



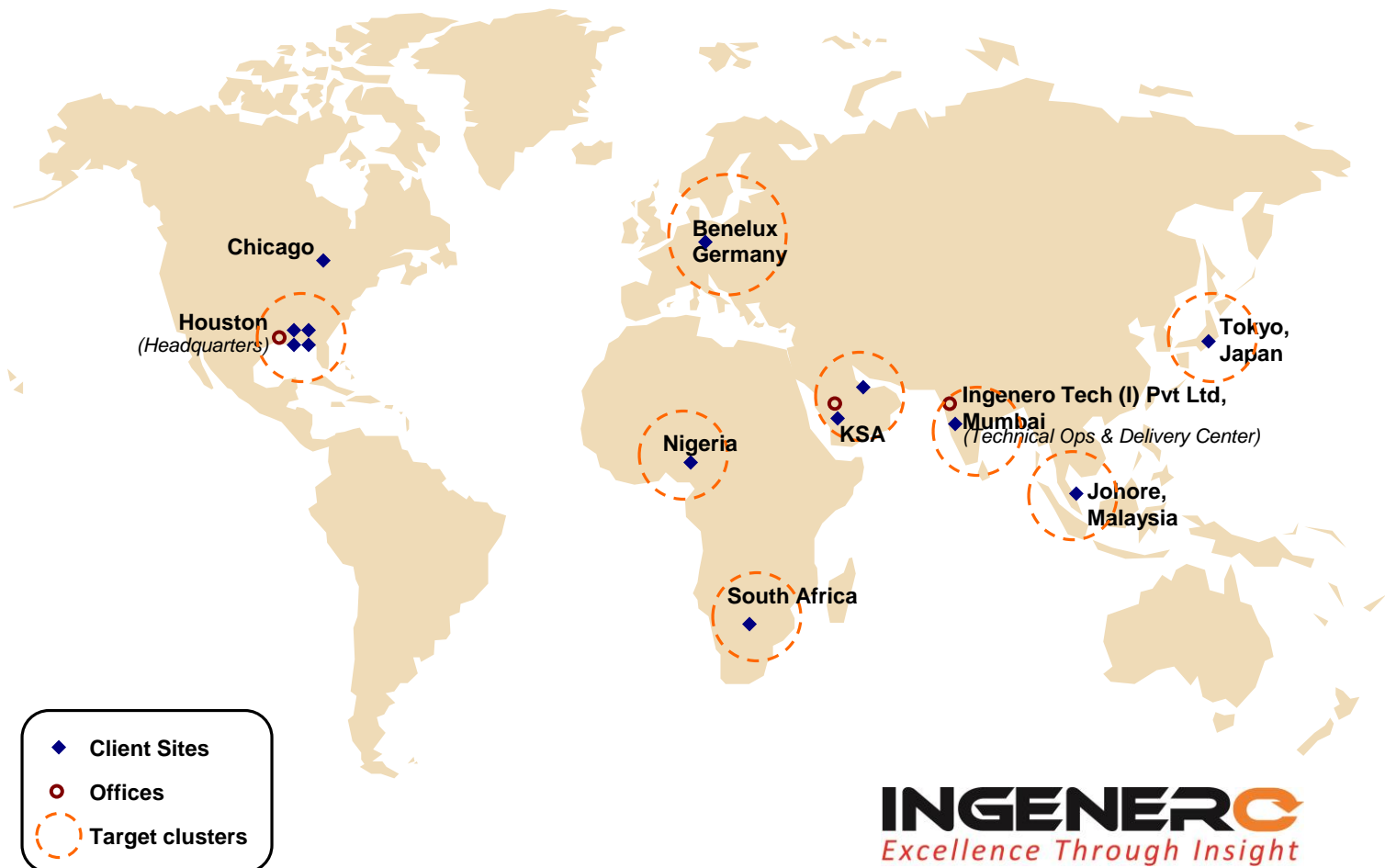
Ethylene
Middle East
Technology
Conference

