massillon

- Produce 100% Recycled Corrugated Medium
- Mill started 1966
- Two paper machines producing 650 TPD
- Solar Turbines cogeneration unit
- #1PM rebuild in 2010
- ETP started in July 2017
- Unionized
- 120 employees

#1 Paper Machine Rebuild 2010

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Explanation of Greif Issues

- Unable to meet permit limits for TSS & BOD issued by local POTW.
- High strength BOD, >5,000 mg/L, was causing significant disruptions for POTW
- Greif was highlighted in the local newspapers as one of the major industrial dischargers contributing to the odors impacting businesses at a nearby shopping plaza.
- Negative image in the local community.

Explanation of Greif Issues (continued)

- Extremely closed water system.
- Only permitted to discharge 100,000 GPD and was heavily surcharged for exceeding permit limits on BOD and TSS.
- Low freshwater usage impacted chemistries used in the papermaking process.
- Unable to use freshwater in key areas on the paper machine.
  - Fourdrinier wire
  - Press fabrics

Greif Anaerobic Treatment Plant

- $7.5MM Capital Investment
- High water cleanliness. 97% BOD and 87% TSS effluent reduction.
- No permit violations since July 2017 start-up.

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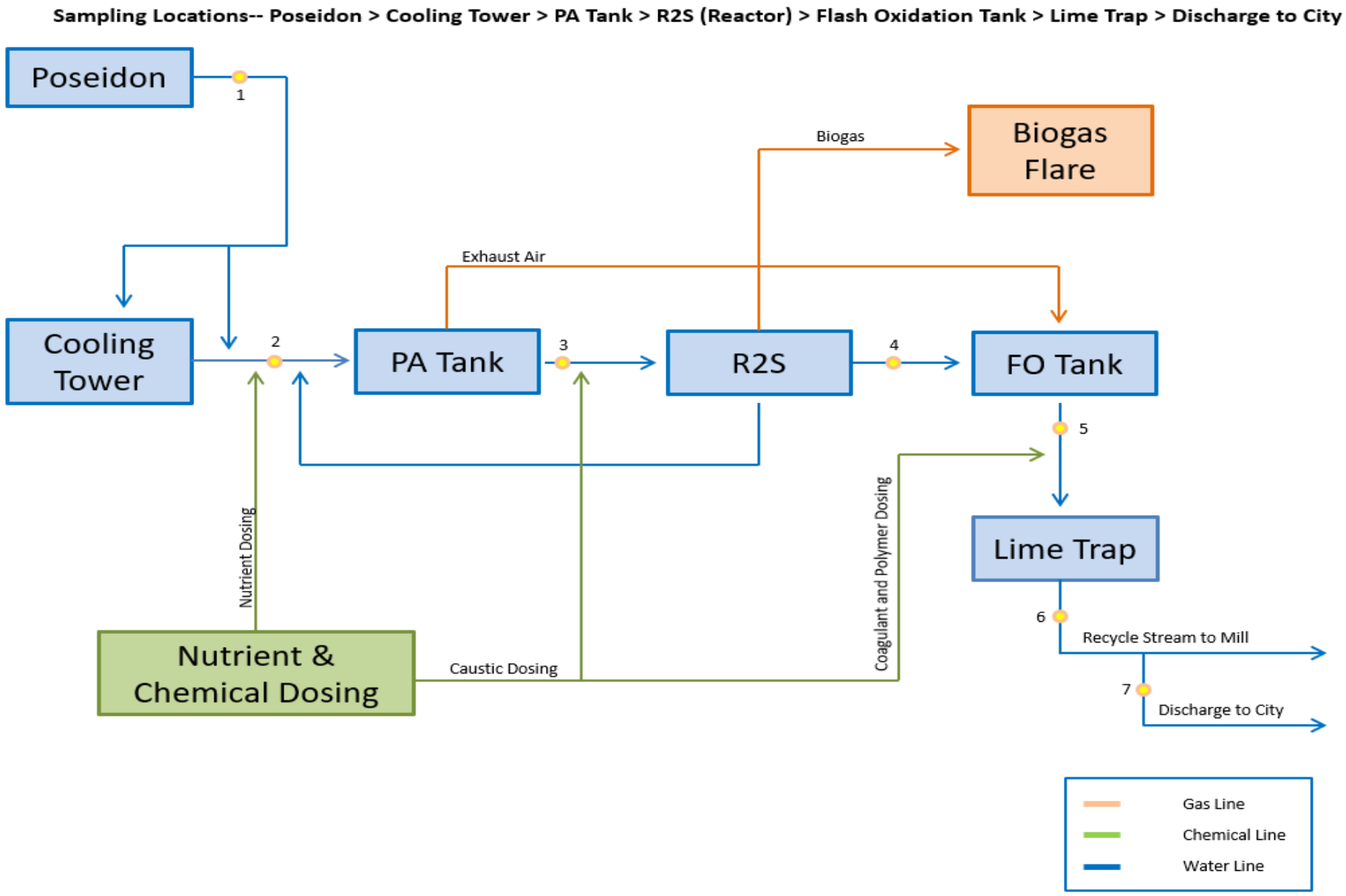
Greif Simplified Drawing of the Process



