SmartProcess Distillation Application Improves Recovery and Saves Energy – A Case Study

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EMERSON GLOBAL USERS EXCHANGE

Presenters

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Agenda

- Operating Challenges
- Project Methodology
- Process Overview
  - Process Flow
  - Operating Objectives
- SmartProcess® Distillation Optimizer
- Results

Operating Challenges

- Purification unit involving multiple distillation trains with 11 columns
- Ultra-high purity product specifications require very tight quality controls
- Multiple large, 200+ tray columns with extremely long time constants
- Large energy consumer
- Different feedstock suppliers with different qualities unloaded from railcars
- Safety margins required to compensate for disturbances in feed quality

Project Methodology

- APC licenses were specified and included as part of the DeltaV migration project
  - Capital expense
- Functional Specification prepared by Emerson that included the design for the complete process unit (11 distillation columns)
- Initial implementation phase covered only the first column in the series
  - Gain customer experience with technology
  - Develop Operator acceptance
  - Demonstrate value to management
- Subsequent phases to be implemented by customer engineers with support from Emerson APC Consultants

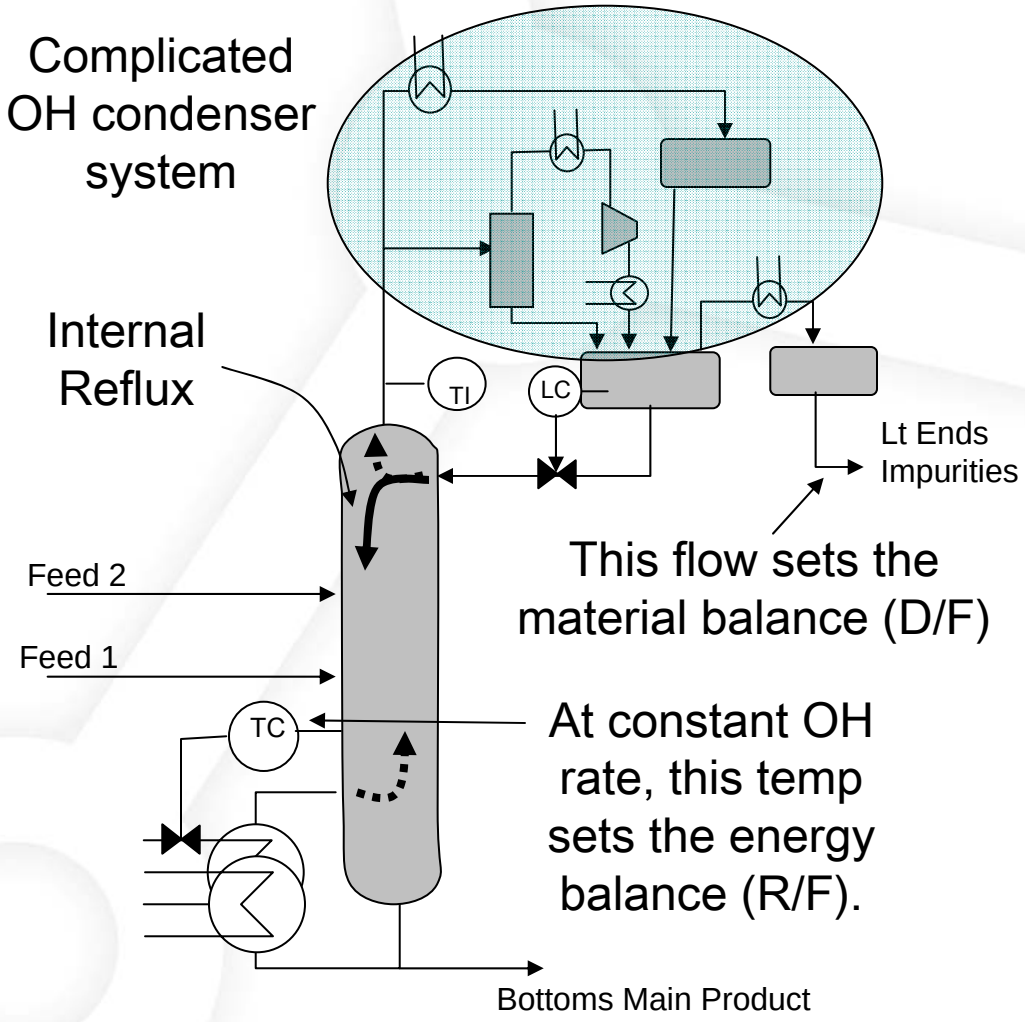
Project Implementation

- FDS phase included on-site audit of instrumentation and control strategies and preliminary step tests
  - Identified regulatory control issues that needed to be addressed prior to on-site work
- Software installation of SmartProcess application performed by customer personnel prior to on-site work
- Emerson consultants spent 2 weeks on-site for configuration and commissioning
- Performance improvements estimated and presented to operations management based on initial trial run

Advanced Control Solution

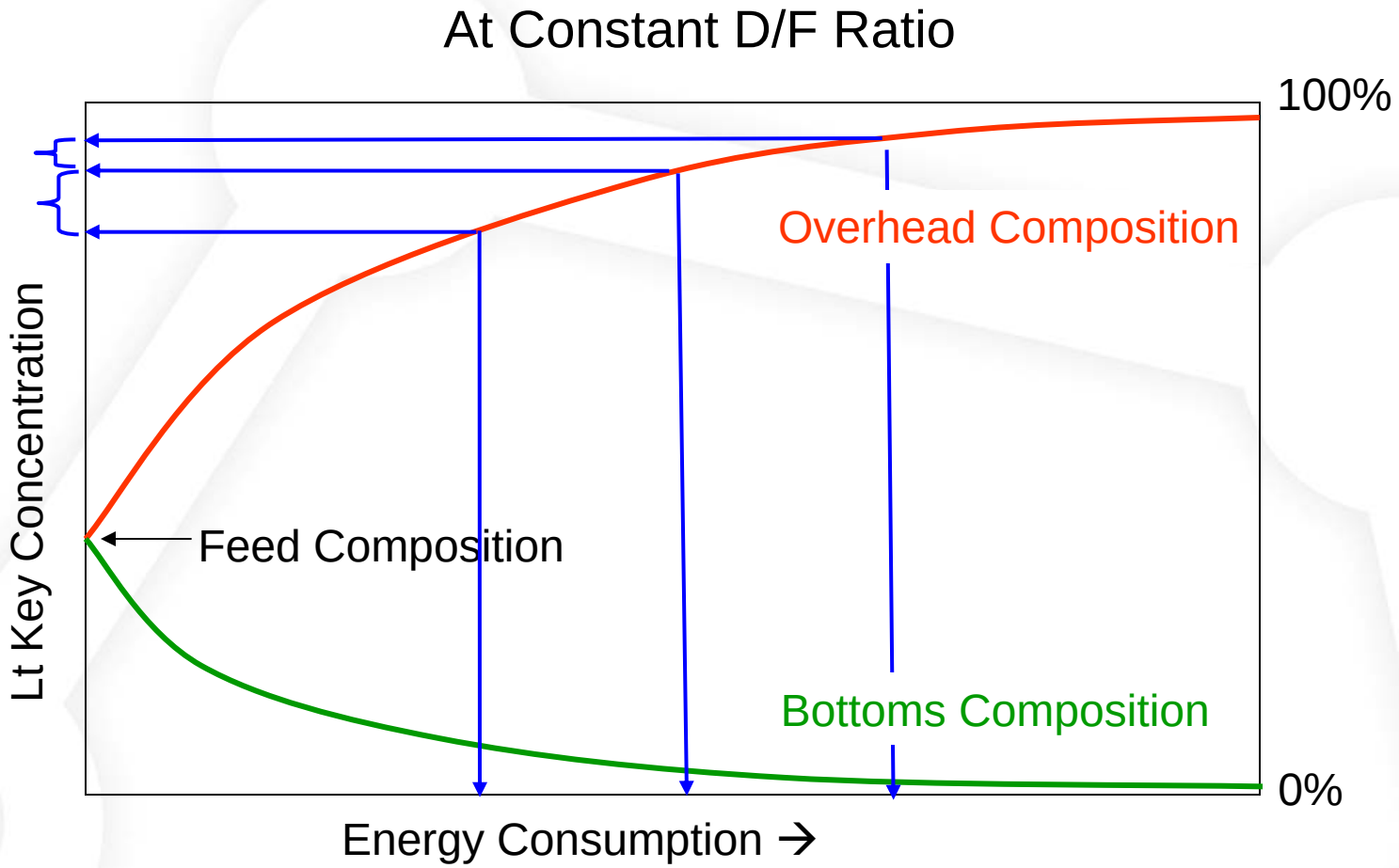
- SmartProcess® Distillation Optimizer
  - Utilizes Embedded DeltaV Advanced Process Control
  - On-Line Key Performance Indicator (KPI) Calculations
- Emerson APC Consulting Services
  - Functional Design
  - Control Performance Audit
  - Implementation Assistance
- Initially started with first column in the train that removes light contaminates

