GPI West Monroe Digester Optimization Project

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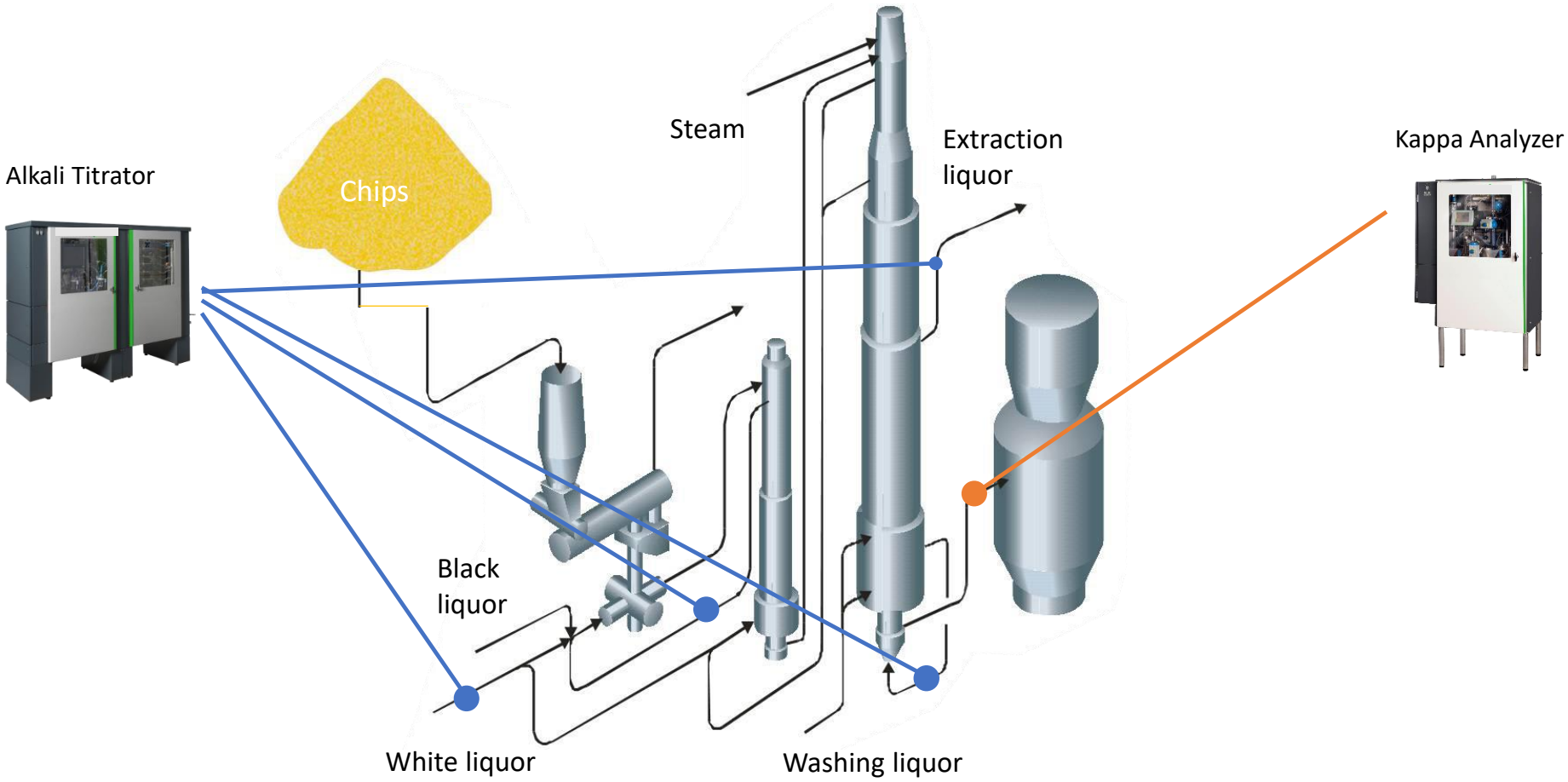
Project Definition

Before advanced control implementation West Monroe had a high degree of Kappa variability and a lower than optimum average Kappa. The aim was to reduce Kappa variation, stabilize operation, and increase the yield and paper mill runnability. The strategy was to incorporate a MPC (Model Predictive Control) based APC (Advanced Process Control) package with all three digesters in conjunction with Kappa and alkali analyzers, and new chip level gauges.

The goal was to find and maintain optimum cooking conditions throughout the digester to ensure selective delignification and to simultaneously optimize pulp quality and production costs. To achieve this, reliable pulp quality measurements that provide accurate real-time information were added.

This presents improved results achieved at the GPI West Monroe mill. Digester blow Kappa variations were reduced by more than 50%. The reduced Kappa variation has been sustained for more than a year.

