PipePatrol

Pipeline Management Solutions

E-RTTM
pipeline leak detection

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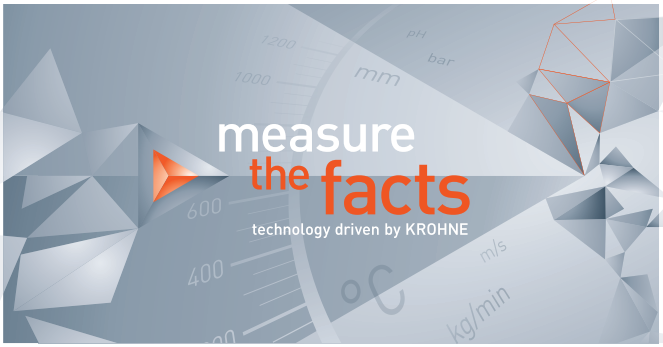
KROHNE
measure the facts

- Comprehensive suite of modules for leak, theft and line break detection as well as monitoring of tightness and lifetime stress
- Complete and sensitive protection of oil, gas, water and multiproduct pipelines
- E-RTTM (Extended Real Time Transient Model) based leak detection and localisation
- From single software applications to full packages including instrumentation, cyber security and field data acquisition



KROHNE – Measure the facts

Welcome to KROHNE. As a leader in process measuring technology, we're at home in a wide variety of industries worldwide. The name KROHNE has stood for innovative and **reliable solutions since 1921.** The company now offers a whole spectrum of instruments for **flow, level, temperature and pressure measurement as well as process analysis.** Our portfolio is completed by comprehensive service support and consulting.

Developed in conjunction with leading experts from one of Germany's technical universities, PipePatrol was initially designed for the most demanding pipelines in German industry. After extensive testing and TÜV approval, the product was subsequently released into the global market.

With over **30 years of experience in the field of leak detection,** PipePatrol has been successfully implemented on more than **350 pipelines throughout the world,** easily meeting or exceeding all applicable quality and performance regulations, such as the German TRFL, the American API 1130 and 1175 and the Canadian CSA Z622.

PipePatrol – Smart monitoring and protection of your pipeline

PipePatrol offers a comprehensive suite of modules for leak, theft and line break detection as well as monitoring of tightness and lifetime stress. The combination of **products, solutions and services for complete pipeline management** addresses operational, security, environmental and legislative requirements.

KROHNE provides solutions for the **monitoring and protection of pipelines** in all operating conditions. Whether you operate a long or short distance pipeline for oil, gas, water or refined products in the chemical or any other industry, you can select single detection systems or complete solutions customised to your special needs and application.

The unique technology of PipePatrol can be complemented by a **wide range of instruments** and **field data acquisition systems** from KROHNE and its partners.

Typical applications

- Crude oil pipelines from oil fields to refineries
- Multiproduct pipelines from refineries to tank farms
- Subsea pipelines from FPSO units and platforms
- Non-continuously operated transport pipelines (e.g. for jet fuel)
- Water pipelines from desalination plants to cities
- Natural gas pipelines