Process Overview

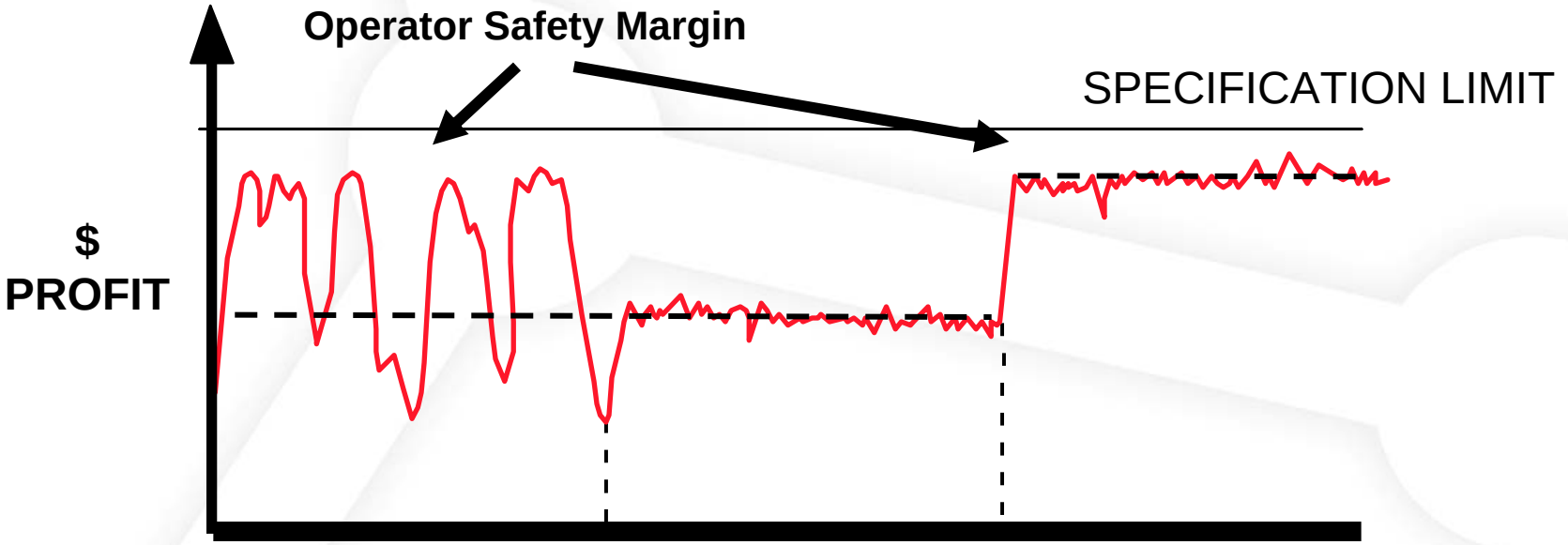


- Column separates components based on different boiling points
- Tray temperatures reflect composition on that tray, but need to be compensated for pressure
- Control strategies based on "What comes in must go out"
  - Material Balance
  - Energy Balance
- Material Balance:
  - OH / Feed Ratio
- Energy Balance:
  - Reflux / Feed Ratio