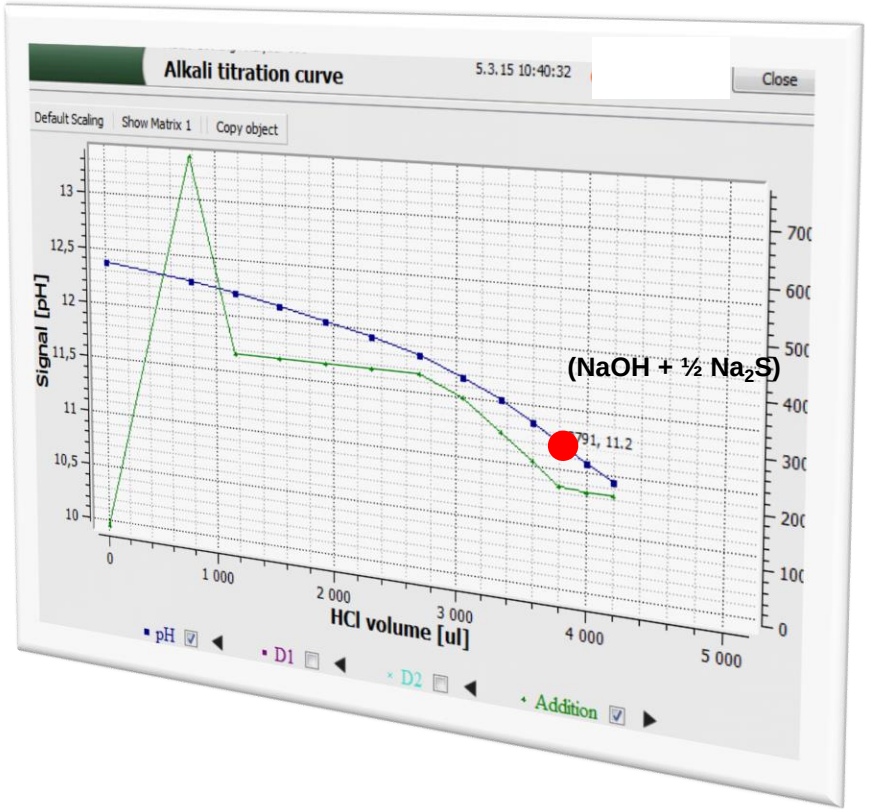
New measurements included in the project



Analysis method

Black liquor

- SCAN N 33:94
- Potentiometric titration with hydrochloric acid (HCl)
- Sodium carbonate is added to give a better inflection and buffer the titration solution
- Autocalibration feature for adaptation to changing process conditions
- CHEMICALS NEEDED
  - 1N Reagent Grade HCL
  - 1.5 M Sodium Carbonate
  - NaOH may be required if residuals are extremely low



Analysis method

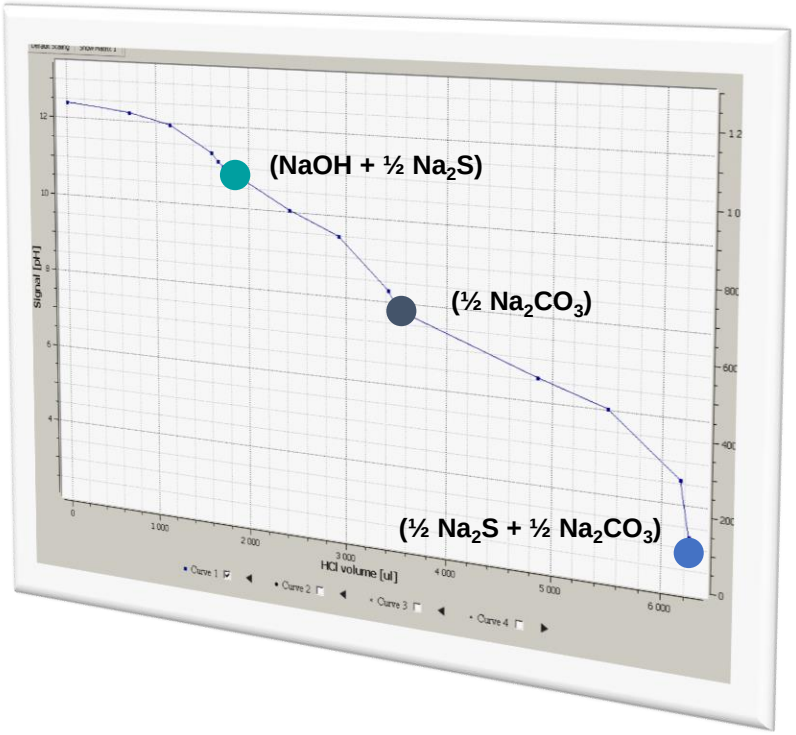
White liquor

- SCAN 30:85
- 2 ml sample is titrated with 1.0 N Reagent grade HCl – an electrode registers pH
- Reactions for the three equivalence points

