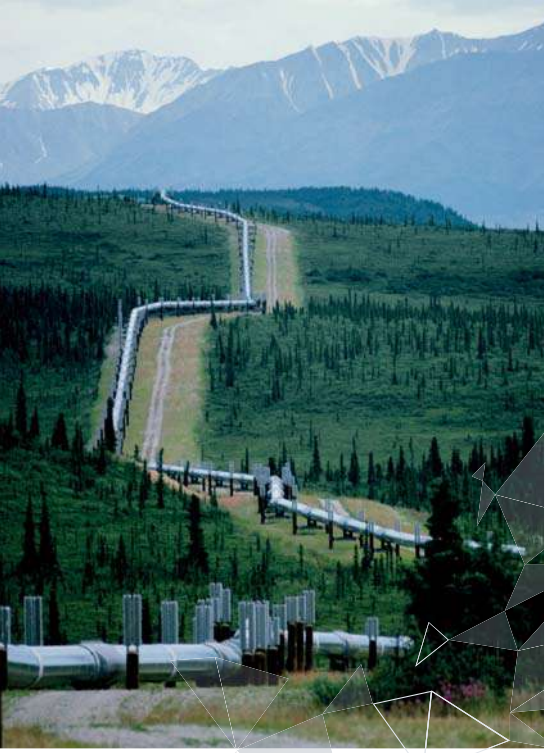
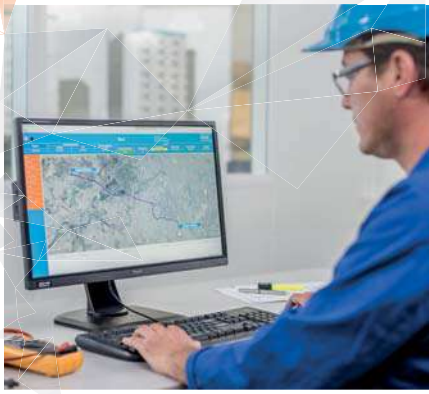
KROHNE
Oil & Gas

Products, Solutions and Services for the Oil and Gas Industry

Overview



measure
the facts
technology driven by KROHNE



Contents

KROHNE Oil & Gas – Pushing the limits for your measurement application

Our Industry Division KROHNE Oil & Gas is dedicated to servicing customers in the up-, mid- and downstream oil and gas industry. Our offering extends from elementary process instrumentation up to fully engineered metering systems, and from engineering consultancy during the design phase through to on-site commissioning and training.

Founded in 1921 as a manufacturer of variable area flowmeters, KROHNE nowadays is a family owned global company with a complete portfolio of instrumentation and measurement solutions. For many projects KROHNE acts as MIV (Main Instrument Vendor), reducing project uncertainty, risk and cost. With a local presence in around 100 countries, local support is available from just around the corner.

True to the KROHNE claim "Measure the facts", our engineers help oil and gas customers to realise reliable and accurate measurements. Do not hesitate to contact us to learn how we can help with improving process control and efficiency by tackling your metering challenges.
www.krohne.com/oilandgas
oilandgas@krohne.com

Some of our highlights:

1921
Ludwig Krohne starts manufacturing variable area flowmeters in Duisburg, Germany

1955
Mechanical level meters for measuring liquids in tanks

1978
Two beam in-line ultrasonic flowmeters

1981
Electromagnetic flowmeters with ceramic measuring tube

1989
FMCW radar level transmitters for process measurements

1994
Straight tube Coriolis mass flowmeters

1999
PipePatrol – pipeline management solutions for leak detection

2008
SUMMIT – flow computer with full colour touch screen

2011
OPTITEMP – temperature transmitters with insulation resistance monitoring to detect cracks in thermowell

2014
OPTIBAR – process pressure and differential pressure transmitters

2017
OPTIMASS – Coriolis mass flowmeters up to DN400 / 16" and 4,600 t/h

2019
WGS – Venturi-based metering systems for wet gas production

Products, solutions and services – One source portfolio for the entire oil and gas value chain

Solutions

- Metering and monitoring solutions from design concept to on-site commissioning
- Seamless integration of KROHNE and third party instrumentation
- Dedicated KROHNE supervisory and validation software
- In-house engineering, manufacturing, testing, commissioning and field-service

