AN OVERVIEW OF PIPELINE LEAK DETECTION TECHNOLOGIES

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Introduction

This paper will provide you with a fundamental understanding of the operating principles of currently available pipeline leak detection technologies. To start with we'll have a look at the topics to be covered:

- Historical development of pipelines
- Why they are monitored for leaks
- The requirements and regulations placed on leak detection systems
- Various causes of leaks
- Different leak detection methods

It will also be shown how pipelines are monitored utilizing leak detection systems which are operated:

- non-continuously
- continuously with *external* measurements
- continuously with *internal* measurements

The paper will also familiarize the reader with how systems localize leaks using various methods. The additional functionality that can be realized from a leak detection system will also be explored. In closing, the reader will gain a better understanding of the unique challenges that each methodology presents.

History

Pipelines originated over 5,000 years ago by the Egyptians who used copper pipes to transport clean water to their cities. The first use of pipelines for transportation of hydrocarbons dates back to approximately 500 BC in China where bamboo pipes were used to transport natural gas for use as a fuel from drill holes near the grounds surface. The natural gas was then used as fuel to boil salt water, producing steam which was condensed into clean drinking water. It is said that as early as 400 BC wax-coated bamboo pipes were used to bring natural gas into cities, lighting up China's capital, Peking.

Today's pipelines originated in the second half of the 19th century and since their adoption have grown drastically in size and number. While drilling for water, crude oil was accidentally discovered in underground reservoirs. This crude oil was not very popular until simple refineries came into existence.

The oil was transported to these refineries in wooden vats that were even transported across rivers via barges pulled by horses. One alternative method of transport was by way of railway tanker cars. However, this meant that the oil supply was controlled by the large railway owners.

So, to make transport independent and more reasonably priced, pipelines were adopted as a more economical means of transportation. The transported oil was boiled off in refineries to obtain the by-products of naphtha, petroleum, heavy crude oil, coal tar and benzene. The petroleum was used as a fuel for lighting and the benzene produced was initially considered an unwanted by-product and was disposed of.

This situation changed drastically with the invention of the automobile which instantly increased the demand for consistent and reliable supplies of gasoline and resulted in the need for many more pipelines. Pipelines today transport a wide variety of materials including oil, crude oil, refined products, natural gases, condensate, process gases, as well as fresh and salt water. Today there are some 1.2 million miles of transport pipelines around the world, with some well over 1,000 miles in length. The total length of these pipelines lined up end to end would encircle the earth 50 times over.

The construction of these longer pipelines with larger diameters also increased the need for more intelligent leak detection systems to better detect and localize accidental releases. Where it was once enough to have inspectors walk the length of pipelines and visually inspect for evidence of leaks, today this is no longer possible. In many cases, due to the longer lengths and the rigorous runs of remotely located pipelines, physical access may be limited. Pipelines can run through snowy landscapes, across mountain ranges, along bodies of water, or be located underground or subsea, even at depths exceeding 1 mile.

But why is it necessary to implement leak detection systems at all? Although they are the most reliable and safe option compared to other methods of transportation possibilities, accidents and thefts can and do occur with pipelines. In such cases, leak detection systems can help minimize damage to people, the environment, and the company image as well as the high costs for repair, renovation, indemnity, breakdowns and the lost value of the liquid or gas that has been released. In addition, there are also different official regulations related to pipeline leak detection. Let's take a look at them.

Regulations

In many countries it has become necessary to observe official requirements in order to ensure safety of pipelines, particularly for hazardous materials. These requirements include:

- Germany - TRFL, the Technical Rule for Pipelines

- United States of America
    - API 1130, which deals with computational pipeline monitoring for liquids
    - API 1149, which deals with variable uncertainties in pipelines and their effects on leak detection performance
    - The former API 1155, which contains performance criteria for leak detection systems, which has since been replaced by API 1130
    - American 49 CFR 195, which regulates the transport of hazardous liquids via pipeline

- Canada - CSA Z662, regarding oil and gas pipelines

Title	Contents of requirement
TRFL	Technical Rules for Pipelines
API 1130	Computational Pipeline Monitoring for Liquids
API 1149	Pipeline variable uncertainties and their effects on leak detection
API 1155 (replaced by API 1130)	Performance criteria for leak detection systems
49 CFR 195	Transport of hazardous liquids via pipeline
CSA Z662	Oil and gas pipelines

Figure 1: International Regulations

Regardless of the specific national regulations, these rules are observed internationally and often form the basis for the selection of a suitable leak detection system.