EP1: NaOH + Na2S + Na2CO3 + 2HCl
-> NaHS + Na2CO3 + 2 NaCl + H2O pH 10.6

EP2 NaHS + Na2CO3 + HCl
-> NaHS + NaHCO3 + NaCl pH 8.4

EP3: NaHS + NaHCO3 + 2 HCl
-> 2 NaCl + H2S + H2O + CO2 pH 3.8



Effect of process variables on cooking

Disturbance source	Effect	Detected by
Chip size	Alkali impregnation	**Residual**, density, kappa
Chip age	Moisture +impregnation	Density
Wood species	Reaction rate	Density, moisture, **residual**
Chip decay	Na consumption	**Residual**
What part of trunk	Kappa	Moisture, density
Chip moisture	Alkali + liquor to wood	Moisture, residual
Bark content	Na consumption	**Residual**
Chip source	Impregnation rate	**Residual**
White liquor Effective Alkali	Alkali to wood ratio	**Residual**
Liquor/Wood ratio	Reaction rate + movement	Moisture, residual
White liquor sulfidity	Reaction rate	**Residual**
Residual	Effective alkali +lignin condensation	**Residual**

Cooking control based on residual alkali

Process disturbances that cause deviations in REA profiles

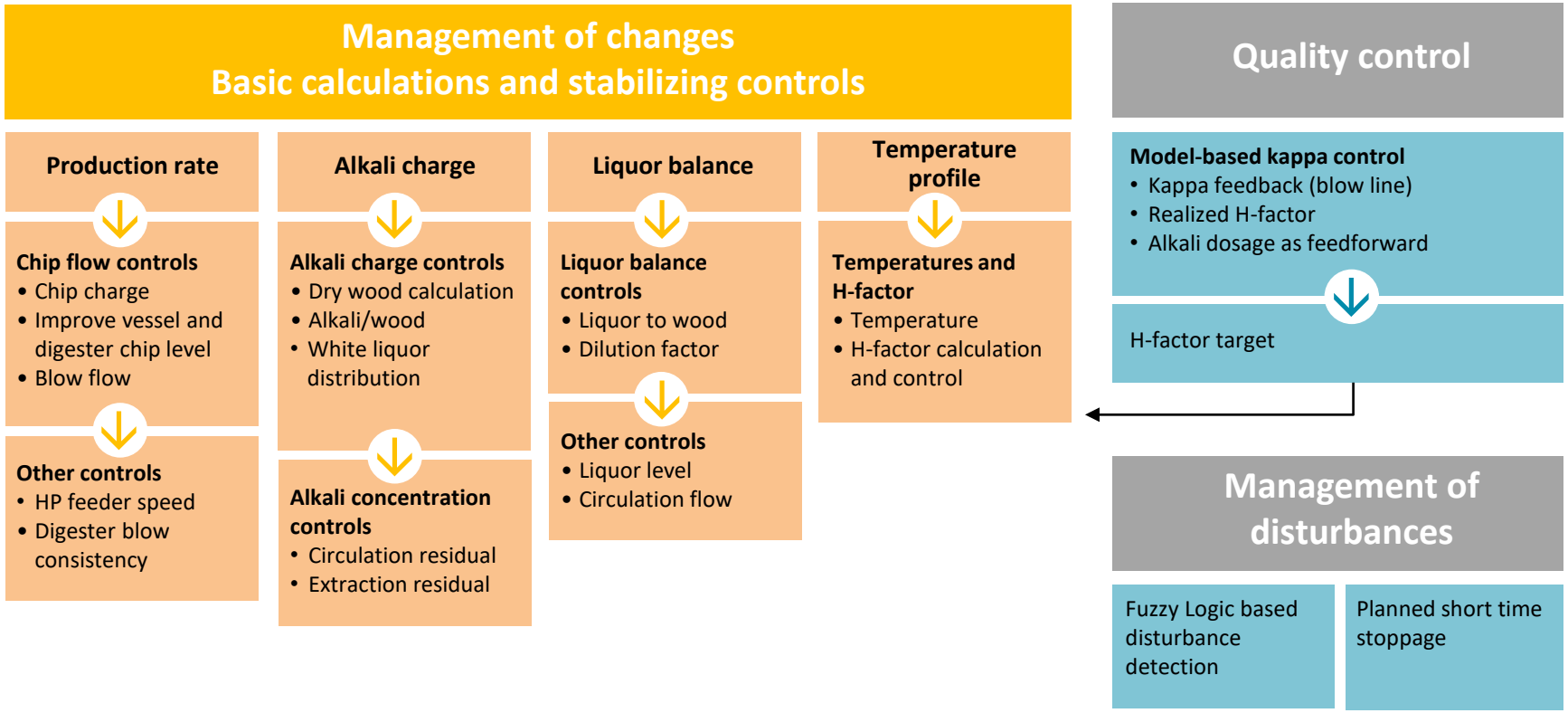
The base idea is to recognize two type of changes in cooking conditions:

