Blending Control Improvement

With advanced tuning services addressing the blending control loops to improve quality after blending.

Introduction

South Indian Customer was facing the quality rejections due to variation in product quality in Machine direction. So process and automation team has setup with OPTIPID consultant to reduce the variations. Variations in a machine can come from a variety of sources. In order to help in the troubleshooting of process variations, seperation of stock approach and the paper machine is often useful. Typically there can be 100 loops in the stock approach and there can be close to that many loops controlling the paper machine. Source detection is even more complected for finding the soruce of product variations.

So we have decided that the bottle neck between these two important process can be defined as the

- ✓ Blending Chest level
- ✓ Blending Chest Consistency
- ✓ Stock Flow and
- ✓ Total Head

We have experienced that the oscillation in the above loops resulting the weight and moisture variations at the reel. So We have decided, source detection has been to move back in the process rather than to try and redirect those problems into control valves. PID controllers can only do so much with disturbance rejection. However, if you can find the source and correct the problem, then 100% of othe disturbance can be rejected

South Indian Customer and OPTIPID team has focused Blending Chest Level Control in this paper.

Step 1 - Troubleshooting Table

No Matter how this area of the machine is controlled, the objective is to stabilize the blending chest control. There are serveral issues that need to be consisdered when troubleshooting the blending level oscillations. In order to help narrrow down the search, serveral years of diagnostic reports associated with this area were reviewed. The following table shows common problem areas.

Green - Good
Orange - Not checked
Red - Needs improvement

	Area	Loop 1	Loop 2	Loop 3	Loop 4	Loop 5	Loop 6	Loop 7
Transmitter	Type	-	-	-	-	-	-	-
	Installation	✓	✓	✓	✓	✓	✓	✓
	Calibration	✓	✓	✓	✓	✓	✓	✓
	Filter	✓	✓	✓	✓	✓	✓	✓
Signal Conditioning	Decimal Points	✓	✓	✓	✓	✓	✓	✓
	Filter	-	-	-	-	-	-	-
	Dead Band	x	x	x	x	x	x	x
Valve	Size	✓	✓	✓	✓	✓	✓	✓
	Type	-	-	-	-	-	-	-
	Precision	✓	-	-	✓	✓	-	✓
	Positioner	-	-	-	-	-	-	-
Control	Tuning	x	x	x	x	x	x	x
	Execution Rate	-	-	-	-	-	-	-
	Dead Time	-	-	-	-	-	-	-
	Delay	-	-	-	-	-	-	-
Process	Disturbance	x	x	x	x	x	x	x
	Design	-	-	-	-	-	-	-
	Oscillations	-	-	-	-	-	-	-

Table: Troubleshooting Table

After putting this table together, it became clear that PID control problems can come from a wide range of places. Rather than go through each x in this table, it was decided that if the fundamental physics of what the control is suppose to be doing can be understood, then recognizing problems becomes much easier.

Step 2 - Process modeling and Tuning

Open and Closed Loop Response

In order to tune the blending controls, each loop will require open and closed loop step tests. The first step test will be performed with the loop in normal automatic control mode. This test will require that the setpoint be changed. Once the automatic mode response of the machine has been captured, then the manual mode performance of the machine is to be tested. This will require manual changes to be made. Once the manual response of the machine has been captured, then the tuning number can be determined.

This data should all be available from the DCS system. The data required for this test would be the setpoint and measured value of the blending loops as well as the setpoint measured value and output of the actuators associated with these loops.

