
# "Finding The Data In The Noise"

## A Data Mining Tool for Quantifying Improved Delayed Coker Performance

REFCOMM
GALVESTON

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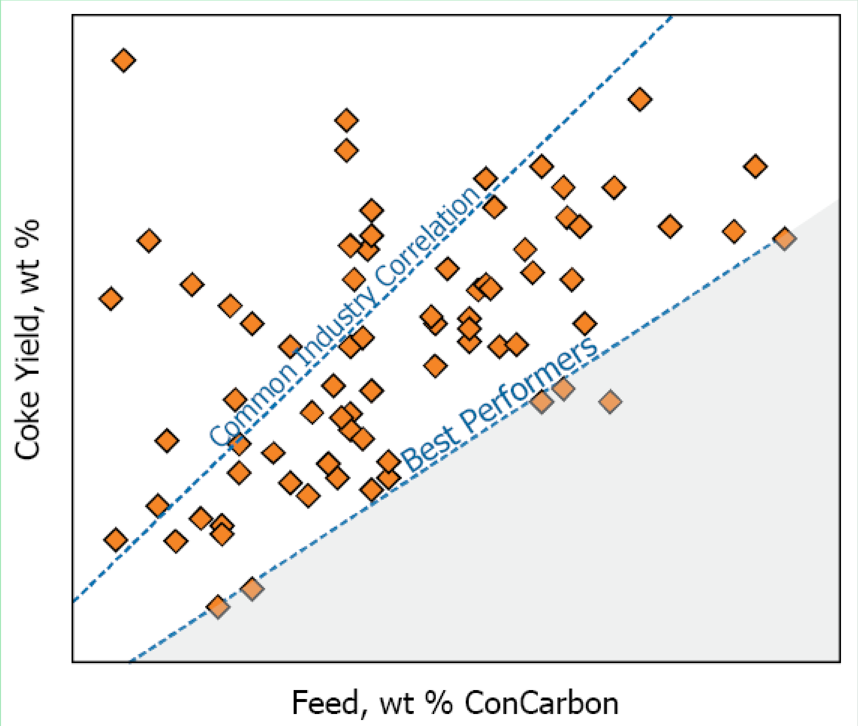
Coking.com

# Agenda

- Introduction to Dorf Ketal
- Challenges in Today's Cokers
- Dorf Ketal Innovation for Improved Liquid Yield
- Data Mining Approach
- Case Histories

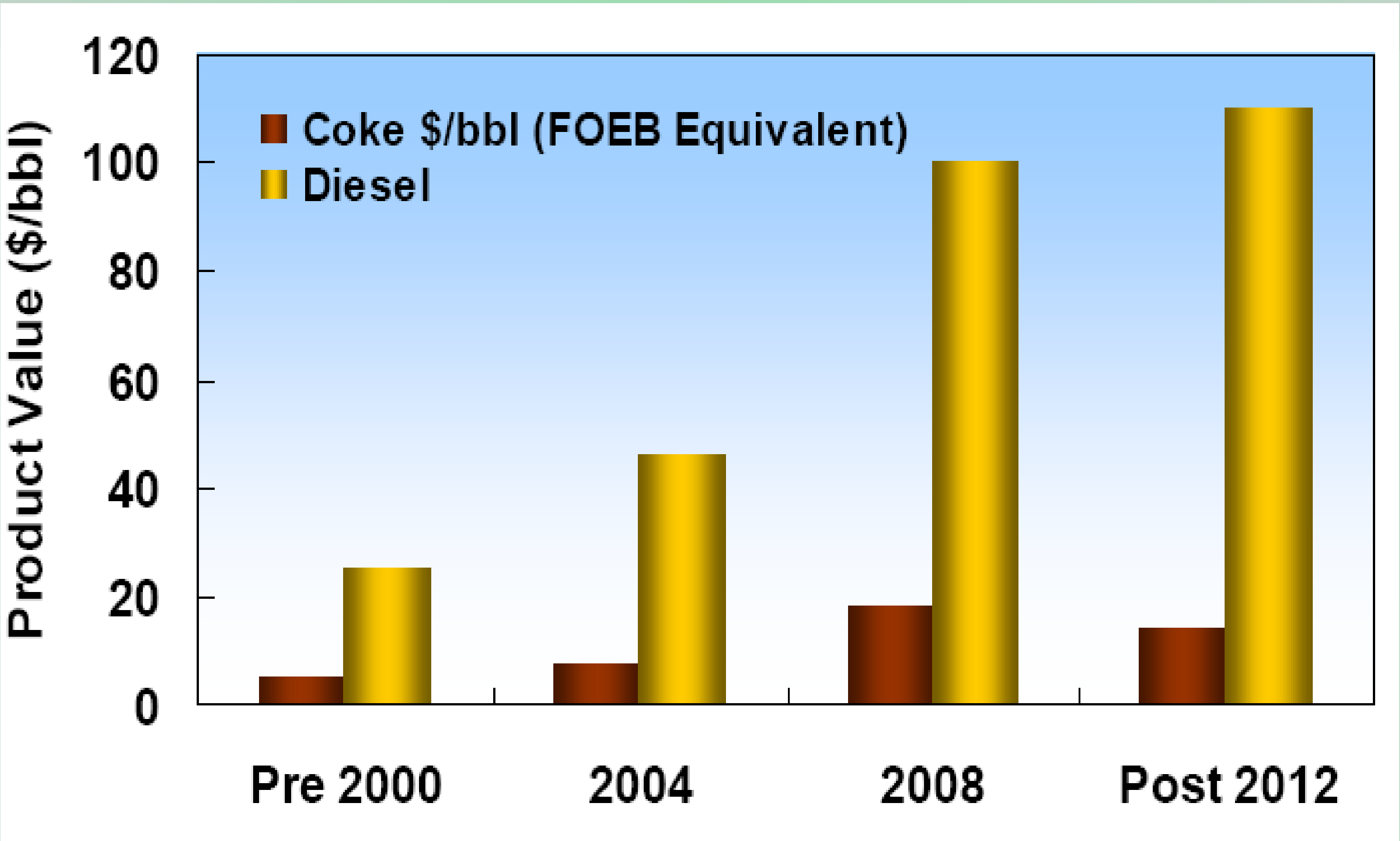
# Challenges in Today's Cokers

- **Significant Gap between current Coke Yield and CCR (theoretical min.)**
  - COKERMAX™ helps close this gap
- **Feed Quality is Poor**
  - More Metals
  - More CCR
  - Higher Asphaltene content
  - High Sulphur Content
- **More prone to fouling**
- **Coke Morphology is changing**
  - Shot Coke formation
  - Less Profitable
  - Operational Challenges
- **More foaming**