AUTO ANALYTICS AND TRACKING OF ETHYLENE PLANTS FOR PLANT PERFORMANCE IMPROVEMENT



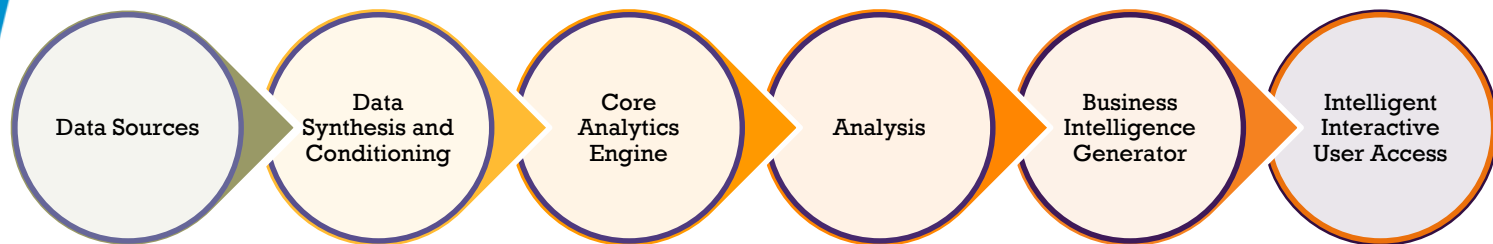
Ingenero Profile

Global Process Engineering Firm headquartered in Houston with major Technology Center in India → World Class Technology / Optimal Pricing



Ingenero's Ethylene Strength

Ingenero provides operations excellence through it's Digitalization software and services



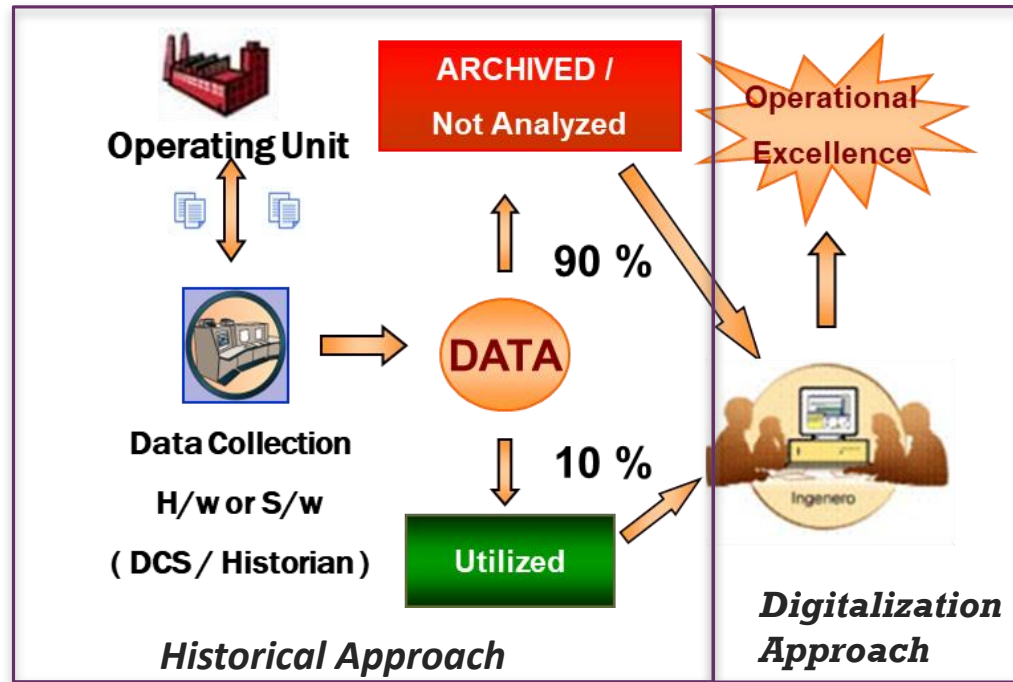
Over \$250MM in savings for one client over 5 years

