BIG DATA ANALYTICS - LESSONS LEARNED FROM GLOBAL E&P OPERATORS

Tremendous untapped potential in your BIG DATA!

SAS FOR DOWNSTREAM PROCESS MANAGEMENT

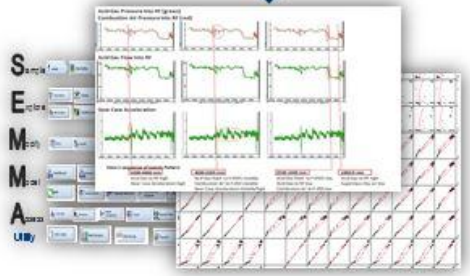
Historian System and Internal Applications

PI-SAS Adaptor

Advanced Analytical Data-Driven Methodologies

Operational Real-time Performance Monitoring with PI System and Dashboards

Data-Driven Modeling, Predictions, Advanced analyses



Reporting	Dashboards	Alerting	Extrapolation	Data Mining
Statistical Analysis	Modeling	Prediction	Simulation	Optimization

AMINE GAS TREATMENT CASE

ANALYTICAL APPROACH

SAMPLE

- Consolidate multiple data sources
- Quality Check
- Cleanse

EXPLORE

- Visualize sensor and fault data
- Collaborate with subject matter experts
- Identify candidate anomalies

MODIFY

- Transform variables
- Filter outliers
- Cluster similar acting groups
- Variable selection

MODEL

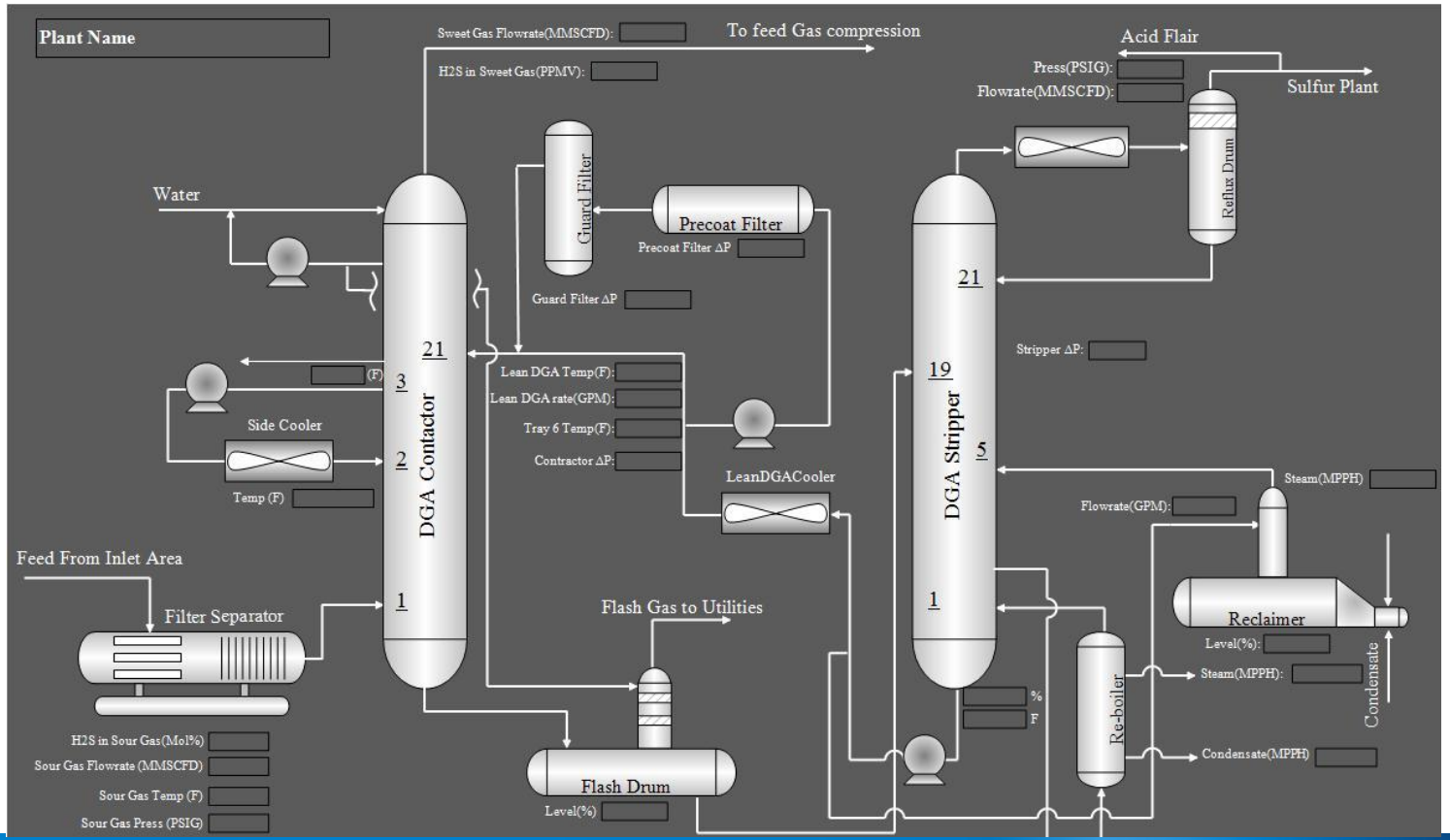
- Identify early fault indicators
  - *Root cause analysis*
- Generate predictive models
  - *Decision trees*
  - *Logistic regression*
  - *Neural networks …*
- Review results with subject matter experts