Furnish 1 - Step Test

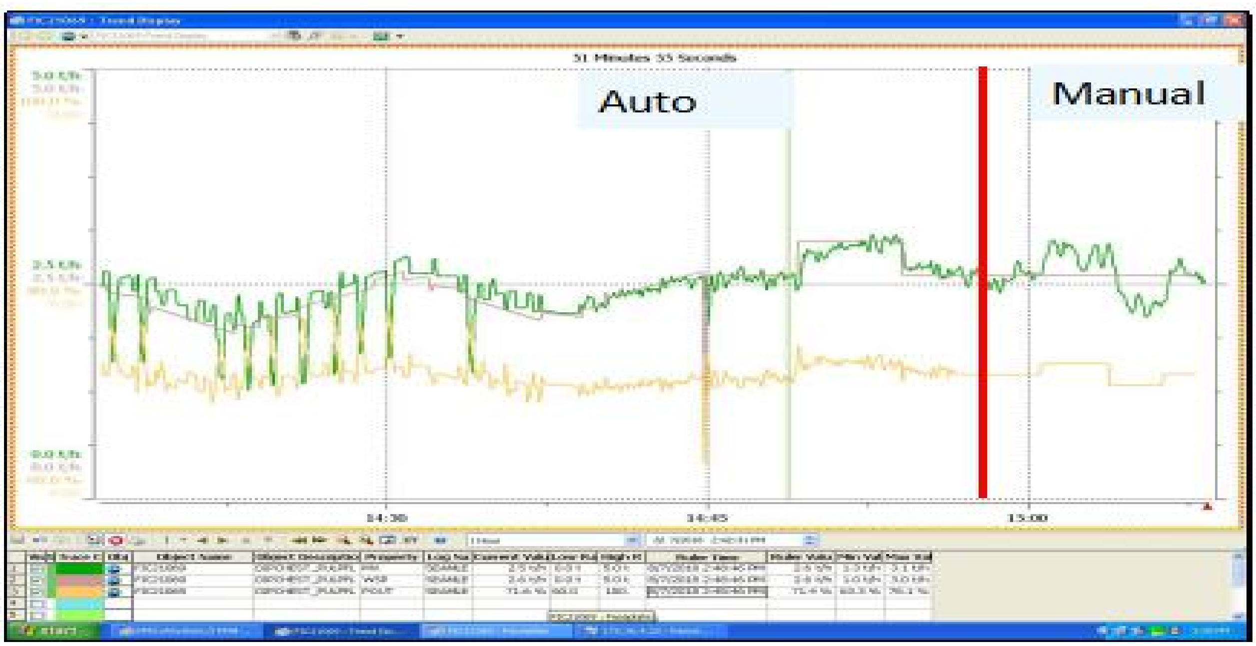
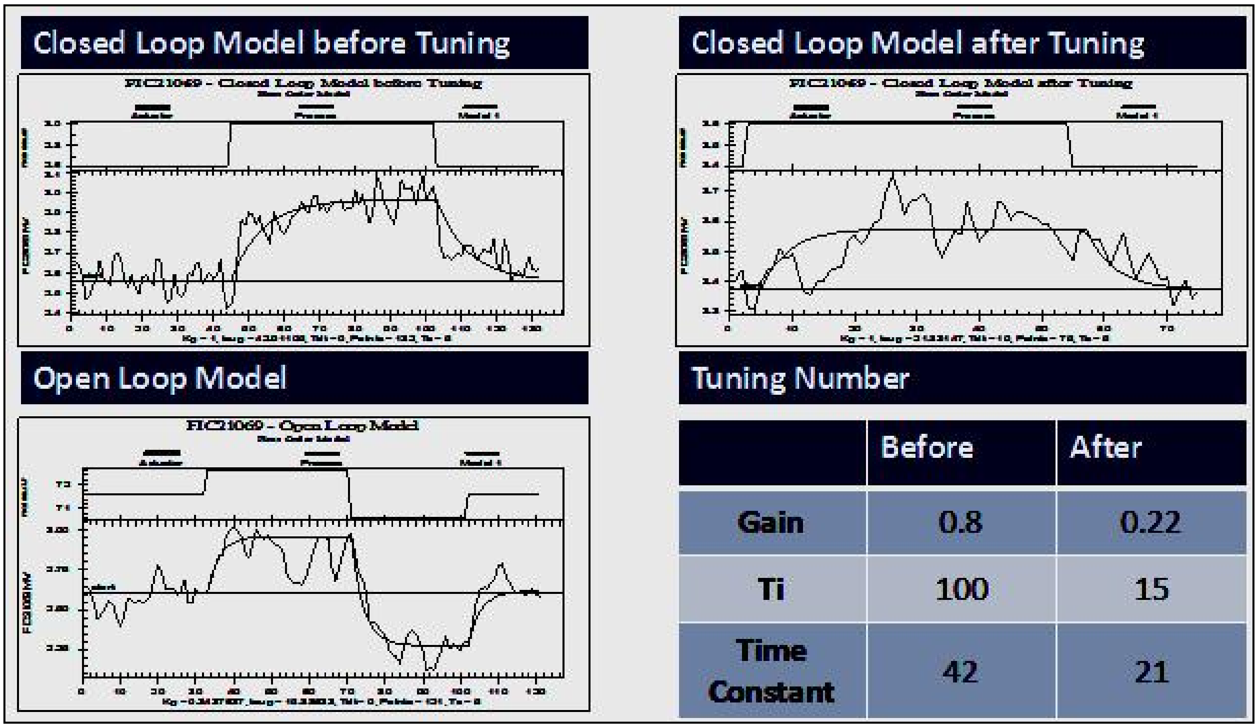


Figure: Furnish 1 - Bump Test

Note:

- Transmitter seems to be good
- Valve seems to be good
- Highly Filtered Data and Filter Removed from DCS
- The Spikes has disappeared after removing the filter
- Loop behaves sluggish
- Consistency variations from back end.