Parameter	Facility A	Facility B	Facility C
Furnace Runlength	2 x Design	+100%	+50%
Yield	Increased	Increased	+2.3%
CGC Performance	+60 tpd	RCA solved problem	Improved
Capacity Increase	Debottleneck study	Best ever (@107%)	Max capability
Other	C2 Splitter optimized /Exchanger improve	Same + RCA	Decoke and C3 splitter improve
Significant What-if Results	25 proactive	8 proactive + 31 queries response	Numerous

Ethylene data analytics is challenging

1. Ethylene plants have incredible heat differentials and this creates challenges:
 - Heat Integration is a must:
 - Variables across the plants are inter-related to each other
 - Effect of one variable is felt across 100's of inter-related variables across the plant.
 - Good operation of an Ethylene plant is finding the sweet spot of pushing the severity of operating conditions against the necessary downtime as a result of routine decoking and equipment / coil replacement
 - Availability / run length versus Conversion
2. The volume of operational data that is available through historians is large
3. Useful information is hidden in the data and is not visible to the naked eye – data analytics while having domain expertise and use of fundamental models is needed

Data Opportunities in Ethylene Plants



1. Opportunities exist to quickly and automatically analyze huge amount of data for early identification of any reliability issue
2. Data analytics coupled with domain knowledge and first principles modeling can help explore hidden insights

Analytics' Tools for Ethylene Plants

Three example tools that Ingenero has developed for Ethylene plants that are linked to Historian data and have had significant performance impact will be discussed

1. Early Warning Asset Reliability Tool :

- Based on multivariate statistical techniques combined with simulation

2. Live auto benchmarking :

- Based on live comparison of equipment performance with its past best for similar conditions

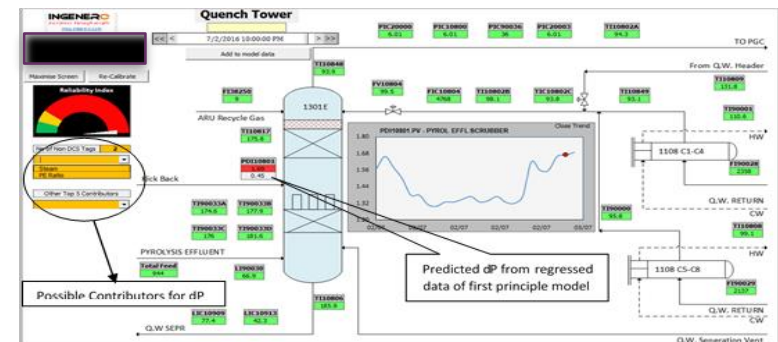
3. Auto tuning furnace run length predictor :

- Furnace run length prediction based on online regression and machine learning techniques

Early Warning Asset Reliability Tool

Features :

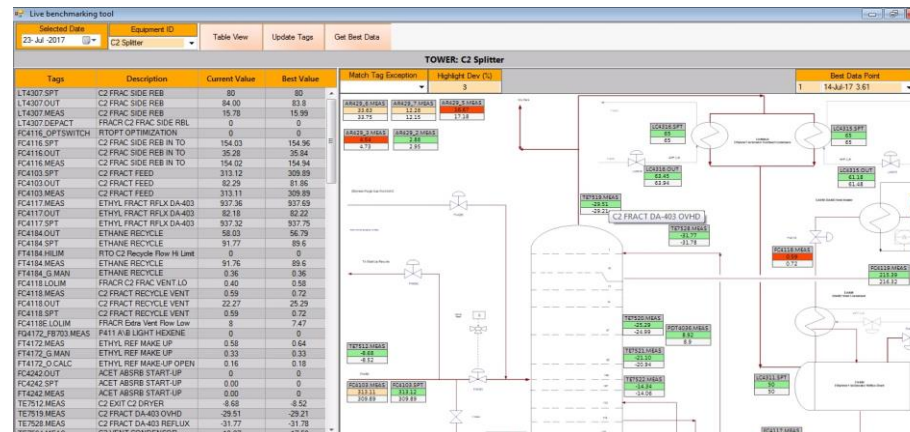
1. One view of critical equipment with flags needing attention
2. Statistical model built on past good operation
3. Vendor Performance Curves and Regression from First Principles' models included
4. Trending of frequent outliers
5. Linked to historian
6. Backend model changes automatically with furnace mode of operation (9E/2P, 10E/1P etc.)