ASSESS

- Score new data
- Automate ongoing assessment of prediction accuracy
- Flag model needing tuning
- Alert when operation becomes unstable

AMINE GAS TREATMENT CASE

Processing Contactor Overview



AMINE GAS TREATMENT CASE

DATA OVERVIEW

- Systems:
  - Contactor C-101 (HAW31): 22 sensor variables & 18 calculated variables
  - Contactor C-201 (HAW32): 22 sensor variables & 18 calculated variables
  - Contactor Feed Flow (HAW22): 1 sensor variable
  - Storage tanks (HAW41, 42 & 43): 3 sensor variables (1 per tank)
- Time range:
  - January 1, 2010 to April 12, 2014

AMINE GAS TREATMENT CASE

DATA OVERVIEW

Location	Tag Name	Tag ID	Tag Type
Machine 1 & Machine 2	Final Product Concentration	MC_X_AI014H	CONCENTRATION
	Raw Material Feed Flow	MC_X_FIC003A	FLOW
	Flow of Chemical Agent to Machine	MC_X_FIC004	FLOW
	Antifoam Feed Flow A	MC_X_FY106	FLOW
	Antifoam Feed Flow B	MC_X_FY107	FLOW
	Chemical Agent Strength	MC_X_HIC004	CONCENTRATION
	Feed Filter Separator Level	MC_X_LI003	LEVEL
	Antifoam Feed Tank Level A	MC_X_LI106	LEVEL
	Antifoam Feed Tank Level B	MC_X_LI107	LEVEL
	Sensor 21 Level	MC_X_LIC016	LEVEL
	Machine Level	MC_X_LIC020	LEVEL
	Drum Level	MC_X_LIC037A	LEVEL
	Feed Filter Separator Pressure Drop	MC_X_PDI006	DIFF_PRESSURE
	Machine Differential Pressure	MC_X_PDI022	DIFF_PRESSURE
	Pressure Differential Precoat Filter	MC_X_PDI205	DIFF_PRESSURE
	Raw Material Feed Flow Pressure	MC_X_PI023	PRESSURE_VALUE
	Raw Material Feed Flow Temp	MC_X_TI015	TEMP
	Machine Lower Tray Temp	MC_X_TI026	TEMP
	Machine Upper Tray Temp	MC_X_TI028	TEMP
	Secondary Process Temp	MC_X_TIC109	TEMP
	Raw Material Feed Temp - Antifoam Temp	MC_X_KPI_Temp	TEMP
	Machine KPI	MC_X_KPI	RATIO
Sub Areas 1 to 4	Raw Material Concentration Sub Area 1	SA_1_AI002H	CONCENTRATION
	Storage Tank Sub Area 2 Level	SA_2_LI029	LEVEL
	Storage Tank Sub Area 3 Level	SA_3_LI029	LEVEL
	Storage Tank Sub Area 4 Level	SA_4_LI029	LEVEL