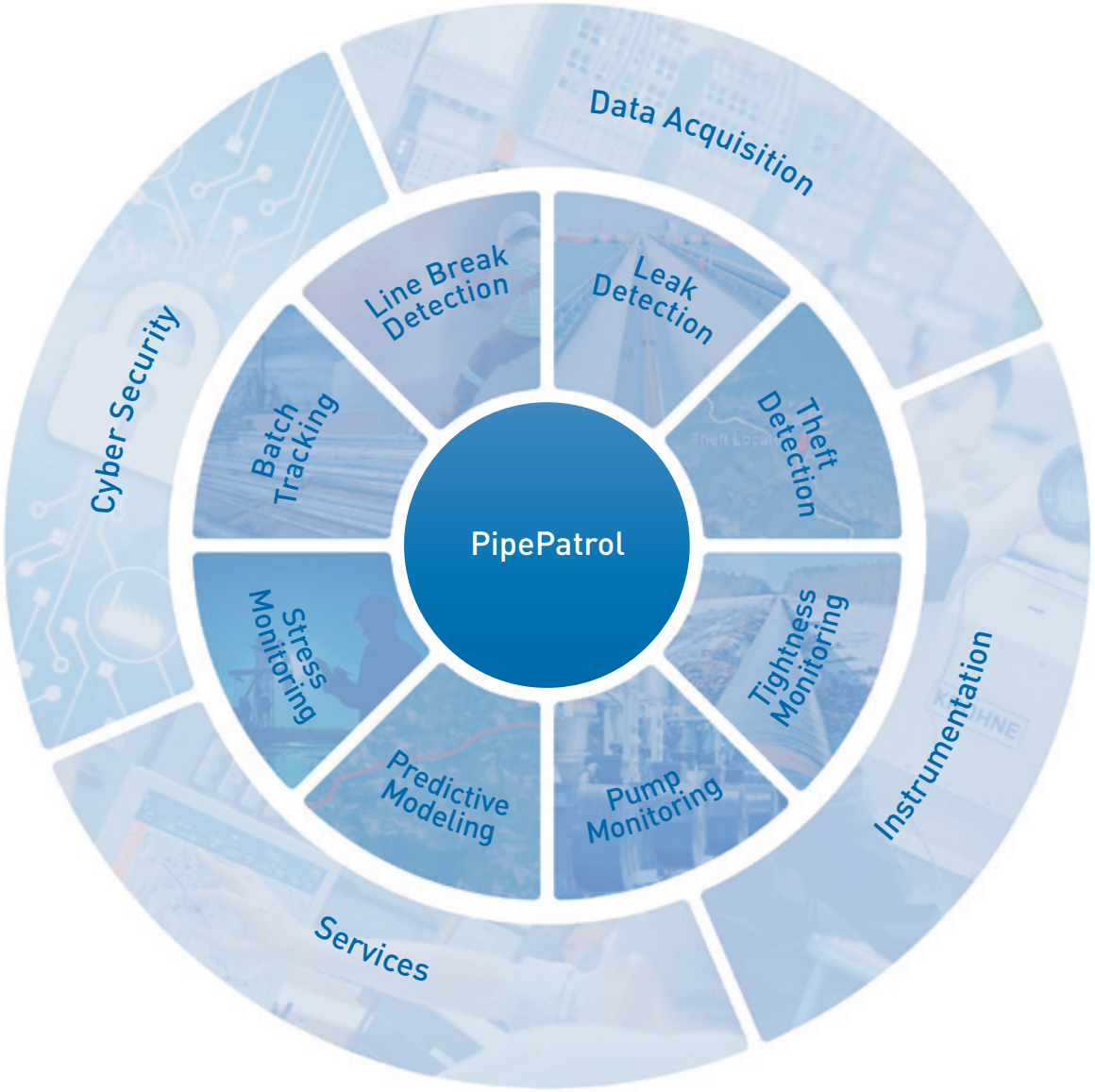
PipePatrol modules

The PipePatrol Pipeline Management suite has been designed in a way that it can be adapted to achieve best results and meet operator requirements in line with the application and the available budget.

The operator now can choose to either start with single software application modules such as Leak or Theft Detection or to get the full Pipeline Management package consisting of several modules, plus the related instrumentation and data acquisition technology as well as dedicated services.

Recommended modules for the different pipeline applications:

	Oil/Liquid pipelines	Chemical and natural gas pipelines	Multiproduct pipelines	Offshore applications	Water transmission pipelines	High consequence areas	Short distance pipelines	Fulfill TRFL requirements	Fulfill API requirements	Perform non-intrusive and autonomous LDS
Leak Detection	•	•	•	•	•	•	•	•	•	•
Theft Detection	•		•							
Stress Monitoring	•	•	•	•	•		•	•		
Line Break Detection	•	•	•			•				
Tightness Monitoring	•	•	•				•	•		
Batch Tracking	•		•							
Predictive Modeling		•		•						
Pump Monitoring	•		•							
Instrumentation	•	•	•	•	•	•	•	•	•	•
Data Acquisition	•	•	•	•	•	•	•	•	•	•
Cyber Security	•	•	•	•	•	•	•	•	•	•
Services	•	•	•	•	•	•	•	•	•	•


Data Acquisition
Instrumentation
Services
Cyber Security
Line Break Detection
Leak Detection
Theft Detection
Tightness Monitoring
Pump Monitoring
Predictive Modeling
Stress Monitoring
Batch Tracking
PipePatrol

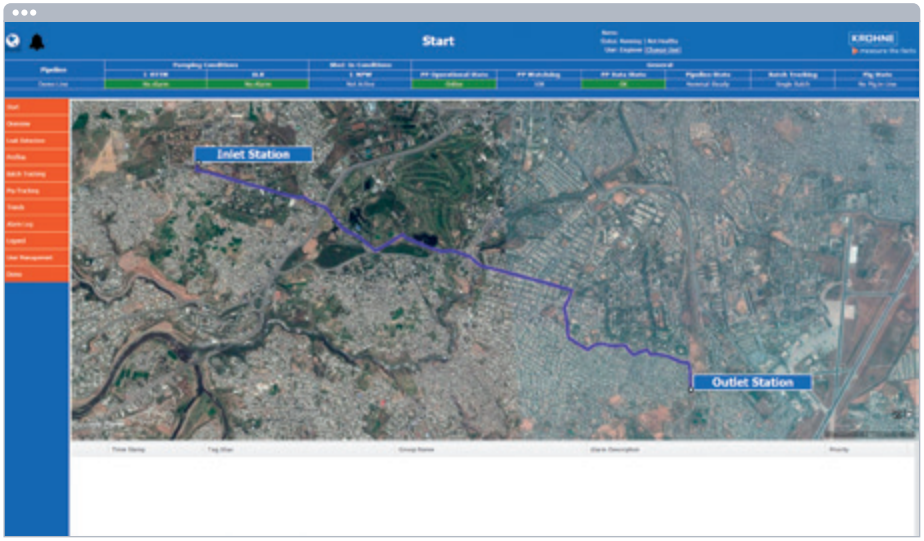
Leak Detection

PipePatrol is the **most sensitive internal leak detection** system available, providing accurate leak information for a high degree of safety. Its **multi-method leak detection** enables pipeline management under both steady and transient pipeline conditions. This way, the LDS is able to reliably distinguish between real leaks and imbalance deviations caused by line pack changes or separation units.