As we have just learned, leak detection systems are subject to official regulations. Leak detection systems must be sensitive, reliable, accurate, and robust.

Sensitivity is a combined measurement which takes into account the minimum detectable leak rate as well as the time it takes until a leak is detected. Here it is best to indicate the total leaked volume that escapes until the leak is detected.

Reliability means that false alarms are avoided but that actual leaks are reliably detected.

Accuracy refers mainly to the localization of leaks. For example, leak location information is indicated in units of length and accuracy information in percent of the entire length of the pipeline, or instrumented segment.

Robustness refers to the operation of the leak detection system under less than ideal operating conditions. This includes things like sensor failure. In this case the leak detection system should be able to detect the failure and at least continue to work, albeit with reduced sensitivity.

Label	Description
Sensitivity	• Minimum detectable leak rate • Detection time
Reliability	• Avoid false alarms • Reliably detect leaks
Accuracy	• Accurate localization of leaks
Robustness	• Detect failing sensors • Fall-back strategies in the event of sensor failure

Figure 2: API 1155 Performance Criteria

When evaluating individual leak detection systems, you should weigh each of these criteria against one another and not decide based on a single specification.

What Causes Leaks

Before we take a closer look at how leak detection in a pipeline can be done, let's first take a look at what causes leaks. Fatigue cracks are one cause. These occur as the result of material fatigue and are often found on longitudinal welds. Tensile strength can cause stress tears which can reduce the effectiveness of Cathodic corrosion protection systems, resulting in corrosion on the pipeline. Stress corrosion is another possible cause. Cracks can also be caused by hydrogen indexing. In this case, atomic hydrogen diffuses into the metal grid of the pipe wall, forming molecular hydrogen. This can lead to the pipe material becoming brittle and prone to early failure.

Material manufacturing errors can also cause leaks, e.g. when cavities are rolled into the material during production of the pipe. Lastly, leaks can also occur when an external force acts from the outside. This is the case when backhoes dig up a pipeline or seismic ground movements cause shifts in the ground surrounding a pipeline.

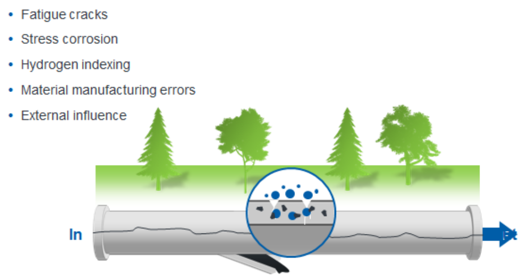

Figure 3: Causes of Pipeline Leaks

Leak Detection Methods

What are our options when it comes to monitoring pipelines for leaks? Leak detection systems can be categorized into (2) major types; continuous and non-continuous systems. The non-continuous systems include: Inspection by helicopter, smart pigging, and even tracking dogs.

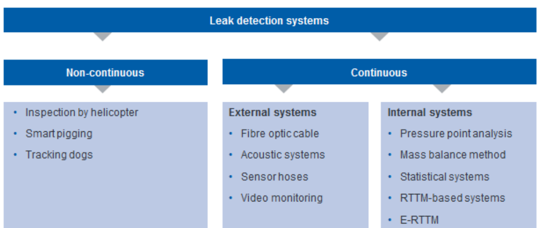

Figure 4: Leak Detection Methods

Continuous systems can in turn be divided into external and internal based systems. External systems include: fiber optic cable, acoustic systems, semi-permeable sensor hoses and video monitoring. Internal systems include: pressure point analysis, Mass balance method, Statistical systems, Real Time Transient Model (RTTM) based systems and Extended RTTM. In practice, non-continuous systems are often used in conjunction with continuous systems.