CONTACTOR EVENT DATA DEVELOPMENT

- Production Offline
  - Used to identify ‘foaming/flooding’ periods
  - Defined as PROD_OFFLINE when Feed Gas Flow (HAW31FIC003A) < 100
- Low Amine Pickup Ratio KPI
  - Defined as LOW_AMINE when HAWGT1PickUpRatio <= 0.2
- Excess Amine Pickup Ratio KPI
  - Defined as EXCESS_AMINE when HAWGT1PickUpRatio >= 0.4

AMINE GAS TREATMENT CASE

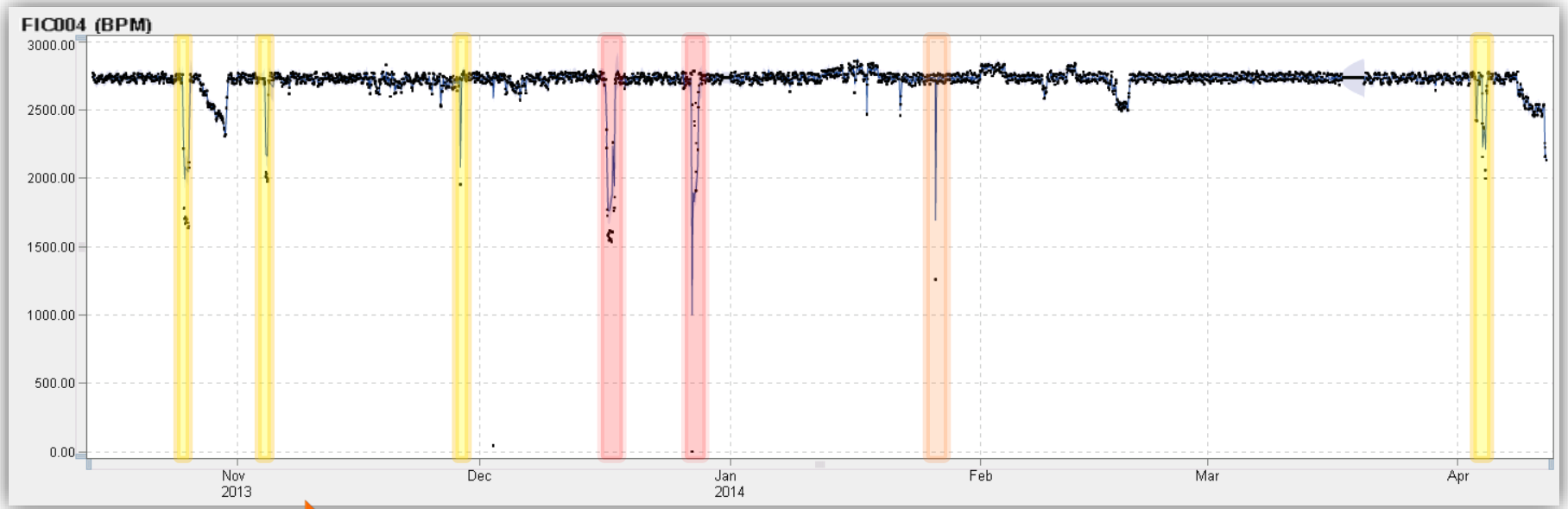
GOAL: PROACTIVELY PREDICT PROCESSING FAULTS