Furnish 1 - Process Model



	Before	After
Gain	0.8	0.22
Ti	100	15
Time Constant	42	21

Figure: Furnish 1 - Process Model and Tuning

Furnish 1 - Before and After Tuning

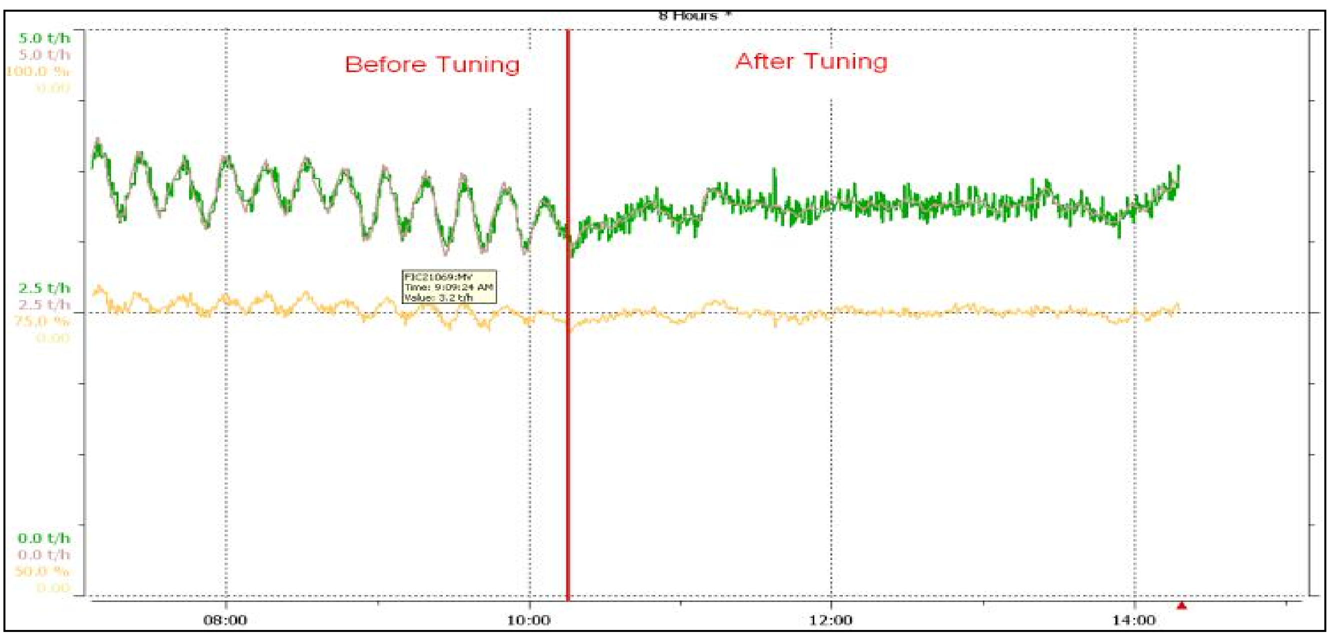


Figure: Furnish 1 - Before and After Tuning