Services

- On-site installation, commissioning, start-up, training, maintenance and operational assistance
- Service Level Agreements (SLAs) consisting of scheduled maintenance, emergency response, spare parts management, remote and operational support
- Periodic inspection, validation, recalibrations and revamps, including environmental and metrological certification
- In-house training and seminars on instrumentation and (custody transfer) measurement principles

Products

- Complete instrumentation portfolio for flow, level, temperature and pressure measurement
- Large choice of measuring technologies, materials and connections
- High level of expertise in calibration – more than 120 in-house calibration facilities
- Advanced self-diagnostics features to enable process optimisation and use in safety systems

From wellhead to refinery – Our oil and gas application know-how is at your disposal

Visit www.krohne.com/oilandgas to learn what products, solutions and services KROHNE has to offer for typical oil and gas applications, such as:

- **Exploration and production**
  - Drilling, cementing, hydraulic fracturing
  - CO_2 and water injection, gas lift
  - Reservoir management
  - Water treatment
- **Liquefied Natural Gas**
  - Drying, filtering, liquefaction
  - Storage, transport
  - Regasification
  - LNG truck loading and fuelling
- **Refining**
  - Amine treatment
  - Catalytic reforming
  - Crude desalting
  - Delayed coking
  - Distillation
  - Fluid catalytic cracking
  - Gasoline blending
  - Hydrocracking
  - Hydrotreating
  - Merox treatment
  - Sulphur recovery
  - Sulphuric acid alkylation process
- **Storage and transportation**
  - Crude oil and refined product pipeline
  - Natural gas pipeline
  - Ship and truck loading

To give you an idea of what KROHNE has to offer, we selected a number of typical oil and gas application examples for our process visualisations. The processes available range from drilling and cementing a well, up to blending refined products in a refinery, or measuring of natural gas at a city gate transfer point.

In addition to our process visualisations, we offer a series of free, online courses about instrumentation and solutions in our KROHNE Academy online: academy-online.krohne.com

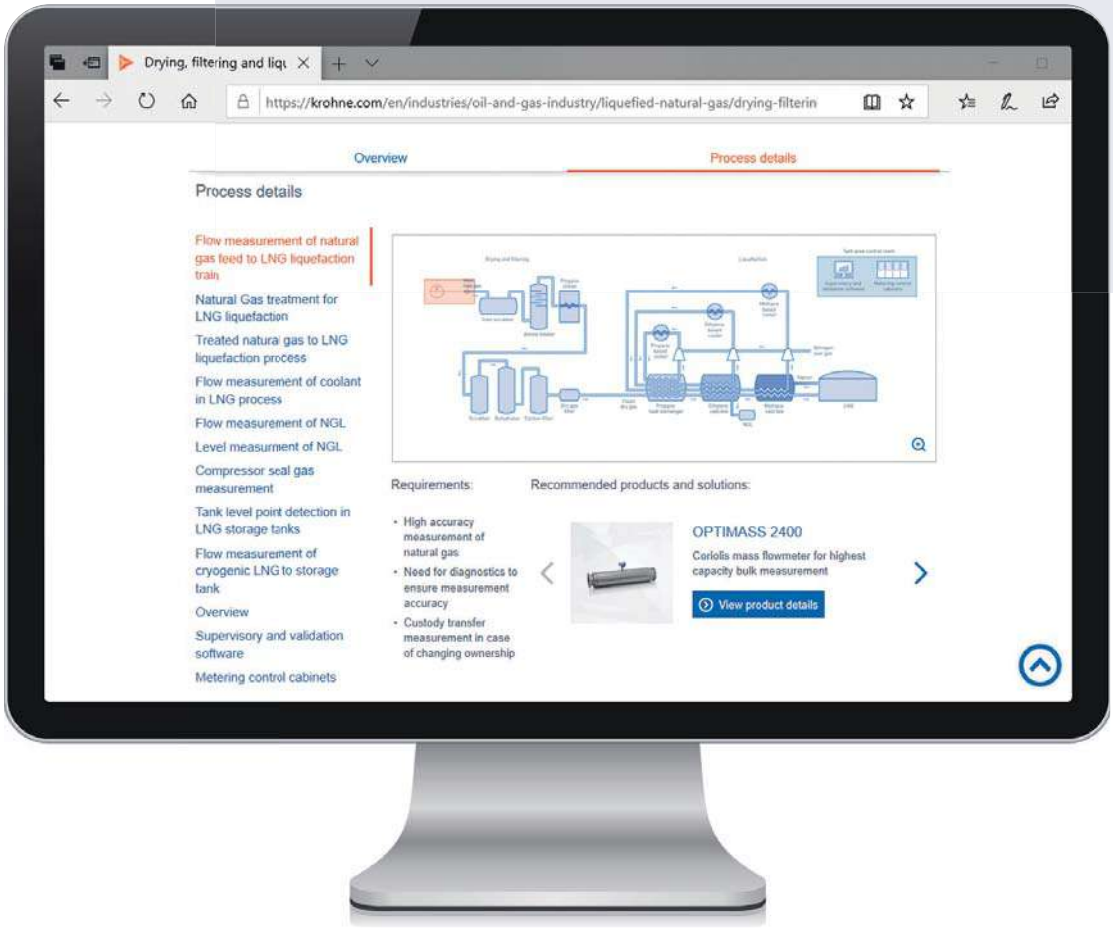
We also offer seminars and workshops on a wide range of applications, or can give tailormade presentations on a specific site or customer application. Please contact your local KROHNE office or our oil and gas specialists to find out more: oilandgas@krohne.com