PipePatrol Leak Detection can be retrofitted onto existing pipelines, using existing instrumentation. KROHNE also supplies complete project packages, including flow and other instrumentation, complete with remote data communications.

Highlights:

- Pipeline **leak detection system** for liquids or gases
- **E-RTTM** (Extended Real Time Transient Model) based leak detection and localisation
- Meets **API 1130, API 1175,** German TRFL standards and CSA Z662
- System is either **independent,** or can be **integrated** with existing systems



30 seconds to detect a leak on a 31 km pipeline with ± 0.6 % location accuracy

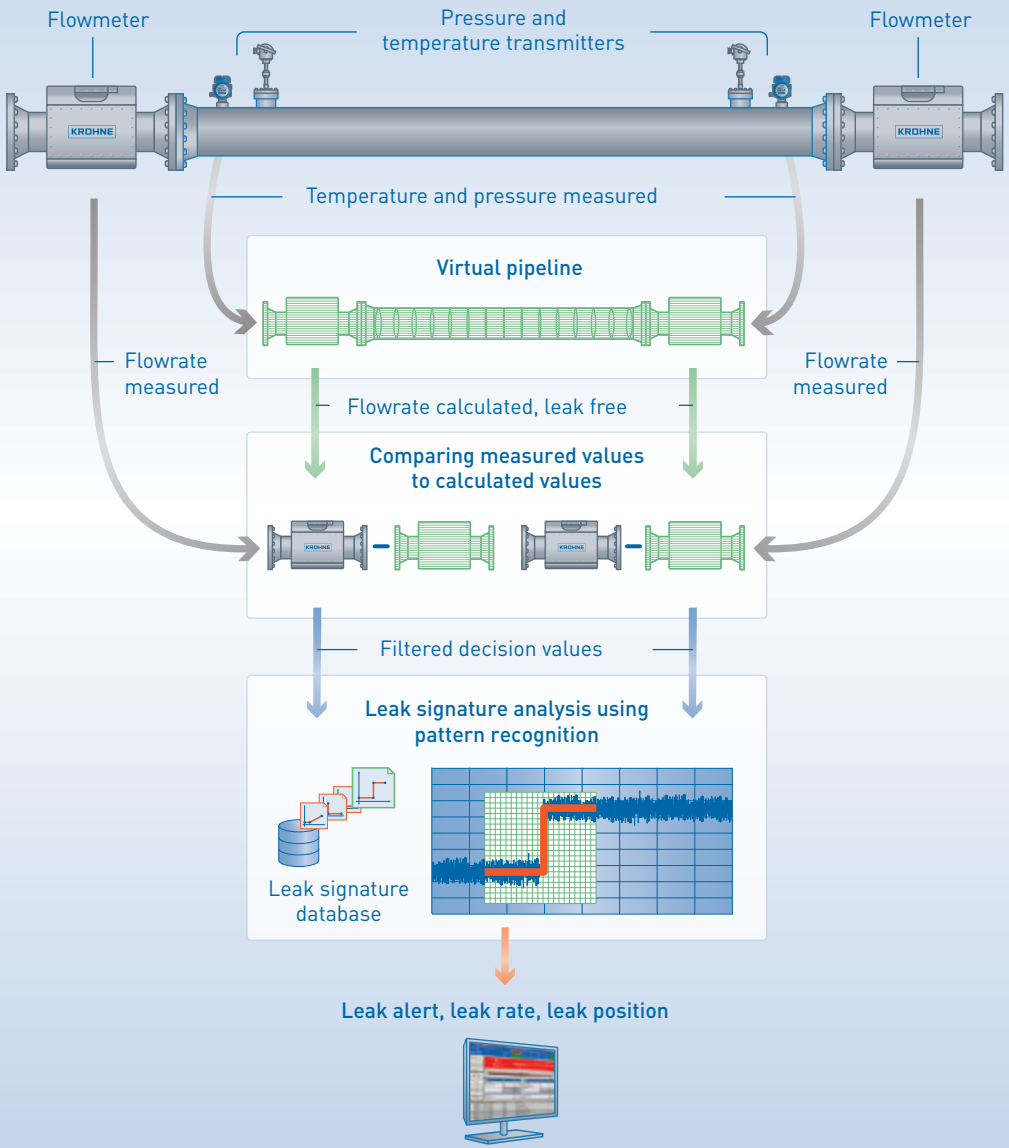
Extended Real-Time Transient Model (E-RTTM)

E-RTTM is the only technology that allows fast and sensitive leak detection in any kind of pipeline operation. PipePatrol's **unique leak pattern recognition** is a proven technology that compares what is actually happening in a pipeline – without generating false alarms.