Flooding/Foaming Event

Excess Amine Pickup

Low Amine Gas Pickup

Lean Amine to Contactor



SAMPLE | EXPLORE | MODIFY | MODEL | ASSESS

AMINE GAS CASE | EXPLORE SENSOR DATA AND FAILURE TIMES

February 10, 2013 to April 12, 2014

Selected Tags

Tag ID
FIC003A
LI107
LIC020
LIC037A
TI026
LI029

Selected Events

Event ID
EXCESS_AMINE
LOW_AMINE
PROD_OFFLINE

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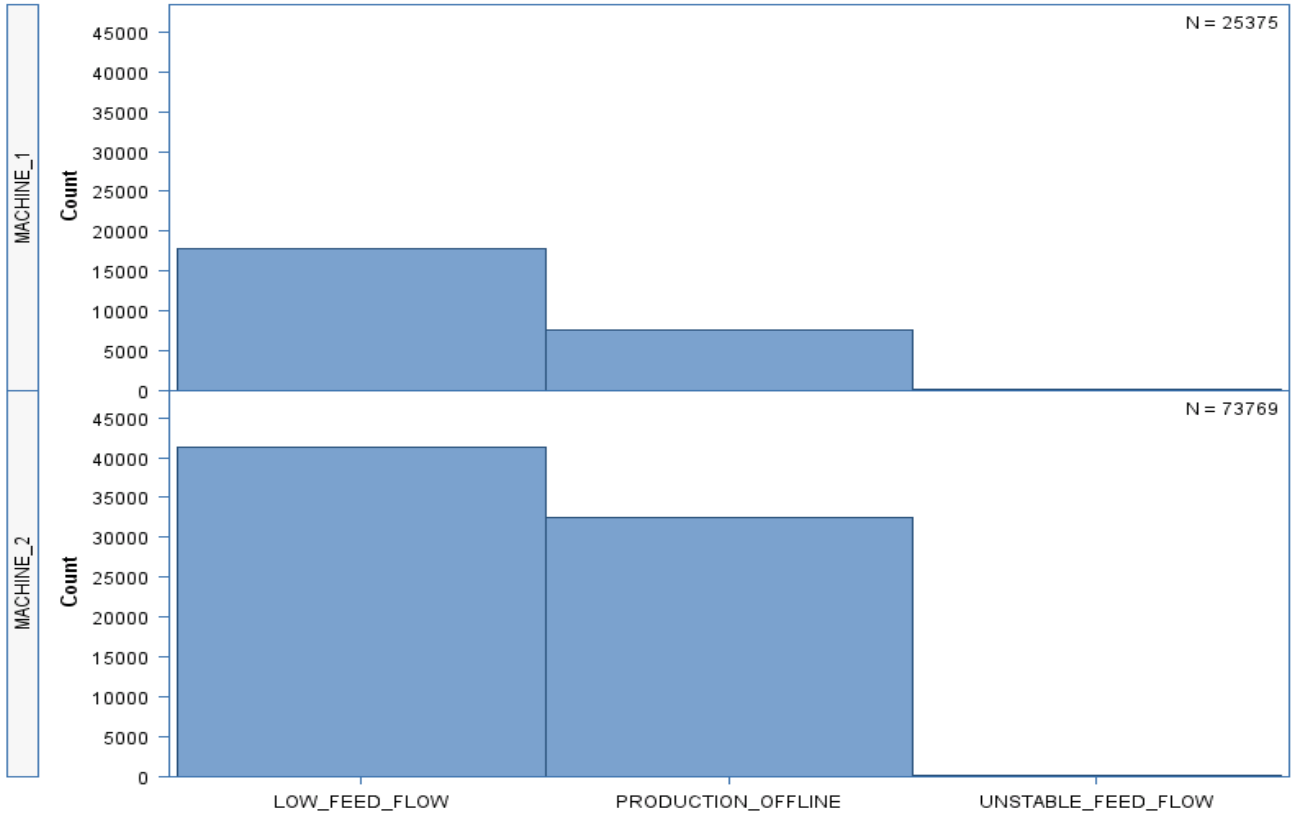
Pareto Analysis

Asset Performance Analytics
Pareto Analysis
Run Pareto Analysis
Created on July 21, 2014 04:18:10 PM