An example – the LNG liquefaction process

Natural gas entering the liquefaction train is measured in a custody transfer metering skid. An analyser house contains the instrumentation used to determine the composition and quality of the gas. Before the main liquefaction processes, various filters and scrubbers complete the drying process.

During the cooling processes, heavier components are extracted as 'natural gas liquids' (NGLs) and measured as recovered by-products. Once liquefied, the cryogenic LNG is stored in large tanks that are fitted with cryogenic level switches to provide alarm and control at high and low levels.

KROHNE supplies the custody transfer metering systems for natural gas entering the LNG plant and for cryogenic LNG being loaded into an LNG carrier or truck. KROHNE also supplies CalSys (AMADAS Analyser Management) software package. That guarantees the performance of the analysers used to determine the quality of the natural gas, LNG and L-QRS – a NMi certified on-line LNG quality release and bill-of-lading software. KROHNE process instrumentation is used throughout the filtering and liquefaction process.



Selection table

	Metering and monitoring solutions							
	Custody transfer metering systems	Metering control systems, SUMMIT 8800	Sampling and analyser systems	Provers and master meters	WGS 1000 / 2000 / 3000 wet gas measurement, wellhead flow measurement	SynEnergy, CalSys, L-QRS supervisory and validation software	PipePatrol pipeline management solutions	OPTIMASS Coriolis mass flowmeters
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Liquids								
Liquids (conductive)	x	x	x	x		x	x	x
Liquids (non conductive)	x	x	x	x		x	x	x
Low flow rates (<0.25 m^3/h / <0.82 ft^3/h)								x
High flow rates (>1000 m^3/h / >3280.83 ft^3/h)	x	x	x	x		x	x	x
High accuracy (Custody Transfer)	x	x	x	x		x	x	x
Cryogenic liquids (e.g. LNG)	x	x	x	x		x	x	x
Gases								
Gases (pressurised)	x	x	x	x		x	x	x
Gases (atmospheric)								o
Low flow rates (<0.25 m^3/h / <0.82 ft^3/h)								x
High flow rates (>1000 m^3/h / >3280.83 ft^3/h)	x	x	x	x		x	x	x
High accuracy (Custody Transfer)	x	x	x	x		x	x	x
Miscellaneous								
Supercritical gases	x	x	x			x	x	x
Wet gas (2 phase flow)		x	o		x	o	o	o
Wellhead (multiphase)		o			x	o	o	o
Overfill / empty tank protection		o						