Unlike other systems, it does not simply compare outlet flow with inlet flow. Instead, it uses the measured conditions to calculate the hydraulic profiles of the pipeline. One of these, the calculated flow profile, is compared to the measured flow for both inlet and outlet.

PipePatrol's signature analysis uses leak pattern recognition to analyse this data continuously and determine the leak status of the pipeline. Because E-RTTM uses relative values, it continues to work effectively under transient pipeline conditions, without any significant effect on its sensitivity.

Principle of Extended Real-Time Transient Model (E-RTTM)



Theft Detection

PipePatrol Theft Detection uses dedicated pattern recognition, to provide fast and reliable **identification and localisation of unauthorised or illegal product discharges,** typically theft. Even for small volumes, the system initiates an alarm within minutes, making it possible to stop theft in the act. To alert the relevant staff, the system provides alarm reporting via e-mail, accompanied by **Google Earth® integration showing the theft location,** enabling a field team to take coordinated and swift action.

For identification of the actual theft times and locations, KROHNE also provide a **post theft analysis service.**

Highlights:

- Dedicated **theft pattern recognition** for product theft detection
- Provides **alarm and theft reporting** via e-mail
- Includes the KROHNE SynEnergy v3 web-based user interface
- Delivers a **Google Earth® location report** to support the field team, enabling swift reactions
- Compatible with any device supporting HTML5, e-mail and Google Earth® (e.g. Android, IOS, Windows)
- Additional **post theft analysis** service

Alarm reporting

The system provides alarm reporting via e-mail, accompanied by Google Earth® integration showing the theft location.

Stress monitoring

Pipelines are constantly working under mechanical stress during normal operations and load cycles. External influences, such as temperature extremes, mechanical shock or vibrations, can increase the local line pressure. Any design pressure violation can have a major effect on the pipeline lifetime. Modern regulations often now require operators to document and evaluate these effects.

This PipePatrol module performs stress monitoring of the pipeline without human interaction and hence provides the base data for an **assessment of the remaining pipeline service life.** The software monitors the pressure measurements at sensor points along the pipeline and compares them with the pressure levels according to DIN 45667 and in line with regulation TRFL 2017. These results contribute **predictive maintenance planning,** to ensure the necessary integrity check is done before critical conditions occur.

Highlights:

- Provides the base data for the assessment of pipeline ageing to **calculate the remaining service life**
- Monitors design pressure violations and load cycles at each measurement point
- Records pressure cycles to plan for the **next integrity check**
- Pressure cycles are counted according to **industry standard DIN 45667**

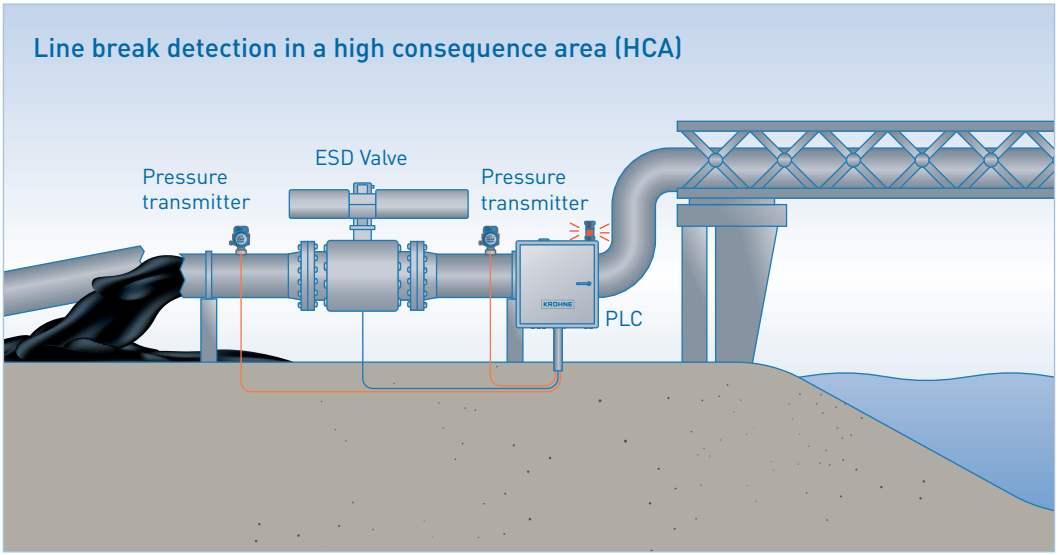
Line Break Detection

Pipeline ruptures can result in dramatic consequences, endangering public safety and the environment. It is critical that fast acting rupture detection, response systems and procedures are designed, structured, and executed effectively. This is especially true for high consequence areas (HCA), where populated areas, ecological resources or water sources are in danger.

PipePatrol Line Break Detection is a dedicated system to **efficiently detect pipeline ruptures instantly,** raise an alarm and **initiate emergency pipeline shutdown procedures.** The system consists of a local PLC with rupture pattern recognition installed, plus two pressure transmitters to act as the pipeline rupture detection sensors. The PipePatrol system includes a self-learning feature for easy commissioning and tuning to the local pipeline operational conditions.