Now let's take a look at how each individual system functions. As we saw in the overview of leak detection methods, inspection by helicopter is one option for detecting leaks. The helicopter flies along the pipeline, looking to detect any outflowing gas. Three common methods when detecting leaks by helicopter include detection using Laser, Infrared cameras and "leak sniffers". When using lasers for leak detection, a laser is set to the absorption wavelength of the medium to be detected. When the laser hits the medium, a part of the laser energy is absorbed. The amount of energy absorbed from the laser is measured to arrive at the amount of leaked medium.

Detecting leaks using infrared cameras functions by using video cameras that are fitted with a special filter that highlights a selected spectrum of infrared wavelengths. Certain hydrocarbons absorb infrared radiation from this spectrum and leaks are detected as a visual indication similar to smoke in the video image.

Figure 5: Video Image of Gas Leak

Leak sniffers draw in air samples to evaluate in an analyzing unit to directly measure the concentration of the leaked medium. To do this, the helicopter must fly low enough to pass through the gas cloud made by a leak. The analyzing unit then indicates whether gas is present and in what concentration. Helicopters are a good option to detect small gas leaks when the pipeline route is suitable for accurate flight routes; however the accuracy also depends on the weather conditions. Poor weather conditions mean that the leaking gas can drift and in severe cases the helicopters cannot even fly during such extreme weather.

Pipeline pigs are utilized for a variety of tasks in pipeline integrity management. This includes cleaning the pipelines, separating product batches, as well as gauging pipeline condition. It can help gain valuable information about corrosion, cracks, wall thickness as well as existing leaks in pipelines. In this case, we use the term smart pigging. To perform pigging, a pig is inserted into the pipeline using a pig launcher. The pig advances through the pipeline, propelled by the medium and gathers data along the way. A receiver is used to guide the pig out of the pipeline in order to subsequently analyze the collected data. Various techniques are used to collect pipeline information using smart pigs; two of the most common are the magnetic flux leakage method and the ultrasonic principle.

With the magnetic flux leakage method, a strong permanent magnet is used to magnetize the pipeline. Any changes to the wall of the pipe, such as corrosion, change the magnetic flux lines which are then recorded by sensing probes attached to the pig. Following pigging, the recorded signals are evaluated based on reference signals to detect any defects or abnormalities in the pipe wall.

When it comes to the method based on the ultrasonic principle, the pig transmits ultrasonic pulses into the pipeline wall and receives their reflected signals. The signals are reflected by both the inner and outer pipe walls and based on the running speed of the pig; the thickness of the pipe wall can be derived.

By using smart pigs, existing leaks can be detected as well as any damage to the pipeline which could result in leaks. Prior to commissioning pipelines they are often pigged and the results used as the baseline for further inspections. This is called zero or baseline pigging. It's important to ensure that the pipeline is piggable in the first place. This means that you must be certain that there are no obstacles in the pipeline such as restrictions or fittings making the passage too narrow and that there are pig launchers and receivers to capture the pig. In addition, the speed of the pig must be kept between 3 – 15 feet per second to obtain accurate results.

Another non-continuous solution for monitoring leaks is the use of tracking dogs. These dogs are specially trained to recognize the odor of certain compounds which are injected into the pipeline to be inspected. The pipeline is then operated as usual and the dog is led along the right-of-way path, sniffing for the compound. The use of tracking dogs usually only takes place with short pipelines or segments of pipeline. It is also a good method when it is not possible to accurately localize the leak using other methods and then the dogs can be used to further narrow down the leak site. However, it is difficult to certify a tracking dog as a leak detection system within the framework of API or TRFL, for example.

The use of fiber optic cables for the continuous external monitoring of leaks is based on physical changes that occur at the leak site. One of those physical changes is a typical change in temperature profile. To detect such changes, the fiber optic cable is placed along the pipeline. A laser then emits pulses that are reflected by molecules in the fiber optic cable. The reflected laser pulse magnitude gives insight as to the temperature at the place where the photon hits the molecule. By adding these reflections, a temperature profile can be made and it is then possible to detect the characteristic change in temperature that occurs at the leak site.