Furnish 2 - Bump Test

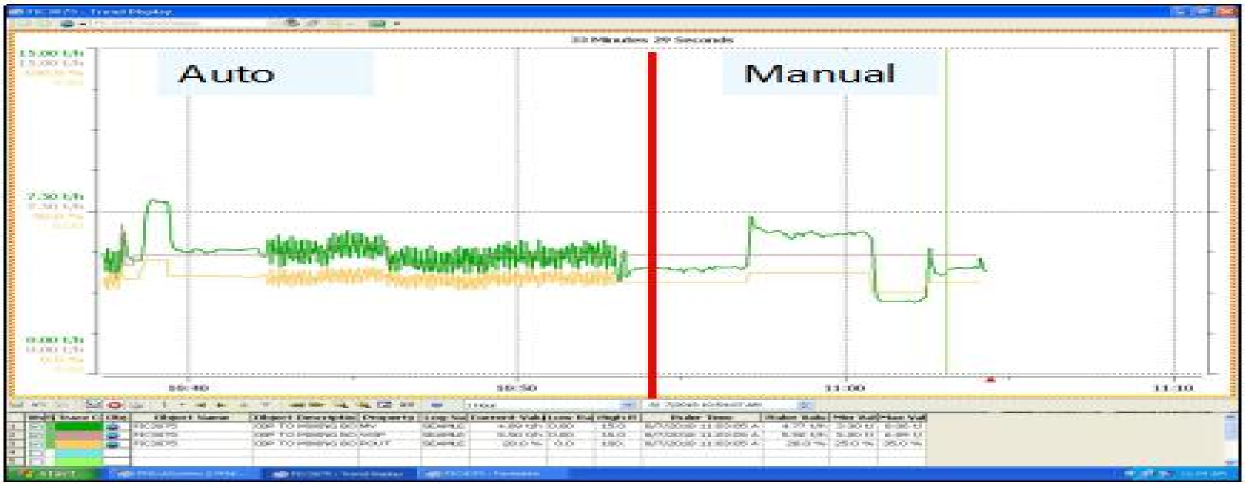
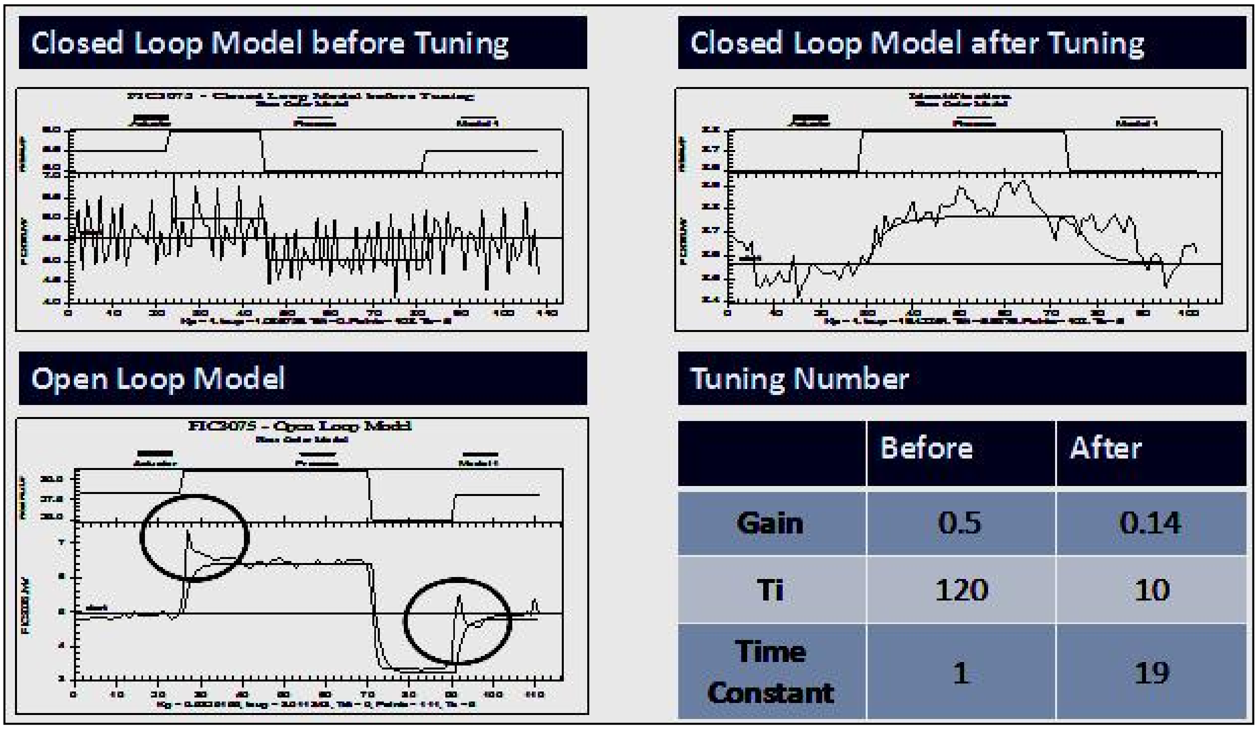


Figure: Furnish 2 - Bump Test

Note:

- Transmitter seems to be good
- Valve seems to be Histersis
- Highly filtered and Filter Removed from DCS
- Loop behaves aggressive