Highlights:

- Pipeline rupture pattern recognition system for **automatic emergency shutdown**
- **Self-learning feature** eases commissioning work in site
- Can be autonomous or integrated into a complete leak detection system
- Configuration via **local display** or by **remote access**
- Fail-safe system version available



Reliable and fast acting to minimize environmental effects and danger

Tightness Monitoring

Small or gradual leaks are often not covered by standard systems, as pressure and temperature changes along the pipeline can mask small losses. The detection solutions possible are normally time and cost intensive.

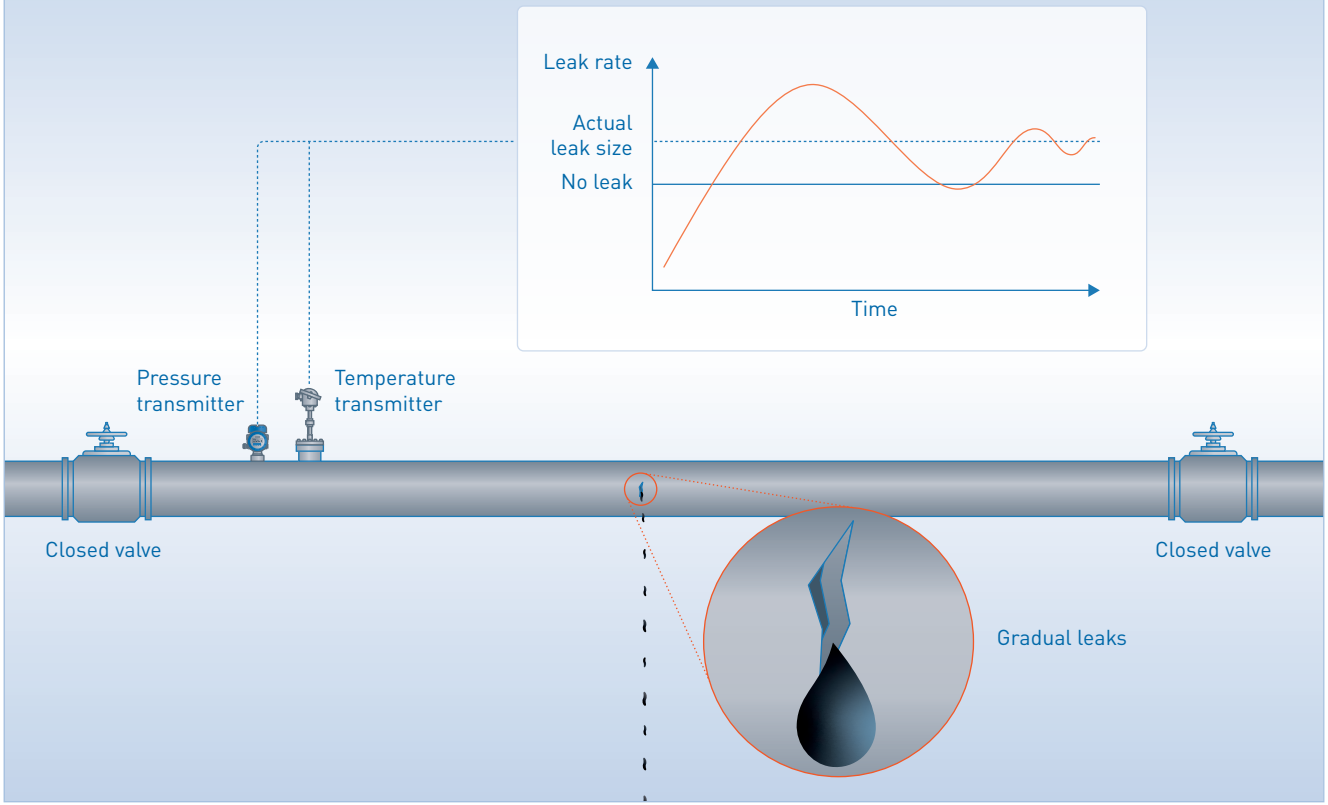
PipePatrol Tightness Monitoring is a method for the **detection of gradual leaks** using standard pressure and temperature instrumentation. This solution completely fulfils the **requirements of TRFL 2017 and VdTÜV Bulletin 1051.** It automatically creates a report according to these regulations and has been validated by independent 3rd party authorities.

PipePatrol Tightness Monitoring avoids the classical pressure tests where the pipeline has to be filled with water, as it works with the actual gas or liquid in the pipeline, avoiding any negative effects on normal pipeline operation.

