Brewing Beer the Smart Way

Kyle Kotaich

DESCHUTES BREWERY®

Presentation Agenda

- About Deschutes Brewery.
- Challenge-Transform old school data to new school data.
- Brewhouse operations and batch event frames.
- Cellar operations PI Vision displays to increase operationa. intelligence
- Conclusion.

About the Brewery

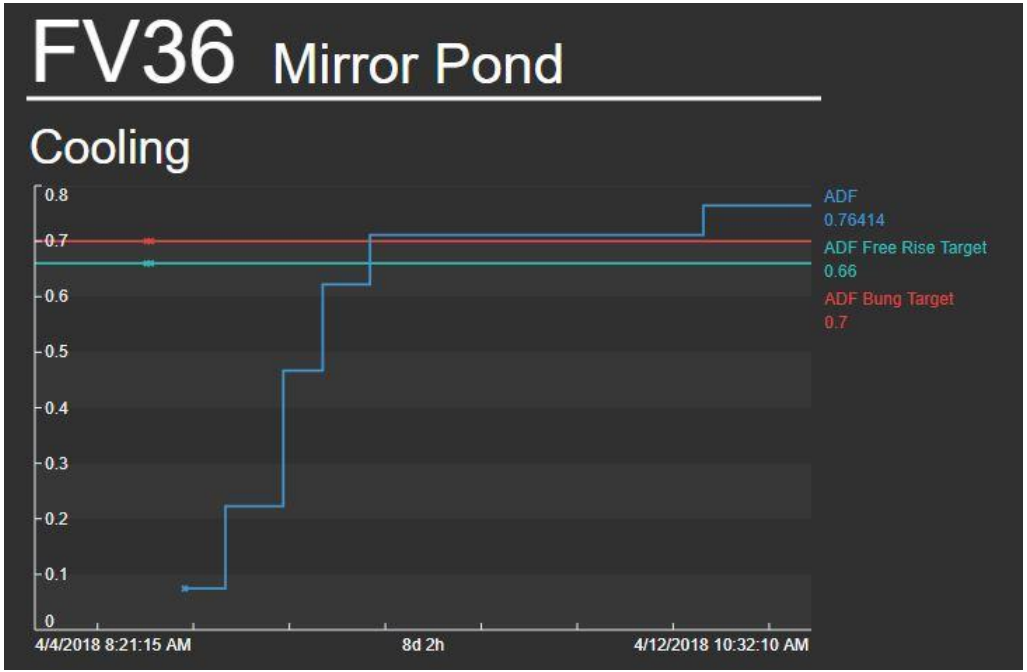
- Pub in Bend, Oregon est. 1988 – Brew 1
- Production facility in Bend, Oregon est. 1993 - Brew 2
- Pub in Portland, Oregon est. 2008 – Brew 3
- 8th largest craft brewery in the US in 2017.
- Distribution in 28 states and District of Columbia.
- Produced over 300k bbl (9.5M gal) in 2017.
- Began using the PI System in 2015.

Challenges Prior to the PI System

- Missing, late, or inaccurate data entries.
- Inefficient process historian.
  - Large amounts of time spent searching for data.
  - Difficult to compare batch data.
  - Limited licensing.
- Large amounts of time spent on building spreadsheets.
- Late action on yeast disposal or harvest.
- Lack of real-time data between manual sample collection.

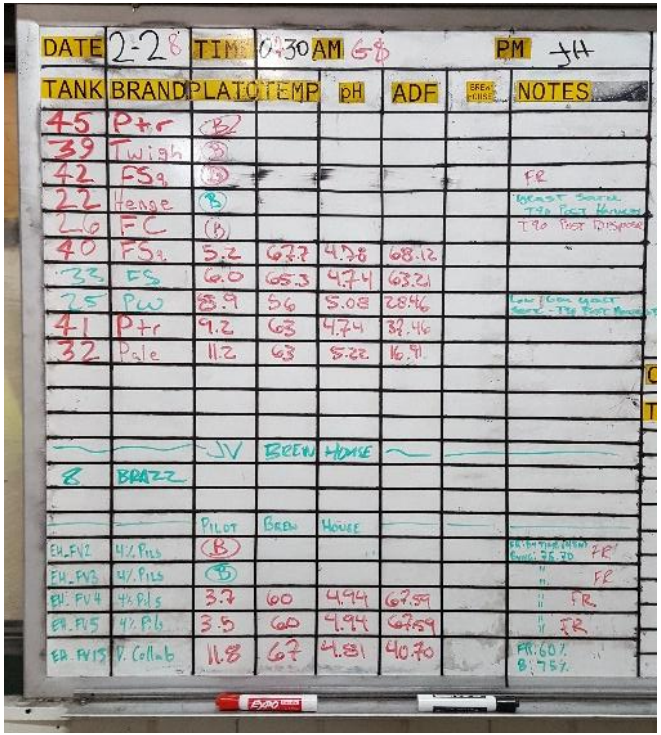
Solution: Leverage Asset Framework, Asset Analytics, and PI Vision.