Furnish 2 - Process Modeling and Tuning



	Before	After
Gain	0.5	0.14
Ti	120	10
Time Constant	1	19

Figure: Furnish 2 - Process Model and Tuning

Furnish 2 - Before and After Tuning

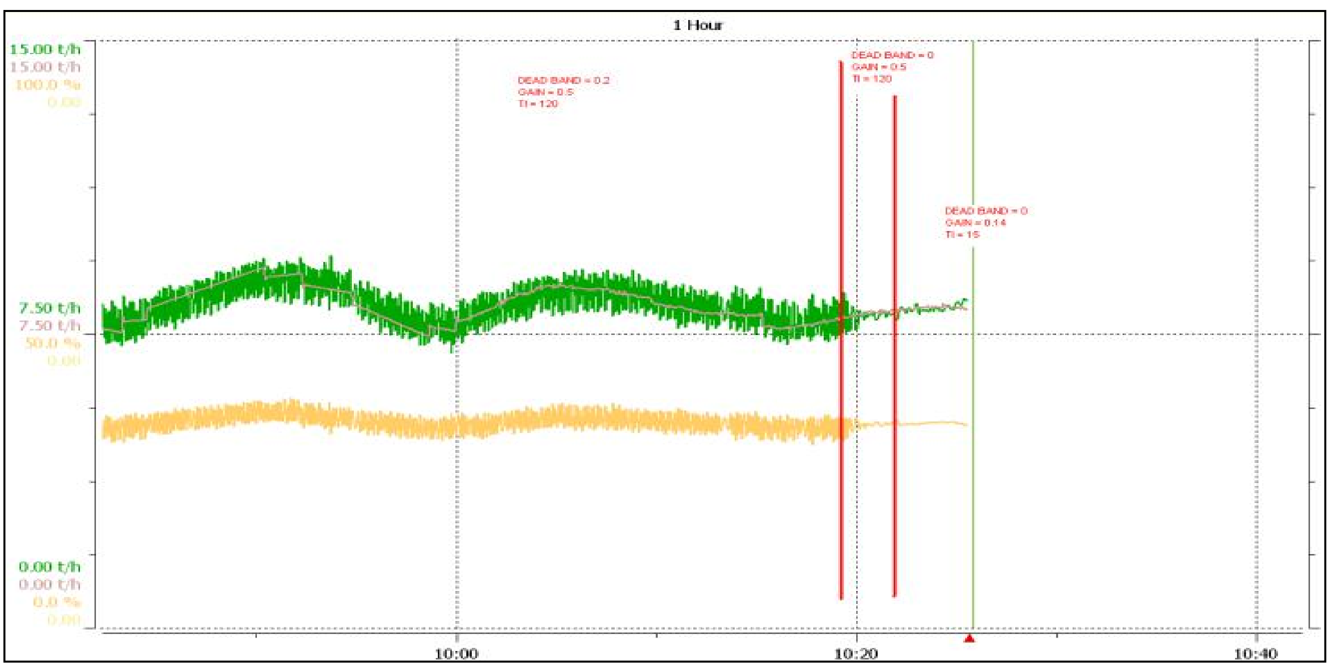


Figure: Furnish 2- Before and After Tuning

Furnish 3 - Bump Test

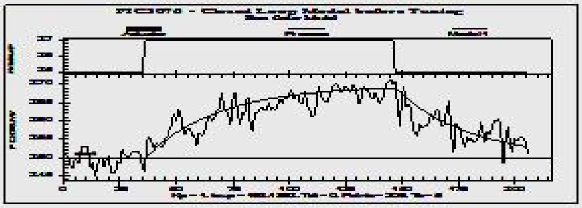
Figure: Furnish 3 - Bump Test

Note:

- Transmitter seems to be good
- Valve seems to be good
- Filter Removed from DCS
- Loop behaves sluggish
- Consistency variations from back end