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Biogas

- 50-75% Methane CH_4
- 30-50% Carbon Dioxide CO_2
- 0.5 - 2% Hydrogen Sulfide H_2S
  - Corrosion and safety
- Siloxane
  - Found in many consumer products
  - Builds up on electrical generation equipment

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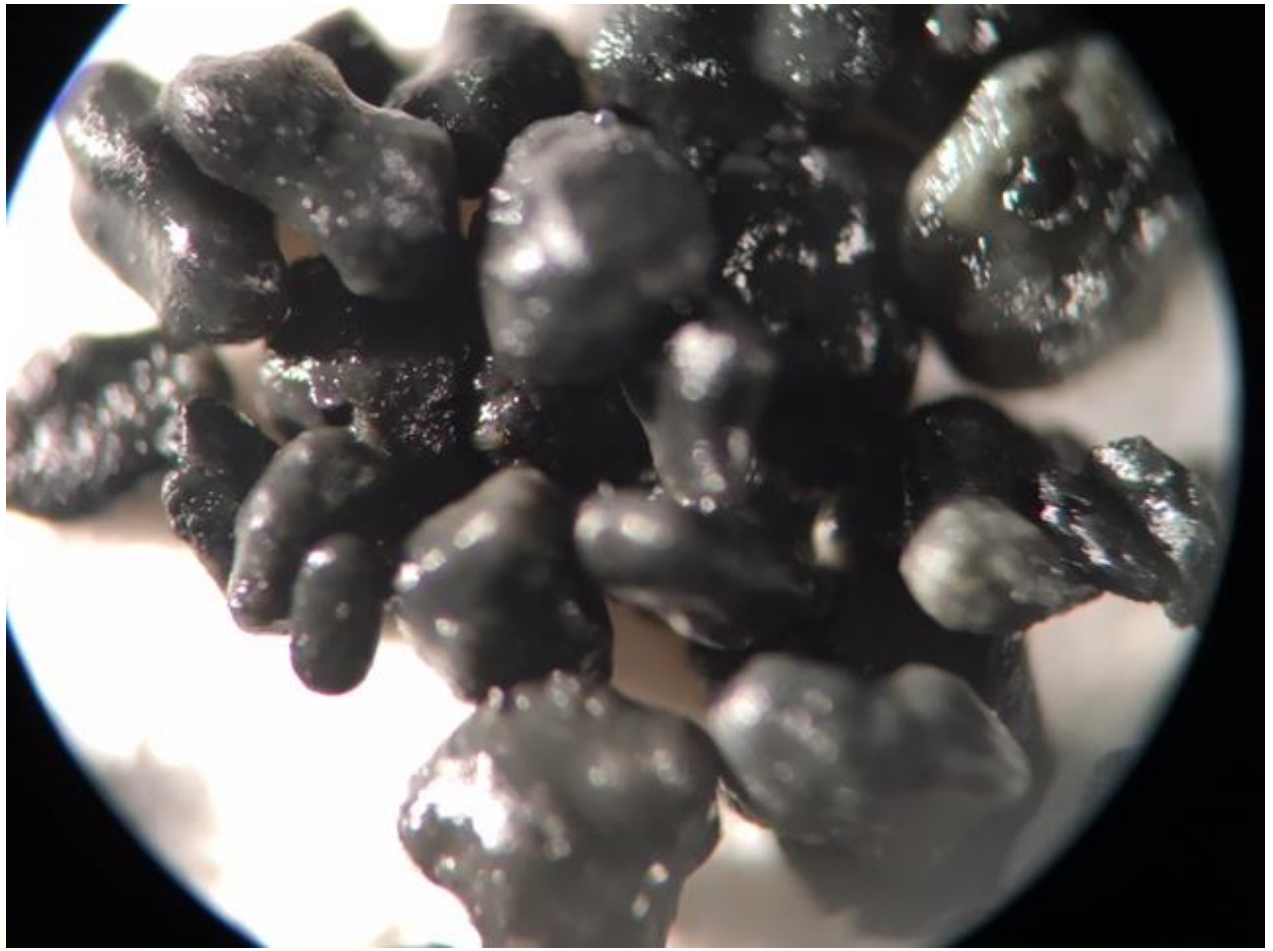
Anaerobic Digestion

