OptiRamp Leak Detection System

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Solution Overview

- Goals
  - Mitigate potential issues before they occur
  - Detect leaks if they are present and identify location as accurately as possible
  - Reduce false positives
- Solution aligns with API RP 1130
- Methods to detect leak:
  - Mass flow-based leak detection
  - Pressure-based leak detection
- Methods may be used together or individually
- *OptiRamp* accounts for branching

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Minimum Data Requirements

- Mass flow-based leak detection
  - Minimum of 2 mass flow sensors: beginning and end of pipeline
  - More sensors allows for more precise location
- Pressure-based leak detection
  - Minimum of 3 pressure sensors: beginning, middle, and end of pipeline
  - More sensors allows for more precise detection
- Temperature sensors
  - Not required, but recommended
  - Makes simulation more accurate = more accurate leak detection

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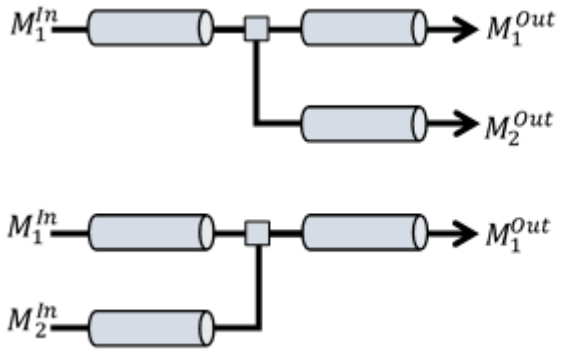
Mass Flow-Based Leak Detection

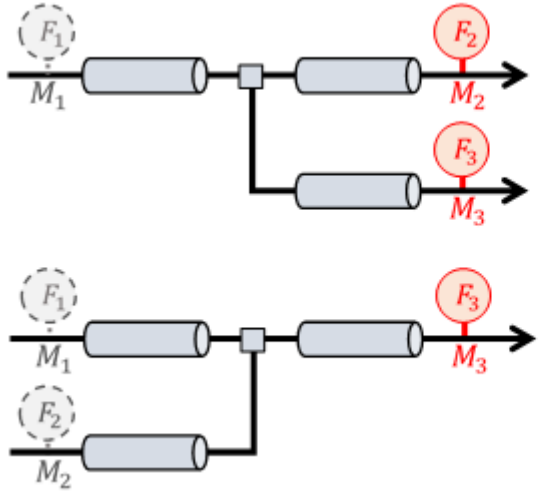
Standard Method



Leak Condition
$M_1^{In} \neq M_1^{Out} + M_2^{Out}$

Leak Condition
$M_1^{In} + M_2^{In} \neq M_1^{Out}$

OptiRamp Method



Leak Condition
$|\Delta M_{Branch}| > \Delta M_{Branch}^{uncert}$
$\Delta M_{Branch} = \sum_{i=2,3} \{M_i^{pr} - M_i^{ob}\}$

Leak Condition
$|\Delta M_{Branch}| > \Delta M_{Branch}^{uncert}$
$\Delta M_{Branch} = M_3^{pr} - M_3^{ob}$

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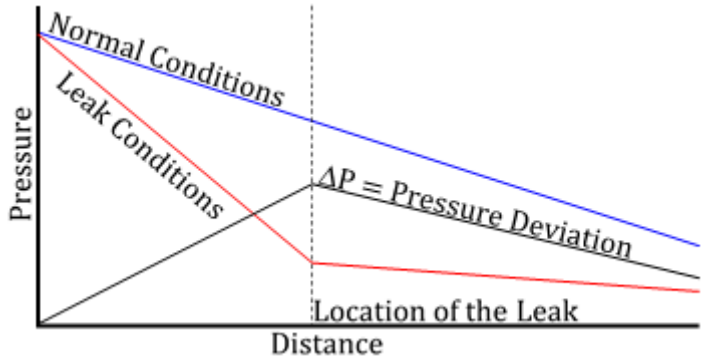
Pressure-Based Leak Detection

- Leak detected: pressure along pipeline deviates from normal, non-leak conditions



- *OptiRamp* simulates non-leak pressures to compare sensor values
  - Helps account for branching
  - Determine the branch where leak is located

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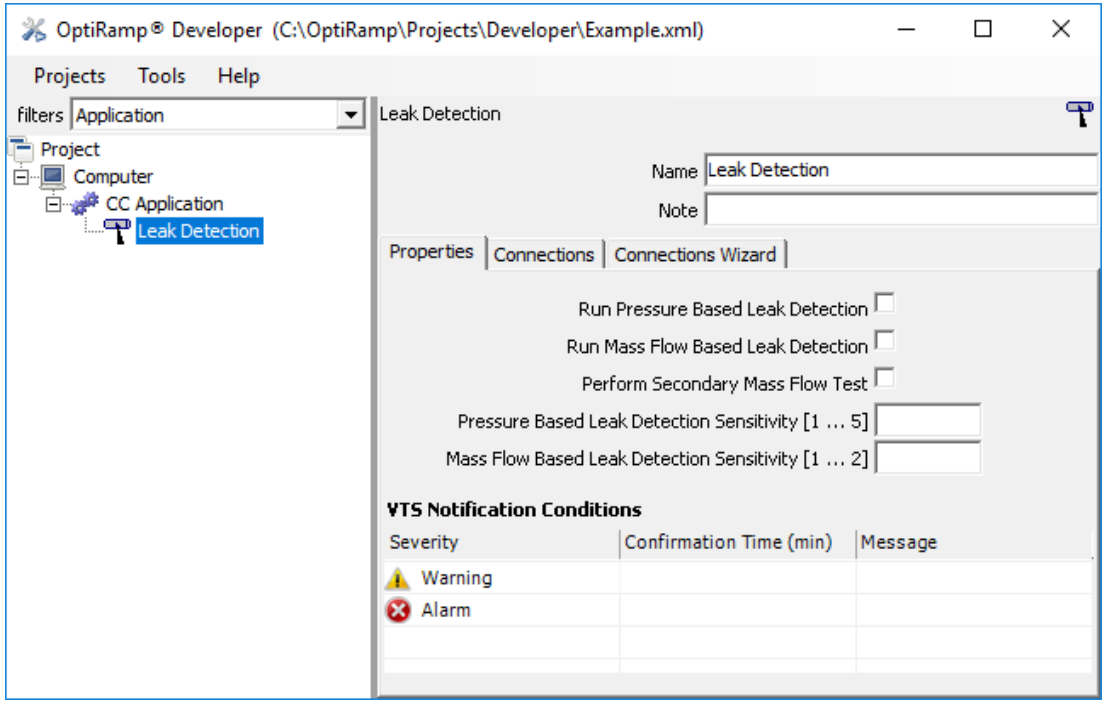
Configuration