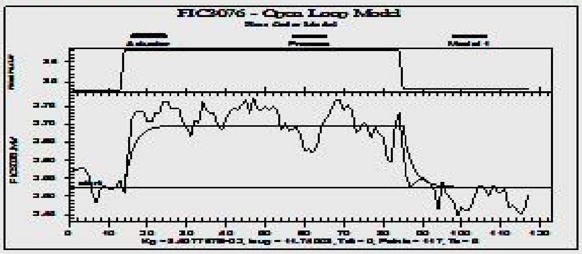
Furnish 3 - Process Modeling and Tuning

Closed Loop Model before Tuning



Closed Loop Model after Tuning

Open Loop Model



Tuning Number

	Before	After
Gain	0.6	0.88
Ti	65	10
Time Constant	163	

Figure: Furnish 3 - Process Model and Tuning

Furnish 3 - Before and After Tuning

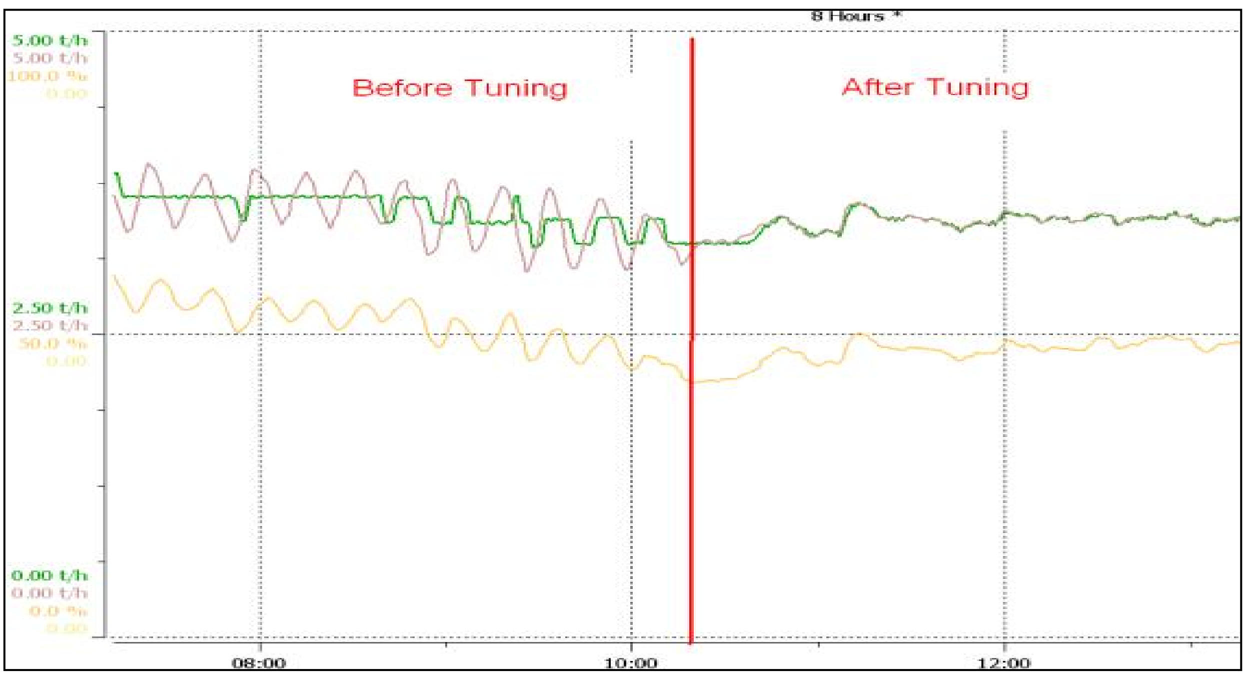


Figure: Furnish 3 - Before and After Tuning

Furnish 4 - Bump Test

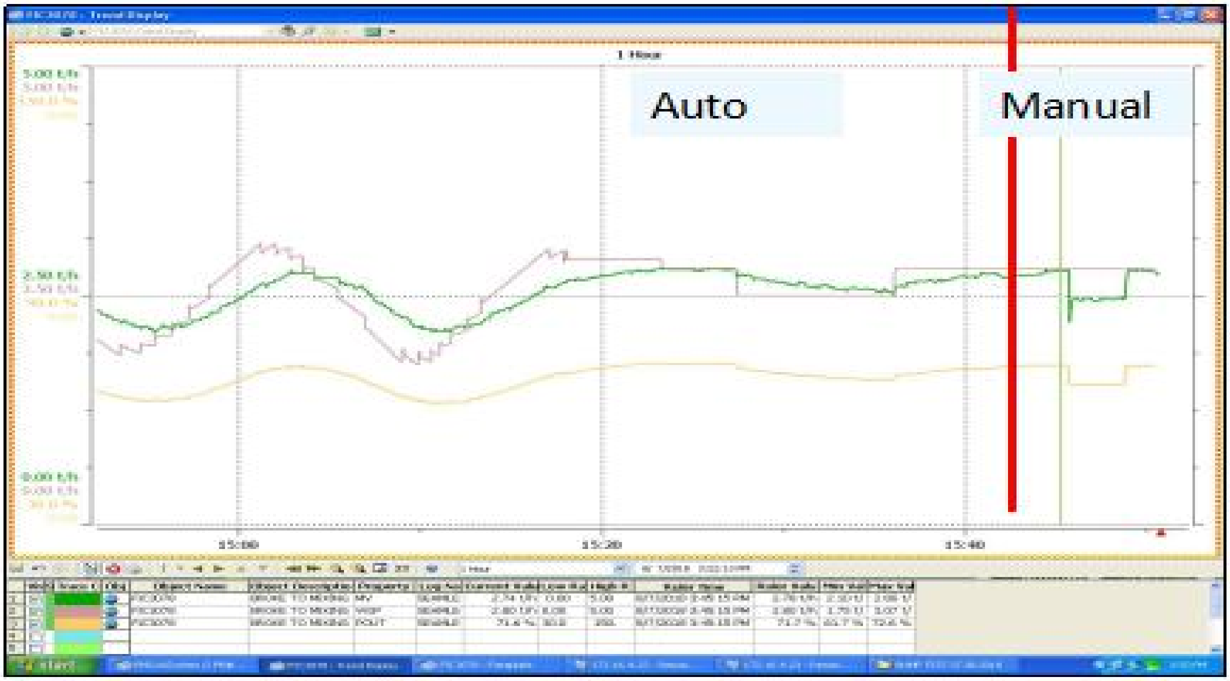
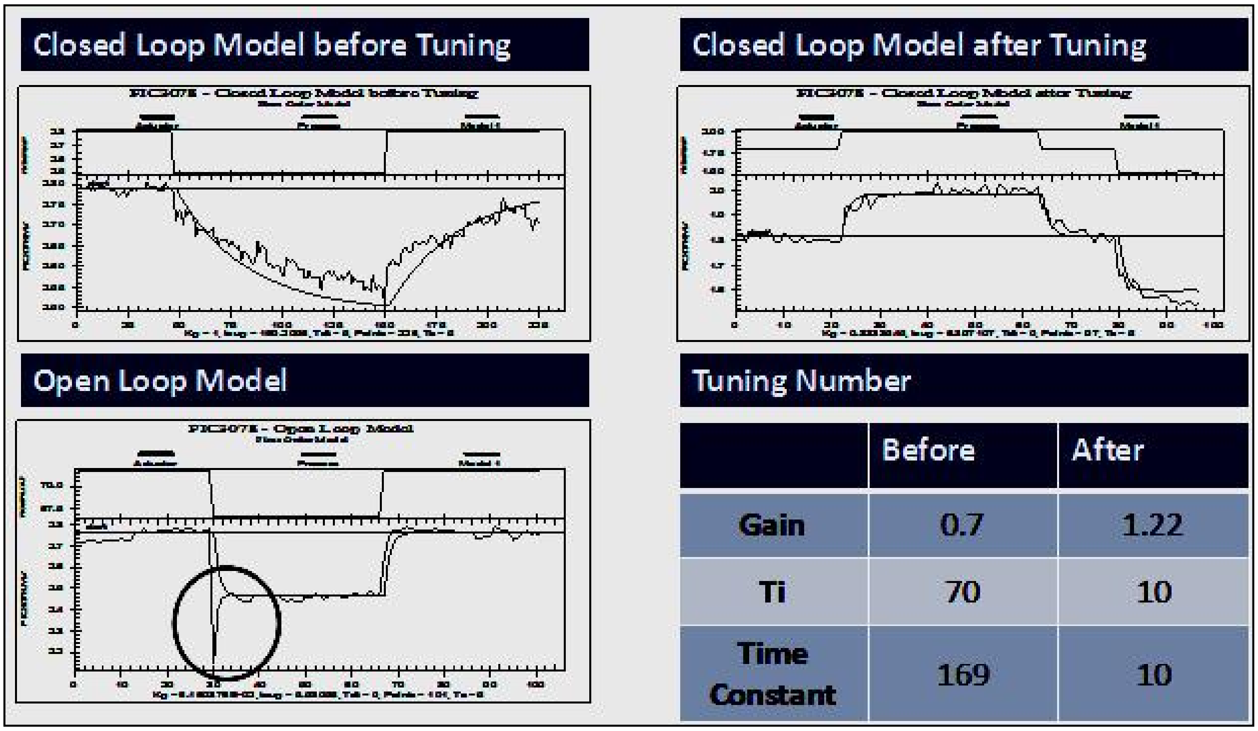


Figure: Furnish 4 - Bump Test

Note:

- Transmitter seems to be good
- Valve seems to be good
- Filter Removed from DCS
- Loop behaves sluggish