- Anaerobic bacteria breaks down the contaminants
- Consumes waste and releases methane biogas



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Anaerobic Bacteria Cost

- Granular Sludge Bacteria - $1/gallon delivered

- Need suppliers and customers for this process to succeed
  - You will lose biomass
  - You will make biomass

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LPI Startup/Operational Issues

- Freezing of outdoor piping
- H_2S safety issues and corrosion
- Calcium carbonate scaling issues
- No excess sludge customer
- Sludge quality degraded over time
  - Nutrient deficiency
  - Mixing deficiency

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Greif Startup/Operational Issues

- Successfully met permit limits for BOD & TSS in the 1st month of start-up.
- Outside piping was not insulated and lines began freezing in early November.
- Scale depositing in pipes around the Lime Trap and UDS.
- High rates of scale accumulation in the reactor due to the hardness levels from incoming well water.
  - High Volatile Fatty Acids (VFAs) coming from the mill
  - pH variability

Anaerobic Impact on Product Odor

VFA control methods

- Boilouts
- Increased freshwater consumption on paper machines
- Caustic used in mill water system to increase pH to 7.1 – 7.3
- Biocide usage in stock system
- Advanced Oxidative Process (AOP) technology
- Tank management
- Anaerobic Effluent Reuse

Testing for Butyric Acid

- Liberty supported testing our finished product for butyric acid.
- Outside 3rd party labs used to compare data points.
- VFAs in our wastewater show a relationship to the butyric acid levels in our paper.
- Purchased a GC Unit to conduct frequent onsite testing to provide continuous incoming data for our VFA control plans.