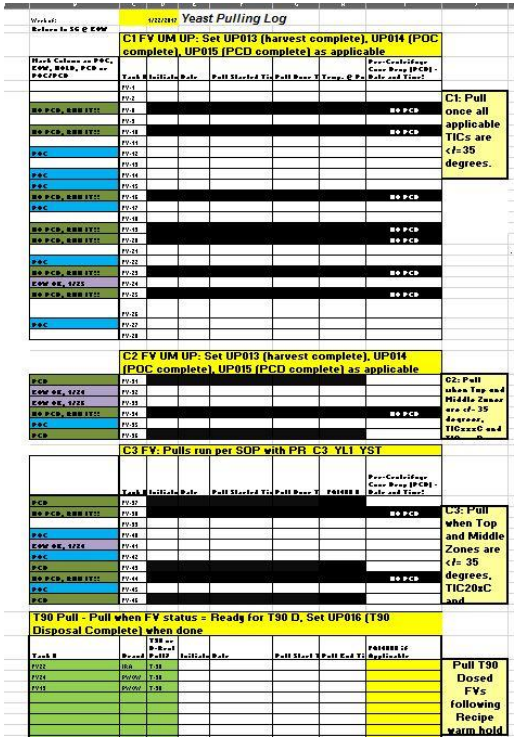
Stages of Fermentation

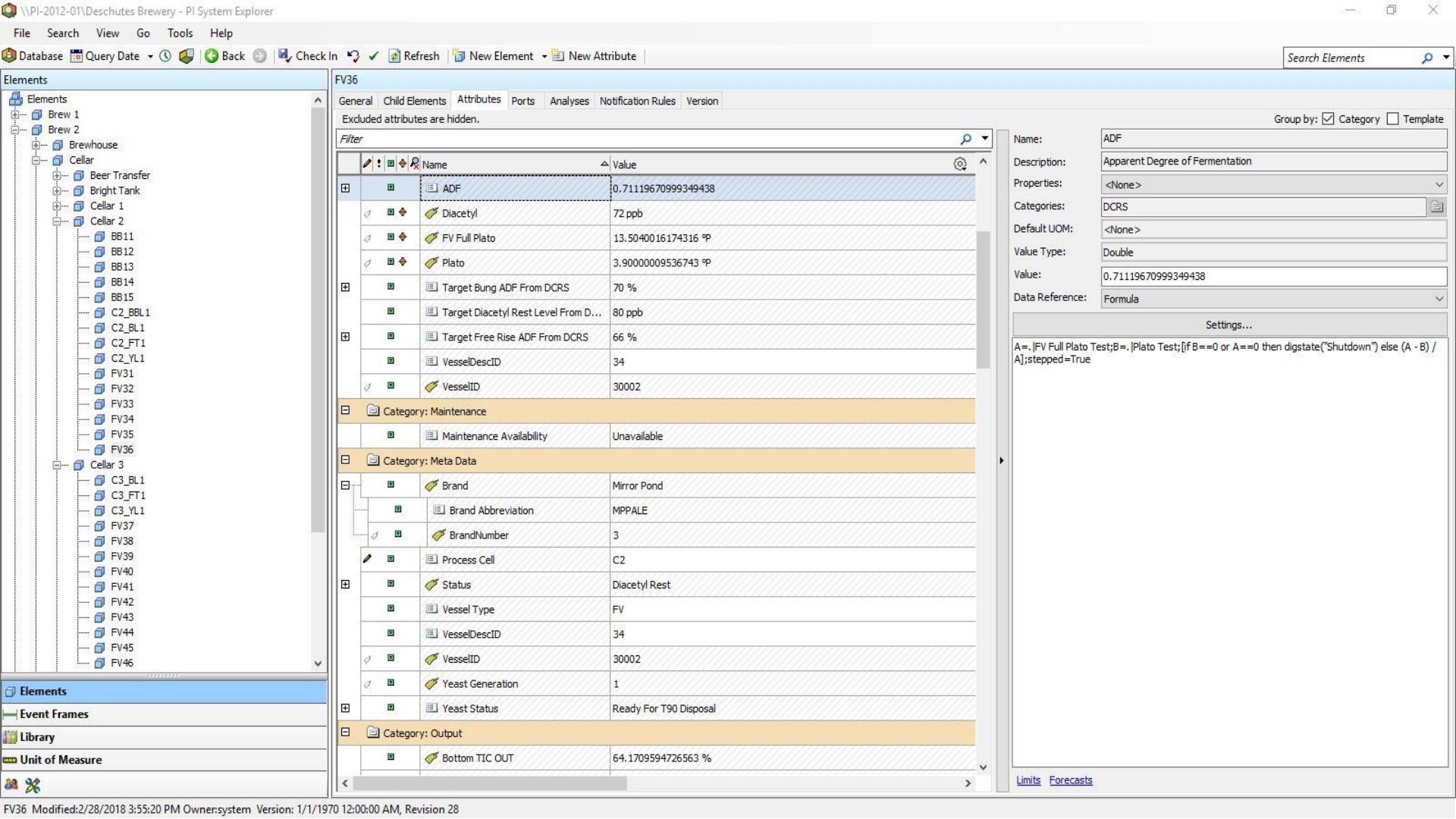


- All transitions are dependent on manual measurements.
- Primary Fermentation
  - ADF (Apparent Degree of Fermentation)
- Free Rise
  - Temperature setpoint is increased.
- Diacetyl Rest
  - Pressure increases.
  - Yeast is harvested when needed.
  - Hops added for increased flavor and aroma.
- Cooling
  - Diacetyl levels within limits.
  - Yeast is disposed at 35 °F.

Old School Data Management






\\PI-2012-01\Deschutes Brewery - PI System Explorer
File Search View Go Tools Help
Database Query Date Back Check In Refresh New Element New Attribute
Search Elements
Elements
Elements
Brew 1
Brew 2
Brewhouse
Cellar
Beer Transfer
Bright Tank
Cellar 1
Cellar 2
BB11
BB12
BB13
BB14
BB15
C2_BBL1
C2_BL1
C2_FT1
C2_YL1
FV31
FV32
FV33
FV34
FV35
FV36
Cellar 3
C3_BL1
C3_FT1
C3_YL1
FV37
FV38
FV39
FV40
FV41
FV42
FV43
FV44
FV45
FV46
Elements
Event Frames
Library
Unit of Measure
FV36
General Child Elements Attributes Ports Analyses Notification Rules Version
Excluded attributes are hidden.
Group by: Category Template
Filter
Name Value
ADF 0.71119670999349438
Diacetyl 72 ppb
FV Full Plato 13.5040016174316 °P
Plato 3.90000009536743 °P
Target Bung ADF From DCRS 70 %
Target Diacetyl Rest Level From D... 80 ppb
Target Free Rise ADF From DCRS 66 %
VesselDescID 34
VesselID 30002
Category: Maintenance
Maintenance Availability Unavailable
Category: Meta Data
Brand Mirror Pond
Brand Abbreviation MPPALE
BrandNumber 3
Process Cell C2
Status Diacetyl Rest
Vessel Type FV
VesselDescID 34
VesselID 30002
Yeast Generation 1
Yeast Status Ready For T90 Disposal
Category: Output
Bottom TIC OUT 64.1709594726563 %
Name: ADF
Description: Apparent Degree of Fermentation
Properties: <None>
Categories: DCRS
Default UOM: <None>
Value Type: Double
Value: 0.71119670999349438
Data Reference: Formula
Settings...
A=.|FV Full Plato Test;B=.|Plato Test;[if B==0 or A==0 then digstate("Shutdown") else (A - B) / A];stepped=True
Limits Forecasts
FV36 Modified:2/28/2018 3:55:20 PM Owner:system Version: 1/1/1970 12:00:00 AM, Revision 28

ADF Predictions * Asset: FV36+ ▼

FV36 Mirror Pond

Cooling

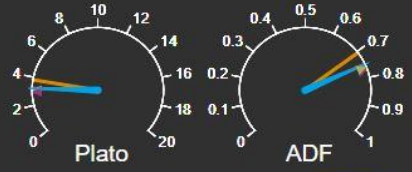
Modified Gravity Board

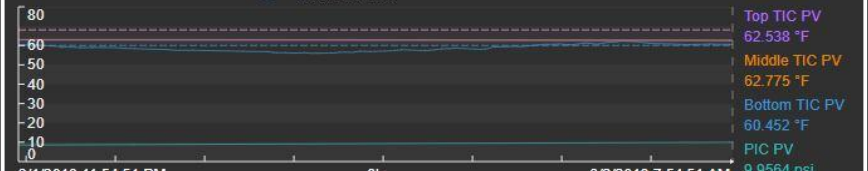
FV39 Twilight

Diacetyl Rest
3/2/2018 2:06:49 AM

Hours to Free Rise — +0 Target: Shutdown

Hours to Bung — +0 Target: Shutdown





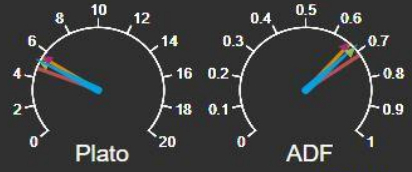
Top TIC PV
62.538 °F
Middle TIC PV
62.775 °F
Bottom TIC PV
60.452 °F
PIC PV
9.9564 psi