Distillation Process Affect of Energy



Cost of Variability

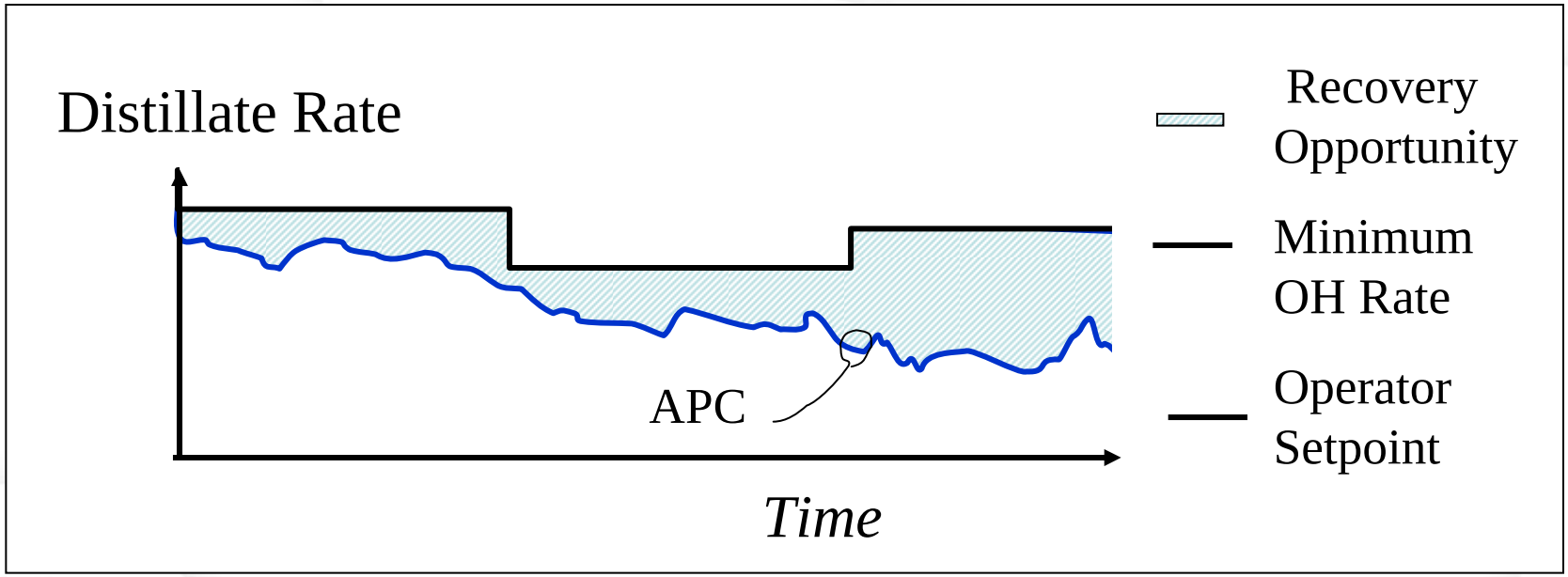


Improvements from:

Advanced Control

APC Optimization

Objective: Minimize overhead product loss while controlling bottoms impurities to target



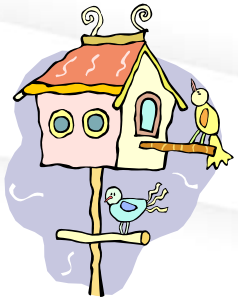
SmartProcess Applications – Tools vs. Solutions

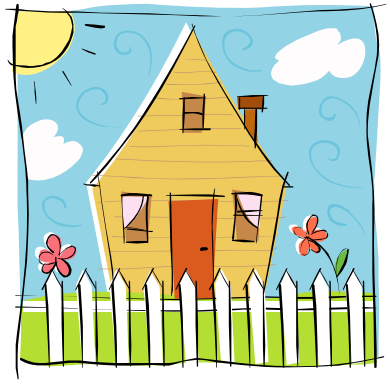
Products, Services, Expertise

We have the best materials, craft skills, tools, and services. What can we build for you?

Applications

We've developed a variety of houses to meet your specific needs.