Data Selection: Pareto Analysis of Events [DSHXW6AP6B]



SAMPLE | EXPLORE | MODIFY | MODEL | ASSESS

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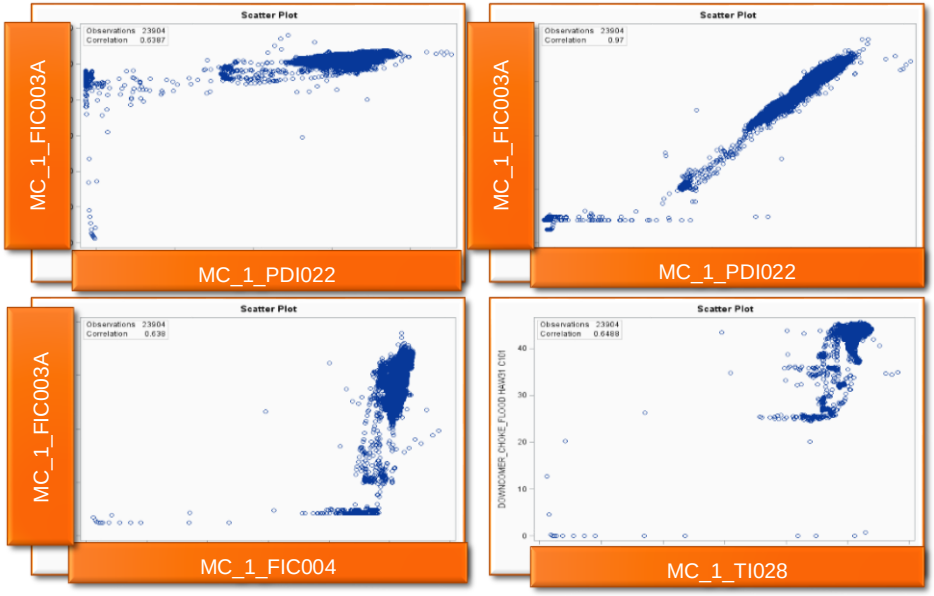
Correlation Analysis

Graphically show associations between sensor variables



Purpose:

- Measures strength of a linear relationship between numerical variables

Benefits:

- ✓ Improves accuracy and performance of predictive models

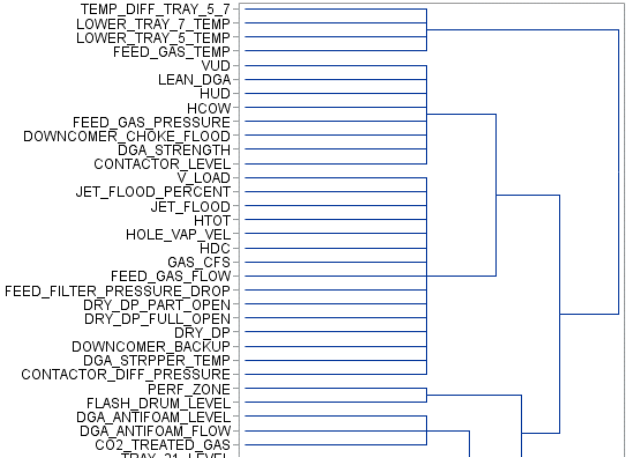
SAMPLE | EXPLORE | MODIFY | MODEL | ASSESS

sas THE POWER TO KNOW.

SAS APA ANALYSIS

VARIABLE CLUSTER ANALYSIS AND PRINCIPAL COMPONENT ANALYSIS

Cluster Analysis



Eigenvalues of the Correlation Matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	19.7955767	14.7322562	0.4828	0.4828
2	5.0633206	2.3147724	0.1235	0.6063
3	2.7485482	0.7093637	0.0670	0.6734
4	2.0391844	0.5284170	0.0497	0.7231
5	1.5107674	0.0653070	0.0368	0.7599
6	1.445			
7	1.153			
8	0.996			
9	0.848			
10	0.829			
11	0.727			
12	0.682			
13	0.622			
14	0.553			