*Source: Solomon Associates 2008 Fuels Refinery Performance Analysis*

# Economic Drivers for Improved Liquid Yield




*Diesel vs. Coke pricing. Pricing varies by geography*
*1% increase of liquid over coke valued at $1 to $1.20 per bbl of Coker Feed in 2014 for USA*

# Joint Industry Project on Delayed Coking Research effort to address these challenges

- *Project began in 1999 and is on-going. Members include major refining companies.*
- *Dorf Ketal is a member of this project.*
- *Improving liquid yield is one of the goals of the project.*
- *Dorf Ketal invested heavily in finding a solution to challenge of improving liquid yield.*

# COKERMAX™ Offering

- **COKERMAX™ is a chemical additive that increases liquid yield 1% to 3%.**
- **Easy to feed**
  - Inject Additive into Suction of Main Fractionator Bottoms Pumps
- **Demonstrated success at one refinery in China**
  - Liquid yield improvement of 1.4% to 1.5%
- **Lab design and protocol to test your feed for liquid yield improvement**
  - Product selection, dosage range, liquid yield improvement
  - Predictive tool for full scale results
- **Data Mining Services to quantify impact of COKERMAX™ on liquid yield**

# Need for Data Mining

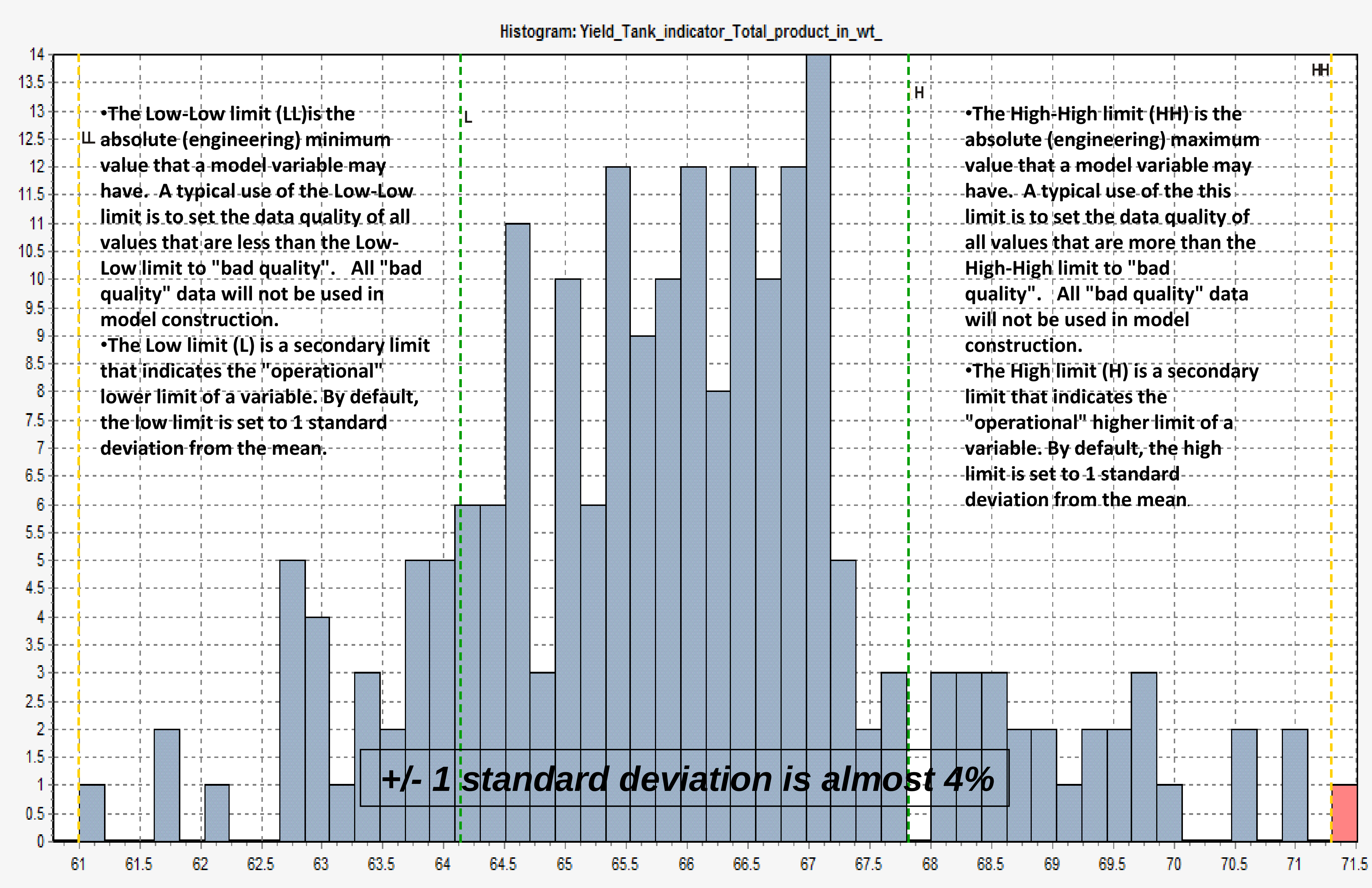
- **Variables affecting liquid yield**
  - feed composition, operating conditions, equipment configuration, processing goals, and nature of the coke.
  - Impractical to hold all these variables constant to isolate impact of additive.
- **Net Value of Converting Coke to Liquid**
  - $100 to $120 per barrel in USA, varies based on diesel & coke pricing
  - 1% improvement in liquid as % of Coker Feed = $1 to $1.2/bbl of feed.
  - 1.5% improvement for 30,000 bbl/day Coker is about $14MM/year.
- **$14MM/year is large number nominally, but:**
  - Benefit of CokerMax™ Additive may appear masked by normal yield variation.

# Dorf Ketal Approach to Data Mining

A multivariate statistical approach towards optimized yield comprising of,

- ✓ Data Preparation, eliminating outliers
- ✓ Principle Components Analysis, A detailed study of key process variables impacting yield.
- ✓ Development of correlations between principle components and actual liquid yield.
- ✓ Definition of baseline for benchmarking impact of change.
- ✓ Detailed root cause analysis for all the batches with yields below potential.
- ✓ Pre-trial protocol to evaluate the impact of change, in this case additive performance.