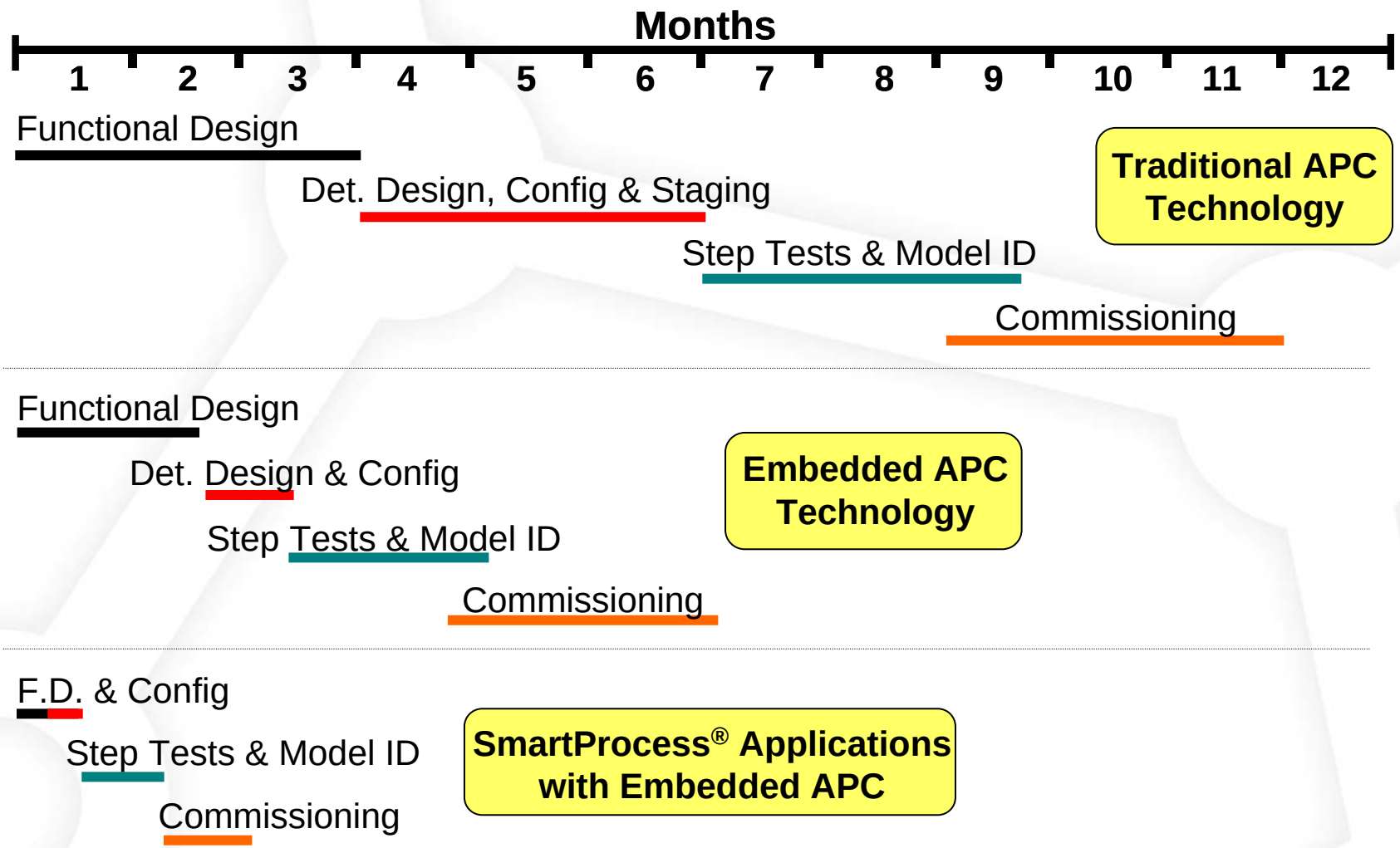




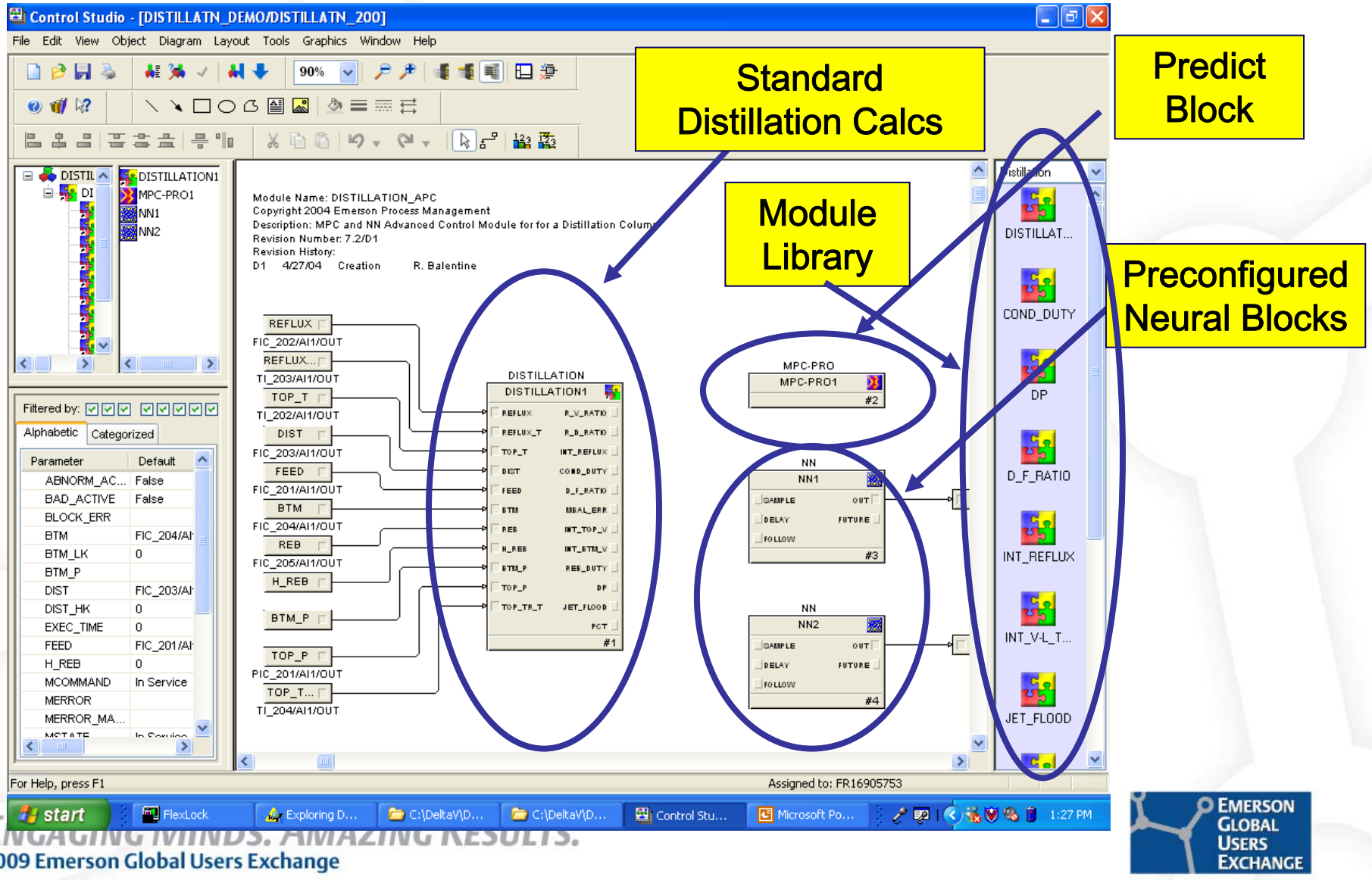
What are SmartProcess Applications?

- Re-usable applications that can be pre-engineered and used multiple times
- Combination of:
  - DeltaV composite blocks, modules & templates
  - APC tools (e.g. PredictPro, Neural)
  - DeltaV Graphics
  - Documentation
  - Sample Configuration
  - Simple dynamic simulation

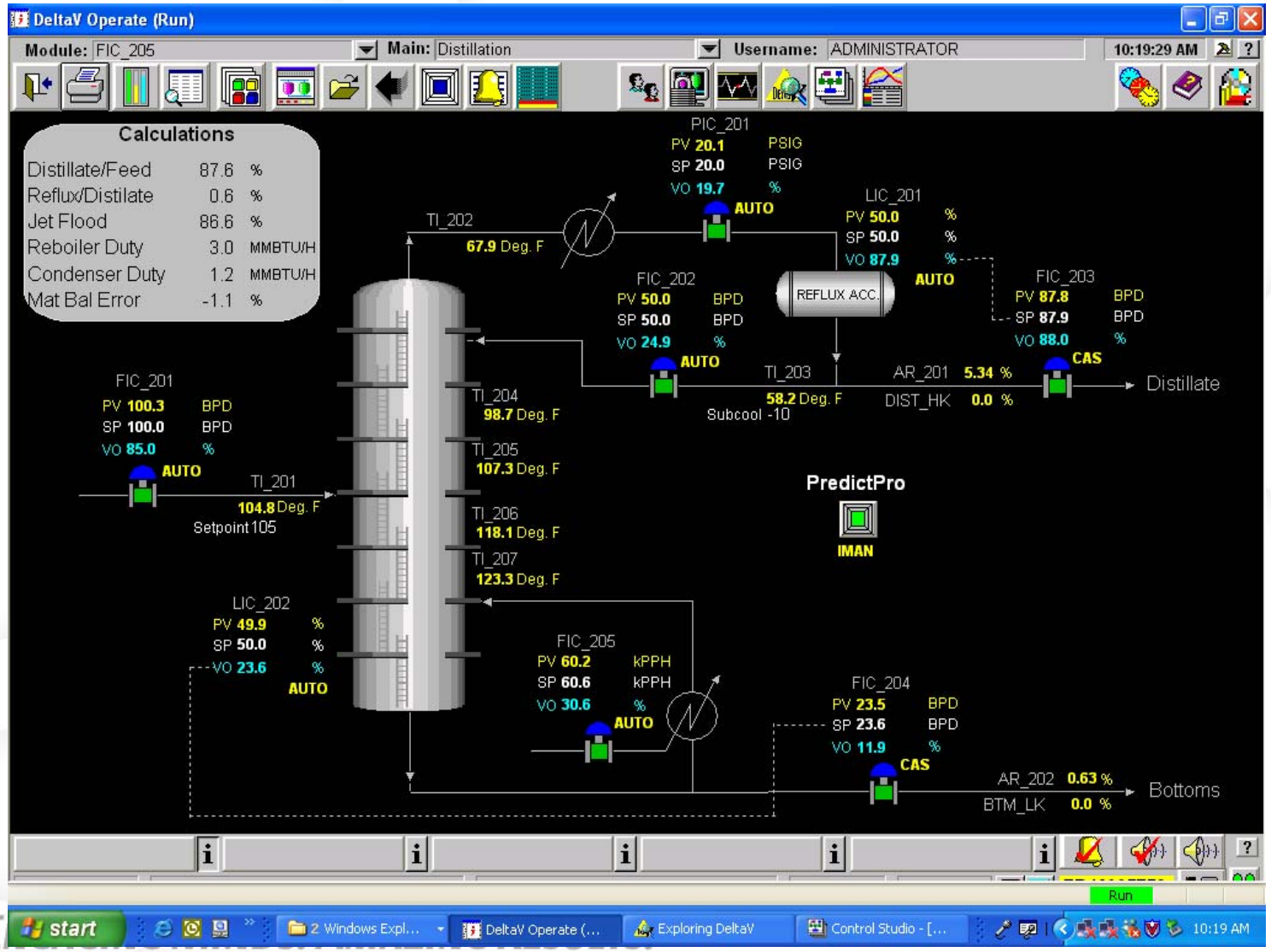
Applications Enable Faster, More Efficient APC Implementations