Flow measurement					Level measurement				Pressure measurement	Temperature measurement
OPTISONIC ultrasonic flowmeters	ALTOSONIC ultrasonic CT flowmeters	OPTIFLUX electromagnetic flowmeters	OPTISWIRL vortex flowmeters	H250 M40, DK32, DK 37 variable area flowmeters	OPTIWAVE FMCW radar transmitters	OPTIFLEX TDR guided radar transmitters	BM 26 Magnetic bypass level indicators	OPTISWITCH switches	OPTIBAR transmitters and primary elements	OPTITEMP assemblies and transmitters
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x	x	x	x	x	x	x	x	x	x	x
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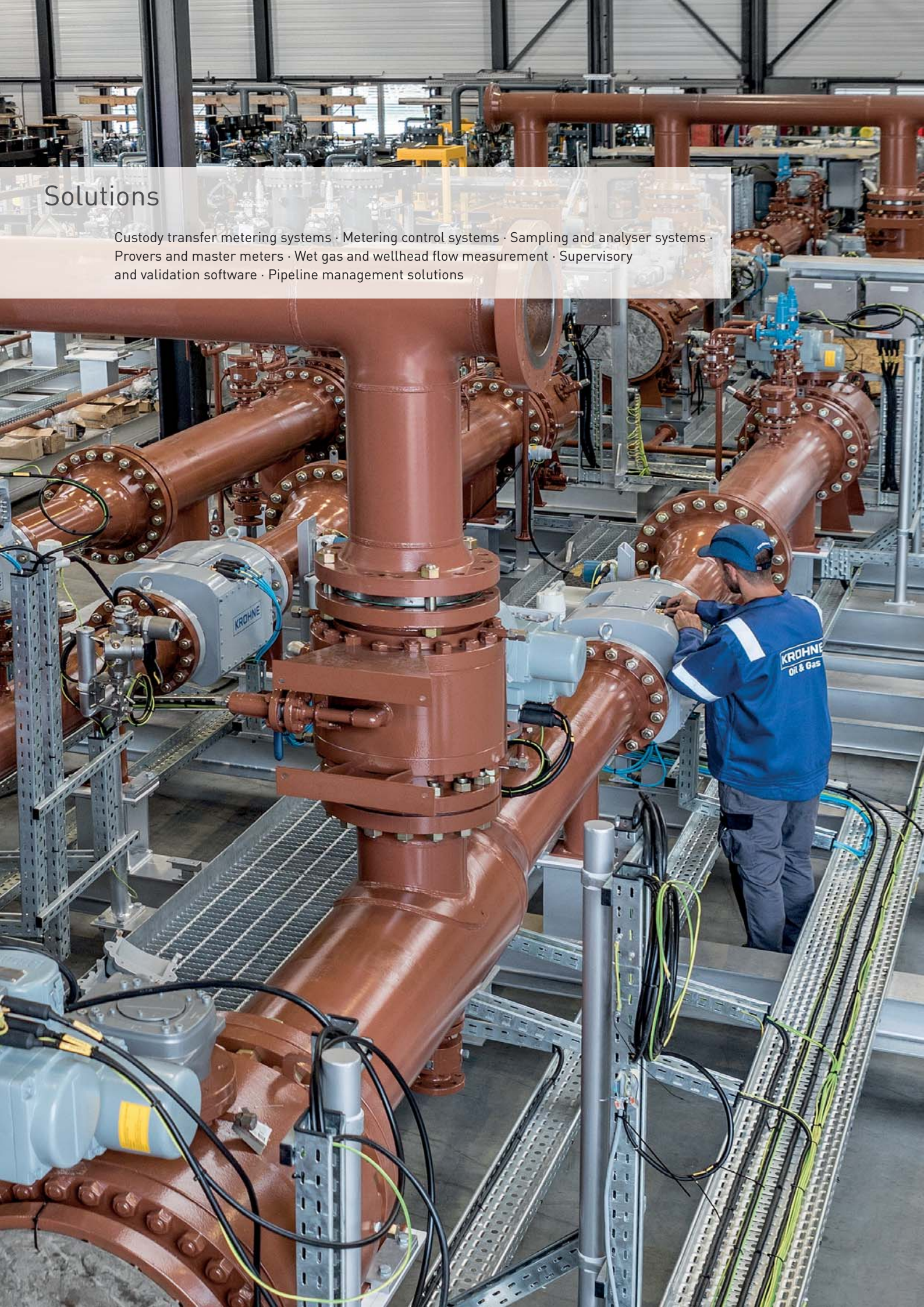
						x	o		x	x
					x	x	x	x		

x = suitable, o = suitable under certain conditions

Solutions

Custody transfer metering systems · Metering control systems · Sampling and analyser systems · Provers and master meters · Wet gas and wellhead flow measurement · Supervisory and validation software · Pipeline management solutions