# A histogram Representation of Yield

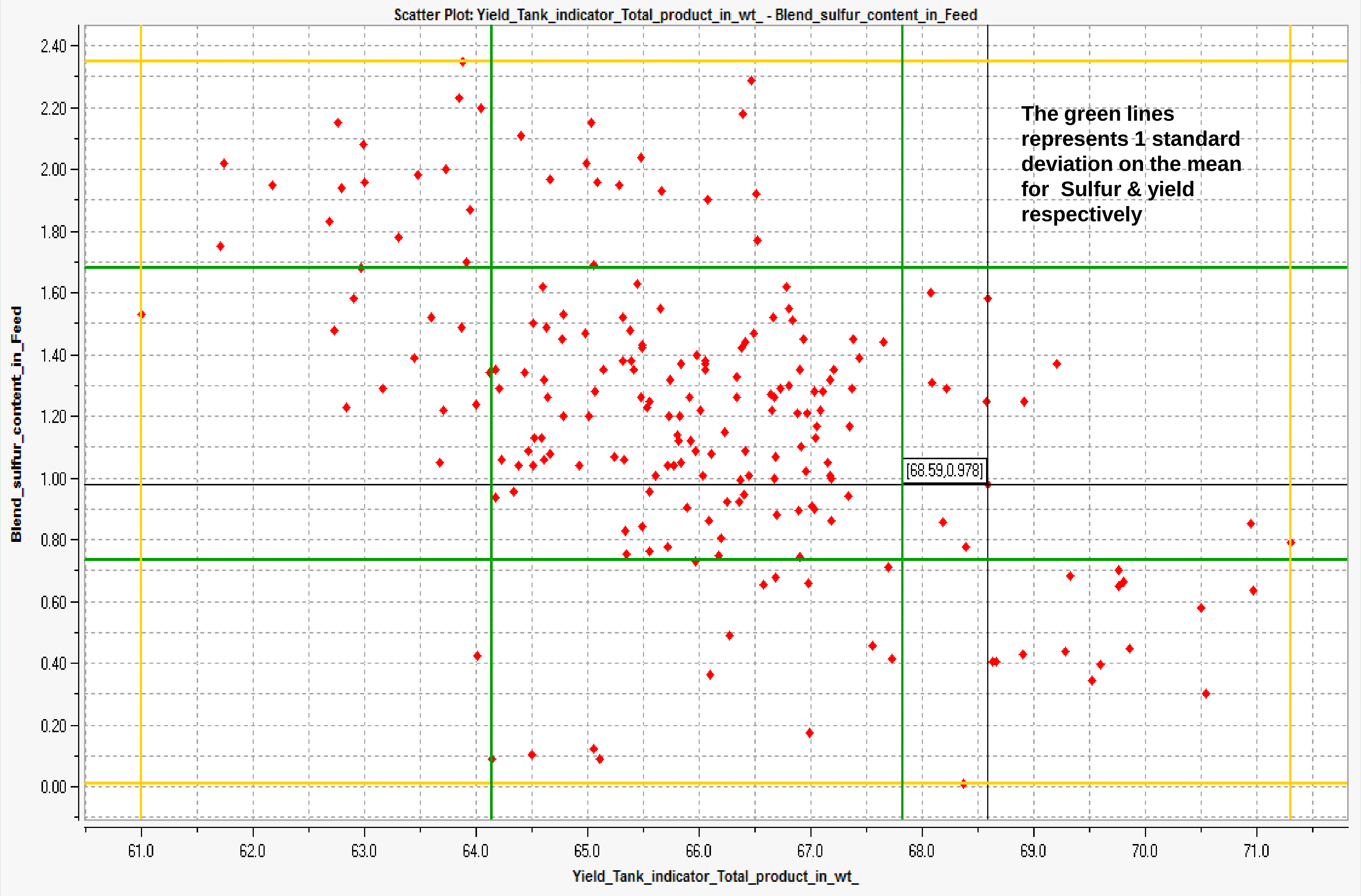



- The Low-Low limit (LL)is the absolute (engineering) minimum value that a model variable may have. A typical use of the Low-Low limit is to set the data quality of all values that are less than the Low-Low limit to "bad quality". All "bad quality" data will not be used in model construction.
- The Low limit (L) is a secondary limit that indicates the "operational" lower limit of a variable. By default, the low limit is set to 1 standard deviation from the mean.

- The High-High limit (HH) is the absolute (engineering) maximum value that a model variable may have. A typical use of the this limit is to set the data quality of all values that are more than the High-High limit to "bad quality". All "bad quality" data will not be used in model construction.
- The High limit (H) is a secondary limit that indicates the "operational" higher limit of a variable. By default, the high limit is set to 1 standard deviation from the mean.