SmartProcess Distillation Control Module



Standard Operator Display & Simulation



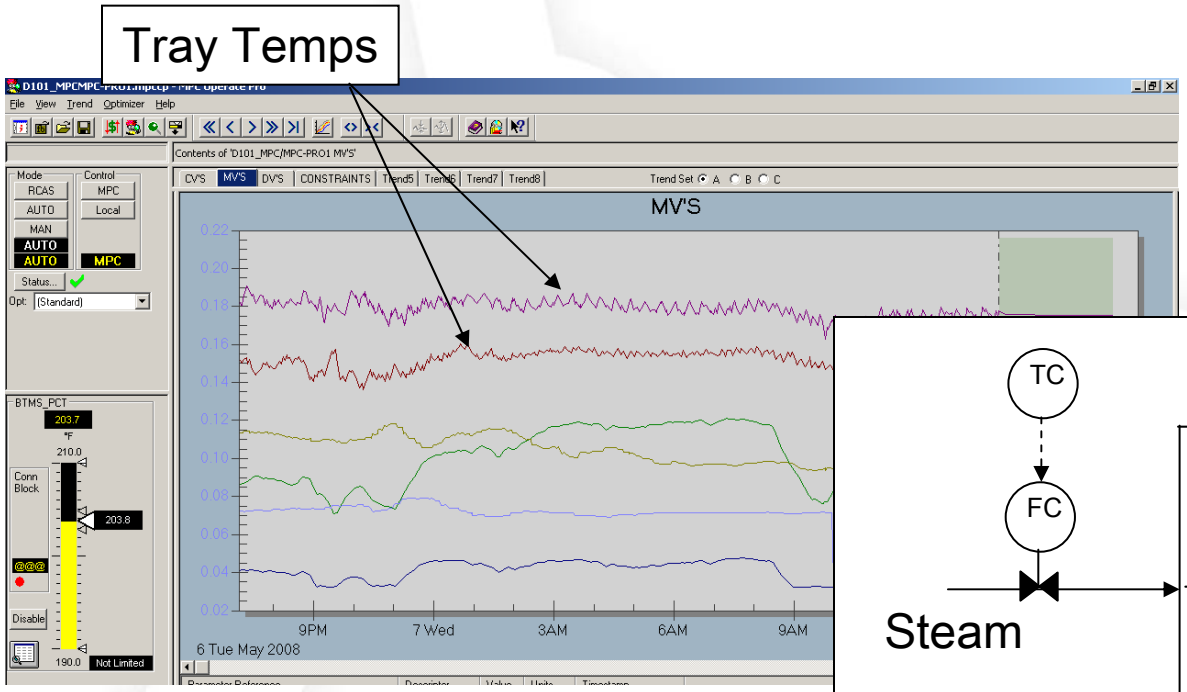
Key Process Variables

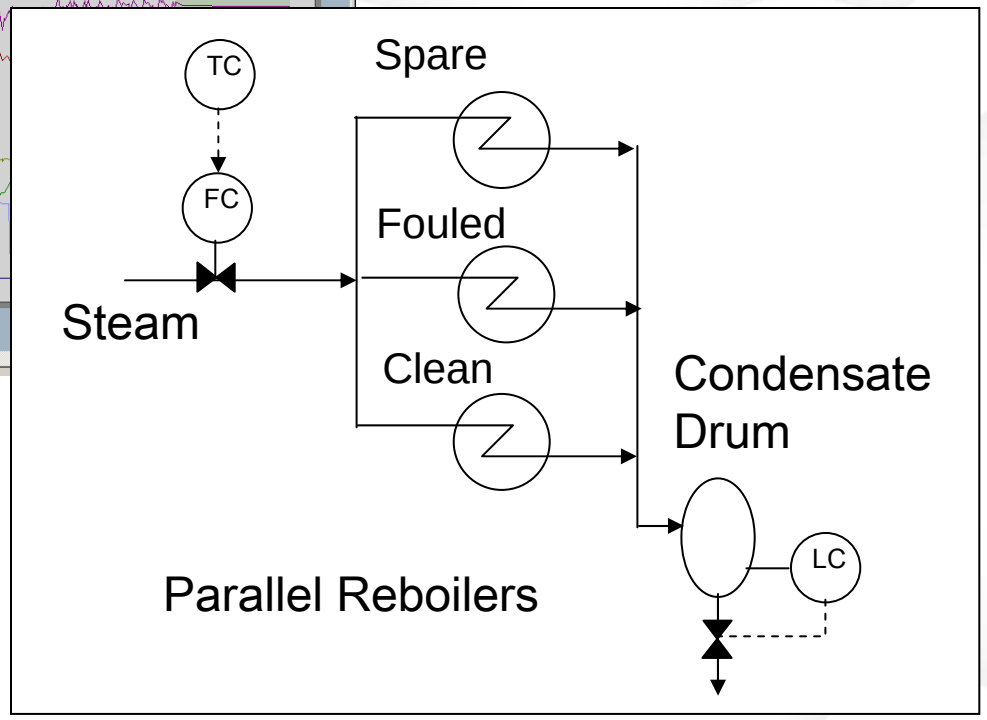
- ***Manipulated Variables*** **(MV)** – Controller setpoints written to by the MPC.
  - Distillate Rate
  - Reboiler Steam
- ***Controlled Variables*** **(CV)** - Process variables which are to be maintained at a specific value; i.e., the setpoint
  - Lower tray Pressure Compensated Temperature (PCT)
  - Overhead PCT
- ***Disturbance Variables (DV)*** - Measured variables which may also affect the value of controlled variables
  - Feed Flows (2)
  - Reflux Temp
- ***Constraints (LV)*** - Variables which must be maintained within an operating range (a special type of CV)
  - Overhead product loss (on-line analyzer)
  - Light impurities in bottoms (on-line analyzer)
  - Internal Reflux Rate
  - Column Delta Pressure
  - Reflux/Distillate Ratio