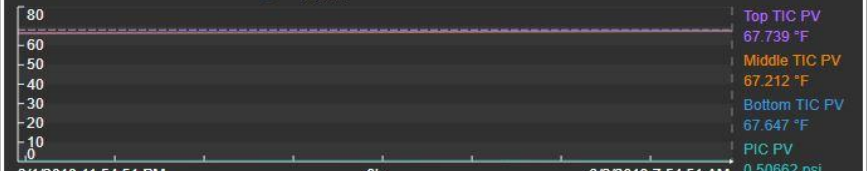
FV40 Fresh Squeezed

Free Rise
3/2/2018 1:06:49 AM

Hours to Free Rise — +0 Target: Shutdown

Hours to Bung +56.007 Target: 0





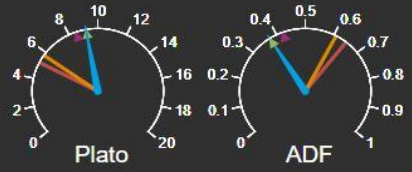
Top TIC PV
67.739 °F
Middle TIC PV
67.212 °F
Bottom TIC PV
67.647 °F
PIC PV
0.50662 psi

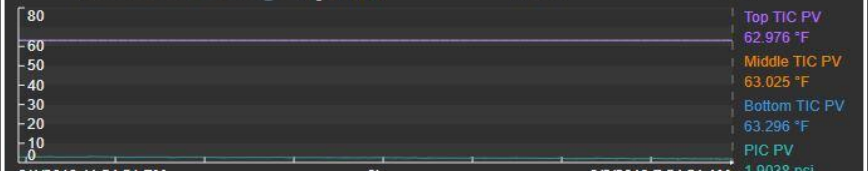
FV41 Black Butte

Fermentation
3/2/2018 12:06:49 AM

Hours to Free Rise -10.983 Target: 37.138

Hours to Bung -15.728 Target: 41.883





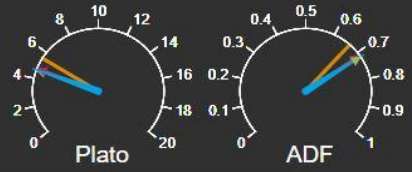
Top TIC PV
62.976 °F
Middle TIC PV
63.025 °F
Bottom TIC PV
63.296 °F
PIC PV
1.9038 psi

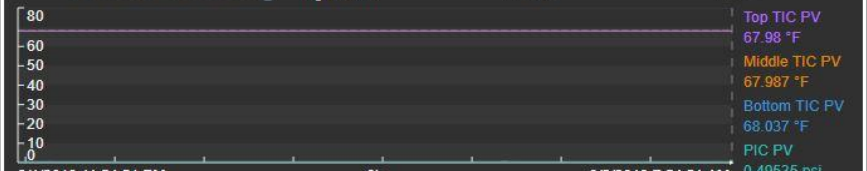
FV42 Fresh Squeezed

Free Rise
3/2/2018 4:16:49 AM

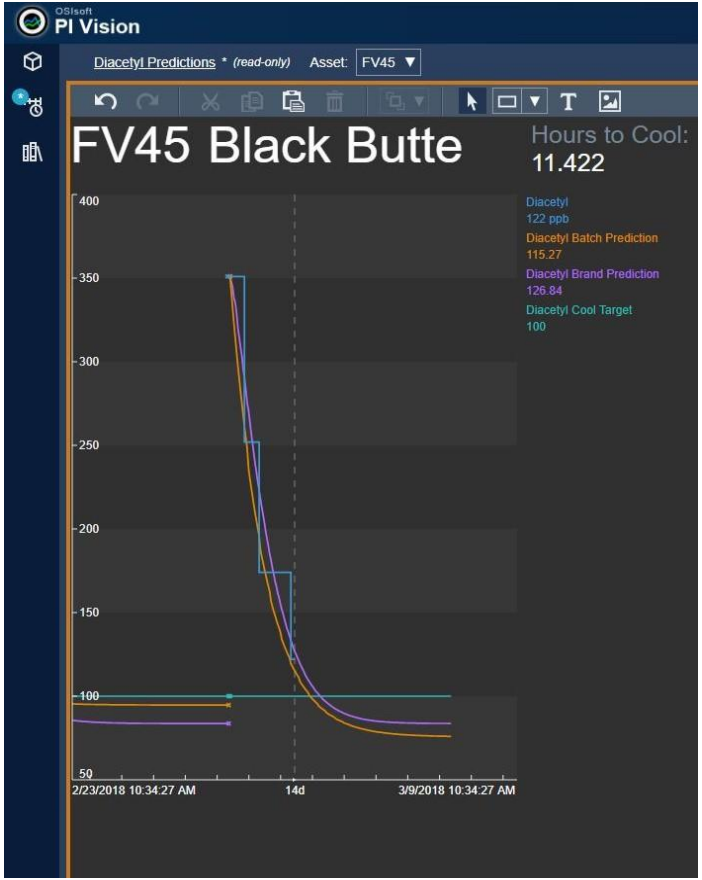
Hours to Free Rise — +0 Target: Shutdown

Hours to Bung -5.0017 Target: 85.332





Top TIC PV
67.98 °F
Middle TIC PV
67.987 °F
Bottom TIC PV
68.037 °F
PIC PV
0.49535 psi



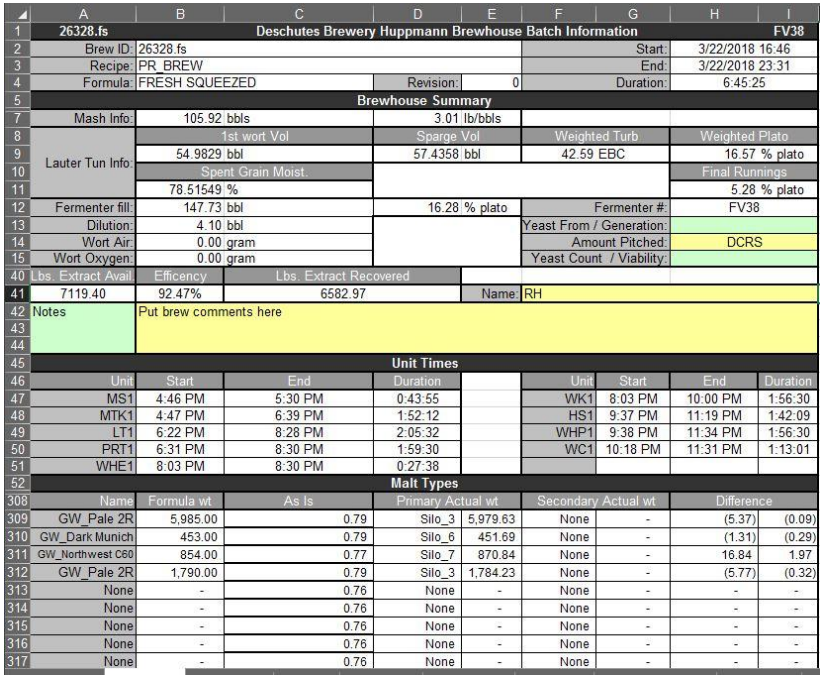
Diacetyl Reduction Model

- Measurements made with Gas Chromatography.
- Up to 12 hours between measurements.
- GC downtime prevents fermentations from cooling.
- Use historical data for each brand to develop a predictive model that reduces GC dependency.