***+/- 1 standard deviation is almost 4%***

# Scatter plot for one of the variables with respect to yield

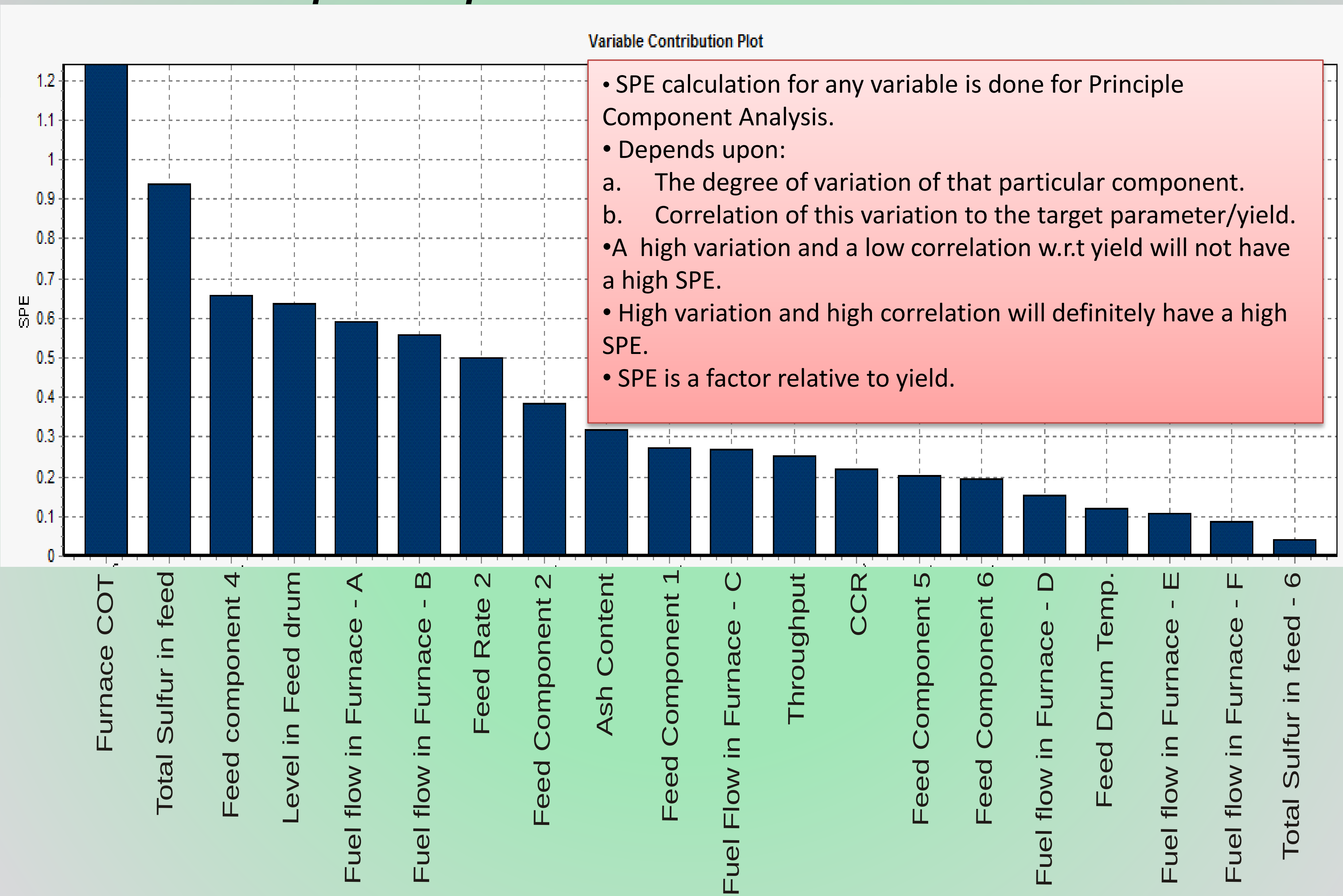


# *Principle Components Identification Matrix*

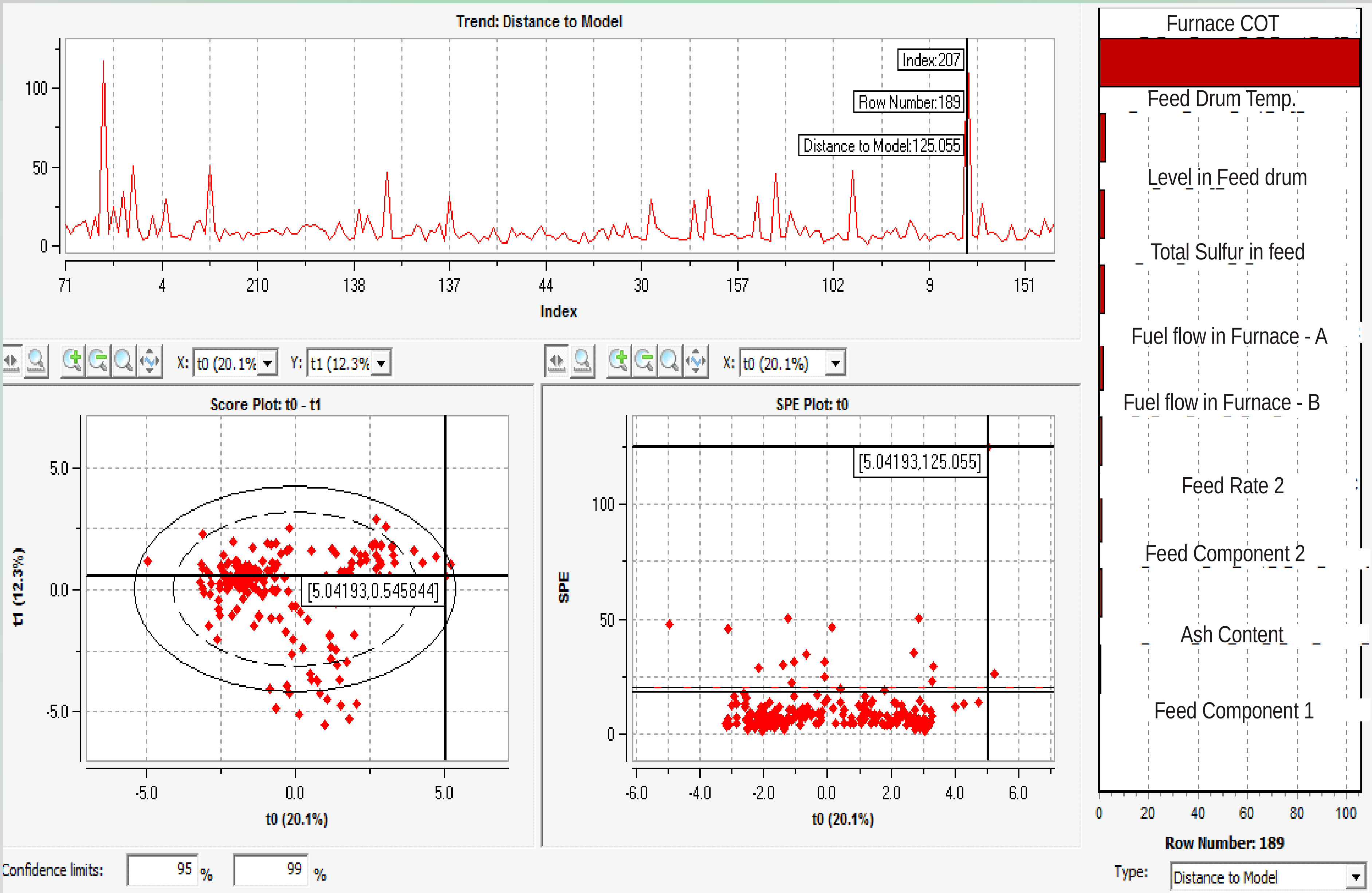
- SPE calculation for any variable is done for Principle Component Analysis.
- Depends upon:

a. The degree of variation of that particular component.
b. Correlation of this variation to the target parameter/yield.