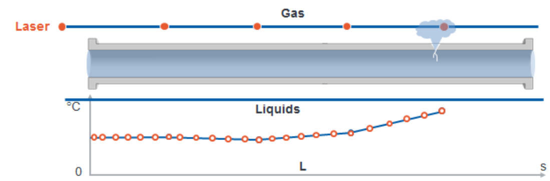

Figure 6: Fiber Optic Leak Detection

Monitoring pipelines with fiber optic cables is a good option for accurately localizing leaks. However, use of this method is only possible up to limited lengths of pipeline and many reflections are required to plot a useful temperature profile. When installing the cable it is also necessary to pay attention to the medium to be monitored. If it is a gas to be monitored, the cable should be installed above the pipeline as gas normally rises. When it comes to liquids, it makes sense to install the cable below the pipeline.

Detecting leaks using acoustic signals is possible because an acoustic signal is created when gases or liquids flow through a crack or hole in the pipeline. Acoustic sensors are installed outside of the pipeline to detect leaks by measuring the noise levels at multiple sites along the pipeline. This information is used to create a noise profile of the pipeline. Deviations from the baseline noise profile that is created results in the leak alarm. Acoustic sensors can be mounted directly to the pipeline or coupled to the pipe wall using steel rods for underground pipelines. To monitor longer pipelines, a large number of acoustic sensors are needed. Small leaks whose acoustic signal is small and only differ slightly from the background noise cannot be detected as otherwise there would be many false alarms.

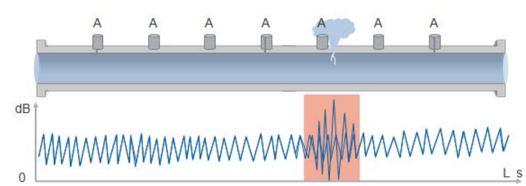

Figure 7: Acoustic Leak Detection

Detecting gas leaks using infrared is made possible through video cameras featuring a special filter which is sensitive to a selected spectrum of infrared wavelengths. Certain hydrocarbons absorb infrared radiation from this spectrum. This makes it possible to detect the leaks as an image of smoke on the video display. Liquid leaks can also be detected using infrared cameras as the thermal conductivity in wet ground is different than in dry ground. In this case, you get a different temperature pattern above the leak position. Video monitoring of pipelines is designed for short distances. It is thus an interesting option in critical areas such as on company premises or for high consequence areas. For its use as a continuous leak detection method, however, it's important to note whether the leak detection occurs automatically or whether monitoring by personnel is necessary.

When using sensor hoses, a semi-permeable hose is installed along the pipeline. In the event of a leak, the medium comes out of the pipeline and into the hose. In a timed cycle, a test gas is injected into the hose at the beginning of the pipeline. Then the contents of the hose are pumped to the end of the pipeline. There is an analyzing unit at the end which then tests the hose contents for the presence of hydrocarbons. The run time of the test gas injected at the inlet indicates the total run time of the pipeline. As the total run time is known, the difference between the arrival of the medium out of the pipeline and that of the test gas can be used to derive the leak site. Due to the material-specific properties of the hose, the use of sensor hoses usually only takes place in short pipelines. The analyzing units can detect very small volumes of substances meaning even the smallest of leaks can be detected. Just as with fiber optic cables, when installing the sensor hoses pay attention to the positioning of the hoses above or below the pipeline.

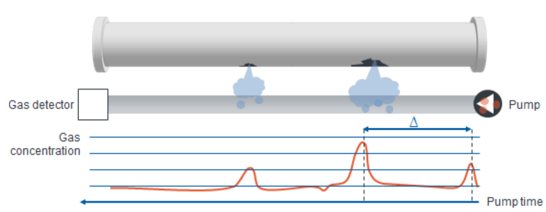

Figure 8: Sensor Hose Leak Detection

Before we look at the individual methods of internal continuous leak detection let's first take a look at the basic functioning of these systems. When there is a leak the pressure and flow patterns in the pipeline change. These changes are recorded by the instrumentation and the SCADA system transmits them to the control room. The leak detection system then calculates whether there is a leak in the pipeline and the operator is informed at the Operator Station of the current status. Continuous internal systems are based on the following principles:

- Pressure point analysis
- Mass or volume balance methods
- Statistical systems
- Real Time Transient Model (RTTM) based systems
- Extended-RTTM (E-RTTM) based systems

Pressure point analysis is based on the evaluation of pressure drop or the pressure profile measured at individual points. As a spontaneous leak brings up a characteristic change in the pressure drop, you can check whether the measured pressure drop, DP within a time period DT exceeds set thresholds. In addition to an upper threshold, a lower threshold for the pressure is also determined and if either one of these events occurs; the system triggers a leak alarm.

Another type of internal leak detection system is based on Antoine Lavoisier's conservation of mass principle. According to this principle, mass in a closed system remains constant and is not changed by processes within the system. If the pipeline is considered to be a closed system and you compare the mass flow at the inlet and the outlet, the difference in a leak-free case should always equal zero. If, however, a leak occurs, the system has been opened and mass escapes. This results in a decrease in the measured mass flow at the outlet and an increase in the mass flow at the inlet.

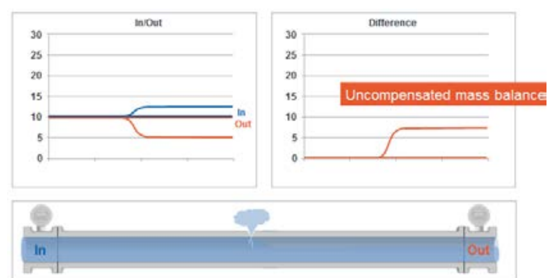

Figure 9: Mass / Volume Balance

The problem with this type of leak detection is that it does not take into account dynamic changes in the contents of the pipe, often referred to as line pack. This can happen, for example, when a gas pipeline produces more product than is currently being consumed and the pipeline packs, serving as a large tank or cache. This type of leak detection is thus also known as uncompensated mass balance.

Statistical leak detection systems subject a previously determined variable to a statistical test. Common statistical variables include pressure change over time and the result of a mass balancing. The so-called hypothesis test is widely used here. With this test, two hypotheses are prepared, namely:

- Hypothesis H_0: No leak
- Hypothesis H_1: Leak

The system checks whether there is enough data for the statistical variable to be a plausible part of the leak hypothesis and if it is, sends out an alarm.

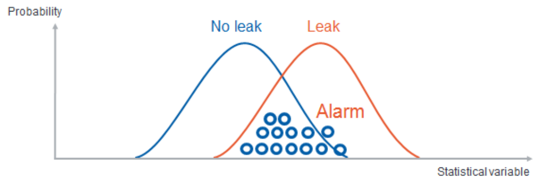

Figure 10: Statistical Analysis

Real Time Transient Model or RTTM systems can compensate for dynamic changes. To do this, they make use of basic physical laws which the pipeline must obey:

- The conservation of mass principle, which includes the density ρ, the time t, the flow velocity v and the pipeline location coordinates s
- The conservation of momentum principle, which includes the flow velocity v, the time t, the pressure P, the pipeline location coordinates s, and the pipeline friction f_s
- The conservation of energy principle, which includes the enthalpy h, the time t, the density ρ, the pressure P, and the specific loss performance L

These physical principles precisely describe the stationary and transient behavior of the flow in the pipeline. Using these equations flow, pressure, temperature and density can be calculated and integrated in real time for each point along the pipeline. These trends are also known as hydraulic profiles and accurately predict the true performance along the entire pipeline.