Yeast Status *

No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.0619 hr	Needs Pre-Centrifuge Drop 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 hr	Needs Pre-Centrifuge Drop 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.562 hr	Needs Pre-Centrifuge Drop 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.732 hr	No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.763 hr
FV20 Pacific Wonderland Addition Maturation No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 hr	**FV21** Fresh Chair Ready to Transfer Needs Pre-Centrifuge Drop 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.757 hr	**FV22** Hop Henge Free Rise No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 hr	**FV23** Swivelhead Addition Maturation No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 hr	**FV24** Hop Henge Maturation No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.343 hr
FV26 Fresh Chair Diacetyl Rest Available For Harvest 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 hr	**FV31** Mirror Pond Ready to Transfer Needs Pre-Centrifuge Drop 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.88 hr	**FV33** Fresh Squeezed Fermentation No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 hr	**FV34** Mirror Pond Cooling No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0.5 hr	**FV36** Inversion Cooling No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 3.45 hr
FV38 Twilight Ready to Transfer Needs Pre-Centrifuge Drop 3/1/2018 8:59:36 AM Yeast Out Totalizer 14,295 lb	**FV39** Twilight Diacetyl Rest Available For Harvest 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 lb	**FV40** Fresh Squeezed Fermentation No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 lb	**FV41** Black Butte Fermentation No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 lb	**FV42** Fresh Squeezed Free Rise No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 0 lb
FV44 Fresh Squeezed Cooling No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 12,971 lb	**FV45** Black Butte Diacetyl Rest No Yeast Action Required 3/1/2018 8:59:36 AM Yeast Out Totalizer 14,453 lb	**FV46** Fresh Squeezed Cooling Ready For Yeast Pull 3/1/2018 8:59:36 AM Yeast Out Totalizer 3,599 lb		

Brewhouse Operations



	A	B	C	D	E	F	G	H	I
1	26328.fs		Deschutes Brewery Huppmann Brewhouse Batch Information						FV38
2	Brew ID:	26328.fs					Start:	3/22/2018 16:46	
3	Recipe:	PR_BREW					End:	3/22/2018 23:31	
4	Formula:	FRESH SQUEEZED		Revision:	0		Duration:	6:45:25	
5			Brewhouse Summary						
7	Mash Info:	105.92 bbls		3.01 lb/bbls					
8		1st wort Vol		Sparge Vol		Weighted Turb		Weighted Plato	
9	Lauter Tun Info:	54.9829 bbl		57.4358 bbl		42.59 EBC		16.57 % plato	
10		Spent Grain Moist.						Final Runnings	
11		78.51549 %						5.28 % plato	
12	Fermenter fill:	147.73 bbl		16.28 % plato		Fermenter #:		FV38	
13	Dilution:	4.10 bbl				Yeast From / Generation:			
14	Wort Air:	0.00 gram				Amount Pitched:		DCRS	
15	Wort Oxygen:	0.00 gram				Yeast Count / Viability:			
40	Lbs. Extract Avail.	Efficency	Lbs. Extract Recovered						
41	7119.40	92.47%	6582.97			Name:	RH		
42	Notes	Put brew comments here							
43									
44									
45			Unit Times						
46	Unit	Start	End	Duration		Unit	Start	End	Duration
47	MS1	4:46 PM	5:30 PM	0:43:55		WK1	8:03 PM	10:00 PM	1:56:30
48	MTK1	4:47 PM	6:39 PM	1:52:12		HS1	9:37 PM	11:19 PM	1:42:09
49	LT1	6:22 PM	8:28 PM	2:05:32		WHP1	9:38 PM	11:34 PM	1:56:30
50	PRT1	6:31 PM	8:30 PM	1:59:30		WC1	10:18 PM	11:31 PM	1:13:01
51	WHE1	8:03 PM	8:30 PM	0:27:38					
52			Malt Types						
308	Name	Formula wt	As Is	Primary Actual wt		Secondary Actual wt		Difference	
309	GW_Pale 2R	5,985.00	0.79	Silo_3	5,979.63	None	-	(5.37)	(0.09)
310	GW_Dark Munich	453.00	0.79	Silo_6	451.69	None	-	(1.31)	(0.29)
311	GW_Northwest C60	854.00	0.77	Silo_7	870.84	None	-	16.84	1.97
312	GW_Pale 2R	1,790.00	0.79	Silo_3	1,784.23	None	-	(5.77)	(0.32)
313	None	-	0.76	None	-	None	-	-	-
314	None	-	0.76	None	-	None	-	-	-
315	None	-	0.76	None	-	None	-	-	-
316	None	-	0.76	None	-	None	-	-	-
317	None	-	0.76	None	-	None	-	-	-

- Milling and Mashing
  - Malted barley and other grains are crushed and steeped to convert starches to fermentable sugar.
- Lauter
  - Wort is removed from grain bed.
- Kettle
  - Wort is boiled to remove volatiles and sterilized.
  - Hops added for bittering, flavor, and aroma.
- Hop Strainer
  - Solids removed from boiled wort.
- Whirlpool
  - Solids present in the wort are separated.
- Wort Cooling
  - Yeast is pitched.
  - Oxygen is added for yeast health.
  - In-line instrumentation for qualification.

