Dense Phase Gas Pipeline Management System Applications

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PMS Introduction

- Gas dense phase pipeline operation usually face multiple uncertainties
  - Single phase transient behaviors
  - Multiphase transient behaviors
- Multiple commercial software used and integrated, including following models and applications:
  - Rigorous hydraulic transient pipeline models
  - Rigorous process dynamic facility models
  - Real-time data historian
  - Control configuration analysis
  - What-if scenario analysis, including fatigue and corrosion analysis
  - Real-time monitoring
  - Scheduling and nomination
- PMS supports design assurance, operation assurance, and asset safety.
PMS Offline Applications

- Compositional Monitoring
- Offline Capacity & Linepack Analysis
- Liquid Prediction
- Hydrate Prediction / Management
- Pipeline Blockage
- Corrosion / Management
  - CO2 only
  - H2S only
  - H2S + CO2
- Pipeline Depressurization / Blowdown
- Fatigue Analysis
PMS Offline Applications (Cont’d)

- Pig Tracking / Monitoring
- Slugging Simulation
- Pipeline Look Ahead Mode
  - Scenario, Analysis, Tuning
- Pipeline Look Back Mode
  - Scenario, Analysis, Tuning
- Database Query & Report Functions
- PMS Data Historian
Gas Compositional Tracking

- Utilizing OLGA compositional tracking feature to track and monitor the compositions in the locations specified along the pipeline
  - C1 – C6
  - C6+
  - N2
  - CO2
  - H2O
  - H2S
  - Methanol
Gas Source Tracking

- Utilizing OLGA compositional tracking feature to track and monitor the compositions in the pipeline inlet
  - C1 – C6
  - C6+
  - N2
  - CO2
  - H2O
  - H2S
  - Methanol
Pipeline Efficiency Calculation

- Mastering the changes of friction factor in time
- Monitoring the pressure drop along the pipeline segments
- Friction factor increasing as pressure drop increasing, thus, pipeline efficiency decreasing
Liquid Prediction

- Utilizing OLGA compositional tracking feature to monitor the liquid content under the operation condition.
- If there is a potential liquid content in the gas, it should create alarm flag and/or report.
Hydrate Prediction and Management

- Utilizing OLGA hydrate curve calculation feature to monitor the hydrate formation condition, and comparing with the current operation condition.
- If there is a potential hydrate formation condition matching the current operating condition along the pipeline pass, it should create alarm flag and/or report.
- Methanol will be considered as hydrate inhibitor for adjusting the hydrate formation curve.
- Operation Strategy will be a guidance applied in the management procedure and/or suggestion.
This application contains H2S + CO2 combined corrosion

OLI corrosion software to monitor the corrosion rate, partial pressure, temperature, scaling tendency, and pH value, etc.

Need to develop the data import and export methods

Operation Strategy will be a guidance applied in the management procedure and/or suggestion

Support Integrity Program
OLGA and OLI Combined Application

- OLGA for pipeline compositional tracking and transient behavior
- OLI for CO2 and H2S corrosion rate simulation
- Corrosion rate as a function of H2S partial pressure at certain conditions
Level 2 Results – Case Study
Level 2 Results – Case Study Continued
More Offline Multiphase Applications

- Pig tracking and monitoring
- Capacity and linepack
- Slugging
- Pipeline depressurization/blowdown
- Pipeline blockage
- Look ahead model, including scenarios, analysis, tuning
- Look back mode, including analysis and tuning
- Line swing
- Startup, shutdown, and restart
- Supply excursion, and
- Optimization Analysis, etc.
Shutdown Example

- Shutdown of LNG Plant
  - Normal Shutdown
  - Mal Operation
- Shutdown of Block Supply
- Determine settle out pressures and pressure swings
- Support Integrity PIM in the pipeline fracture control analysis
Blowdown Example

- Simulation provides:
  - Blowdown time required
  - Liquid flowrate at outlet during depressurization
  - Residual liquid in pipeline after blowdown
  - Temperature profile in trunkline during blowdown
  - Temperature downstream of blowdown valve, etc.

- Blowdown scenarios:
  - Blowdown from settle out and packed conditions
  - Blowdown to offshore at various rates
  - Blowdown to LNG Plant at various rates
  - Simulated with fixed chokes, etc.
PMS Online Applications

- Pipeline Network Monitoring
- Virtual Measurement Displays
- Operational Data Displays
- Capacity & Line Pack Management
- Pipeline Leak Detection
- Pipeline Look Ahead
  - Scenario, Analysis, Tuning
- Look Back Mode
  - Scenario, Analysis, Tuning
PMS Online Applications (Cont’d)

- Pipeline Blockage
- Auditable Record of Pipeline Capacity Related Transactions
- Database Query & Report Functions
- PMS Data Historian
Real-time data and simulation results comparison

Model Estimated State
SCADA Reported State
Acceptable Data Point Bounds
Min and MAX acceptable values

(For one data point in time)
Performance Monitoring

- Predict production rate in real time
- Perform pipeline monitoring in real time
- Verify the production rate with offline simulation results in real time
- Verify the current operating conditions with offline simulation results in real time
- Alarm setup for the observed parameters based on abnormal operations
Linepack Simulation

- Simulate the inventory for each line based on the settle out pressure of pipeline for a number of scenarios
- Define the maximum and minimum inventory
- Based on the requirement, provide the necessary simulation results to gas management program, through out the interface of SCADA data historian.
Leak Detection Simulation

- Calculate the pipeline current state, searching for anomalies that suggest a leak
- Using two different leak detection techniques concurrently, provides truly effective leak detection
- Internal leak detection only
  - Volume Balance
  - Pressure Analysis
  - Real Time Transient Modeling
- It is a challenge since the system only has the measurements located on both ends
- Require to provide the alarm flag based on the analysis
Integrity Program Support

- OLGA provide the pipeline internal pressure profile for the fracture control analysis in PIMS
- OLI provide the CO2 and H2S corrosion simulation results in the particular location of pipeline
- OLGA provide the CO2 and H2S composition profile of pipeline
- Combined OLGA and OLI, provides the integrated information of corrosion in pipeline
- Other abnormal operation, such as shutdown scenario to analyze the settle out pressure and pressure swing for fracture control analysis in PIMS
Other Program Support

- Provide accumulated flowrate calculation to SCADA system for comparison
- Provide accumulated flowrate calculation to Gas Management system for comparison
- Provide gas property calculation to Gas Measurement system for comparison
- Provide the simulated operation conditions to other systems based on the interested segment along the pipeline
- Will discuss more for the possible support requirement with other systems