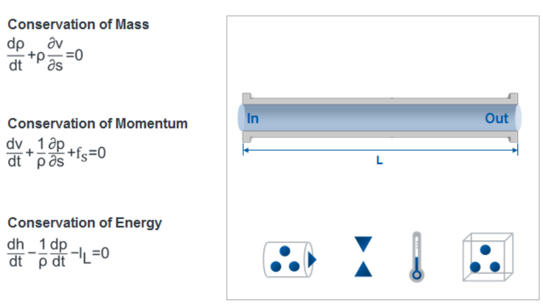

Figure 11: Real Time Transient Model

But how do we actually detect leaks? To answer that question, let's take a closer look at the individual measurements. We also talk about RTTM-compensated mass balancing. At the inlet the pressure P_0 and the temperature t_0 are measured and at the outlet the pressure P_L and the temperature T_L are measured. Using these measurements along with detailed knowledge of the pipeline geometry and the properties of the product being transported the leak detection system calculates the actual change in pipe contents or line pack. This is subtracted from the difference between the measured flow values F_0 at the inlet and F_L at the outlet and results with the current, compensated leak rate of the system.

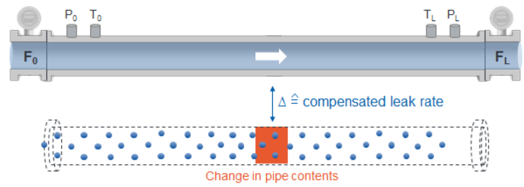

Figure 12: Compensated Mass Balance

E-RTTM systems use the same principle as RTTM systems. The pressure P_0 and the temperature T_0 are measured at the inlet and the pressure P_L and the temperature T_L are measured at the outlet. Using these measurements as boundary conditions the leak detection system calculates using the laws of physics, expected flow rates at the inlet and outlet. These expected values are then compared to the measured flow values F_0 at the inlet and F_L at the outlet. Subtracting the expected from measured values we then obtain the so-called residuals:

- X = measured flow at the inlet – calculated flow at the inlet
- Y = measured flow at the outlet – calculated flow at the outlet

In a leak-free situation, both X and Y should equal ~ 0. In the event of a leak, we see deviations where residual X > 0 and residual Y < 0.

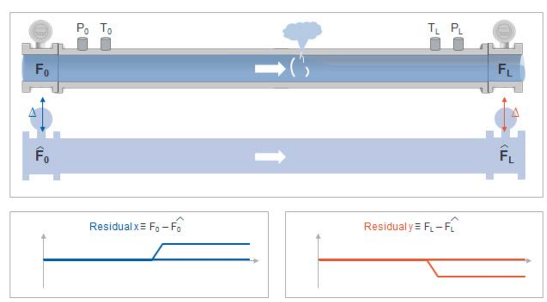

Figure 13: Residual shift due to leak

In order to avoid false alarms, E-RTTM systems also use leak pattern recognition. The system uses the residuals x and y as decision values and a leak situation is not the immediate result of a deviation. Let's take a look at residual x. Leak pattern detection accesses an expandable database of different leak signatures and can thus differentiate between accidental interference (such as instrument drift) and leaks. Thanks to this special type of signal evaluation, small leaks are reliably detected and false alarms avoided.

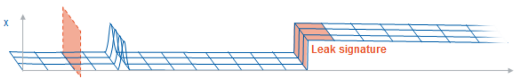

Figure 14: Pattern Recognition

Now that we know how the different internal leak detection systems function, let's take a look at their capabilities. Pressure point analysis shows a typical minimum detectable leak rate starting at 5% of nominal pipeline flow rate. Detection time for liquid pipelines is short, for gas pipelines it is long and only spontaneously occurring leaks can be detected. The frequency of false alarms is relatively high. With additional pressure gauges, high accuracy when it comes to localizing leaks is possible, depending on the sensor sampling rate.

Method	Typical min. detectable leak rate	Time to detect leak (liquids)	Time to detect leak (gases)	Detectable types of leak	False alarm frequency
Pressure point analysis	> 5%	Short	Long	Spontaneous leaks	High
Mass balance method	> 1%	Long	Very long	Spontaneous and creeping leaks	High
Statistical methods	> 0.5%	Long	Very long	Spontaneous and creeping leaks	Slight
RTTM	> 1%	Short	Short	Spontaneous and creeping leaks	Average
E-RTTM	> 0.5%	Very short	Short	Spontaneous and creeping leaks	Slight

Figure 15: Typical Performance of LDS's

Mass balance methods can typically detect leaks starting at a 1% leak rate. The time needed to detect leaks for both liquids and gases is longer but creeping leaks can also be detected. The frequency of false alarms is high in this case as well, especially with transient pipeline operation.