Process Issues

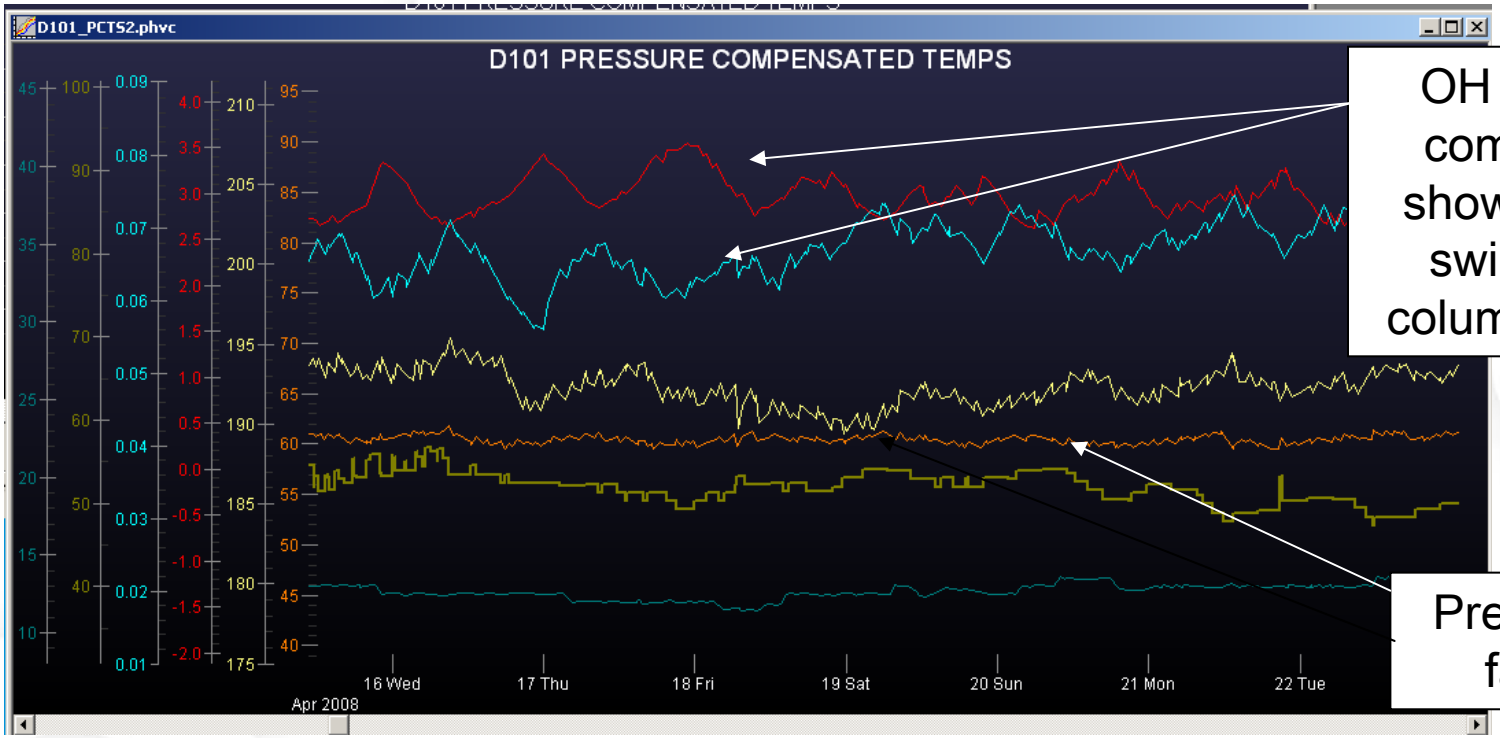
- Reboiler steam instability
  - Interaction between parallel reboilers with common steam trap, one fouled, one clean. In Manual and Auto, steam flow varied ~10kLb/Hr out of 50. Process design issue.
  - Caused ~0.5 Deg F variability in tray temp used as CV
- Overhead pressure controller range
  - Pressure is controlled by two valves in the condenser system, one large and one small
  - OH PIC operates small valve with large valve normally in Manual.
  - Small valve had insufficient range to control between day and night
  - Pressure swings caused changes in temps and qualities
  - Implemented control function to adjust large valve to keep small valve in control range
- Small process gains
  - Issue primarily due to big difference in instrument ranges
  - Solved by using scaler blocks for process inputs