Metering and monitoring solutions – From wellhead to distribution of refined products and natural gas

KROHNE started supplying fully engineered metering solutions in the early 2000s. Initially offering custody transfer metering systems for crude oil and refined products, today KROHNE has expanded to become a well-known one-stop-shop for engineering, procurement and construction of measurement solutions for the up-, mid- and down-stream oil and gas industry.

The KROHNE portfolio spans the entire value chain, from wellhead up to distribution of refined products, natural gas and LNG. KROHNE custody transfer metering skids, metering control systems and flow computers are supported by in-house engineered sampling and analyser systems, pipeline management and metering supervisory software.

Measurement solutions are usually based on KROHNE instrumentation, allowing a seamless integration of instrumentation, flow computers and supervisory software. However, third party instrumentation can be integrated whenever requested.

KROHNE Oil & Gas metering and monitoring solutions:

- **Custody transfer metering systems** of crude oil, refined products, natural gas, process gases, LNG and produced water
- **Metering control systems,** supplied in combination with new metering systems, or for an upgrade to existing systems
- **Sampling and analyser systems** for crude oil, refined products, natural gas and liquid hydrocarbons
- **Provers and master meters** designed and manufactured in-house and certified according to local and international metrology standards
- **Wet gas and wellhead flow measurement** for measurement directly on the wellhead, using various technologies optimised for different flow regimes
- **Supervisory and validation software** for a fully integrated process overview, with measured values, trending, instrument diagnostics and health just a mouse-click away
- **Pipeline management software** including leak, theft and line break detection, with KROHNE or third party instrumentation

Custody transfer metering systems – From initial design phase up to on-site comissioning and training

KROHNE metering systems are used throughout the entire oil and gas value chain, from allocation measurement during oil production up to truck and train loading of refined products at the refinery.

KROHNE takes full project responsibility for the metering systems, including all process instrumentation, gas chromatographs and analysers, flow measurement computers, metering control cabinets and all supervisory and validation software.

KROHNE metering systems are often designed as a master-duty configuration, where a Z-configuration allows periodic verification of the duty meters against the master meter. The diagnostic features of the flowmeters are used to guarantee maximum performance and lowest measurement uncertainty.

Metering systems for crude oil and refined products

- Based on ultrasonic, Coriolis mass, turbine or positive displacement flowmeters
- Straight tube Coriolis mass and ultrasonic flowmeters to minimise pressure drop
- With integrated master meter or ball prover where required
- For use on crude oil, refined products, LPG, produced and potable water

Best practice

For South Oil Company (SOC) in Iraq, KROHNE supplied over 30 custody transfer metering skids based on ultrasonic flowmeters in a master-duty Z-configuration to measure the crude oil. The ALTOSONIC 5 master meters installed on the skids are periodically calibrated against a truck mounted mobile calibration facility, which in turn is calibrated against a high-end stationary bi-directional ball prover. The complete project, including on-site commissioning and confirmation of measurement uncertainties, was supplied and performed by KROHNE in co-operation with SOC and in full compliance with the “Iraqi National Code for Measurement of Hydrocarbon Liquids”.

Metering systems for gases

- Based on ultrasonic, Coriolis mass, turbine or differential pressure meters
- Custody transfer ultrasonic flowmeters with different multi-path configurations to avoid common mode errors
- For natural gas and chemical process gases
- Pressure reduction stations and HIPPS systems

Metering systems for cryogenic LNG

- Based on ultrasonic or Coriolis mass cryogenic flowmeters
- Flowmeters can be fully insulated, preventing thermal leaks from parts sticking outside the insulation
- Simultaneous measurement of the volume and quality of the LNG
- Full portfolio for vessel (un)loading, bunkering and truck loading of cryogenic LNG

Metering systems for produced water

- Based on ultrasonic or electromagnetic flowmeters
- Pre-calibrated to meet custody transfer regulations (e.g. OIML R49, MID MI-001)
- For e.g. contaminated and treated water from oil wells
- Special phenolic lining and alloy valves for corrosive and brackish water contaminated with oil

Metering control systems – The brains behind reliable metering systems

The KROHNE range of metering control systems extends from a cost-effective flow computer solution to custom designed dual-redundant metering systems in HVAC enclosures. Our metering control systems are designed in-house and completely assembled, configured and integration tested before shipment.