- Determine which method (algorithm) to use
  - Both mass flow and pressure
  - One method
- Set sensitivity
- Configure conditions for alerts
  - Time based
  - Customized messaging
  - Warnings & Alarms



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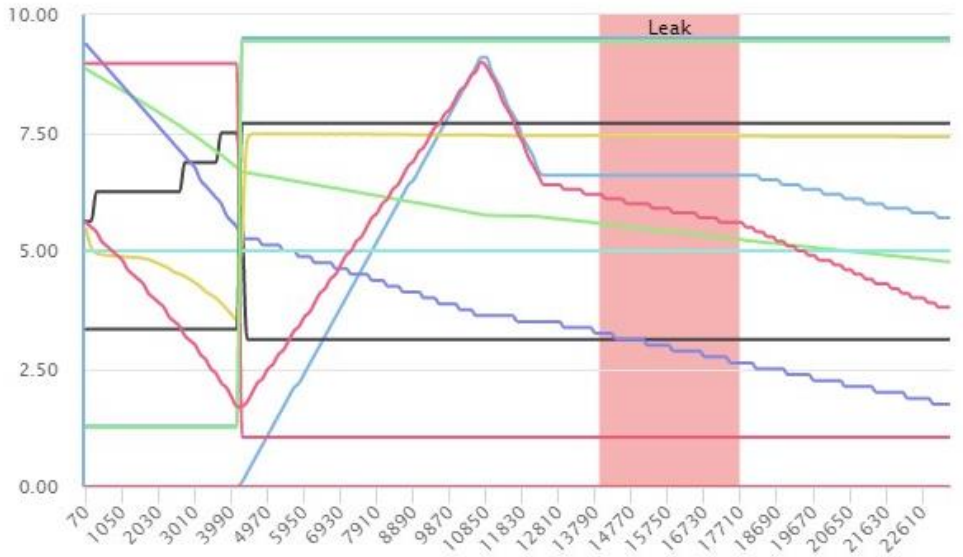
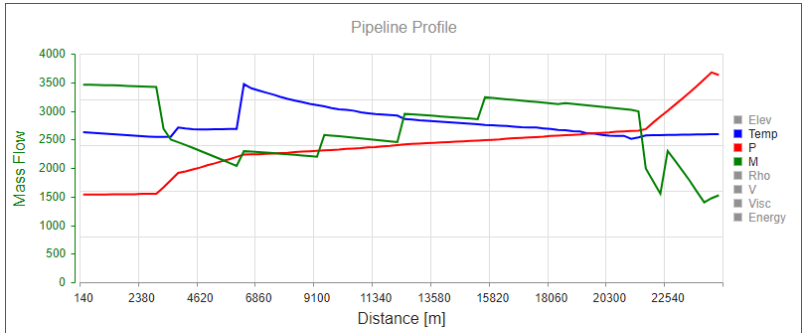
Visualization: Pipeline Profile

- Visualizes pipeline properties in relation to distance
  - Fluid composition
  - Pressure profile
  - Temperature
  - Elevation changes
  - Speed profile
  - Viscosity changes
- Detects events
  - Leaks
  - Slugging
  - Congealing
  - Pigging
  - Batching





COMPONENT	140 [M]	7140 [M]	14140 [M]	20020 [M]
Elevation [m]	0	0	0	0
Temperature [°F]	118.2	149.4	126	116.1
Pressure [PSIA]	323.3	324.4	324.7	324.9
Mass Flow [lb/min]	3458	2269	2892	3069
Density [Kg/m³]	16.99	89.57	102.4	120.7
Speed [m/s]	0.9947	0.1238	0.138	0.1242
Viscosity [centiPoise]	1.218×10^{-2}	1.314×10^{-2}	1.340×10^{-2}	1.422×10^{-2}
Specific Energy [KJ/Kg]	131.2	24.97	21.86	18.56
Gas Proportion [%]	100	100	100	100
Oil Proportion [%]	0	0	0	0
Water Proportion [%]	0	0	0	0
Component 0	1	1	1	1
CO2; Carbon Dioxide	1.647×10^{-2}	0.1399	0.1248	0.1249
C2H6; Ethane	1.854×10^{-2}	5.619×10^{-2}	0.1615	0.1691
CH4; Methane	0.9009	0.1581	0.1398	0.1382
N2; Nitrogen	1.312×10^{-2}	0.1324	0.1157	0.1132
C3H8; Propane	1.894×10^{-2}	0.1613	0.1426	0.141
S; Sulfur	1.266×10^{-2}	0.1323	0.1155	0.113

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Additional Information

- For additional information, please contact

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