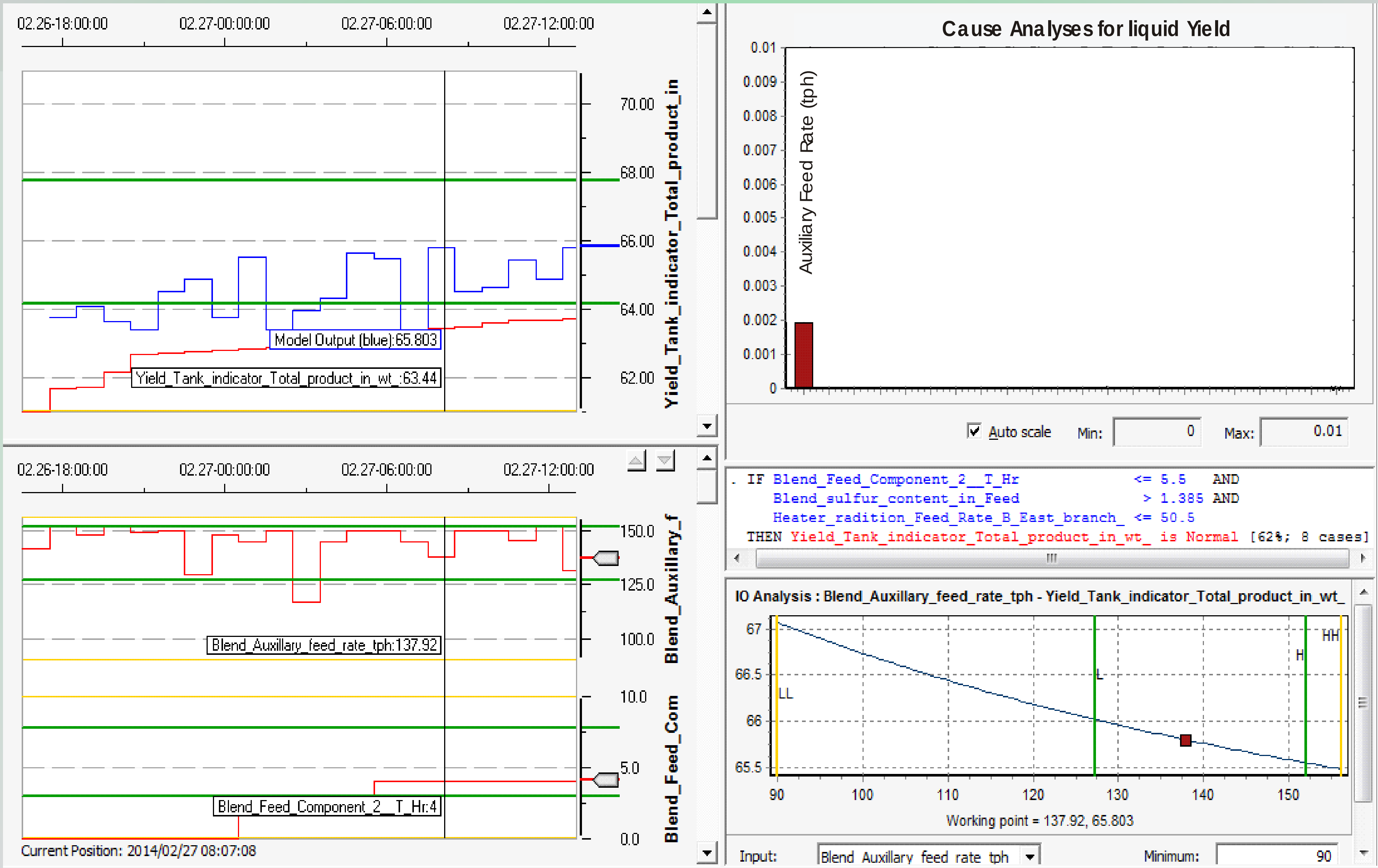
- A high variation and a low correlation w.r.t yield will not have a high SPE.
- High variation and high correlation will definitely have a high SPE.
- SPE is a factor relative to yield.



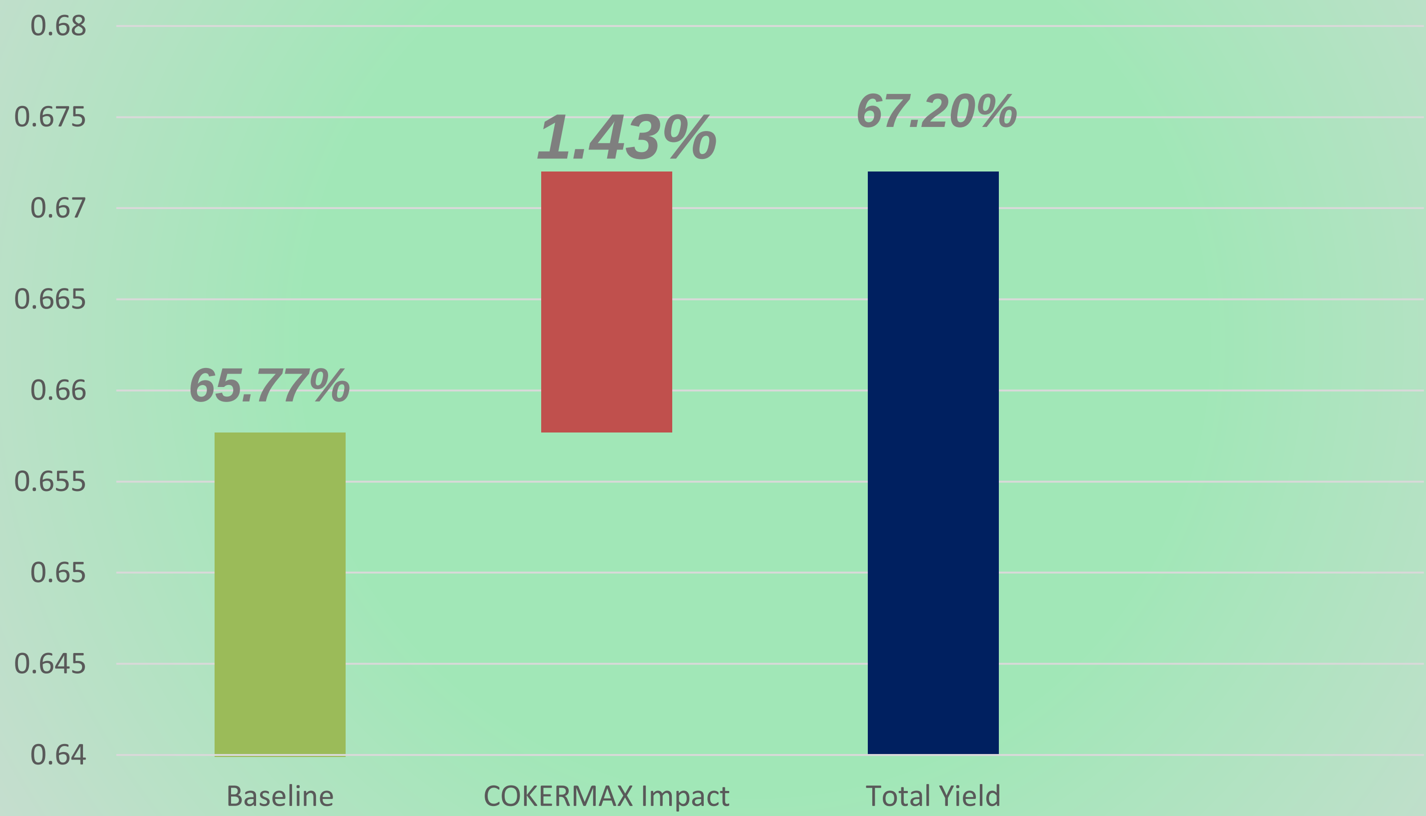
# Batch Wise Plot Identifying the Outliers