Highlights:

- Fulfils German requirement **TRFL 2017** and **VdTÜV Bulletin 1051**
- **Continuous and automatic reporting** according to regulatory requirements
- Export of data for further analysis tools
- **Easy retro-fit** through variable interface (OPC-Server)
- Approved by independent 3rd party authority

Principle of tightness monitoring



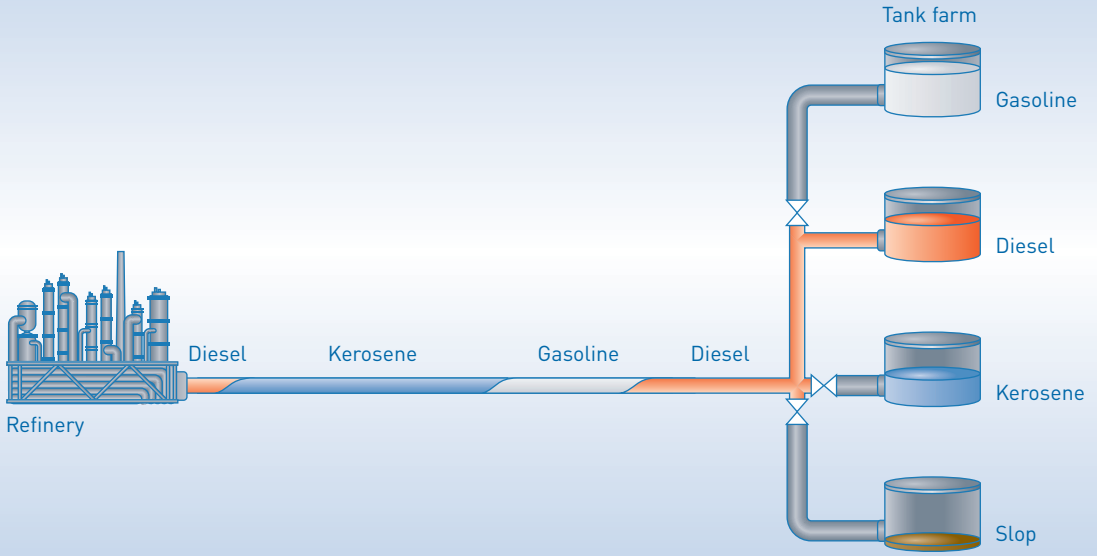
Batch Tracking

The determination of the position of a batched product and identifying the mixing zone, enables **accurate predictions for arrival times** and **amounts of pure product available.** In addition, separation of the interface from the actual product is easier, enabling planning for the most efficient yields.

This PipePatrol module **tracks every batch and interface in multi-product pipelines,** where several products such as gasoline, diesel and jet fuel are transported in sequence. It ensures safe operation as well as optimum capacity use of the pipeline. This enables the operator to minimise slop volume and increase the overall yields.

For even better results PipePatrol Batch Tracking accepts input data from instruments along the pipeline, such as density meters or ultrasonic flowmeters, e.g. the KROHNE OPTISONIC 6300 clamp-on flowmeter.

Batch and interface tracking in multi-product pipelines



Pump Monitoring

The **control cabinet solution for monitoring pumps and motors** provides an opportunity to substantially reduce the operational energy consumption through demand-oriented system management. The monitoring of the essential mechanical, electrical, and hydrodynamic measurement values enables predictive maintenance and, therefore, higher system availability.

All relevant settings can be displayed and configured via an **integrated touch panel** or simply by means of **remote access.**

Highlights:

- Minimisation of repair work, thanks to **predictive maintenance**
- Minimised operation-related power consumption
- **Increase in system availability** through vibration and bearing image analysis
- **Quick parametrisation and diagnosis** using integrated touch panel with graphics-capable TFT display

On-site overview of the data thanks to touch panel operation on the control cabinet solution

Reliable pump monitoring by means of vibration sensors as a full solution

Predictive Modeling

PipePatrol Predictive Modeling is a **simulation tool to predict pipeline conditions** from current operating and manually definable static data. The predictor uses a CFD-based simulation kernel, permanently supplied with real measurement data from the pipeline network. The simulation takes place in parallel, and presents the thermodynamic and fluid-mechanical conditions.

The online monitoring and static prediction modules **forecast the future events and states of the simulated pipelines.** Different types of rules can be defined, such as different values for pre- and main alarms.The forecast plots allow the user to view both the current signal values and the calculated future values. Possible rule violations are graphically represented and can be exported for example as a CSV file.

Highlights:

- **Continuous monitoring of pipelines** for the occurrence of inadmissible operating conditions
- **Predictive pipeline state simulation** based on optional operator process intervention
- **Modular architecture:** Installation on any computer in the same network as the service host

Mass flow and pressure live data

The monitoring modules forecast the future events and states of the simulated pipelines

Data transmission from the field

Together with our partners we provide a large number of reliable systems for data acquisition and transmission. This is based on infrastructures that guarantee a particularly **reliable transmission** and on components for data encryption.