Reboiler Flow Variability





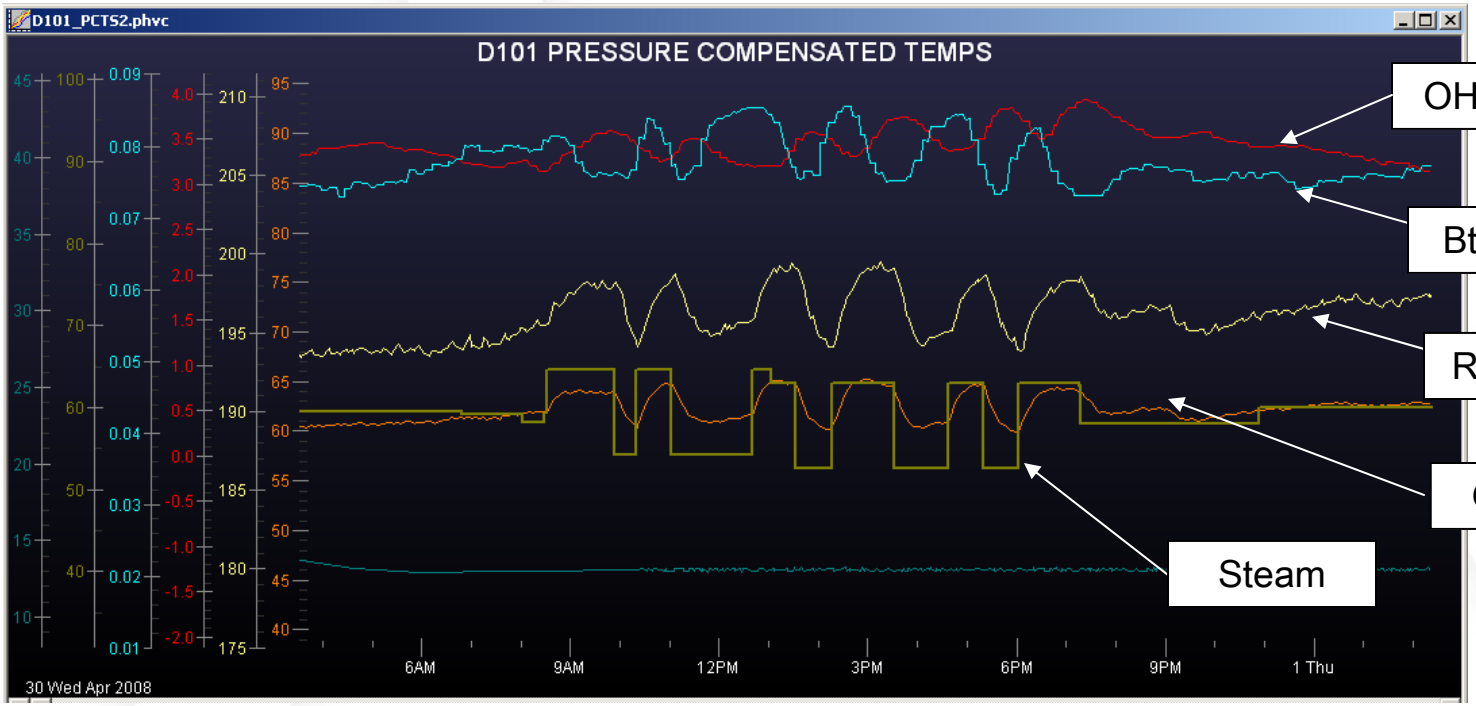
Pressure Effects



OH and Btms compositions show day-night swing due to column pressure

Pressure looked fairly stable

Steam Step Tests



OH Prod Loss

Btms Impurity

Rebolier Out T

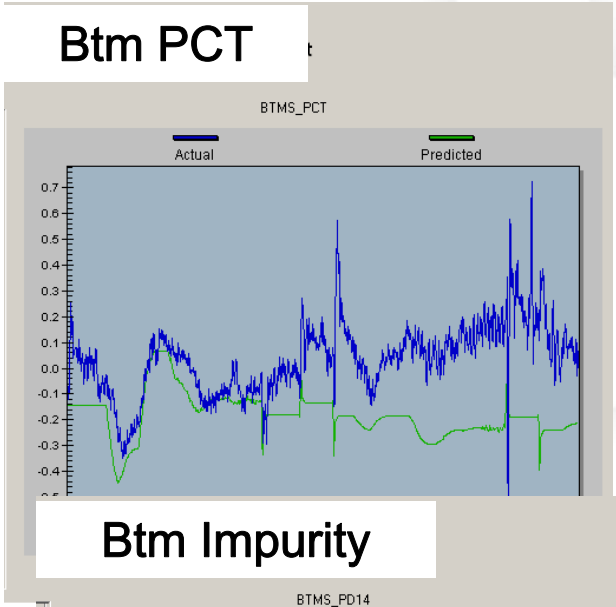
OH Pressure

Steam

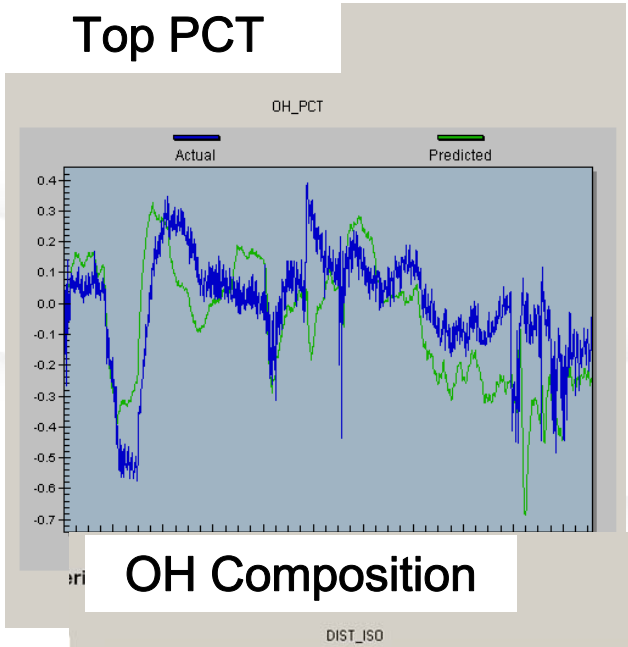
Test Compromised due to OH pressure swings