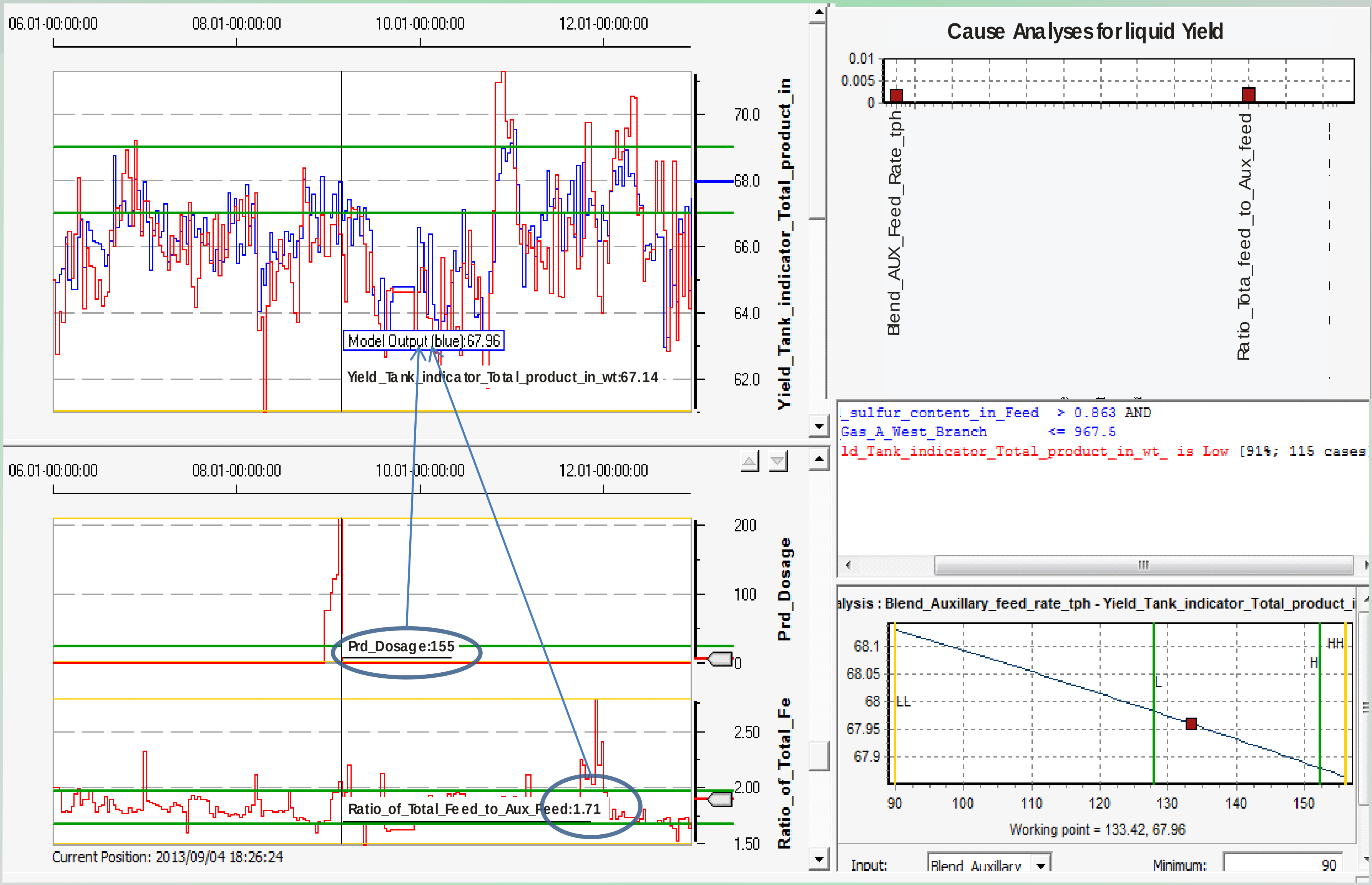
# A snapshot of the model output screen



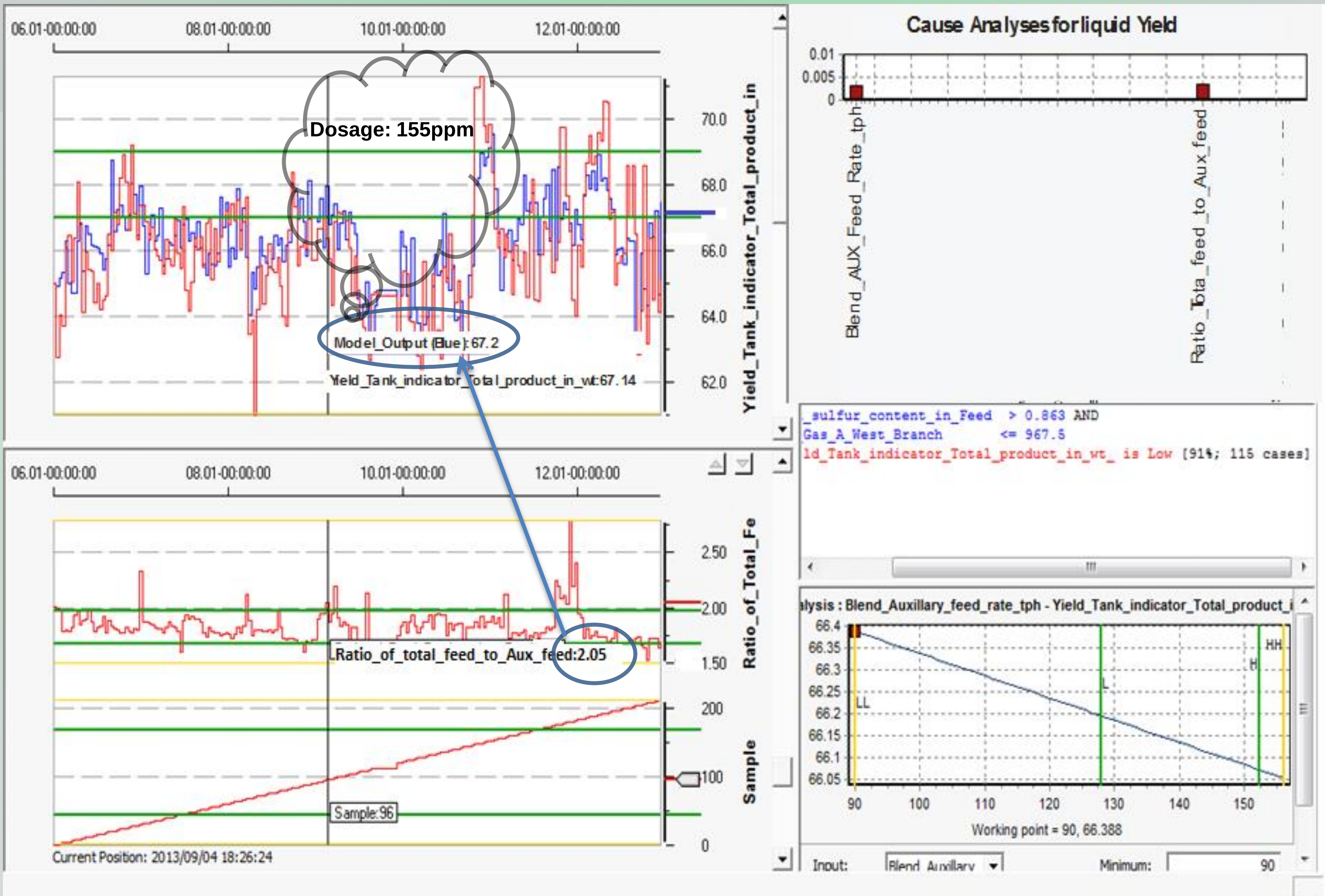
# Using the Model to Isolate Impact of COKERMAX™ Additive