IC Testing for Butyric Acid

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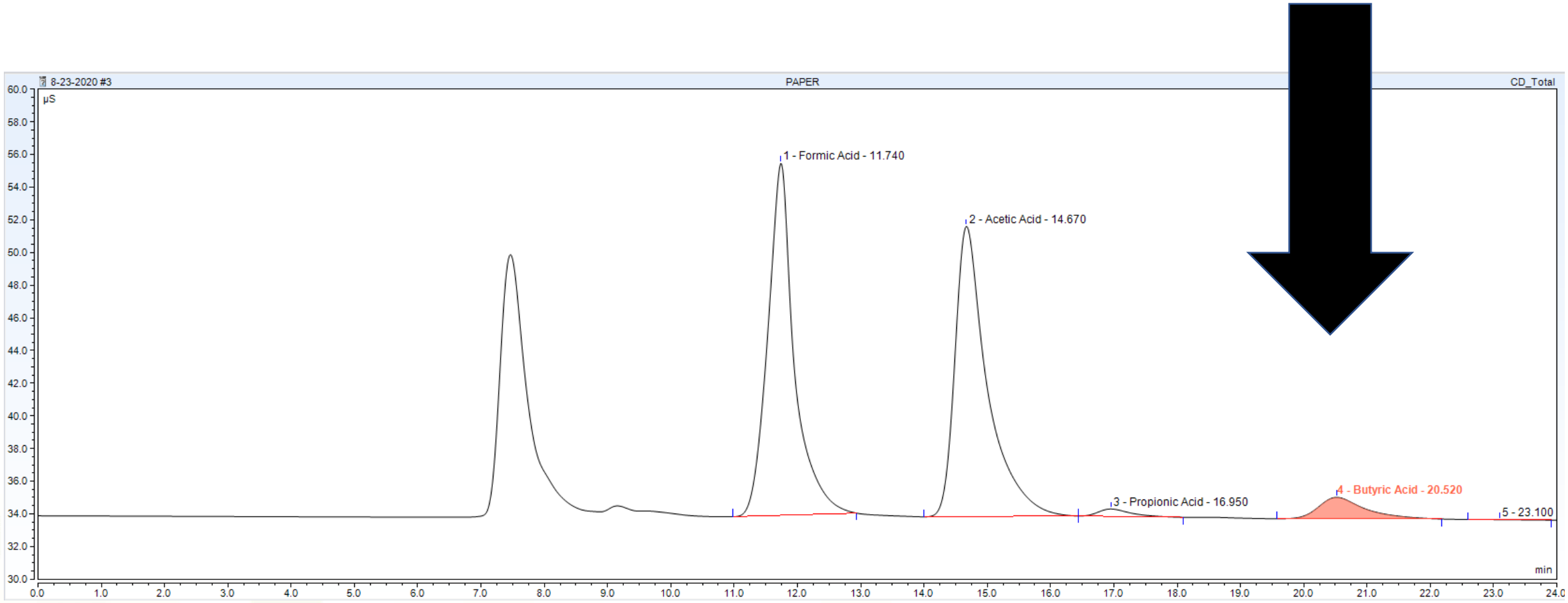
IC Peak for Butyric Acid