Statistical methods generally detect leaks starting at a 0.5% leak rate but the detection times are longer. Both spontaneous and creeping leaks are detected and the frequency of false alarms is low.

RTTM-based systems detect both spontaneous and creeping leaks quickly with a typical minimum leak rate starting at 1%. The frequency of false alarms is average. E-RTTM systems can detect leaks in liquid pipelines very quickly and in gas pipelines quickly starting typically at a 0.5% leak rate. Spontaneous and creeping leaks are detected and accuracy is high, as with RTTM-based systems. The frequency of false alarms is reduced or even eliminated with the use of pattern recognition.

Leak Localization

When leaks occur in pipelines, it is not enough to know that a leak has occurred; you must also know where it is located. There are several methods that can be used to localize the leak. Internal leak detection systems include:

- Gradient Intersection Method
- Wave Propagation Method
- Extended Wave Propagation Method

These methods can be combined to improve accuracy and to ensure that it is actually possible to localize the leak. Let's go into some detail on these methods to become familiar with the advantages and limitations of each method.

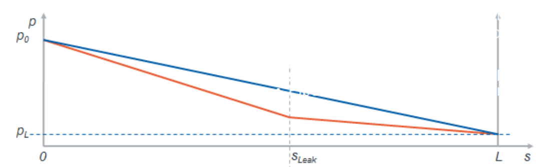

Figure 16: Gradient Intersect Method

The Gradient Intersection Method uses the pressure profile along the pipeline to localize the leak. Ideally, the pressure drop is linear (in a horizontal pipeline without elevation changes). If a leak occurs, the flow before the leak site increases and decreases after. This results in an increase in the pressure drop before the leak and decreases after the leak, whereby we obtain two lines with different slopes for the pressure profile. If you then follow the lines to the intersection, the leak site can be determined. The advantages of this method are that spontaneous and creeping leaks can be localized and that the accuracy is good in stationary operation. One weakness of this method is that the accuracy depends on the total length of the pipeline and that localizing accuracy is not good in transient operation. In addition, with non-model-based systems you must take into account any changes in the height, cross-section and pipe friction along the pipeline because the pressure drop is then nonlinear due to these physical attributes of the pipeline and not from a leak.

The Wave Propagation Method uses the sound velocity of the medium in the pipeline. Spontaneously occurring leaks create a negative pressure wave which propagates in both directions of the pipeline at the speed of sound. Pressure gauges at the inlet and outlet record these pressure waves and we obtain the point in time at which the pressure wave reached the sensors.

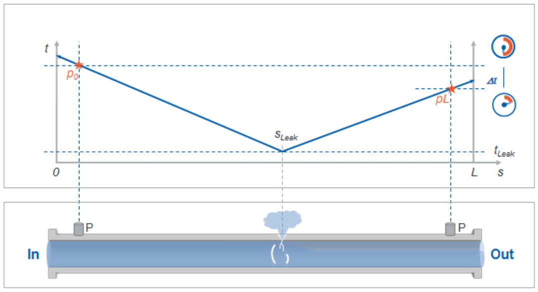

Figure 17: Wave Propagation Method

The differential time of arrival of the pressure wave can now be obtained from these points in time. If the pressure wave arrives at both sensors at the same time that would mean that the leak was in the middle of the pipeline as the wave propagates in both directions at the speed of sound of the media, and if we assume a uniform density travels at the same speed in both directions. The Wave Propagation Method boasts good accuracy during stationary and transient operation as long as operational pressure waves are compensated for. The method can be used during pumping and during pauses in pumping. Creeping leaks and spontaneous leaks that are not large enough cannot be detected with this method as the negative pressure wave in these cases are not large enough. In addition, the pressure gauges must sample quickly in order to measure the point in time of the pressure wave as accurately as possible.