Furnish 4 - Process Modeling and Tuning



	Before	After
Gain	0.7	1.22
Ti	70	10
Time Constant	169	10

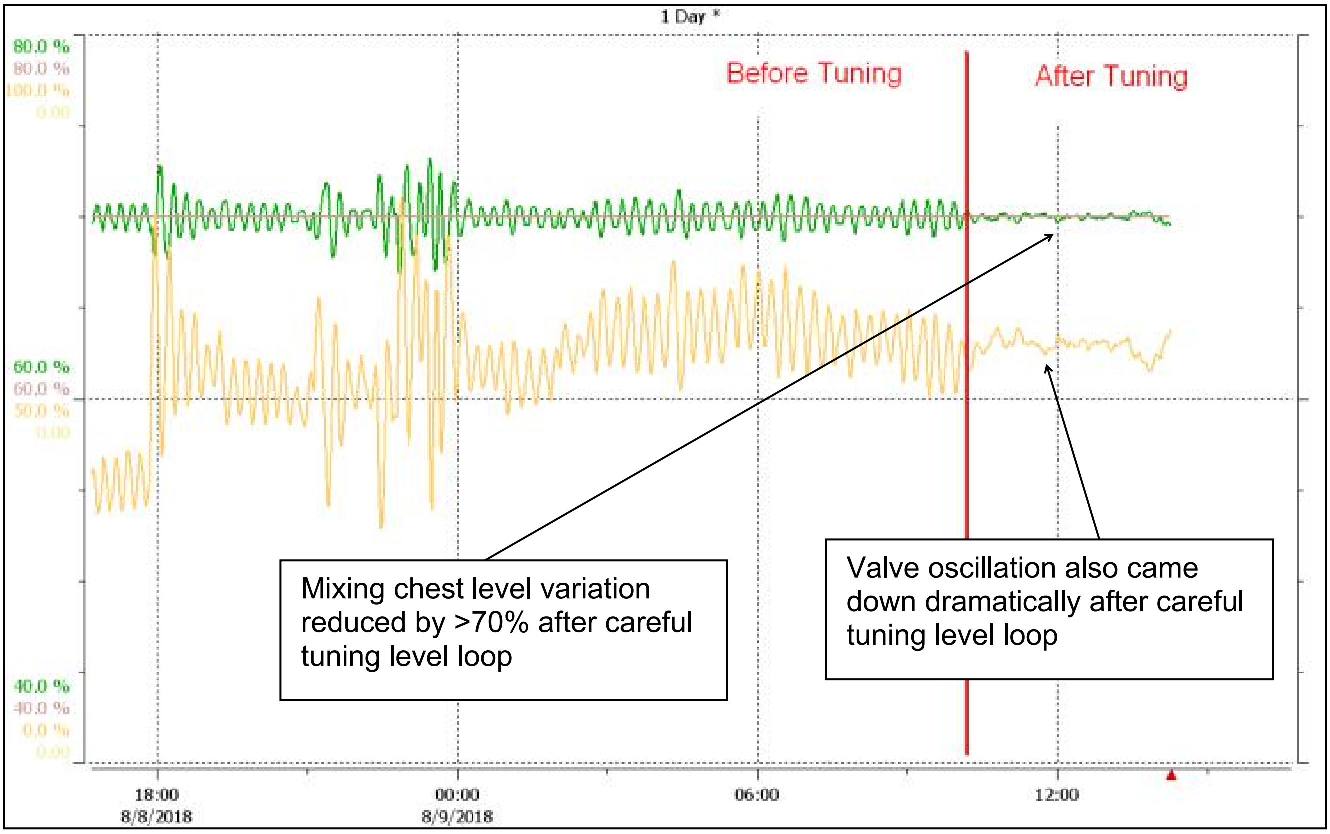
Figure: Furnish 4 - Process Model and Tuning

Furnish 4- Before and After Tuning

Figure: Furnish 4 - Before and After Tuning

Result Overview

The below DCS trend shows the improvement in the blending chest level control after control tuning.



Benefits of Blending Control Tuning

The Blending performance in terms of steady state variation and transition time to target has improved

- Improved loop performance by > 70%
- Mixing Chest level variation is reduced from peak to peak +- 1% to +/- 0.15%. But this can be further improved by back end setup and tuning.
- Improved stock stability which provided more stable stock to paper machine
- Control valve life must be improved by reducing unnecessary oscillations.

The below is the comparison table for the key performance indexes.

Steady stage variations reduction (Error Variability index)

Index	Tag	Goal	Before	After	Remarks
Blending Chest Level	LICA3095	< 0.15	1.2	0.3	Ext. Disturbance
DIP Flow Control	FIC21069	< 0.15	0.879	**0.7**	Cons Variation
CTMP Flow Control	FIC3074	< 0.15	0	**0**	Not Runing
CBP Flow Control	FIC3075	< 0.15	4.16	**0.19**	96%
MBP Flow Control	FIC3076	< 0.15	0	**0**	Not Runing
Broke Flow Control	FIC3078	< 0.15	4.1	**0.17**	96%

Table: Variation (error variability) Index reduction

Time to Target Improvement

Index	Tag	Before	After	Remarks
Blending Chest Level	LICA3095			
DIP Flow Control	FIC21069	42	**21**	50%
CTMP Flow Control	FIC3074	110		Valve Sticky
CBP Flow Control	FIC3075	1	**15**	Valve Backlash
MBP Flow Control	FIC3076	163		Not running during Pilot
Broke Flow Control	FIC3078	169	**10**	Valve Backlash

Table: Time To Target Improvement