Principal Component Analysis

		Prin1	Prin2	Prin3	Prin4	Prin5	Prin6	Prin7	Prin8	Prin9	Prin10	Pr
CO2_FEED_GAS_1	CO2_FEED_GAS HAW22 HAW	0.054815	0.060942	-.259114	0.494106	-.090448	-.037819	0.107795	-.070237	-.015924	0.226244	-.12
CO2_TREATED_GAS_2	CO2_TREATED_GAS HAW31 C101	-.019847	0.076926	0.087978	-.089087	0.058364	0.423580	0.401735	-.412259	0.210193	0.101637	-.42
CONTACTOR_DIFF_PRESSURE_2	CONTACTOR_DIFF_PRESSURE HAW31 C101	0.220028	0.058078	0.017036	-.002823	0.028408	0.031222	0.008137	-.022020	0.006898	-.025864	0.02
CONTACTOR_LEVEL_2	CONTACTOR_LEVEL HAW31 C101	-.070383	0.208170	-.079555	-.286756	0.161913	0.044408	0.056782	-.205672	0.136628	0.362545	0.28
DGA_ANTIFOAM_FLOW_2	DGA_ANTIFOAM_FLOW HAW31 C101	-.003357	0.004545	-.026090	-.028752	0.032548	-.510212	0.503536	-.158862	0.124205	0.019595	-.29
DGA_ANTIFOAM_LEVEL_2	DGA_ANTIFOAM_LEVEL HAW31 C101	-.041735	0.025095	0.070154	0.083953	-.029798	0.530033	-.378915	-.114532	-.017454	0.210962	-.27

Purpose:

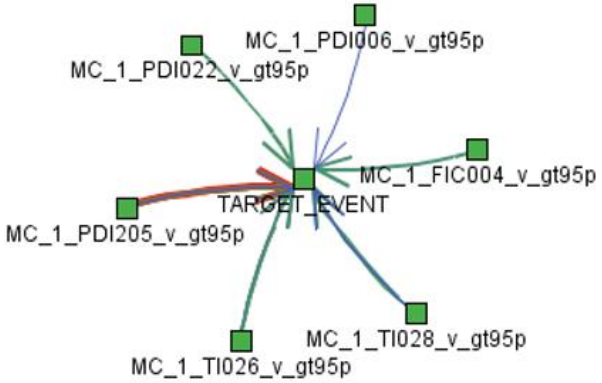
- Predicts contactor processing liquid levels
- Explains variables or combination of variables affecting contactor processing liquid levels

Benefits:

- ✓ Analyzes more information generating greater predictive power
- ✓ Generates better understanding of relationships between variables

Foaming/Flooding Event

Analytical rule	Lift
PDI205_v_gt95p & PDI022_v_gt95p ==> TARGET_EVENT	17.86
PDI205_v_gt95p & PDI006_v_gt95p ==> TARGET_EVENT	16.76
TI028_v_gt95p & PDI205_v_gt95p ==> TARGET_EVENT	15.94
TI028_v_gt95p & FIC004_v_gt95p ==> TARGET_EVENT	15.59
PDI022_v_gt95p & FIC004_v_gt95p ==> TARGET_EVENT	15.52
TI026_v_gt95p & FIC004_v_gt95p ==> TARGET_EVENT	15.45
TI026_v_gt95p & PDI022_v_gt95p ==> TARGET_EVENT	15.12



Purpose:

- Helps understand why processing fault occurred
- Identifies variables potentially contributing to fault/failure event

Benefits:

✓ Identifies association rules to predict occurrence of future faults/failures

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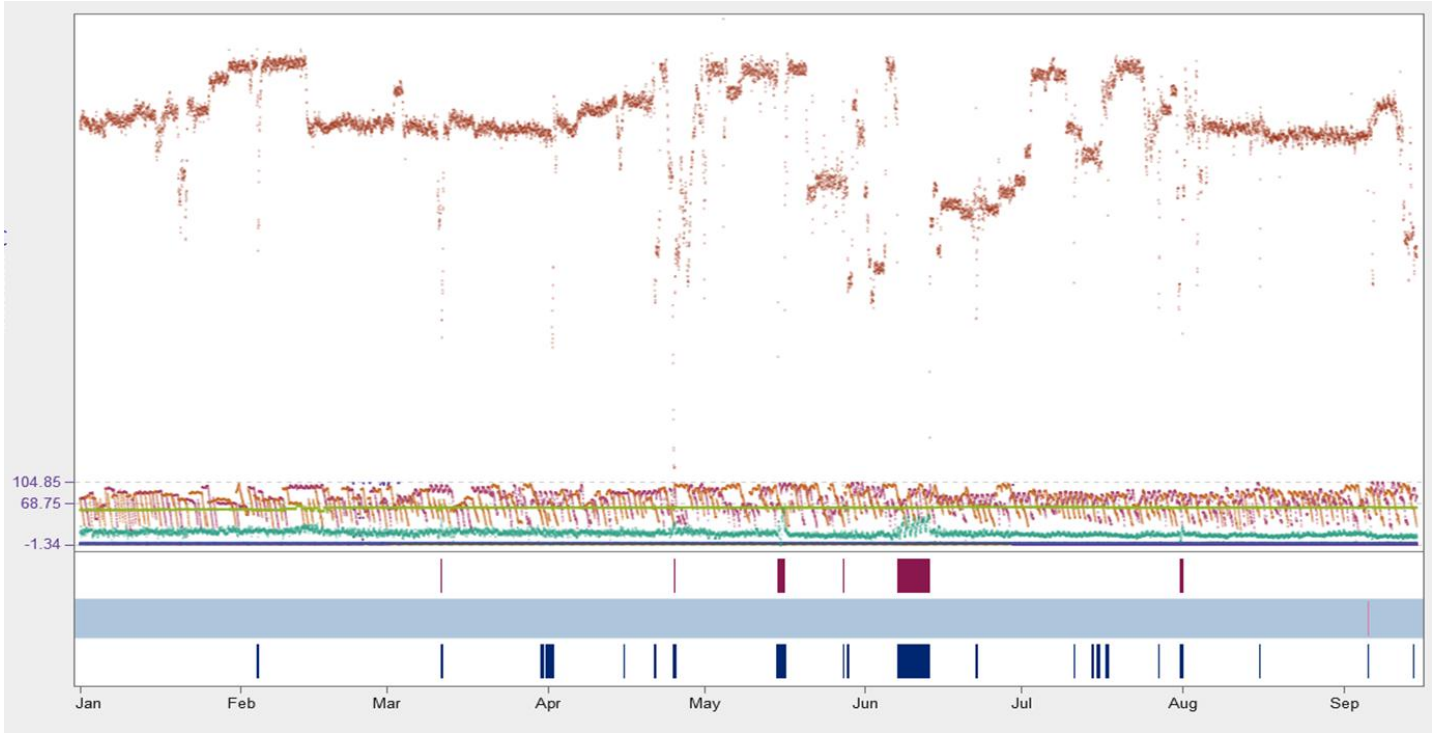
PREDICTION OF FUTURE PRODUCTION EVENTS USING NEW DATA