Live Auto Benchmarking

Features :

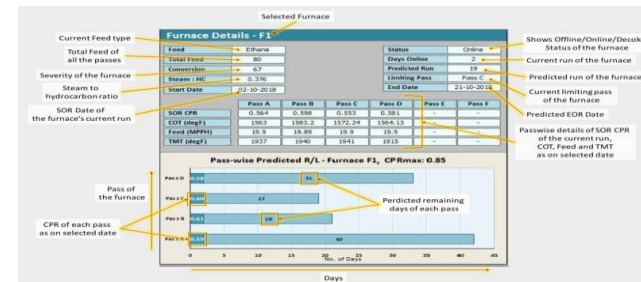
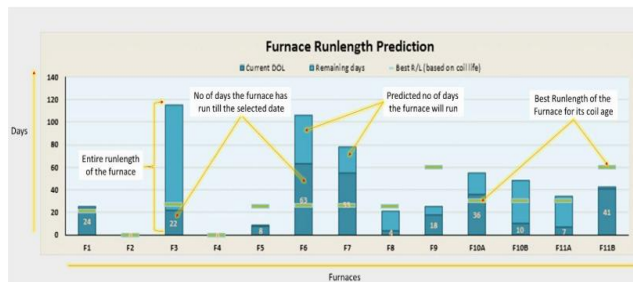
1. Identifies equipment degradation
2. Identifies instrument calibration issues
3. Easy to configure (drag and drop)
4. No model building required. Tool is generic and can be configured for any equipment.
5. For same input conditions, tool identifies equipment's past best performance based on specified criteria.



Auto tuning furnace run length predictor

Features :

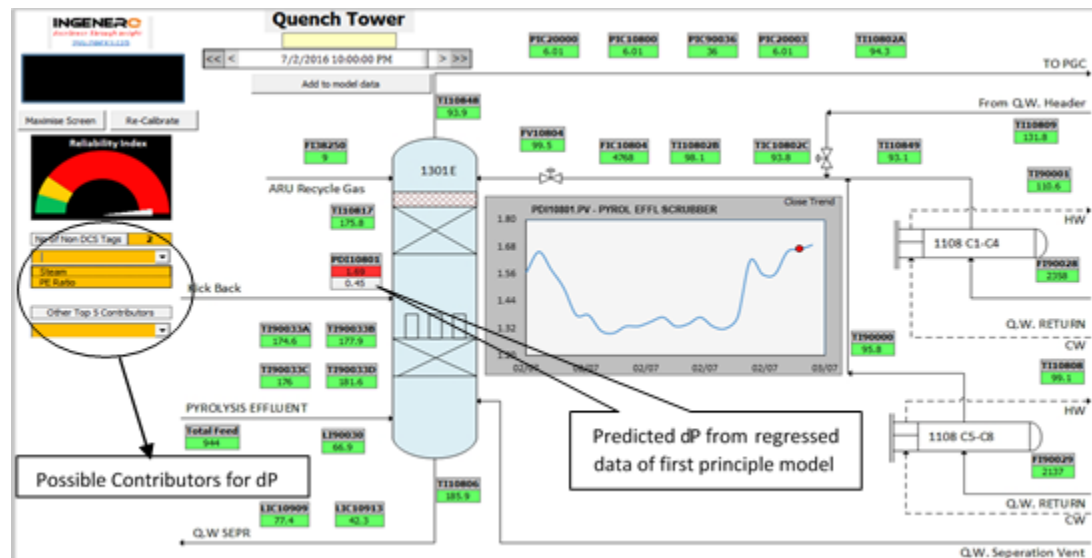
1. Predicts end of the run CPR based on past historical data and current age of all coils/passes
2. Identifies limiting coils/passes
3. Identifies opportunities for feed biasing
4. Helps in furnace scheduling