1) **Error in alkali/wood ratio**
2) **Change in cooking reaction rate**

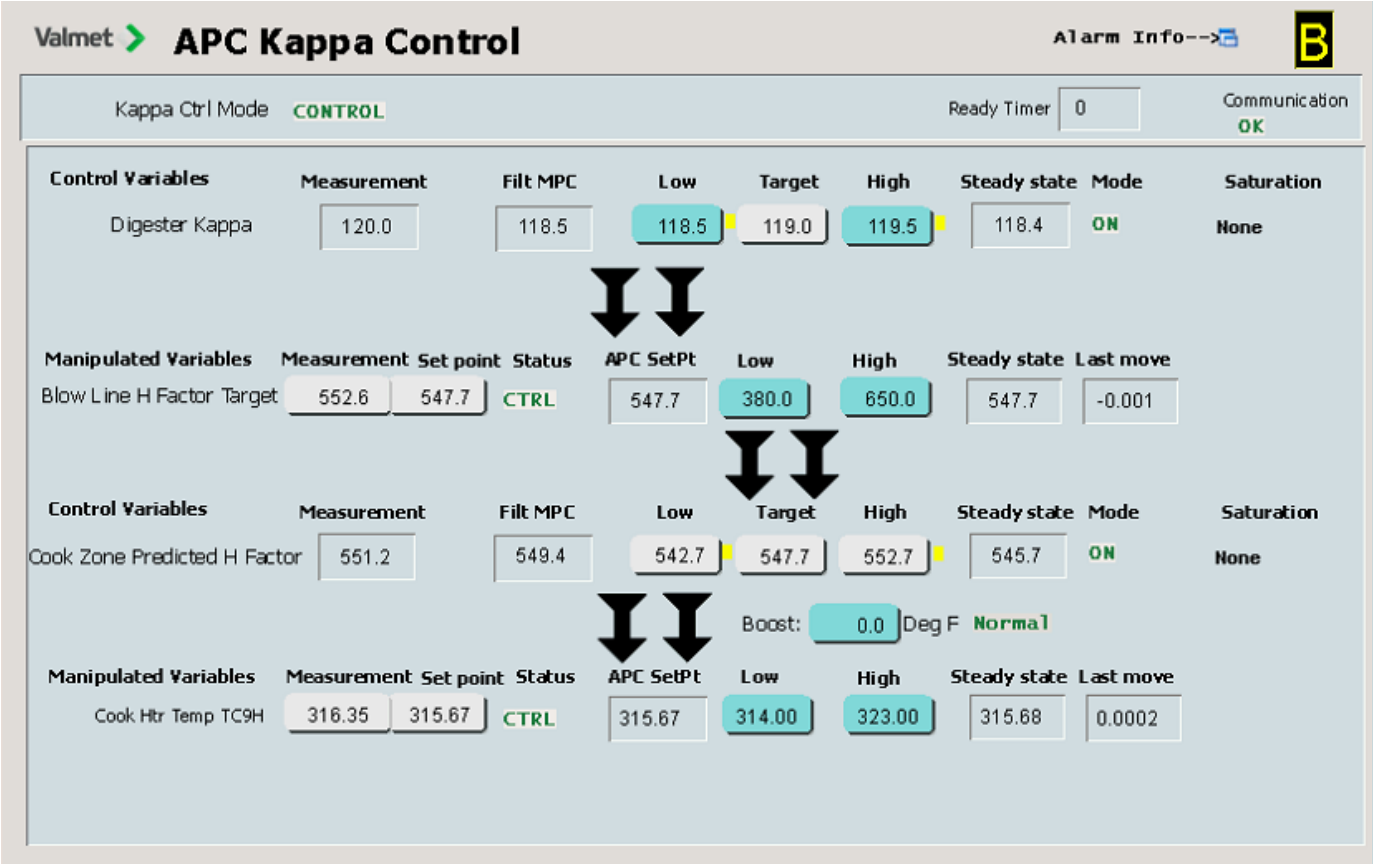
For both of this cases are several possible reasons that are listed and sorted in the tabl

Disturbance source	Alk/wood error	Changed reaction rate	Unclear
Dry wood in	●		
Chip age		●	
Chip size		●	
Bark in	○	○	
WL concentration	●		
Sulfidity		●	
Temperature		●	
Digester channeling			●