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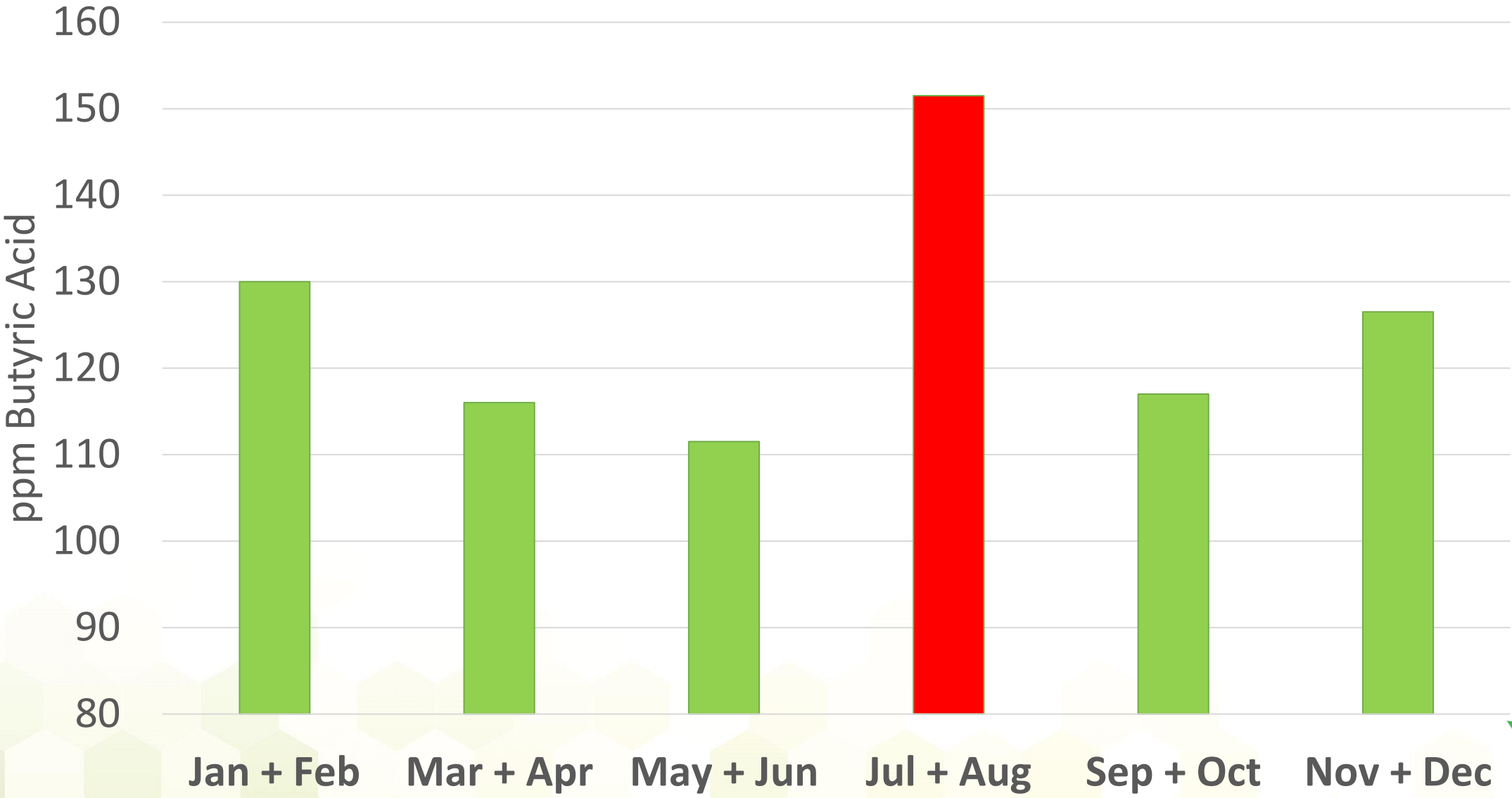
Seasonal Impact on Butyric in Product