Both KROHNE and third party equipment is seamlessly integrated, and KROHNE takes full project responsibility from design to on-site commissioning.

Flow computing

- Cost-effective solutions based on the SUMMIT 8800 flow computer
- Fully pre-configured, tested and certified flow computer application according to the customer specification
- Graphical representation of all measurements on the SUMMIT 8800 full colour touch screen
- Liquid and gas streams can be measured and displayed on a single flow computer, minimising CapEx

Modular flow control and data transfer cabinets

- Cost-effective solution based on cost-effective small cabinets with SUMMIT 8800 and key components such as barriers, PLCs and UPS systems
- In-house design as per customer specification, using customer preferred brands
- Metering control cabinets fully wired, preconfigured and tested prior to shipment
- In-house expertise to negotiate and agree upon custody transfer approvals with local metrology offices

Best practice

Gasunie is an energy network operator that manages and maintains the infrastructure for large-scale transport and storage of gas in the Netherlands and the northern part of Germany. The Gasunie infrastructure comprises thousands of kilometres of pipeline and is part of the European gas roundabout.

As part of a multi-year frame agreement, KROHNE provided over 500 modular flow control and data transfer cabinets to replace a previous generation of cabinets, some dating back to the time before the MID regulations came into force. Fully wired and pre-configured, the new cabinets can be installed on site within 4 hours to reduce the operational impact to an absolute minimum. The new cabinets are fully prepared for the energy transition towards green gas and hydrogen.

Supervisory control cabinets

- Provides full control over the metering system and enables reporting from a central location
- For large installations, all equipment in the metering control cabinet can be installed in single or redundant layout, with flow computers in cold or hot standby
- For ship (un)loading, border crossing stations, CT pipeline applications or measurement at refineries, LNG liquefaction and regasification plants
- For new-builds and revamps
- Hot-Swap possibilities in collaboration with the KROHNE service team