Library

- Deschutes Brewery
  - Templates
    - Element Templates
      - AA
      - Analog Valve
      - BB FV
      - BLRTemplate
      - Brewhouse
      - Brewhouse Unit
      - Cellar Transfers
      - Centrifuge
      - CO2 Meter
      - CO2Zone
      - CT
      - Discrete Pump
      - Discrete Valve
      - Double Hop - Brew
      - Double Hop - Brew
      - Double Hop - Brew
      - FV Status
      - GLP
      - GT
      - Keg Equipment
      - Keg Lane
      - Keg Transport
      - LP
      - New Centrifuge
      - Release Line
      - Water Meter
      - Water Tank
      - Yeast Tank
    - Event Frame Templates
    - Model Templates
    - Transfer Templates
  - Enumeration Sets
  - Reference Types
  - Tables

Elements
Event Frames
Library
Unit of Measure

Brewhouse

General | Attribute Templates | Ports | Analysis Templates | Notification Rule Templates

Name
Batch List
Latest Batch Info
Batch List Example

Name: Batch List Example
Description:
Categories:
Analysis Type: (•) Expression ( ) Rollup ( ) Event Frame Generation ( ) SQC
[x] Enable analyses when created from template

Example Element: Brew 2\Brewhouse\Huppmann

Evaluate

Name	Expression	Va	Va	O
CombinedBatchID	IF HasChanged('.\WP1|Batch ID','*-1s') THEN NoOutput() ELSE IF '..\..\Malt Room\Huppmann\MT1|Formula'<>"" AND '.\MS1|Operation'="OP_MS_FILL_MALT:1" AND '..\..\Malt Room THEN Concat(Left('.\MS1|Batch ID',5),"_",'..\..\Malt Room\Huppmann\MT1|Formula') ELSE NoOutput()			Ma
NewBatch	PrevVal('..\..\Malt Room\Huppmann\MT1|Operation','*-1s')="OP_MTR_START:1" AND TimeEq('.\MS1|Batch ID','*','*-1d','.\MS1|Batch ID')<=TimeEq('.\MS1|Batch ID','*','*-1h','.\MS1|Batch ID')			Ma
CloseBatch1	PrevEvent('.\WP1|Batch ID','*+1s')='*' AND '.\WP1|Batch ID'="" AND ((TagVal('.\WP1|Operation','*-2s') = "OP_WHP_END:1") OR ('.\WP1|Operation' = "OP_WHP_END:1")) AND Contains('Batch 1 ID', Left(PrevVal('.\WP1|Batch ID','*'),5))			Ma
Batch1	If NewBatch AND (BadVal('Newest Active Batch') OR ('Newest Active Batch' = 5)) THEN 1 ELSE IF CloseBatch1 THEN 0 ELSE NoOutput()			Ma
Batch1ID	IF Batch1=1 THEN CombinedBatchID ELSE NoOutput()			Ma
ActiveBatch	IF (Batch1 = 1) THEN 1 ELSE IF (Batch2 = 1) THEN 2 ELSE IF (Batch3 = 1) THEN 3 ELSE IF (Batch4 = 1) THEN 4			Ma