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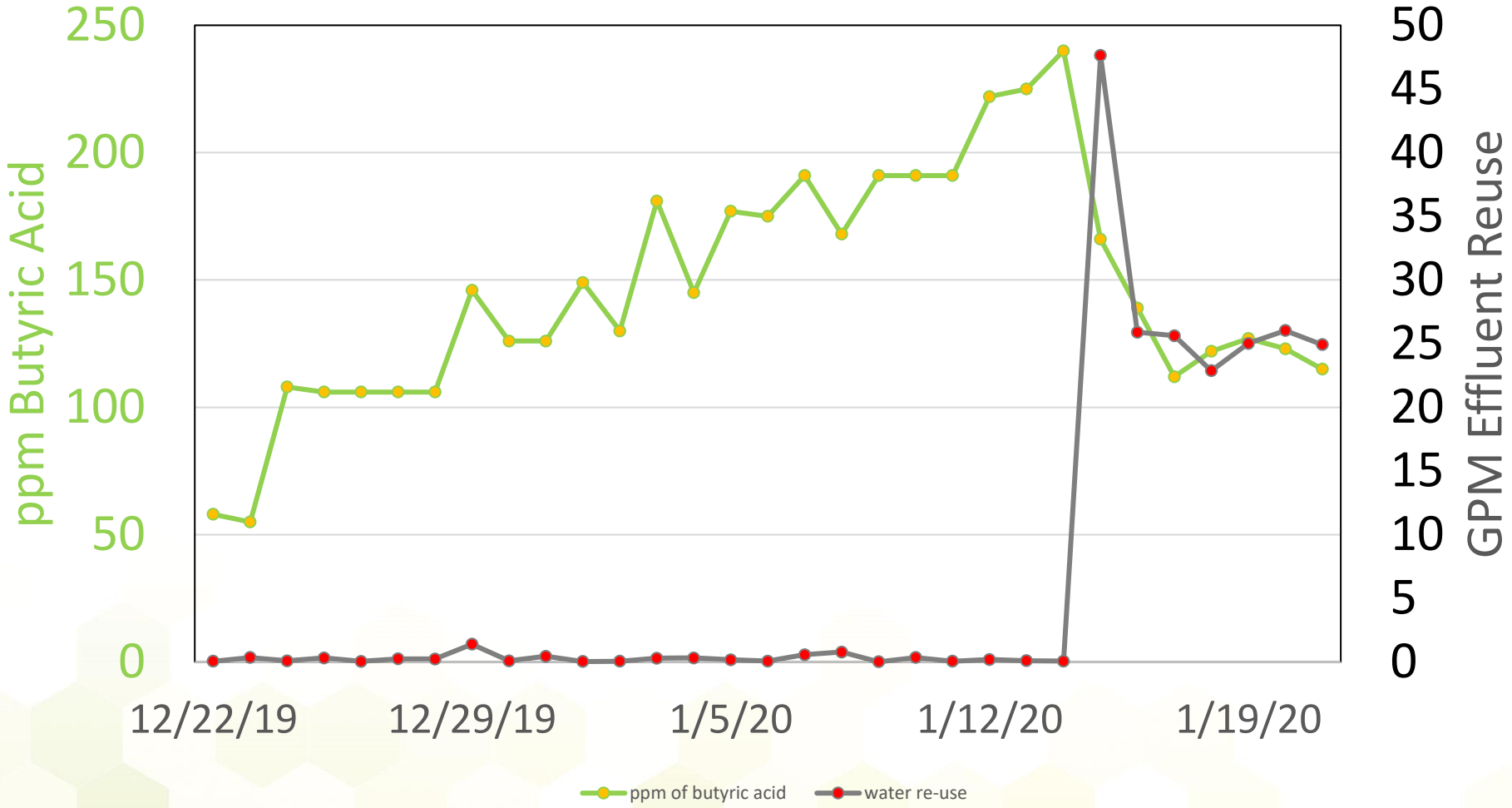
Reuse Impact on Butyric in Product