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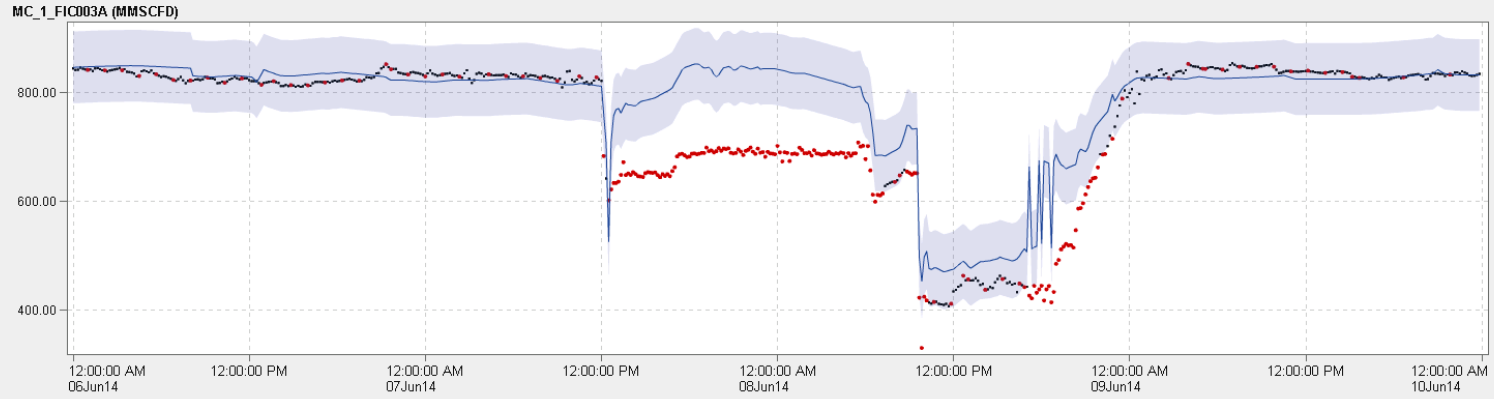
CONTACTOR LEVEL STABILITY FORECAST

Scoring Input | Scoring Output

REG | ARIMA

▾ On-demand scoring output



▾ Summary of test violations

Test	Description	Violations (Count)	Violations (%)
Test 1	One actual value lies outside the confidence band.	156	27%
Test 2	Seven actual values in a row lie either all above or all below the ...	72	13%
Test 3	Six actual values in a row are either steadily increasing or stead...	8	1%
Test 4	Fourteen actual values in a row are alternating up and down.	0	0%

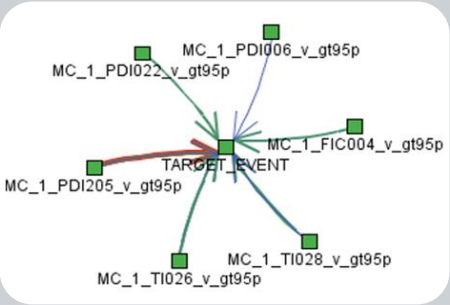
Total violations: **236 (41%)**

AMINE GAS TREATMENT CASE

SUMMARY OF ANALYTICAL FINDINGS

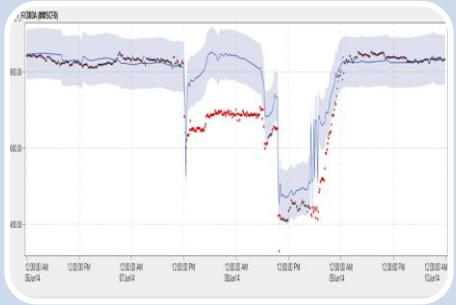
Proactively predict foaming and flooding events

- ✓ Discovered foaming/flooding fault signatures



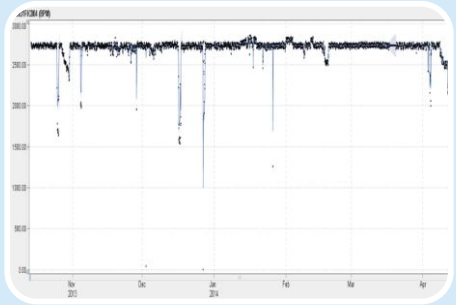
Predict and monitor processing liquid levels

- ✓ Developed prediction models and stability monitoring forecast models



Optimize Amine utilization

- ✓ Developed stability model to feed optimization model



AMINE GAS TREATMENT CASE

LESSONS LEARNED

- ✓ Sensor and fault data can easily be analyzed
- ✓ Wide variety of analytical methods available
- ✓ Tremendous business value discovering root cause of faults and failure initiating variables

Tremendous untapped potential in your BIG DATA!

THANK YOU

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VISIT OUR OIL & GAS SITE FOR FURTHER INFORMATION