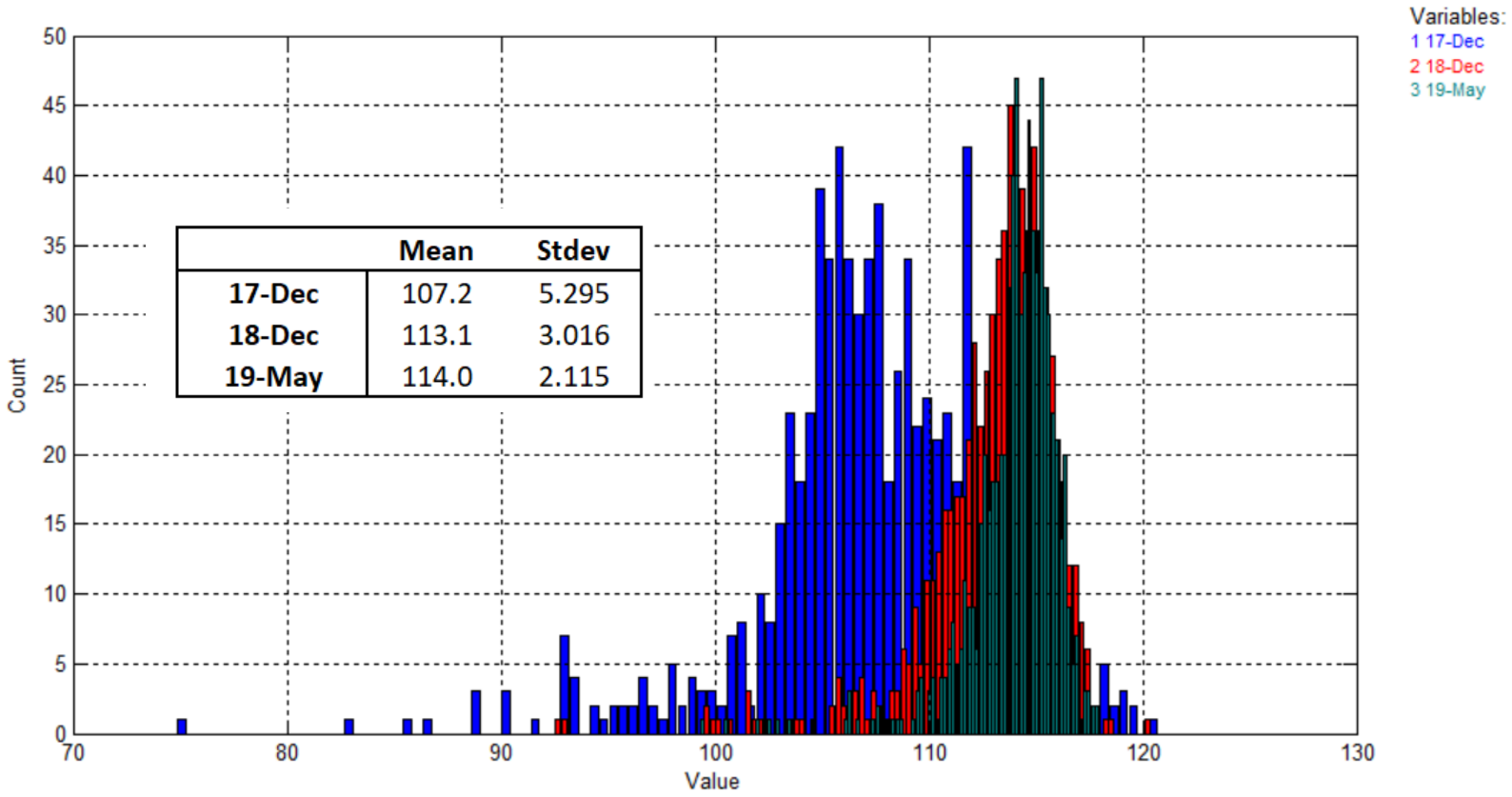
Implemented Solution Components



Kappa Control Display Example

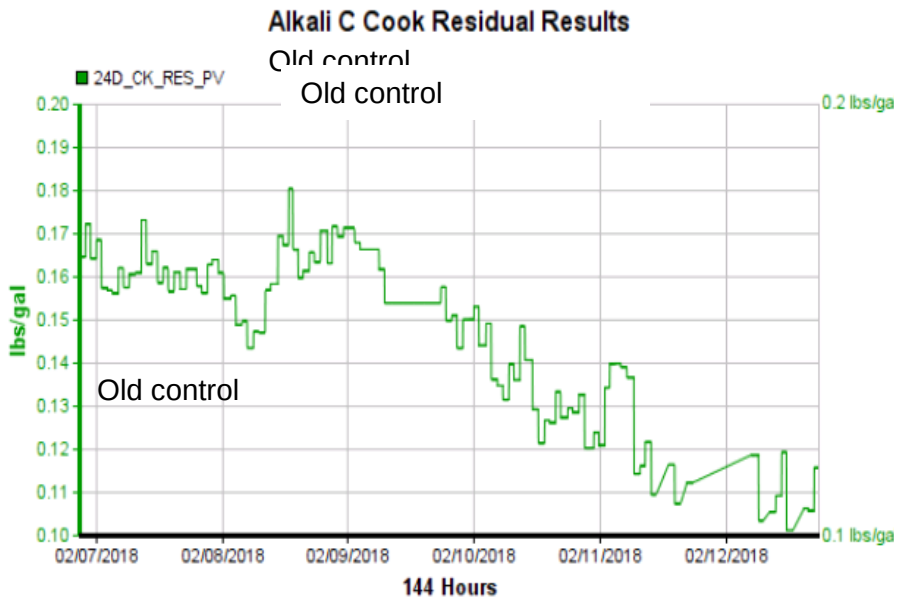


Blow Kappa level and variation development

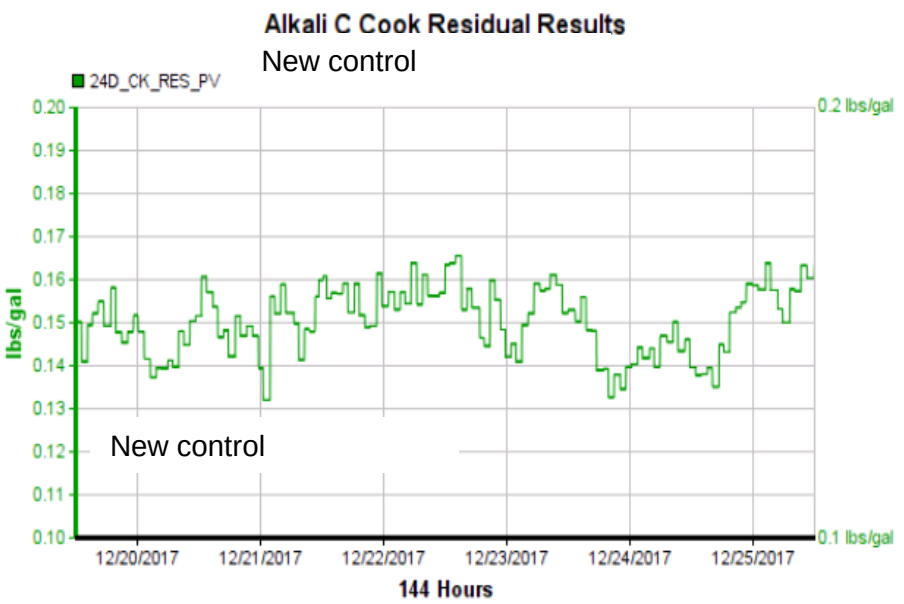


