Advanced Process Control applications to improve industrial productivity and operational effectiveness in the Oil & Gas industry
Presentation Agenda

- Brief Introduction to Advanced Process Control
- Sample applications
  - APC on Oil & Gas Separators & Stabilizer
  - APC on Acid Gas Removal unit
Advanced Process Control - Positioning

Timescale

Years / months

Management Level

Weeks / days

Advanced Control & Supervision Level

Advanced Control & Optimization

Days / hours

Control Level

Advanced Process Control (APC) & Optimization

60 seconds, hours

Enterprise Level

Minutes / seconds

DCS / PLC

20-500 ms

Field Level

Sensors, Actuators, etc

Milliseconds
How APC Improves Performance (1)

Time domain view

Before MPC

Actual constraint

Reduce Variance

Shift Target
How APC Improves Performance (2)

Statistical view

Reduces Variance And Pushes To Limit

% Samples/ Degree F

Degree F

330° 350° 370° 390° 410° 430°
How APC Improves Performance (3)

- Handling simultaneous constraints and variables

Diagram showing:
- Steam
- Reflux
- Condenser Constraint
- Flooding Constraint
- Economic Optimum
- Reboiler Temperature Constraint
- Initial MPC Region
- MPC Region
- How APC improves performance by handling simultaneous constraints and variables.
**MVs** = Independent, Manipulated Process Inputs (Base Controller SPs)

**CVs** = Dependent, Controlled (Constraint) Process Outputs

**FFs** = Independent, Process Inputs (Disturbances)
APC & Optimization Suite

- Deliver state of the art technology
- Create a suite of products that have consistent look and feel that work together seamlessly
- Reduce service and maintenance efforts
Gas & Oil Separation – Typical configuration
Gas & Oil separators – basic diagram & objectives

Process control Main Objectives:
- Keep column temperature (composition) at target
- Keep separators pressure at target
- Keep levels in range
- Manage composition changes
- Manage flow variations in inlet (HP separator)
- Preserve stable operation
Gas & Oil separation – process control

- Oil & gas separation by means of sequence of separators and stabilizer column
- Hi pressure separator affected by large disturbances that get cascaded to lower pressure separators and column
- Advanced process control strategies provide better results than standard DCS control schemes
- Moving from multiple local objectives to coordinated overall objectives
Gas & Oil separation – disturbance path

- Hi pressure separator affected by large disturbances
- Disturbances get cascaded to lower pressure separators and stabilizer
- If level control is tight disturbance is fully propagated or even amplified
Separator trends – prior to implementation

Flow

Temperature

Flow

Temperature

Steam reboiler

Oil Stabilizer

LPS

HPS

From wells

Oil
Separator trends – consistent pattern

- Pattern: consistent over time
Disturbance source: oil wells

- HP separator btm flow
- HP separator level
- Line pressure: feed forward information
APC Solution

- DCS control scheme modifications and re-tune
- Advanced Process Control implementation
  - Keep level in range, use level buffer to smooth disturbance transfer
  - Coordinate column feed with steam to improve temperature control
  - Use existing well pressure to anticipate level/temperature changes

  - Main CVs
    - HP, MP, LP levels
    - Stabilizer temperatures

  - Main MVs
    - Level flows (HP to MP, MP to LP, LP to column)
    - Steam
    - P.A.

  - FFs
    - Line pressure
APC Results

Results:

- Improvement in temperature control (std. dev. Decrease >60%)
- Consistent composition control
- Process stabilization
- Reduction in operations workload
Acid Gas Removal unit

- Chemical separation
- Ammine injection to separate H2S from sour gas
- Rich ammine sent to regenerator for H2S stripping
- Different ammine types or solvents could improve efficiency but overall still large LP consumer
Preliminary evaluation

- Residual $H_2S$ not consistently at specification – large fluctuations
- Multiple trains with inconsistent residual $H_2S$
- Ammine circulations typically kept at constant value
- Steam/ammine ratio typically kept at constant value
- Potential improvement also in the area of gas inlet temperature control (refrigerant)

- Large potential savings with APC implementation
Addolcimento Gas – Unità 330 L4

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Steam

Ammine flow

H2S, day/night cycling
Acid Gas Removal unit

- Main CVs
  - Residual H2S
  - Regen top temp
  - Sour gas inlet temp

- Main MVs
  - Ammine injection
  - Steam/ammine ratio
  - Refrigerant

- Objectives
  - Maintain specs, minimize steam usage
Results

- Consistent control of H2S
- Large energy savings (steam savings ~ 15%)
- Unit stabilization
  - Reduction of disturbances to downstream units - SRU
Conclusions

- APC can provide large, tangible benefits to the O&G industry
- APC Software and technology in the mature stage
- In addition to financial benefits, other operational benefits can be achieved
  - Stabilization of operations
  - Reduction of operators workload