Hydraulic Pipeline Application Modules
PSI's Tools
to Support Pipeline Operation

Inhalt

1 Leak Detection and Location Modules

1.1 Dynamic Balance Leak Detection

Leak detection system based on counters/flow meters and pressure/temperature profiles of the pipeline system. Enables leak detection during pipeline standstill, steady state operation and in transient conditions.

1.2 Transient Model Leak Detection

Leak detection based on pressure measurements as well as on a transient hydraulic model of the pipeline system. No counters/flow meters are required. A leak alarm will be generated whenever the discrepancy between simulated pressure and measured pressure exceeds a selected threshold; further measurements can be used for validation.

1.3 Transient Model Leak Location

A given (measured) pressure profile is compared with a model based reference pressure profile. A leak is located by determining the place of greatest discrepancy between measured profile and reference profile.

1.4 Pressure Drop Analysis Leak Location

In the event of a leak a negative pressure wave starts to propagate upstream and downstream from the leak position. The leak can be located by accurately determining the point in time in which the stations located on either side of the leak first detected a drop in pressure. The following evaluation is based on pipeline topology and local acoustic velocity.

2 Modules to Support Pipeline Operation

2.1 Batch/Quality Tracking

If the pipeline is used to transport different products, it is very important to know the exact location of heads and tails of the different batches, the location of pigs and spheres as well as density and viscosity profiles. This information is provided by a batch tracking system. Included in the system, tools to modify, include, delete or replace batches are available.

2.2 Local Quality Profile Monitoring

If a highly accurate separation of consecutive batches is required, local quality (mostly density) profile monitoring enables the precise determination of valve switching to initiate the change of flow path. This tool can minimise the amount of contaminated product.

2.3 Hydraulic Profile Visualisation

Any pipeline system has a number of set points representing maximum and minimum pressure limits. Especially in mountainous areas it is useful to supervise the real pressure profile in order not to violate these set points. The visualized pressure profile is based on a transient model including a batch tracking system. This enables the influence of dynamic operations as well as the effect of mixed linefill to be taken into account. Besides the pressure profile, display of other profiles (temperature, flow, density etc.) is possible.

2.4 Closed Loop Control

This tool can be used for pipeline-wide control circuits, e.g. slack line control to avoid violation of local minimum pressure (even if no pressure transmitter is installed at the summit point) or flow control to ensure constant flow rates.

2.5 Automatic Shutdown

The tool “User-defined Control Sequences” can be used to create automatic shutdown sequences for the entire pipeline system.

3 Modules to Optimise Pipeline Operation

3.1 Pump Optimisation

Based on pump characteristics, the pump optimisation module cyclically calculates (e.g. every 5 minutes) whether modification of the actual pump configuration (without violation of hydraulic/electric/logistic restrictions) will lead to a more effective pipeline operation.

3.2 Pipe Friction Supervision

During steady-state operation, the pipe friction factor of all pipeline sections is continuously calculated and stored (like normal measurement values) in archives. Permanent supervision of these pipe friction coefficients provides information to decide when the next scraper launch should take place.

4 Modules to Support Pipeline Maintenance

4.1 Calculation of pipeline integrity considering alternating pressure

The remaining lifetime of a Pipeline section largely depends on the way it is operated. Frequent changes of pressure will lead to a shorter lifetime than steady state operation. To evaluate the remaining lifetime, an archive of pressure changes in each pipeline section is provided.

4.2 Measurement Supervision

Using a hydraulic model, most of the measurements used for pipeline operation (pressure, flow, temperature, density) have a certain redundancy. This means that these values are measured and can be estimated at the same time. Most of the measurements have a “measured value” and an “estimated value”. This can be used to supervise proper functioning of the measuring equipment.

4.3 Post Mortem Analysis

This tool allows for the reconstruction of any situation that happened in the past and to repeat the course of events and measurement trends at any given time interval. This includes reconstruction of hydraulic profile and specific linefills.

5 Simulation Modules

5.1 Look-Ahead Simulation

Based on current operating conditions (pump status, valve positions, set points, linefill), the future situation is calculated via a transient model. As a result, the module produces "future measurement values" such as pressure or flow. If any foreseeable restriction violation is detected, a warning will be generated. The module runs cyclically in the background. Operator input is not necessary.

5.2 Predictive Simulation

Predictive simulation resembles Look-Ahead Simulation. As a what-if simulation, it runs only per operator request. The actual state of the pipeline system is taken as initial state. Beginning at this state, the operator can simulate pump switches, modification of set points or flow path variations. Simulation speed can be real time or fast motion.

5.3 Offline Simulation

This simulation can be used to try out operation with different pump characteristics, different demand scenarios, extreme linefill situations etc. Initial states can be taken from actual pipeline operation, from past situations or from former offline simulation runs.

5.4 Training System

The Training System is based on Offline Simulation, but includes all restrictions from the real system (e.g. automatic pump shutdown in case of pressure violation). A training system simulates not only pipeline hydraulics, but behaviour of local automation systems in the stations as well. In addition, simulation of hazardous situations such as occurrence of leaks is possible. The training system can also be used to create and test User-defined Control Sequences.