	Mean	Stdev
17-Dec	107.2	5.295
18-Dec	113.1	3.016
19-May	114.0	2.115

Residual alkali level improvement

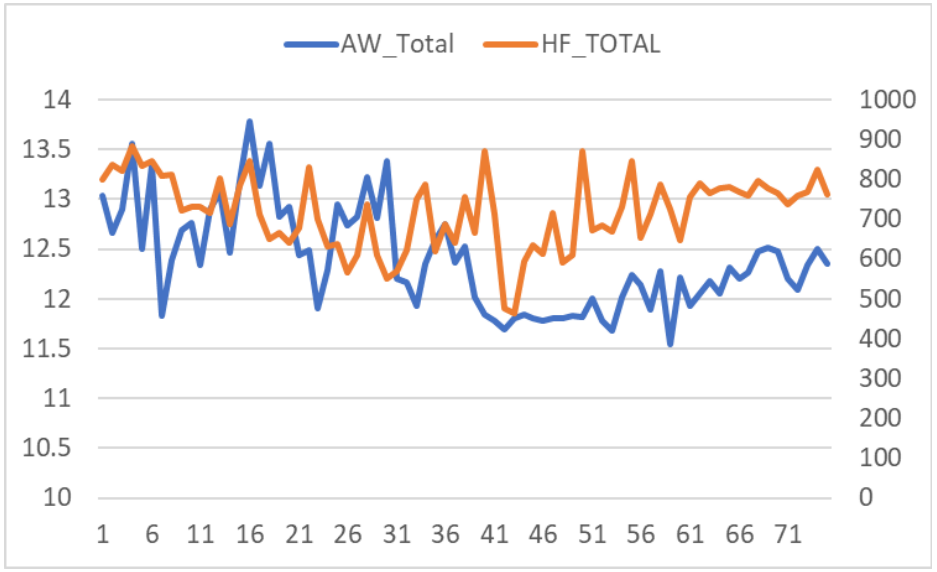


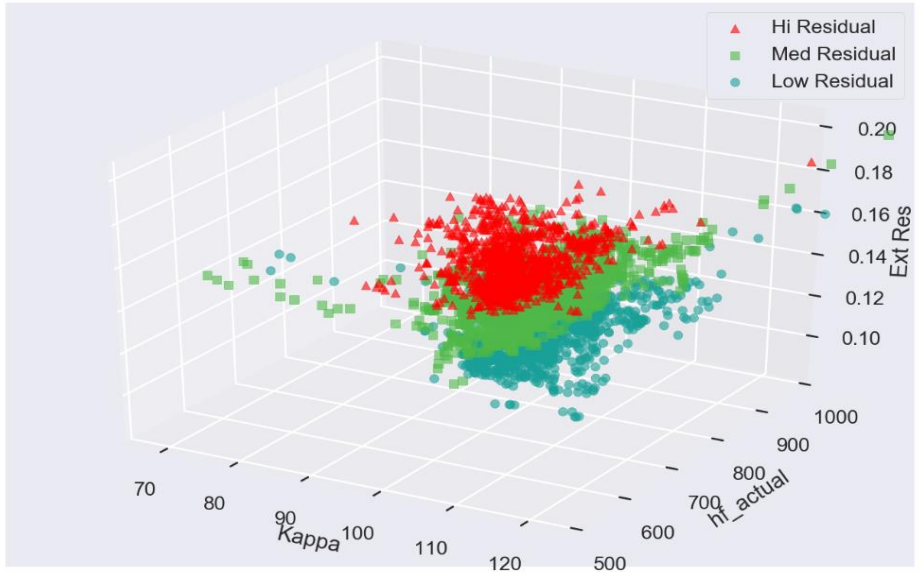
Tag	Count	Min	Max	Average	StdDev