Case Study

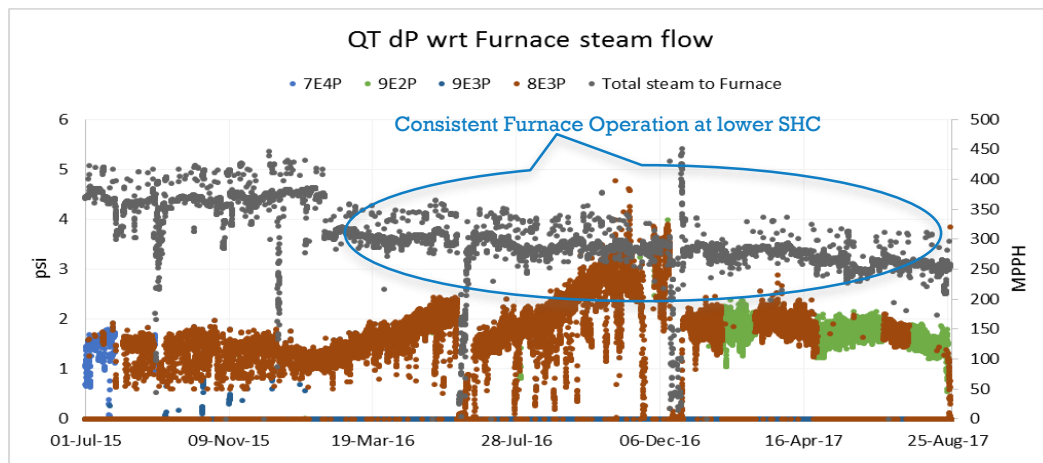
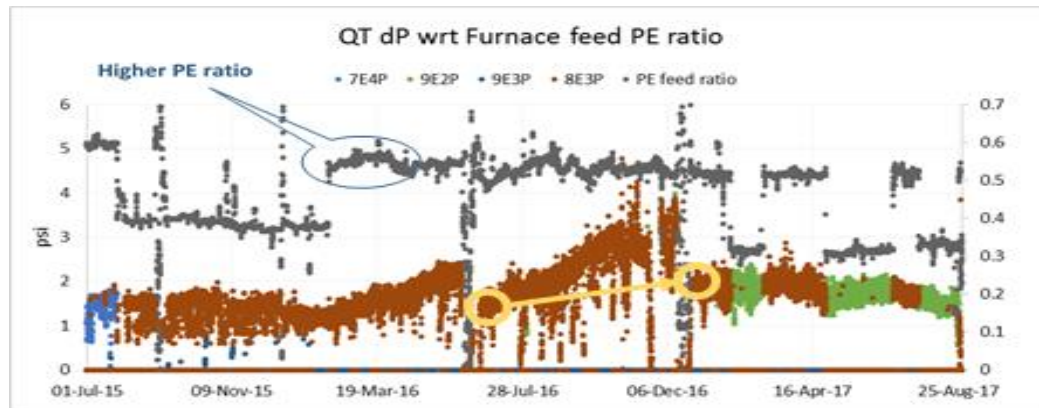
Quench Tower Failure RCA

1. The Reliability tool was pre-tested to do a retro analysis of a past failure of the quench tower
2. Failure date is Aug 17. Test date is Feb 16.
3. Tool showed possible root causes of failure (Consistent operations of the Furnaces at High PE and lower SHC)



Quench Tower Failure RCA...contd.

- Manual Trend analysis indicated that Furnaces were indeed run at higher Propane to Ethane feed ratios and lower SHC.



Additional Thoughts

1. The benefits of Digitalization are real
2. If you cannot connect the data to the science, there is an issue → success comes from a combination of AI/machine learning, fundamental simulation, and domain expertise
3. If your company is not actively utilizing simulation and first principles modeling on a daily/weekly basis (i.e. other than APC) to help engineers and operators (i.e. have not found time in the last few decades)...and now plans to skip that step and go directly to machine learning and AI...it may not happen internally...at least not quickly or well
4. Get help early...time value of money is real
5. Artificial Intelligence is not the goal...it's a tool to deliver Augmented Intelligence to your personnel
6. The DMAIC process can be considered a foundation to building tools