Model Verification

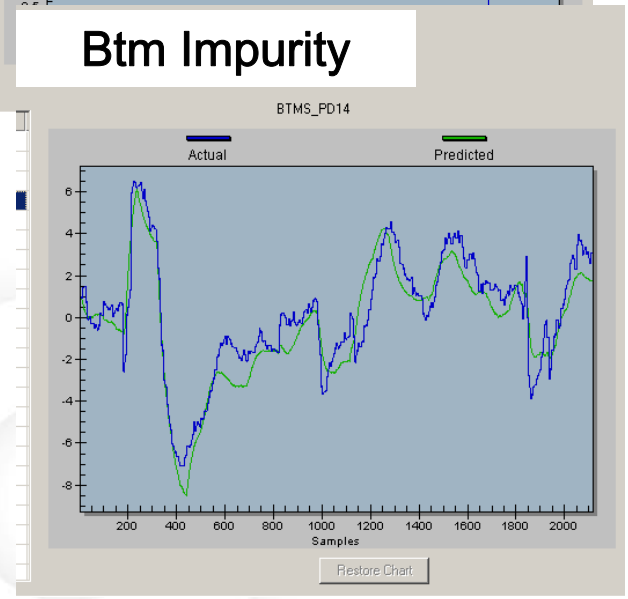
Btm PCT



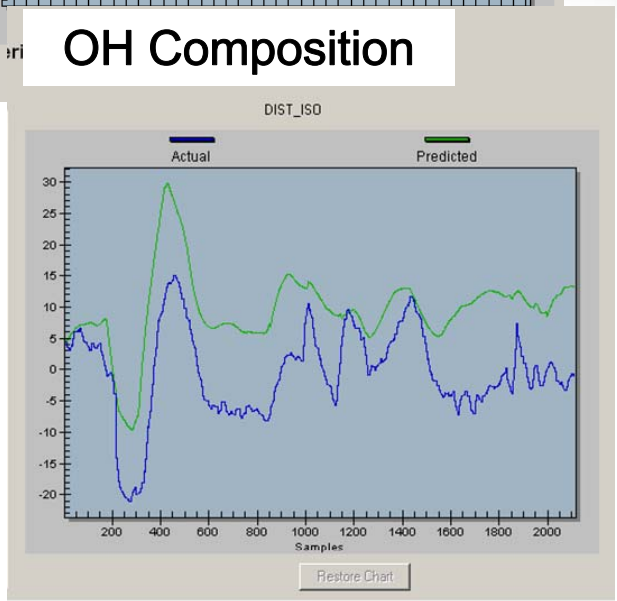
Top PCT



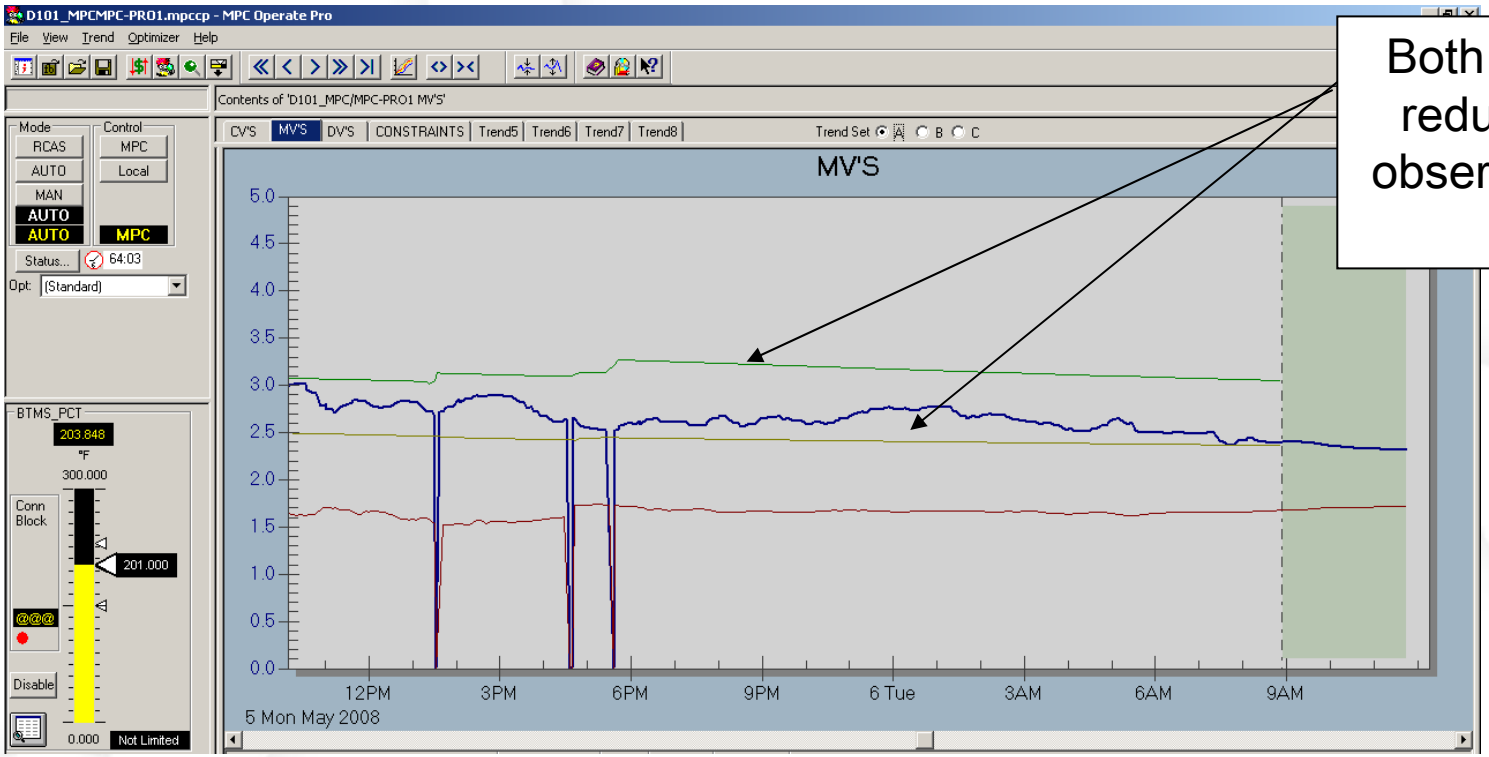
Btm Impurity



OH Composition

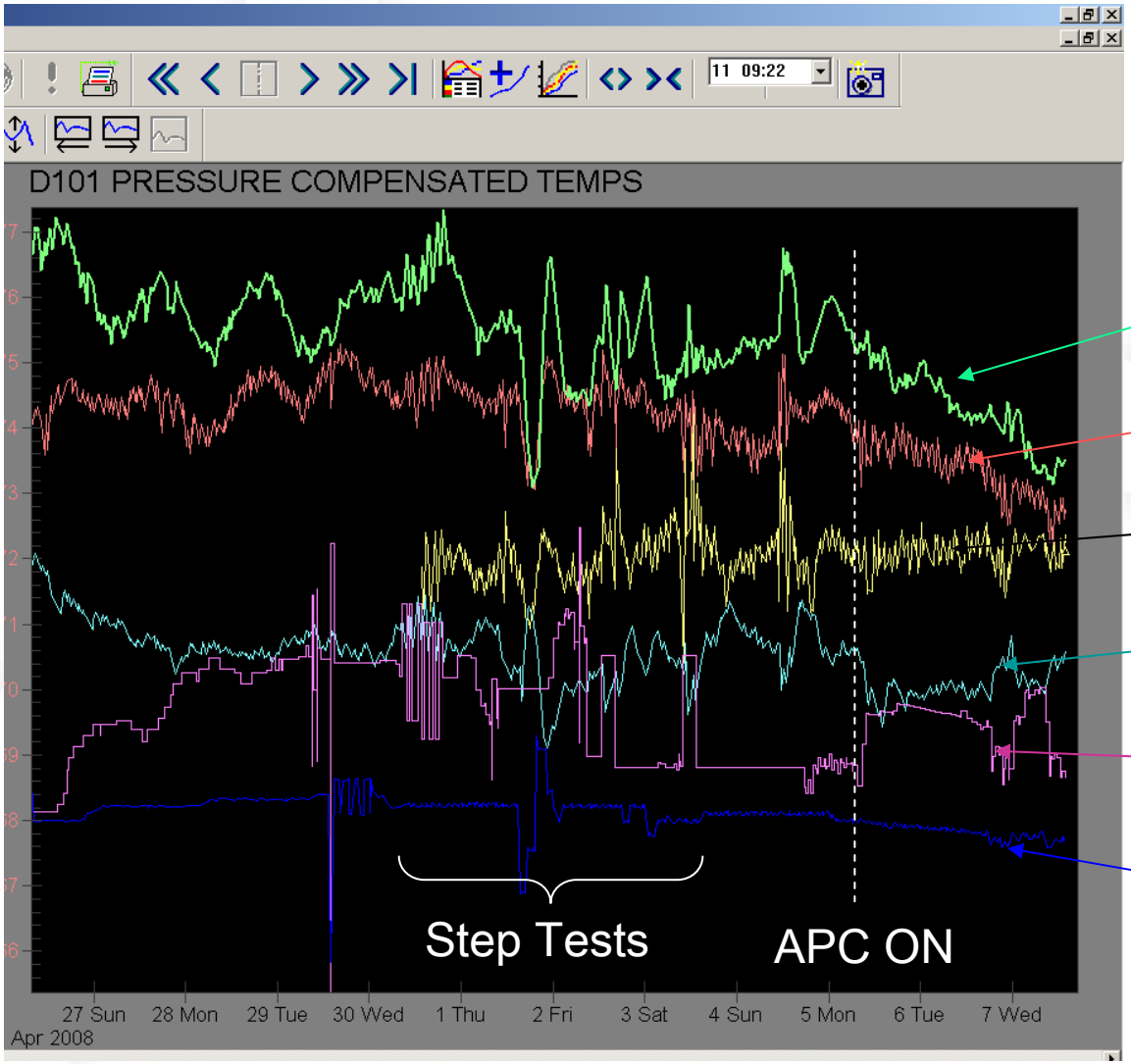


Initial Closed Loop Operation – Small Gains



Both MV's slowly reduced, but no observable control action

Initial Controller Results



OH Prod Loss

OH PCT

Btm PCT

Btm Impurity

Steam

OH Flow

Summary of Results

- Controller immediately started reducing distillate rate and OH product losses
- Average OH product loss reduced by approximately 22%
- Impurities in Btms were maintained within specifications.
- Steam usage reduced on average around 7%
- Estimated value over $700k per year

Summary

- High-purity distillation columns offer significant opportunities for improvement from APC
- A SmartProcess® Distillation Optimizer was implemented on a large purification column
- Following the functional design, the project was completed in 2 weeks on-site
- Excellent project payback achieved

Where To Get More Information

- TO BE ADDED LATER