Add a new variable

Functions

Insert functions into the expression

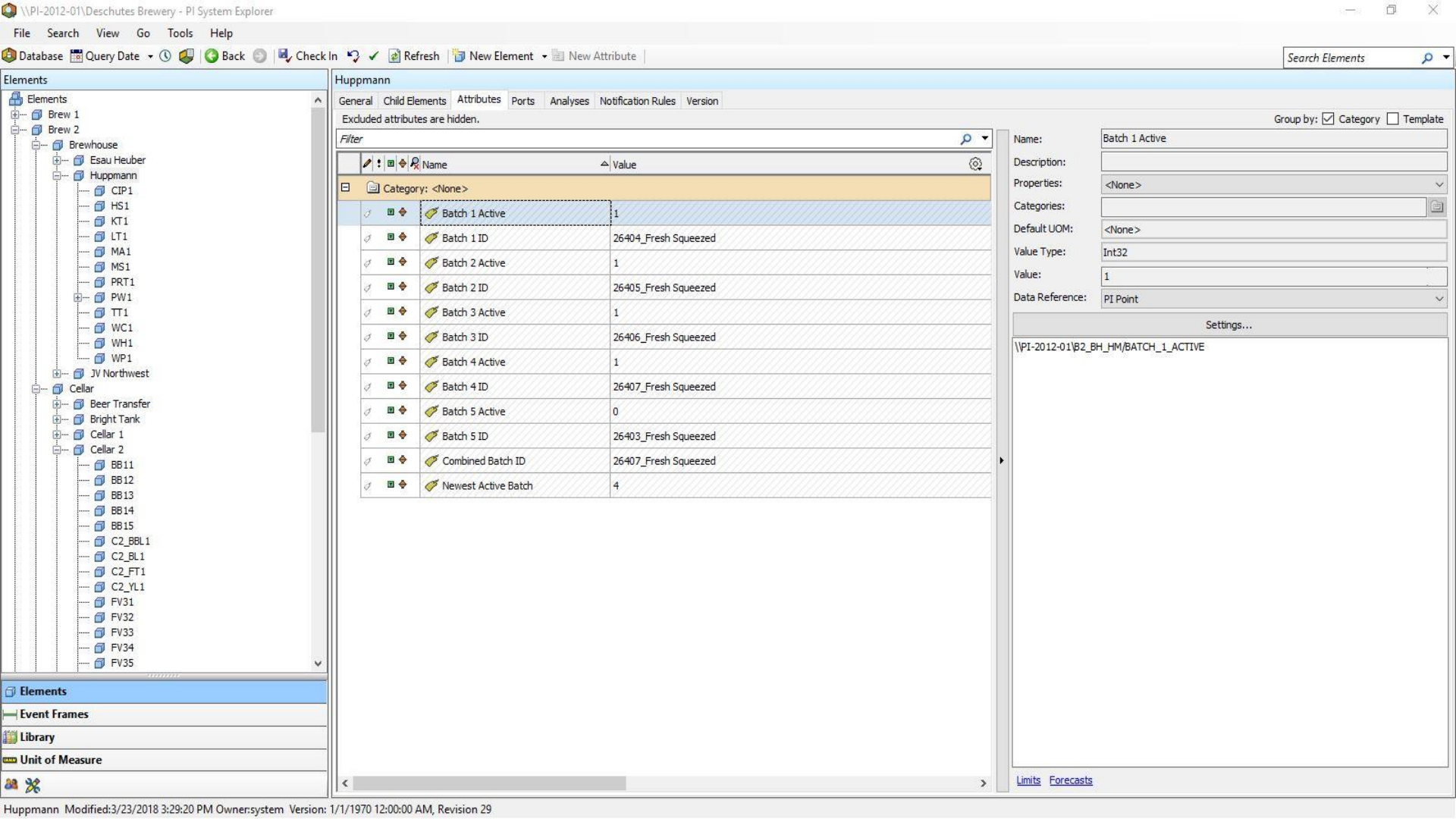
All

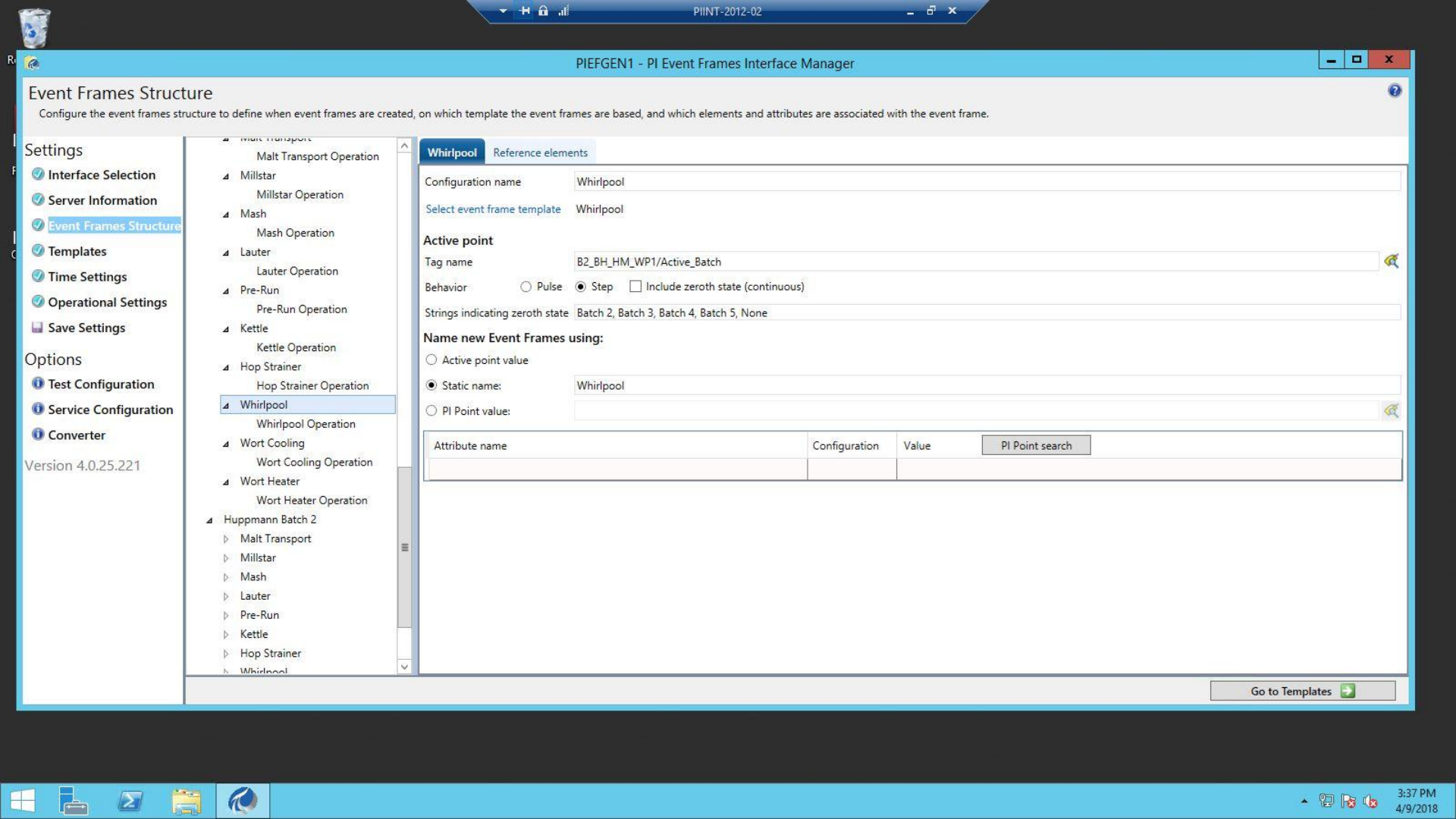
Abs
Acos
And
Ascii
Asin
Atn
Atn2
Avg
BadVal
Bod
Bom
Bonm
Ceiling
Char

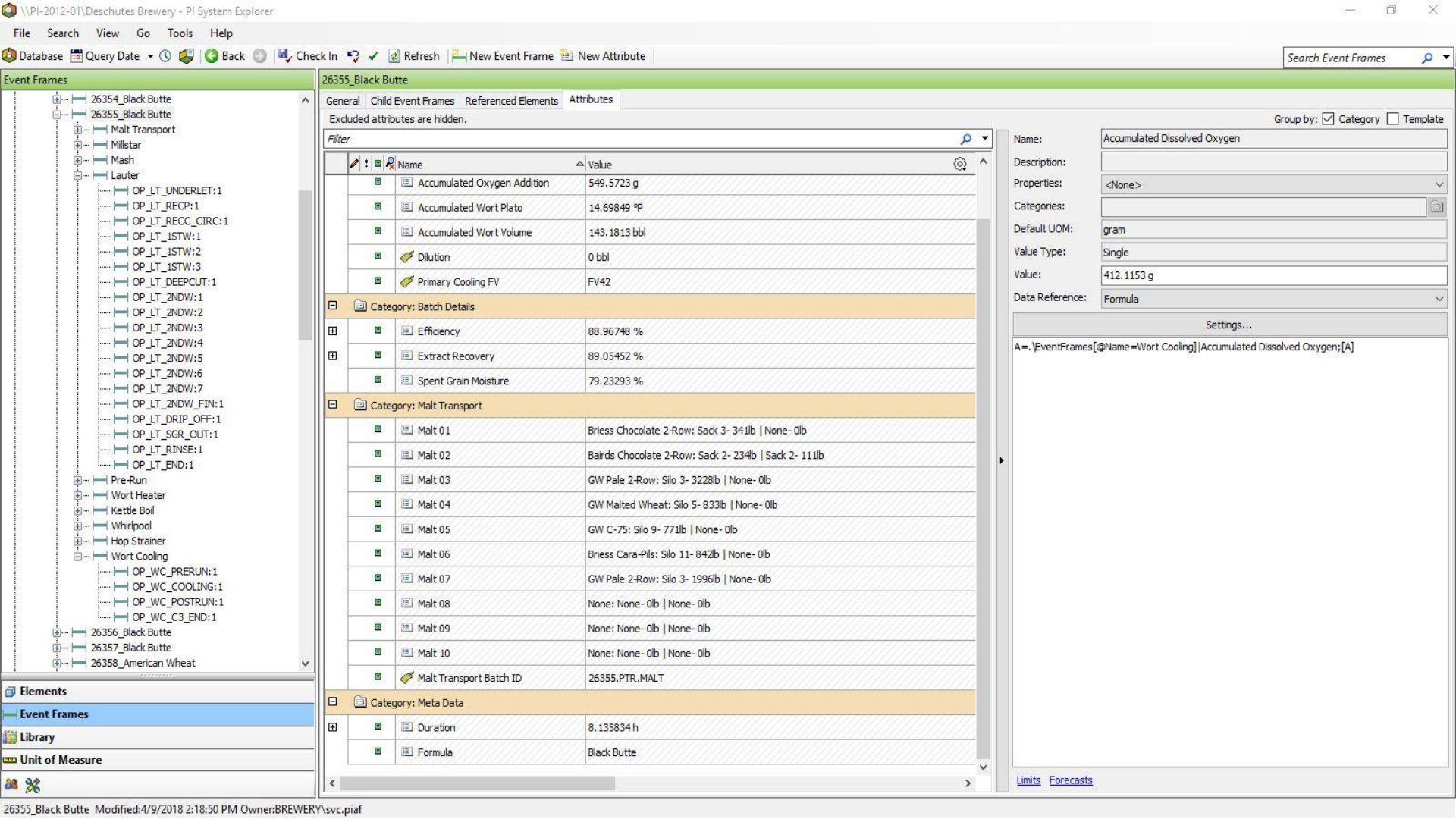
Abs(**number x**)
Return the absolute value of an integer or real number.
Example: Abs(-2.2) [Returns 2.2]

Attributes

Scheduling: (•) Event-Triggered ( ) Periodic
Trigger on: Any Input
Advanced...