# Actual Yield is 67.14%, Model Output is 67.96%.

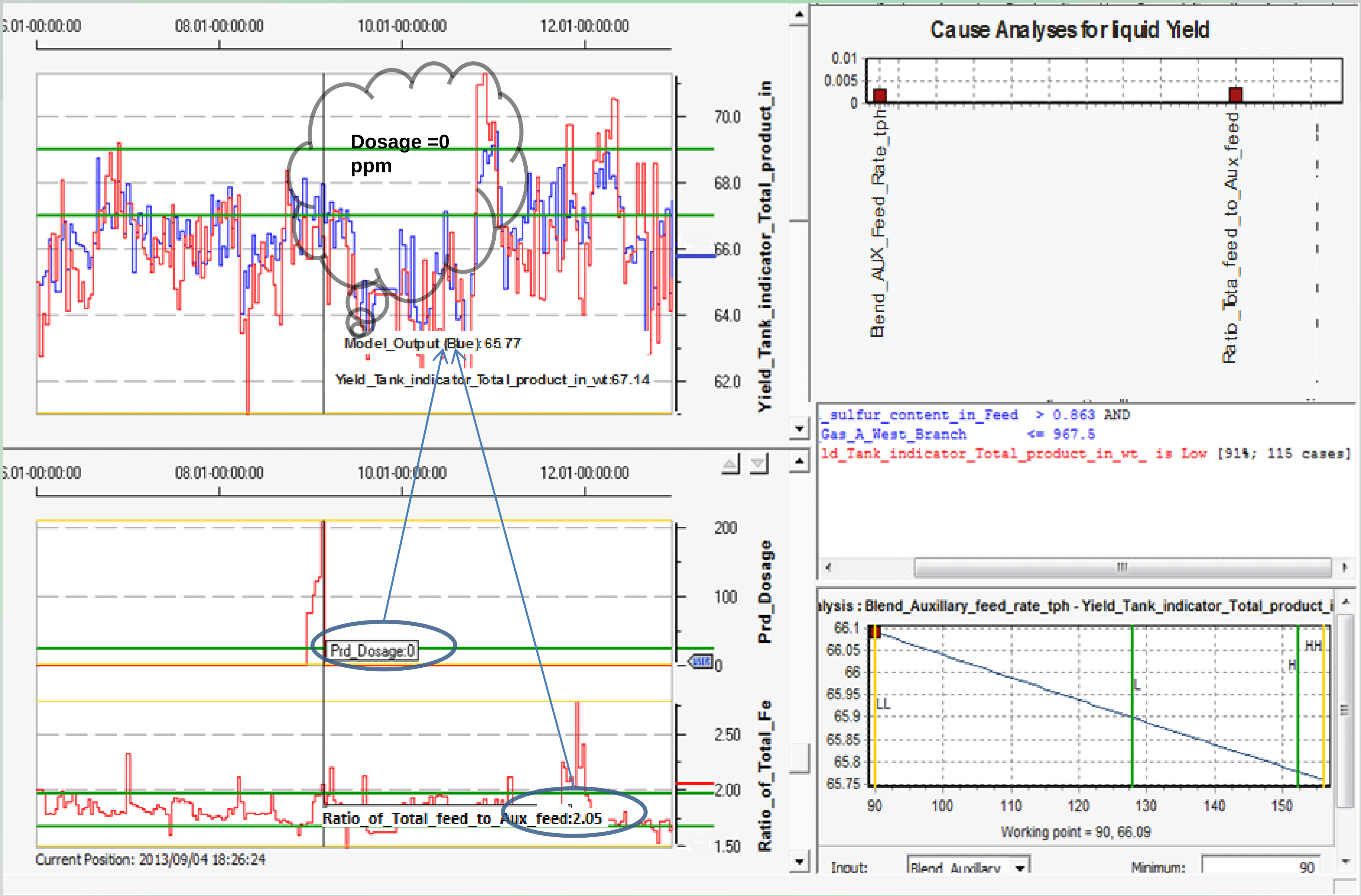


# Model 67.2% vs. 67.14% adj. for principle components



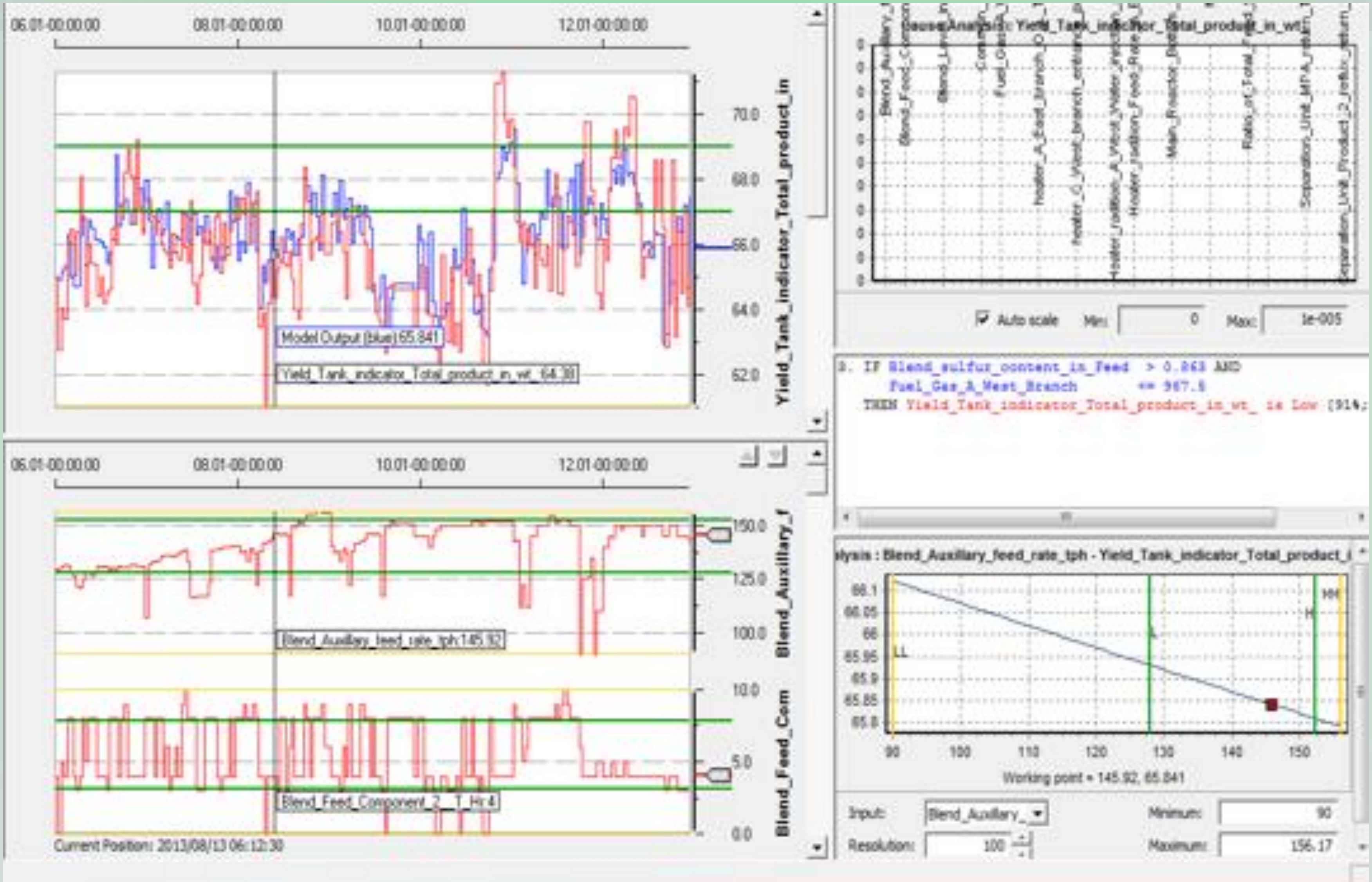
# Taking Chemical Out, Modeled Baseline is 65.77%, 1.43% due to COKERMAX™

## Modeled baseline of 65.77% in close agreement with agreed actual baseline of 65.63%

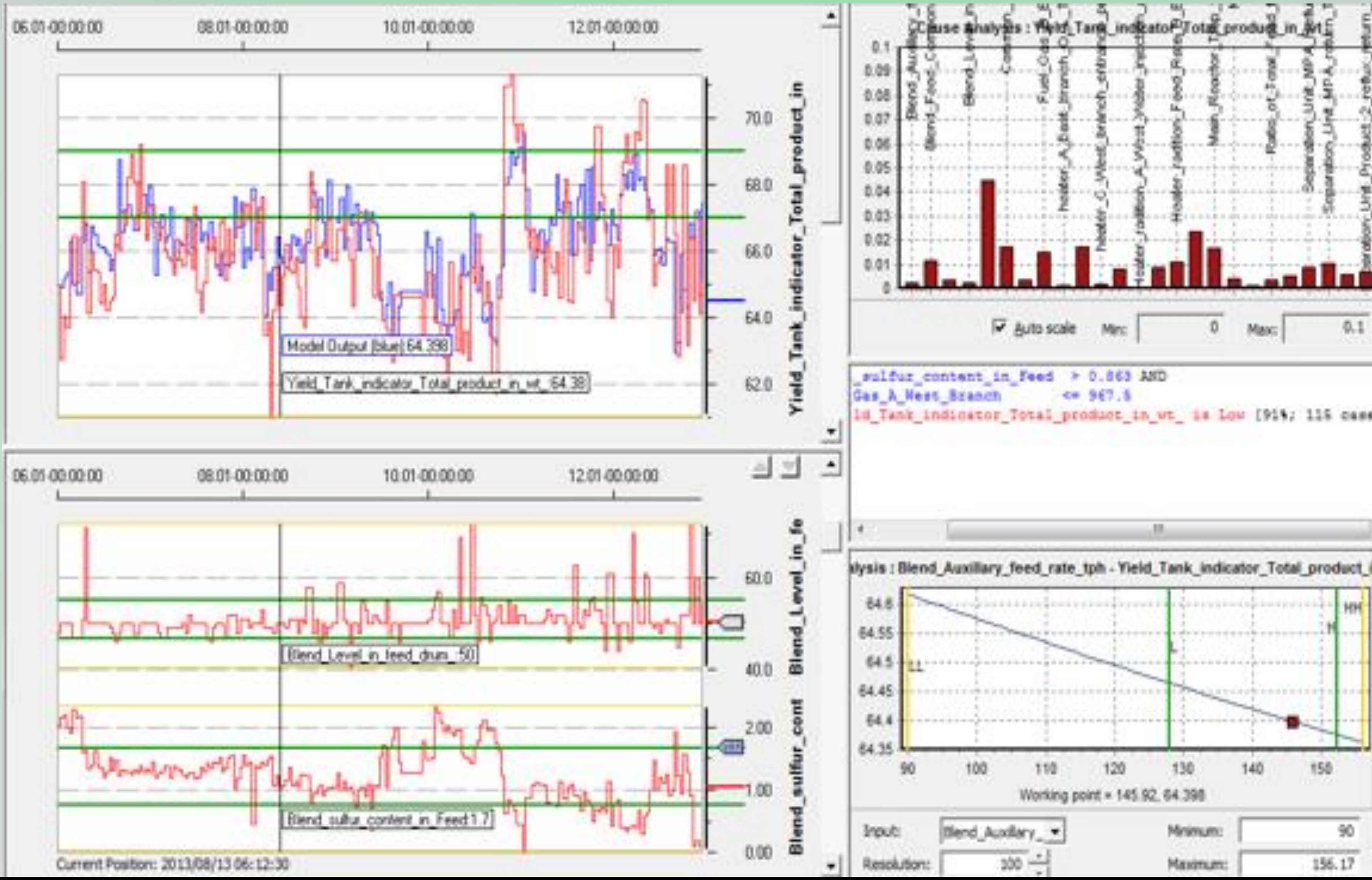


# Using the tool to evaluate how to improve yield with better control of principle components

# Actual yield is 64.38%, model predicts 65.841%



# Adjusting for principal components, Model is close to actual.



# Summarizing Data Mining Process

- Outliers are removed from data set.
- Multivariate analysis rank orders principle components effecting liquid yield in baseline, used to create model.
- The model gives operator real time information on how variation in principle components is impacting liquid yield.
- The Model allows for every batch to have an adjusted baseline calculation, thereby isolating impact of COKERMAX™ Additive on batch by batch basis
- Ability to confirm additive effectiveness over time
- Model gives operator "What if" capability