ADVANCED FLOW ASSURANCE TOOLS TO MINIMIZE PIGGING RISKS IN CHALLENGING LINES
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INTRODUCTION

INTEGRITY SERVICES

Working across all assets with all the key disciplines covered in-house

- Pipelines, Flowlines, Flexibles & Risers
- Offshore Structures
- Production Facilities
- Upstream Pipelines
- Tank & Terminal Facilities
- Onshore Distribution
- Gas Networks
- Renewables

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INTRODUCTION

INTEGRITY SERVICES

- Risk and Reliability
- Stress Analysis, Fracture and Fatigue
- Corrosion
- Materials and Welding
- Laboratory Services
- Pigging Feasibility and Optimization
- Flow Assurance
- Geotechnics
- Structures
- Flexibles

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Pigging Feasibility
PIGGING FEASIBILITY RISKS

- All pigging operations contain an element of risk:
  - Stuck or stalled pig
  - Blocked pipeline
  - Damaged pig
  - Damaged infrastructure

- Run success is not guaranteed:
  - Sensor lift-off
  - Damaged cleaning / ILI tool
  - Speed excursions
**PIGGING FEASIBILITY CHALLENGES**

Operational pigging employed for cleaning operations and management of – liquid, hydrates, solid deposits and corrosion

**WHY?**
- Minimize liquid holdup to reduce ΔP losses
- Clean sand / wax / scales / debris / hydrates
- Reduce corrosion (under deposit, MIC etc.)
- Effective application of chemical treatment
- Pre-inspection cleaning service

**OUTCOMES**
- Increase pipeline operational efficiency
- Pipeline integrity – extend life of pipeline
- Minimize production deferment / trips / stoppages
- Minimize sensor lift-off of the ILI tool
‘Achieving ILI run success requires close collaboration between the Client and Contractor teams, where adequate planning and preparation are important factors.’ – POF 2018

Operational Causes of Failed ILI Runs

- Pipeline Cleanliness: 22
- Pipeline Restriction: 41
- Speed Excursions: 37
PIGGING FEASIBILITY CHALLENGES

Operating Conditions

Challenging

Very Challenging

Proficient

Challenging

Pipeline Construction

Wye

Deep Water

Check Valves

Multi-diameter

CRA Cladding

Pipe-in-pipe

Heavy wall thickness

No pigging infrastructure

Multiphase Flow

Mitre bends

Low pressure

Production deferment

Wax deposition

Slide 9
PIGGING FEASIBILITY SOLUTION

- Asset Data
- Data Review
- Site Survey
- Pipeline Threat / Operational Drivers
- Define Infrastructure Constraints
- Specify Campaign Performance Requirements

Optimization Loop
- Define Operating Conditions Flow Assurance
- Define Infrastructure Configuration Options
- Define Inspection Technology Options
- Define Cleaning Technology Options

Cost / Benefit / Risk Analysis

INPUT

OUTPUT

- Technology Selection
- Campaign Sequencing
- Infrastructure Set-up
- Developmental Work
- Contingency Options

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**FLOW ASSURANCE INTRODUCTION**

*Assure* transportation fluids from *source to facility* in a *safe* and *economical* manner over the *life of the asset*

- Process conditions
- Hydraulic calculations
- Corrosion, erosion
- Severe slugging
- Solids: sand, slurry, dust etc.
- Gas hydrates, wax and asphaltenes
- Liquid management during pigging
- Production deliverability
- Pressure surge analysis
FLOW ASSURANCE
CHALLENGES DURING PIGGING

• Operating conditions
  o Pressure, temperature, flowrate limits

• Liquids
  o Rate of accumulation
  o Pig generated liquid slug could flood the receiving equipment

• Solids
  o Rate of accumulation and location
  o Avoid “stuck pig” scenario

• Maintaining production
  o Minimize deferment
  o Maximize throughput

• First pass success
  o Pig velocity control within recommended limits
FLOW MODELLING APPLICATION IN PIGGING OPERATIONS

- Estimate solids / liquid inventory
  - Blockages due to deposit build-up
  - Motive pressure for propulsion

- Tool behaviour due to hydraulics
  - Pig wall frictional factors to simulate pig behavior
  - Bypass port sizing to maximize production flow without flooding the slugcatcher

- Pigging optimization
  - Process conditions for optimum tool velocity
  - Pigging frequency

- Pigging diagnostics for flow model validation
  - Data, data and more data!
Need to Combine Pigging Feasibility and Flow Modelling
Objective:

- Optimized process conditions for economical “off-the-shelf” pigging solutions
- Assured piggability of the system
FLOW ASSURANCE & PIGGING FEASIBILITY SERVICES

Cleaning
• Pigging frequency for sand / wax / liquid management
• Liquid holdup estimation and surge calculations
• Pig velocity tracking and validation
• Pigging feasibility & configuration e.g. standard / bypass pig, challenging tool

Inspection
• Pig velocity tracking
• Optimization of pigging operation in single & multiphase flow

Corrosion
• Corrosion models integrated with flow calculations, e.g. DeWaard, Norsok, TOLC IFE
• Support NACE ICDA for un-piggable lines
• ILI data validation
• Inspection location prioritization
• Optimize inhibitor injection rates & performance

Integrity
• Risk studies: Water hammer / pressure surge analysis, blowdown modelling etc.
• Black powder: root cause analysis and mitigation
• Erosion in slurry / sand transporting lines: root cause analysis and mitigation
CASE STUDY – CONDENSATE LINE CLEANING & ILI

OVERVIEW

System

Dual flow line system in deep water (~1500m)
- 22” diameter
- Each ~80 km long
- Flow line 1 produces multiphase fluids
- Flow line 2 supplies dry gas
CASE STUDY – CONDENSATE LINE CLEANING & ILI CHALLENGES

• Client preferred “online” pigging at maximized production:
  o The asset produced most of the client’s revenue.

• Multiphase in deep water → Large liquid holdup (>1500 m³):
  o Limited liquid handling capacity of 50 m³

• Large hydrostatic head
  o Insufficient driving pressure for pigging
  o Well close to backing out

• Different service fluids
  o Compressible gas in one and multiphase fluid in other.

• Maintaining pig velocity challenging in multiphase line
CASE STUDY – CONDENSATE LINE CLEANING & ILI

SCOPE OF WORK

The scope of work consisted of the following:

- Data Review
- Site Visit
- Mechanical Feasibility Study
- Identify Requirements for Cleaning and Baseline Inspection
- Flow Assurance for In-Service Progressive Pigs and ILI
- Develop In-Service Progressive and ILI Procedures
- Emergency Response Procedure
- Pig Tracking Procedure
- Pig Stuck Emergency Rescue Plan
- Supervise Pigging Operation
CASE STUDY – CONDENSATE LINE CLEANING & ILI METHODOLOGY

- **OLGA multiphase hydraulic simulator** employed to estimate the liquid inventory in the flow lines
- Bypass pig calculations
- Critical pig wall frictional factors to model pig behavior
- Various configurations considered:
  - Gas wells, increased gas velocity, standard pigs, passive and active bypass pigs etc.

**Optimized cleaning pigging (Configuration 4):**
- Sweep the line with gas at high flowrates
- Passive or “fixed” bypass pigging at reduced production
CASE STUDY – CONDENSATE LINE CLEANING & ILI
STANDARD PIG

Liquid Holdup (Standard pig)

Production Line (Flowline 1)
CASE STUDY – CONDENSATE LINE CLEANING & ILI

THE SOLUTION

A standard pig would:

• Cause the wells to back out
• Overwhelm the receive facilities causing a trip / shutdown

Therefore a solution was sought…

Solution

High velocity sweep of the pipeline to remove excess liquid holdup

Cleaning pigs with 3% bypass – Pigging needed to be continuous as liquids were replenished within 24 hours
CASE STUDY – CONDENSATE LINE CLEANING & ILI BYPASS PIG

Liquid Holdup (3% bypass pig)

Production Line (Flowline 1)
CASE STUDY – CONDENSATE LINE CLEANING & ILI

CONCLUSIONS

Overall Results:

![Graph showing Recycle Line and Production Line](attachment:graph.png)

KEY BENEFITS

- **Reliable** and **cost effective** solution for an “online” pigging specification
- An **acceptable level of production** could be maintained
Conclusions
Flow assurance is key for ensuring operational feasibility:

- **OLGA Multiphase simulator** for solid / liquid estimates
- **Pig frictional factors** for predicting bypass pig behavior
- **Access** to PDL diagnostics and inspection data for validation

**Combining** flow assurance into pigging feasibility studies is beneficial for:

- **Assurance** of a pigging solution
- **Management of risks** in complex challenging assets
- **Profitable, safe and efficient** running of a pipeline asset
Questions…?
THANK YOU FOR JOINING THIS PRESENTATION.