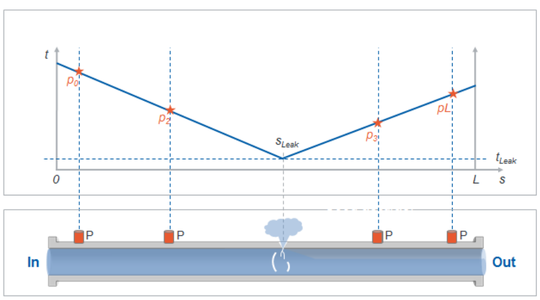

Figure 18: Expanded Wave Propagation

To attain better accuracy the Wave Propagation Method can be expanded by adding more pressure gauges. Now when a leak occurs, we obtain additional points in time at which the pressure wave reaches the sensors. By now taking into account the sensor sampling time and the actual fluid density / sound velocity profile the exact point in time at which the pressure wave reached the sensors can be narrowed down even further.

Additional Functionality

In addition to leak detection and localizing, leak detection systems can also take on other functions. One of these is efficiency analysis, for example. The efficiency of a pipeline decreases over time. Residues and deposits constrict the cross-section, pipe friction increases and with that the resistance of the pipeline against which the pump must work. A modern leak detection system can monitor the efficiency status of the pipeline and help the user operate his pipeline in an energy-saving, economic way, by indicating the current efficiency.

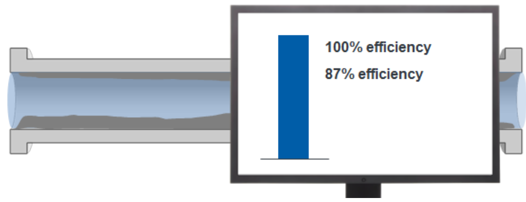

Figure 19: Efficiency Analysis

In addition, model-supported systems with the help of density profiles can portray an exact calculation of the contents of the pipeline. This can be used, for example, to financially evaluate the amount of product currently stored in the pipeline. This can be of great benefit, especially when it comes to long transport pipelines.

Operator training is another added function. Simulated or recorded field data can saved and replayed to be used to train the operator directly at the HMI.

In the case of theft, even the smallest leaks must be detected. This requires a particularly high sensitivity such as that offered by state-of-the-art leak detection systems.

It is also possible for the leak detection system to analyze the hydraulic profiles. In this way, taking into account the elevation profile of the pipeline, it can illustrate the pressure profile and in the case of over or under pressure, e.g. undershooting the vapor pressure of the medium, set off an alarm indicating a ‘slack’ line condition.

In the case of multi-product pipelines, it is interesting to know what product is flowing through the pipeline at any given time. Using the leak detection system you can perform batch tracking. Here, the positions of the products and mixing zones within the pipeline are tracked. Batch scheduling allows arrival times and capacities to be planned. Deliveries to individual tanks and buyers can also be scheduled. It is also possible to reduce the waste created by the mixing of products in the pipeline.

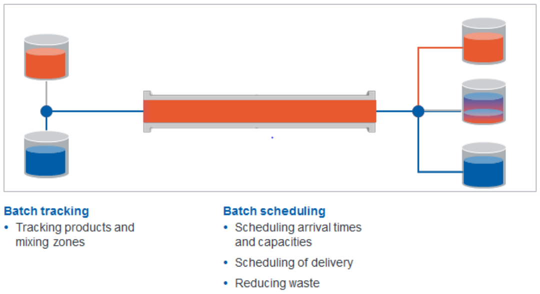

Figure 20: Multi-Product Batch Tracking

Summary

Pipelines and thus also leak detection systems can be found in a wide variety of areas for various products. Accordingly, the challenges that the leak detection system faces vary depending on the application.

At the end of the day, the question is which leak detection system is the right one? There is no one right leak detection system. The selection must always be made while taking into consideration the requirements placed on the application. That means it is necessary to make a decision for each application. Among other things, proper selection depends on the desired results, the cost of installation, operation, maintenance and servicing of the leak detection system and the installation conditions such as if a pipeline has to be dug up or uncovered.

Modern leak detection systems function in a wide variety of environments and allow for individual adaptation to customer surroundings, guaranteeing optimal performance under all normal operating conditions.