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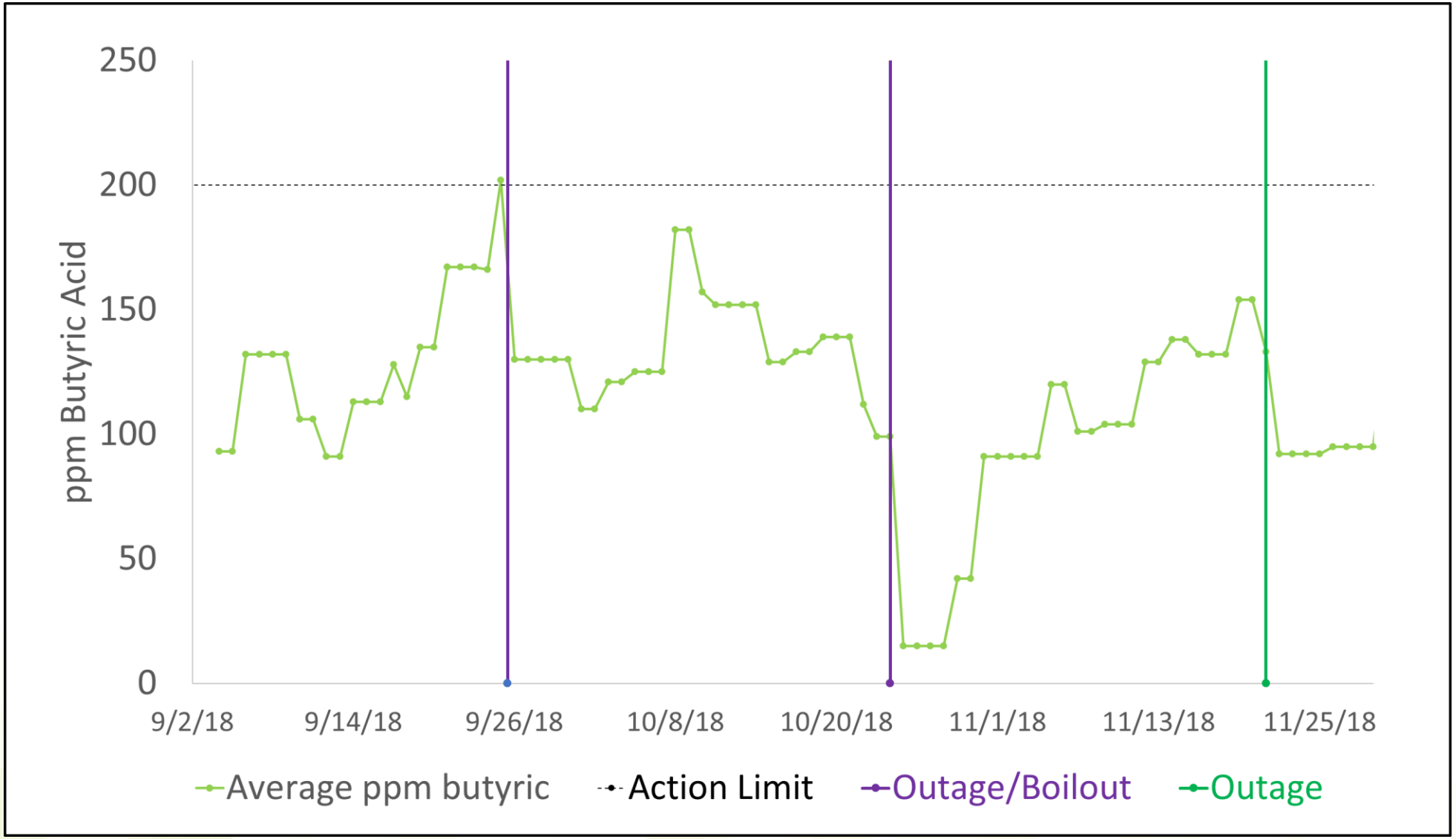
Outage/Boilout Impact on Butyric in Product