Metering houses and shelters

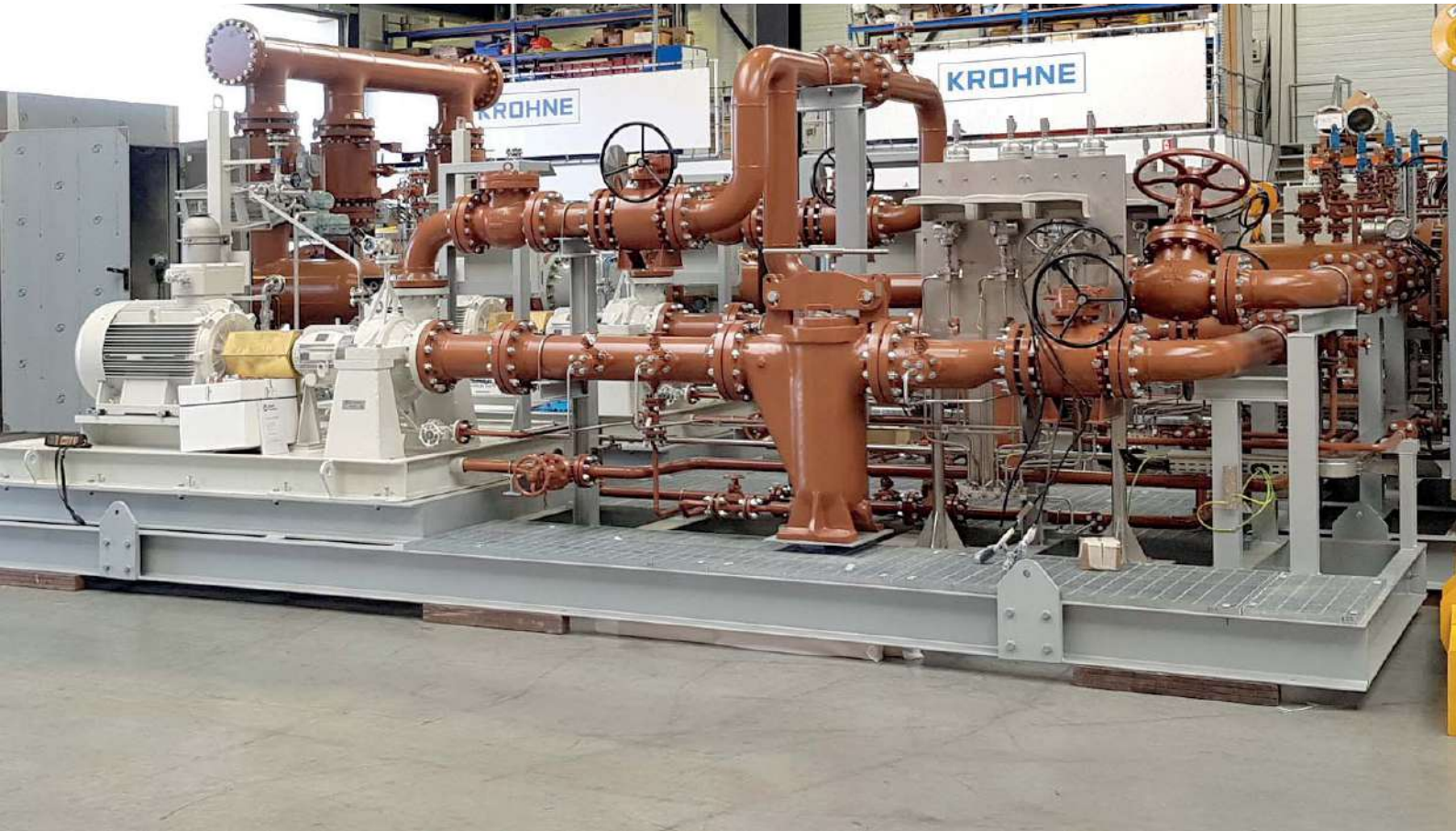
- Dedicated metering house for the on-site installation of electronic systems and cabinets
- Turn-key solution to eliminate on-site construction and electronics installation
- A safe area for the installation of electronic equipment and cabinets
- Integrated HVAC system where required
- Local operator supervisory work station can be included
- Integrated instrument validation tools and equipment where required

Sampling and analyser systems – For complex metering systems or as standalone modules

KROHNE sampling and analyser systems can be equipped with KROHNE or third party instrumentation and are provided fully wired, pre-configured and tested. Site installation and commissioning will be coordinated through one of our 100 local offices.

Sampling systems

- Automatic sampling systems for liquid hydrocarbons (crude oils, refined products and condensates) compliant with relevant standards, such as ISO 3171, ASTM D 4177, API 8.2 and IP 6.2
- Wide range of system configurations and types available:
  - In-line
  - Fast loop
  - Jet-mixers combined with fast loop
  - Portable shipboard systems, multi-line
- The sampling controller can be an integrated Scada + HMI KROHNE solutions architecture, Client SCADA / DCS architecture or a dedicated on-board sampling system controller
- KROHNE proprietary designed grab sampler is available in both pneumatic and electric version, fully compliant with the standards, available in special materials up to ratings #1500



Analyser houses and shelters

- Analysis systems for gas and liquid samples in the most critical conditions
- Analyser shelters complete with pressure reducing station, sample (pre-)conditioning systems, analysers and conditioning (HVAC or air) suitable for both hazardous and safe areas
- Integration of process analysers, such as:
  - Gas chromatograph
  - Sulphurs
  - HC dew point
  - H_2O dew point
  - O_2, etc.
- The systems are designed with all the components necessary to protect workers' health, optional Fire & Gas system can be integrated in the solution

Provers and master meters – Fully certified to local and international metrology requirements

Based on its extensive expertise in calibration, KROHNE supplies fully wired, pre-configured and tested provers and master meters, tailored to the required application range. We offer support during all project phases – from fundamental design choices during FEED up to commissioning and on-site training and service.
Site installation will be coordinated through one of our 100 local offices.