24D_CK_RES_PV	22109	0.1012	0.1805	0.1464	0.0194



Tag	Count	Min	Max	Average	StdDev
24D_CK_RES_PV	25905	0.1320	0.1656	0.1502	0.0077

Residual Alkali Level Influence





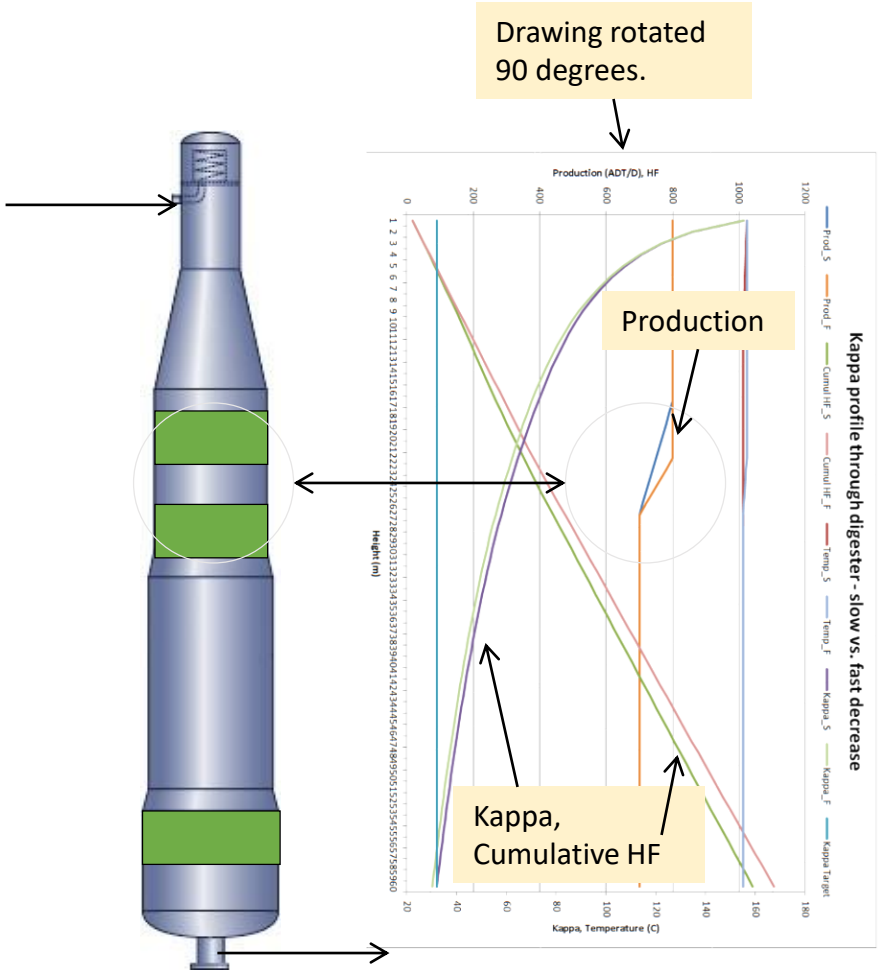
-3.047	kappa per %EA
-0.328	%EA per Kappa