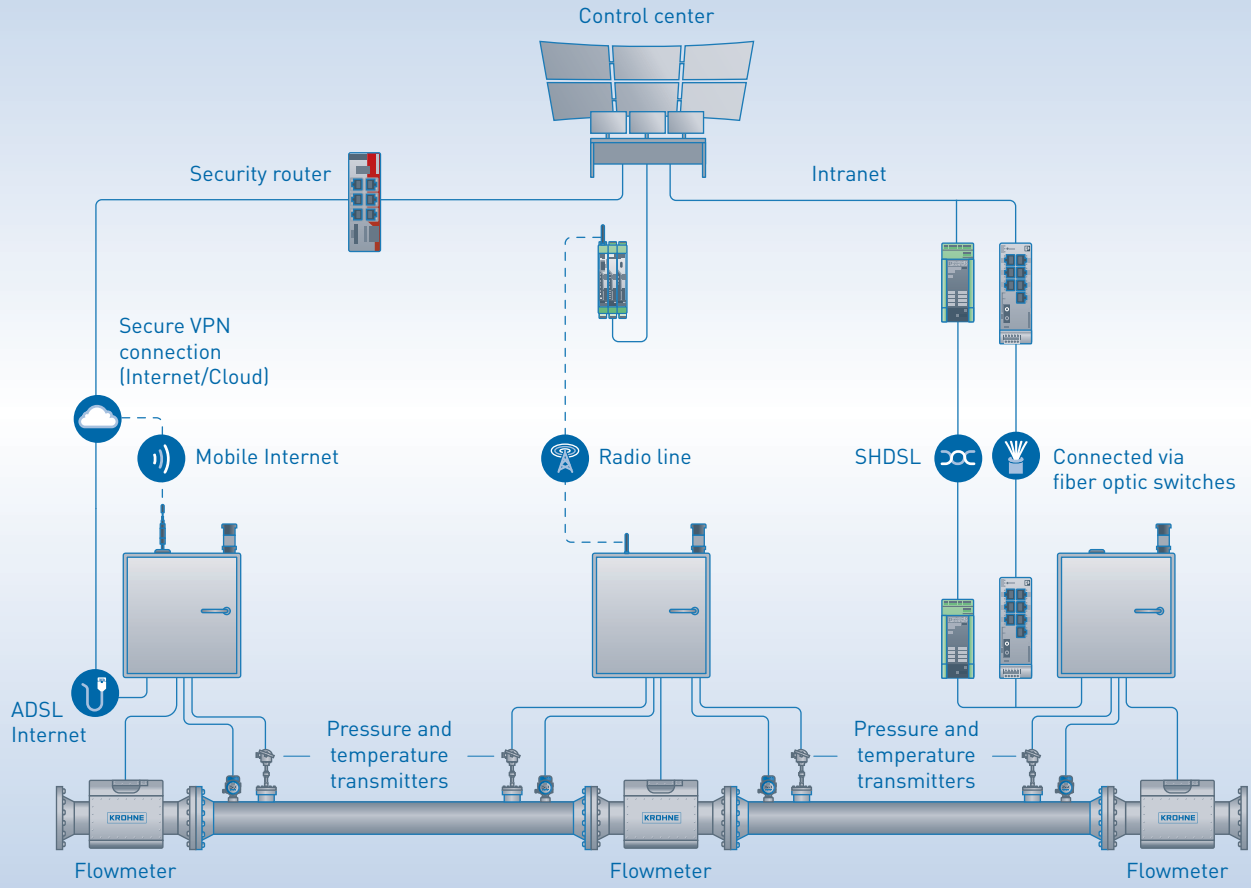
At different measuring stations, precise time stamps are added to data concerning flow rate, pressure, and temperature; then this data is transmitted to the control system. Even under harsh environmental conditions with fluctuations in temperature, the particularly robust components allow reliable data transmission over the respective distances.

The transmission options, e.g. Internet connections secured via VPN tunnel and SHDSL, mobile, Radio line, and WLAN connections, are all **adapted to local conditions and enable optimal data transmission.**

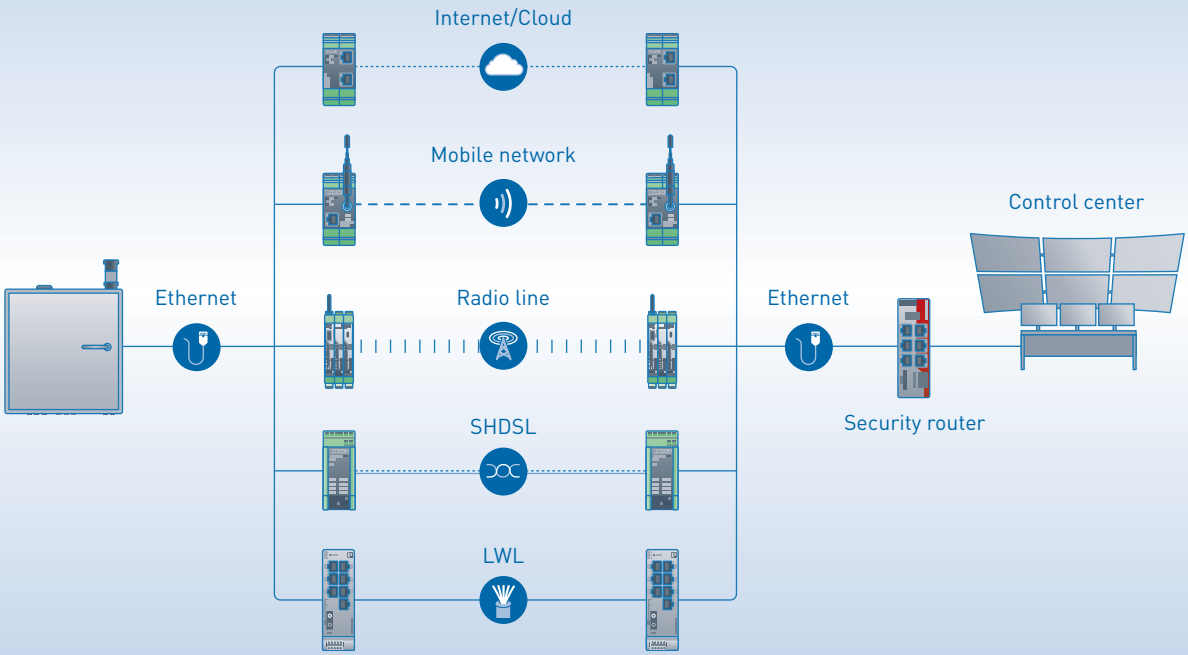
Highlights:

- Comprehensive **transmission options** for individual infrastructures
- Particularly **safe communication,** fulfilling the latest safety standards
- Complete, well coordinated system solutions from a single source

Data acquisition for pipeline management



Connectivity options between measuring points and control center



Cyber Security

In order to guarantee secure data transmission and the function of pipeline monitoring systems, the cyber security solutions are an essential part of the necessary scope of supply for any modern system.

Highlights:

- **Maximum safety level** with stateful inspection firewall and deep packet inspection
- **Easy and secure remote maintenance,** thanks to VPN connection and IPsec protocol
- High performance with a data throughput of up to 99 Mbps
- **Wide range of possible applications:** as a compact DIN rail module, in PCI format or as a portable device with USB supply
- Grows in line with your requirements, thanks to licenses and function extensions

Secure data transmission with dedicated security routers

Pipeline instrumentation

With PipePatrol KROHNE offers complete solutions, from leak detection, data acquisition to pipeline instrumentation. The Pipeline Management Solutions provide monitoring and protection for pipelines in all operating conditions. PipePatrol can use existing instrumentation or provide tailor-made technical solutions for your measurement requirements.

Flowmeters

OPTISONIC 3400

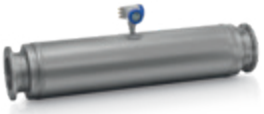
Ultrasonic flowmeter for liquid process applications

ALTOSONIC 5

Ultrasonic flowmeter for custody transfer (CT) measurement in upstream and midstream applications

ALTOSONIC V12

Ultrasonic flowmeter for custody transfer (CT) measurement of gases



OPTIMASS 2400/ 6400

Coriolis mass flowmeter for highest capacity CT bulk measurement or advanced process applications with EGM™

Pressure transmitters and temperature assemblies

OPTIBAR PC 5060

Pressure transmitter for advanced process pressure applications

OPTITEMP TRA-TF56 /TRA-TS53

Resistance (RTD) temperature assembly for high flow velocities and pressures

OPTITEMP TRA-W30

Resistance (RTD) cable sensor for surface temperature measurement in industrial applications

OPTITEMP TRA-W80

Resistance (RTD) cable sensor for measurement of soil temperature

Pipeline Management Services

PipePatrol encompasses more than just the necessary hardware and modular software suite. It also comprises the whole project management **from consultation to instrumentation, integration and service support.**

In addition to the PipePatrol Pipeline Management Solutions, KROHNE is committed to offer excellent **pre- and after-sales service** for our customers. We can provide additional support by our consultants, either project related or via maintenance contracts. These services cover:

- Consultancy regarding the operation and design of pipelines
- Support during the certification
- Manual offline analysis of pipeline processes
- Seminars and training
- Maintenance contracts
- 24/7 hotline
- Post theft analysis
- Leak testing

References

With over 30 years of experience, PipePatrol has been successfully implemented on more than 350 pipelines throughout the world.

References include pipelines for:

- Gas (including non-ideal sub-critical and supercritical/dense phase gases)
- Single product liquids
- Crude oil
- Multi-product liquids (including refined products)
- LPG, LNG
- Brine
- Water and wastewater

Compliance to regulations and standards

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

PipePatrol complies with international standards for Pipeline Management and Leak Detection Systems including but not limited to:	• API RP 1130 • API RP 1149 • API RP 1175 • TRFL – Technical Rules for Pipelines • 49 CFR 195 – Transport of hazardous liquids via pipeline • Canadian Standard Association CSA-Z662-11 Annex E • SS 512 – Code of practice for the design, construction and operation of pipeline service corridors
PipePatrol complies with company standards including but not limited to:	• Shell DEP 31.40.60.11-Gen. • Kuwait Oil Company Recommended Practice KOC-MP-039 • DOW Global LDS Standard • Saudi Aramco SAES-Z003

KROHNE – Process instrumentation
and Measurement solutions

- Flow
- Level
- Temperature
- Pressure
- Process analysis
- Services

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