\\PI-2012-01\Deschutes Brewery - PI System Explorer
File Search View Go Tools Help
Database Query Date Back Check In Refresh New Element New Attribute
Search Elements
Elements
Elements
Brew 1
Brew 2
Brewhouse
Esau Heuber
Huppmann
CIP1
HS1
KT1
LT1
MA1
MS1
PRT1
PW1
TT1
WC1
WH1
WP1
JV Northwest
Cellar
Beer Transfer
Bright Tank
Cellar 1
Cellar 2
BB11
BB12
BB13
BB14
BB15
C2_BBL1
C2_BL1
C2_FT1
C2_YL1
FV31
FV32
FV33
FV34
FV35
Elements
Event Frames
Library
Unit of Measure
Huppmann
General Child Elements Attributes Ports Analyses Notification Rules Version
Excluded attributes are hidden.
Group by: Category Template
Filter
Name Value
Category: <None>
Batch 1 Active 1
Batch 1 ID 26404_Fresh Squeezed
Batch 2 Active 1
Batch 2 ID 26405_Fresh Squeezed
Batch 3 Active 1
Batch 3 ID 26406_Fresh Squeezed
Batch 4 Active 1
Batch 4 ID 26407_Fresh Squeezed
Batch 5 Active 0
Batch 5 ID 26403_Fresh Squeezed
Combined Batch ID 26407_Fresh Squeezed
Newest Active Batch 4
Name: Batch 1 Active
Description:
Properties: <None>
Categories:
Default UOM: <None>
Value Type: Int32
Value: 1
Data Reference: PI Point
Settings...
\\PI-2012-01\B2_BH_HM/BATCH_1_ACTIVE
Limits Forecasts
Huppmann Modified:3/23/2018 3:29:20 PM Owner:system Version: 1/1/1970 12:00:00 AM, Revision 29


PIINT-2012-02
PIEFGEN1 - PI Event Frames Interface Manager
Event Frames Structure
Configure the event frames structure to define when event frames are created, on which template the event frames are based, and which elements and attributes are associated with the event frame.
Settings
Interface Selection
Server Information
Event Frames Structure
Templates
Time Settings
Operational Settings
Save Settings
Options
Test Configuration
Service Configuration
Converter
Version 4.0.25.221
Malt Transport Operation
Millstar
Millstar Operation
Mash
Mash Operation
Lauter
Lauter Operation
Pre-Run
Pre-Run Operation
Kettle
Kettle Operation
Hop Strainer
Hop Strainer Operation
Whirlpool
Whirlpool Operation
Wort Cooling
Wort Cooling Operation
Wort Heater
Wort Heater Operation
Huppmann Batch 2
Malt Transport
Millstar
Mash
Lauter
Pre-Run
Kettle
Hop Strainer
Whirlpool
Whirlpool
Reference elements
Configuration name
Whirlpool
Select event frame template
Whirlpool
Active point
Tag name
B2_BH_HM_WP1/Active_Batch
Behavior
Pulse
Step
Include zeroth state (continuous)
Strings indicating zeroth state
Batch 2, Batch 3, Batch 4, Batch 5, None
Name new Event Frames using:
Active point value
Static name:
Whirlpool
PI Point value:
Attribute name
Configuration
Value
PI Point search
Go to Templates
3:37 PM
4/9/2018


\\PI-2012-01\Deschutes Brewery - PI System Explorer
File Search View Go Tools Help
Database Query Date Back Check In Refresh New Event Frame New Attribute
Search Event Frames
Event Frames
26354_Black Butte
26355_Black Butte
Malt Transport
Millstar
Mash
Lauter
OP_LT_UNDERLET:1
OP_LT_RECP:1
OP_LT_RECC_CIRC:1
OP_LT_1STW:1
OP_LT_1STW:2
OP_LT_1STW:3
OP_LT_DEEPCUT:1
OP_LT_2NDW:1
OP_LT_2NDW:2
OP_LT_2NDW:3
OP_LT_2NDW:4
OP_LT_2NDW:5
OP_LT_2NDW:6
OP_LT_2NDW:7
OP_LT_2NDW_FIN:1
OP_LT_DRIP_OFF:1
OP_LT_SGR_OUT:1
OP_LT_RINSE:1
OP_LT_END:1
Pre-Run
Wort Heater
Kettle Boil
Whirlpool
Hop Strainer
Wort Cooling
OP_WC_PRERUN:1
OP_WC_COOLING:1
OP_WC_POSTRUN:1
OP_WC_C3_END:1
26356_Black Butte
26357_Black Butte
26358_American Wheat
Elements
Event Frames
Library
Unit of Measure
26355_Black Butte
General Child Event Frames Referenced Elements Attributes
Excluded attributes are hidden.
Group by: Category Template
Filter
Name Value
Accumulated Oxygen Addition 549.5723 g
Accumulated Wort Plato 14.69849 °P
Accumulated Wort Volume 143.1813 bbl
Dilution 0 bbl
Primary Cooling FV FV42
Category: Batch Details
Efficiency 88.96748 %
Extract Recovery 89.05452 %
Spent Grain Moisture 79.23293 %
Category: Malt Transport
Malt 01 Briess Chocolate 2-Row: Sack 3- 341lb | None- 0lb
Malt 02 Bairds Chocolate 2-Row: Sack 2- 234lb | Sack 2- 111lb
Malt 03 GW Pale 2-Row: Silo 3- 3228lb | None- 0lb
Malt 04 GW Malted Wheat: Silo 5- 833lb | None- 0lb
Malt 05 GW C-75: Silo 9- 771lb | None- 0lb
Malt 06 Briess Cara-Pils: Silo 11- 842lb | None- 0lb
Malt 07 GW Pale 2-Row: Silo 3- 1996lb | None- 0lb
Malt 08 None: None- 0lb | None- 0lb
Malt 09 None: None- 0lb | None- 0lb
Malt 10 None: None- 0lb | None- 0lb
Malt Transport Batch ID 26355.PTR.MALT
Category: Meta Data
Duration 8.135834 h
Formula Black Butte
Name: Accumulated Dissolved Oxygen
Description:
Properties: <None>
Categories:
Default UOM: gram
Value Type: Single
Value: 412.1153 g
Data Reference: Formula
Settings...
A=.\EventFrames[@Name=Wort Cooling]|Accumulated Dissolved Oxygen;[A]
Limits Forecasts
26355_Black Butte Modified:4/9/2018 2:18:50 PM Owner:BREWERY\svc.piaf