Profiles through digester

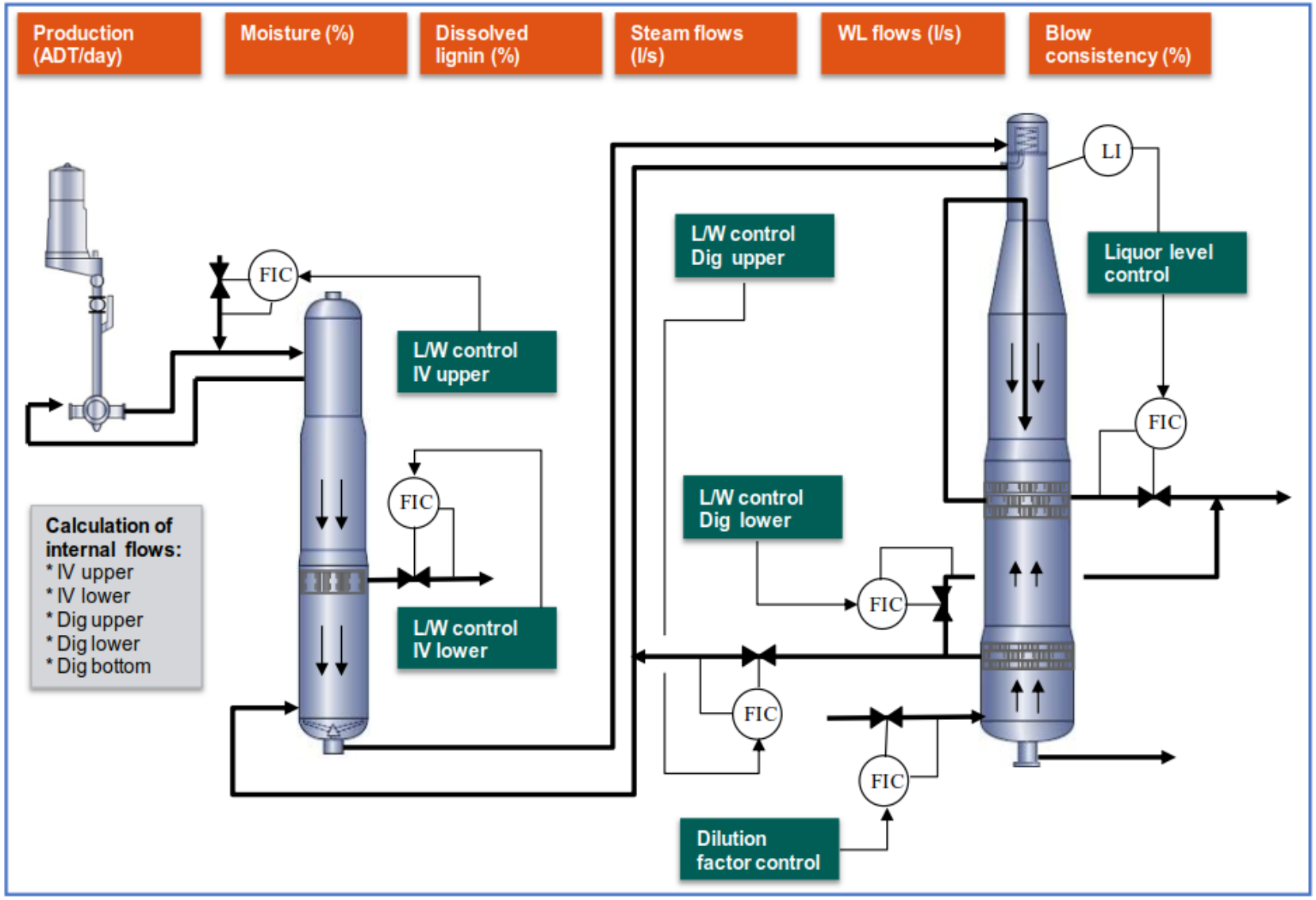
-Profile on the right illustrates history for pulp in blow line at the moment.

-Profiles of temperatures, H-factor and kappa are shown through digester.

-Here, production was changed, when chips were between upper extraction and cook circulation.



Liquor balance controls



GPI West Monroe - Results

- Project Results

Customer:

3 continuous digesters producing 100% softwood pulp for food packaging board

Products: KappaQ, AlkaliC, CL1000 & Digester Optimizer APC

Results:

Kappa# variability (before project): Digester A 5.47, Digester B 4.48, Digester D 5.47

Kappa# Variability (after project commissioning): Digester A - 2.16, Digester B - 1.08, Digester D: 1.31

Large decrease in variability (exceeding guarantee of 3.0)

76% reduction Digesters B & D, 61% reduction in A Digester

Customer Comments:

Decrease in Kappa variability has removed the major pulp quality concern to paper mill.

Project has allowed digesters to change other parameters to improve fiber quality for paper mill.

Mill has seen record paper production following our project implementation

Summary

Automated titration based on-line measurement and optical Kappa measurement provides quality measurements for operators and optimization purposes. All this is combined with sophisticated optimization control algorithms. As a result, Kappa and residual alkali level standard deviation reduction was achieved. This resulted in chemical savings and better yield in digester. Based on an increased Kappa target, the mill can justify 20 incremental tons/day vs. the 6 ton/day project goal. Other significant savings are realized from better runnability, and the mill has seen a record production following the project implementation.