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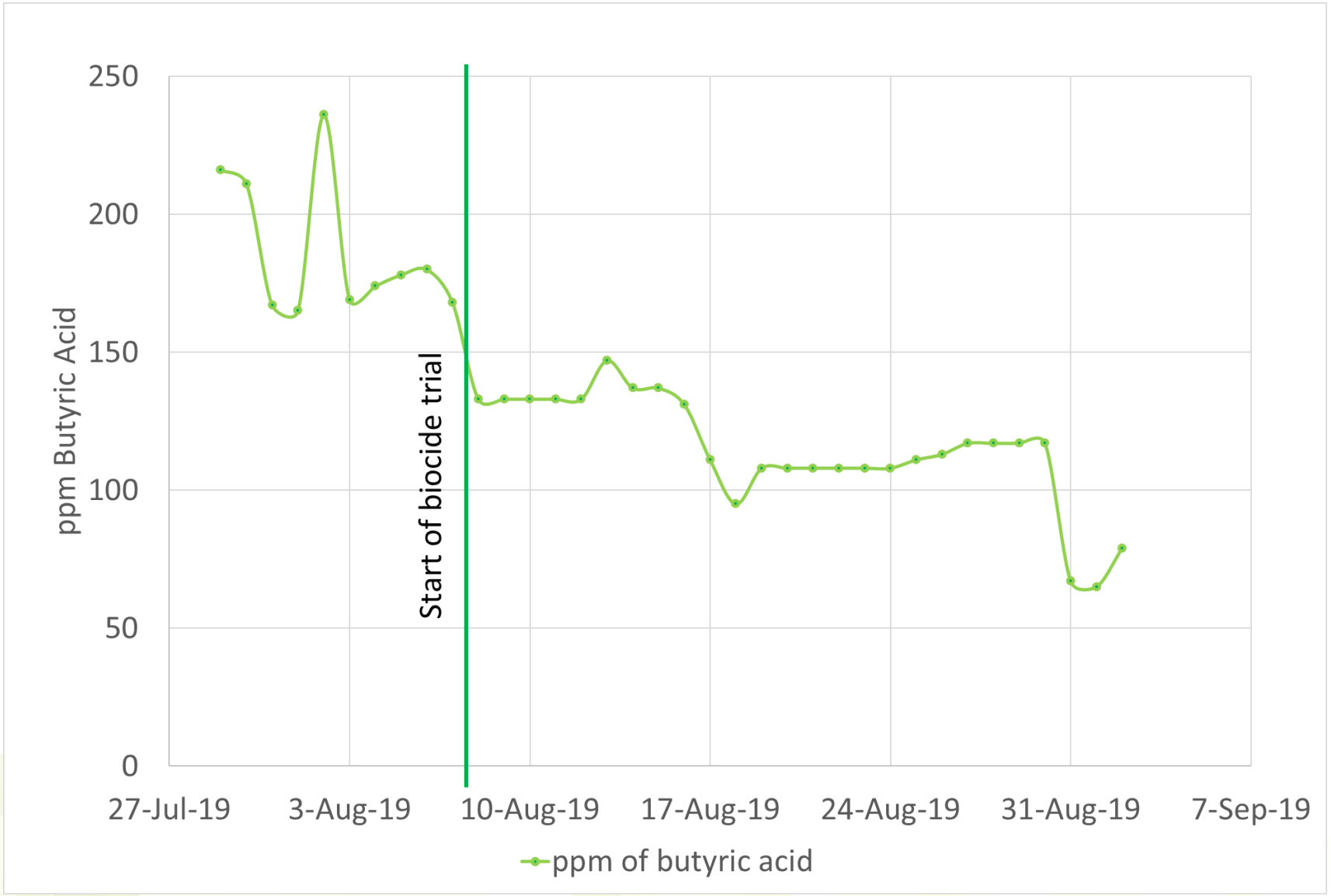
Biocide Impact on Butyric in Product



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VFA Control Plan

VFA Control Plan			
Variable	**Action Limits**	**Number of consecutive points prior to implementing action**	**Process Control Actions**
Volatile Fatty Acid (VFA)[1] *(Paper Mill feed to Effluent Treatment Plant)*	> 2500 ppm (tested twice/day)	> Above Action Limit for 2 days in a row implement Process Control Actions > Below Action Limit for 2 days in a row decrease Process Control Actions	1a) Increase paper butyric testing frequency to once/day until control is reestablished 1b) Increase fresh water use if possible 2) Carbamate increase 3) Treated Process Water Reuse increase 4) Machine boilout
Butyric Acid[2] *(Concentration in paper - PPM)*	> 200 ppm action for paper sample IC (tested 3 times / week)	> One test above Action Limit requires Process Control Action, if retest confirms	1a) Increase paper butyric testing frequency to once/day until control is reestablished 1b) Increase fresh water use if possible 2) Carbamate increase 3) Treated Process Water Reuse increase 4) Machine boilout

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Conclusions

- Anaerobic Treatment:
  - has successfully controlled BOD and solved many mill issues
  - startups do have some concerns that must be managed
  - reduces the VFA and butyric acid in the treated water
- Odor In Paper:
  - results from VFA and butyric acid in the final product
  - can be controlled by reusing Anaerobically treated water
  - is also controlled by biocide programs, system boilouts, and process cleanliness
  - can be monitored using a GC or IC unit

White Water Pre-Treatment

RPTA®

Recycled Paperboard Technical Association

Questions?

LIBERTY PAPER INC.
an LDI Company

meri
A Voith Company

GREIF

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Please respond to follow-up request for feedback

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