PIG MOTION AND DYNAMICS IN COMPLEX GAS NETWORKS

Simulating a complex pigging program

Dr Aidan O’Donoghue, November 2016
Aim of the analysis;

Piglab Model description;

Three analyses presented:

1. Initial pipeline;
2. Expanded capacity;
3. Following pipeline repair.
Aim of the model

- Simulate pigging a complex system;
- Reduce disruption to customers;
- Manipulate flows, valves, pressures in real time as the analysis proceeds;
- Avoid possible pig stalling ("Flow diversion");
- Avoid high valve DP before opening;
- Understand schedule / time to pig;
- Cut down on unnecessary downtime or penalty.
Overall aim of the analysis...

- Balance the requirements of the pigs (velocity limitations, pressures, avoid stalling etc) with...

- The requirements of the system and the customers (minimum pressures, required flows etc)
Model description

Model the process and pigging of a complex gas network

With full pipeline description and elevation changes
Pig types:
- Standard cleaning pigs;
- ...with or without bypass;
- Inspection tools with / without speed control;
- Different mass and pig friction...
Model 1: Scheme

Total capacity 5.5 mmscmd
Model 1: Establish Steady State
Model 1: Pig at river crossing
Model 1: Velocity Profile
Model 1: Launching the 12-inch pig
Model 1: Launching the 12-inch pig

- Time pig starts moving
- Time pig is launched
Model 1: Estimated Time of Arrival (ETA) with changing conditions

Final ETA, 259 hours

Initial ETA, 256.5 hours

(The time is since the beginning of the simulation)
Total capacity 12 mmscfd
Model 2: Establish steady state conditions
Model 2: Timetable for pigging

- Pipeline at steady state;
- Run cleaning pig through Line 1;
- Run an ABC (speed control) MFL pig through Line 1 or reduce flow and deploy MFL tool. Increase flow after the tool passes KP 25 (three way valve to the new line) – note predicted ETA;
- Reduce flow and switch off compressor (a pig cannot be deployed through the compressor);
- Launch pig into Line 2 and examine risk of flow diversion;
- Launch pig into line 3 (no change from previous);
- Launch pig in new line 4. Risk of low pressure at outlet to customer.
Model 2: Flow diversion

Two lines with common inlet and outlet. Flow is proportional to pressure gradient. Pressure gradient less in line with pig so risk of stalling as flow diverts.
Model 2: Flow Diversion
Model 2: Speed control Vs Flow reduction (Line 1)
Model 2: ETA for reduced flow case

Initial ETA with low flow

Final ETA after recovery of the flow
(The time is since the beginning of the simulation)
Model 3: Following repair to pipeline
Model 3: Pigging the 24-inch x 20-inch line
Model 3: Checks on minimum pressure
Summary

- Model set up to allow investigation and sensitivity analysis into pigging in complex gas networks;
- Interlinked network of pipelines, valves, compressors, gas sources and sinks, pressure controls;
- Steady state and transient analysis along with pig motion;
- Reduction of disruption to customers and ensuring the system runs as it was designed to and pigging is performed as required.
Thank You!