Events

Automatically refresh the list

- Wort Collection 2017-09-07 14:18:11.723 (24986.FS)
- Wort Collection 2017-09-07 12:07:45.937 (24985.FS)
- Wort Collection 2017-09-07 09:57:40.313 (24984.FS)
- Wort Collection 2017-09-07 07:48:19.029 (24983.FS)
- Wort Collection 2017-09-07 05:04:34.527 (24982.FS)
  9/7/2017 5:04:34 AM - 9/7/2017 7:20:10 AM
- Wort Collection 2017-09-07 02:54:40.339 (24981.FS)
- Wort Collection 2017-09-07 00:51:08.966 (24980.FS)
- Wort Collection 2017-09-06 20:29:40.684 (24978.FS)
- Wort Collection 2017-09-06 18:19:05.988 (24977.FS)
- Wort Collection 2017-09-06 16:07:56.300 (24976.FS)
- Wort Collection 2017-09-06 13:57:43.985 (24975.FS)

Edit Search Criteria

Attributes

Wort Collection 2017-09-07 05:04:34.527 (24982.FS)

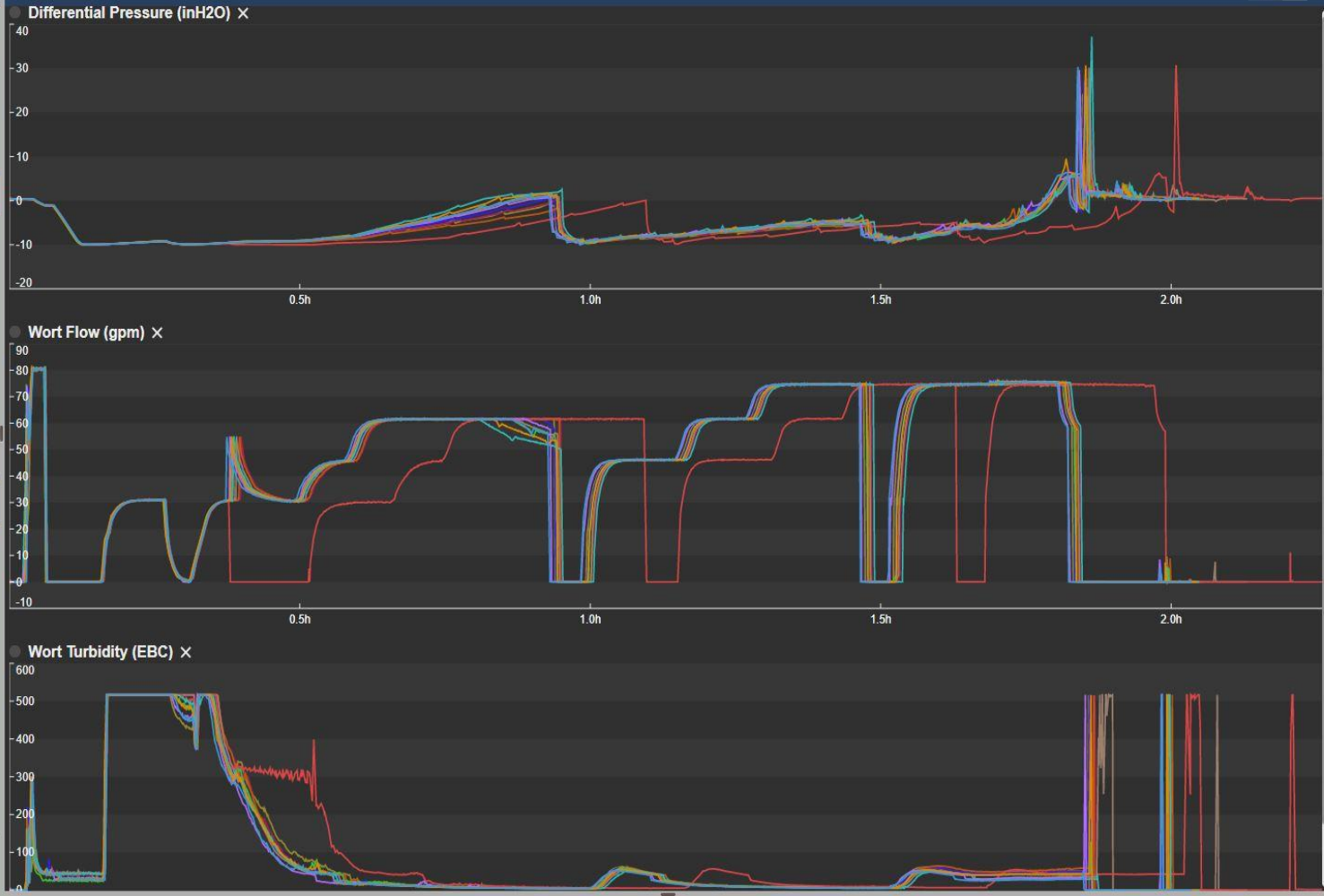
Batch Info

- Batch ID: 24982.FS
- Formula: Fresh Squeezed

Process Value

- Deep Cut Count: 2
- Duration: 135.6 min
- Maximum Plato: 20.888 °P
- Minimum Plato: 6.0806 °P
- Sparge Water Total: 58.749 bbl
- Volume: 155.1 bbl
- Weighted Plato: 16.669 °P

FS Lauter



Brewing with the PI System

Deschutes Brewery wanted to provide **Real-Time** data and analytics to Brewers and Quality Technicians in order to increase efficiency and improve the quality of beer for our fans.

CHALLENGE

Reduce spreadsheets, product non-conformities, decreased yield, and lost time associated with delays in data.

- Manual data entry in complicated spreadsheets could result in miscommunication across shifts.
- Biological processes are difficult, costly, or impossible, to track in real-time.

SOLUTION

Create dynamic, real-time displays for operators that leverage a variety of PI System tools.

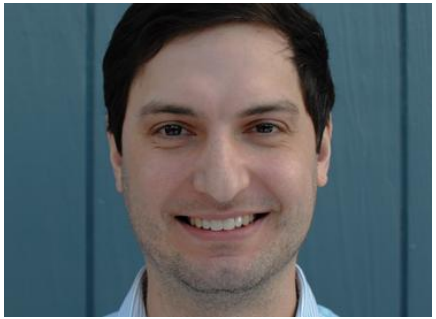
- Asset Framework
- Asset Analytics
- PI Integrator for Microsoft Azure
- PI Vision

RESULTS

Reduction of time spent on generating spreadsheets, lost time, and non-conformities associated with bad or missing data leads to increased cellar capacity.

- 4% decrease in total fermentation time.
- 2% decrease in diacetyl rest time.

Contact Information



- **Kyle Kotaich**
- kkotaich@deschutesbrewery.com
- Operations Technology Lead
- Deschutes Brewery, Inc.

Merci

谢谢

Danke

Спасибо

Gracias

Thank You

감사합니다

ありがとう

Grazie

Obrigado

Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

Please remember to…

Complete the Online Survey for this session

Conference Theme & Keywords