Ball provers

- Fully certified uni- and bi-directional ball provers from 3" to 36"
- Low-friction baked phenolic lining with excellent chemical and abrasion resistance
- Proven design of microset sphere detector ensures best-in-class performance

Mobile provers

- Cost-effective solution by sharing the equipment between different locations
- Lowest measurement uncertainty by periodic verification of prover against national and international standards
- Engineered prover solution optimised for specific applications
- Fully traceable to (inter)national standards and certified against local and international metrology requirements

Calibration runs and skids

- Flow calibration systems for air, natural gas, water or oil products, in a closed loop or bypass systems, fully certified according to ISO 17025 and (inter)national metrology regulations
- KROHNE expertise is based on the design and manufacture of over 100 calibration rigs, for external customers and in-house use
- Flexible concept, with a design tailored to the requested flow range of the application

Wet gas and wellhead flow measurement – State-of-the-art solutions for changing conditions

WGS 1000 / 2000 / 3000 – Wet gas measurement system for continuous well and reservoir performance monitoring

The KROHNE wet gas measurement system is designed to measure unprocessed gas directly from single-stream and complex multi-wells – even under varying process conditions. It is capable of determining flowrates of dynamically changing well streams, fullfilling the need for continuous well and reservoir performance monitoring in daily production.

Compared to other technologies, such as the test separator, it is space-saving, can be implemented much quicker and requires only low maintenance.

- Complete system incl. wet gas Venturi meter, pressure and temperature transmitters, plus supervisory software
- Flow and allocation metering of wet gas (gas volume fraction: 90...99%)
- Real-time well data to diagnose well conditions
- Cost-effective, space-saving alternative to test separators according to ISO 11583

Wellhead flow measurement – Coriolis based solutions for single phase and multiphase measurement

Cost-effective, repeatable, reliable and robust measurements are what every operator is looking for to optimise the performance of wells and reservoirs. KROHNE OPTIMASS Coriolis flowmeters ensure continuous measurement for gas and liquid mixtures. With Entrained Gas Management (EGM™) the meter maintains operation over a wide range of gas fractions and complex flow conditions.

OPTIMASS can be installed directly on the wellhead, for example in heavy oil applications. The integrated density measurement can be used for net oil and water cut calculations, making OPTIMASS exactly the right instrument for installation on test separators and production separators. Liquid carry-over and gas carry-under can be detected at an early stage, ensuring optimum performance of equipment.

- For liquid and gas mixtures
- Net-oil and watercut measurement
- Direct measurement on the wellhead
- Cost effective approach based on OPTIMASS Coriolis technology
- Mounted on test separator or production separator
- Mass and volume flow measurement
- Density measurement for concentration, water cut and net-oil calculations
- Straight and bent tube designs with minimised footprint

Technology highlight

EGM™ Entrained Gas Management

Helps to overcome problems caused by air or gas entrainments in a measured medium, even during a transition from a liquid to a gas phase and back – giving stable and continuous mass flow and density measurements in e.g. batch / loading / empty-full-empty applications.

EGM™ Entrained Gas Management

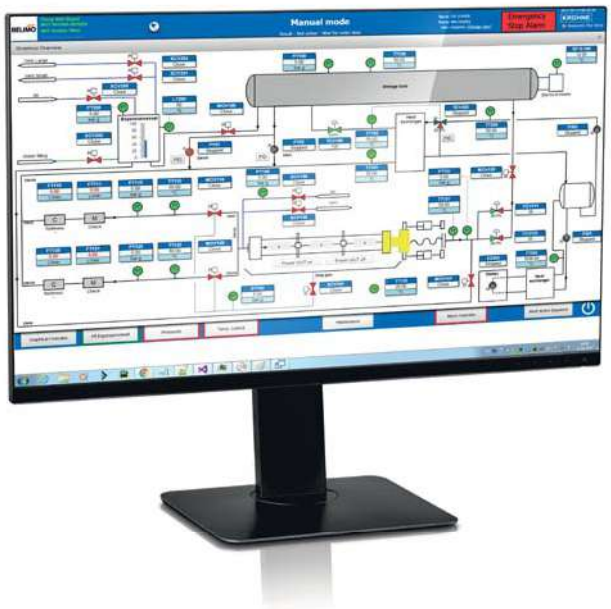
OPTIMASS series

Supervisory and validation software – Dedicated solutions for oil and gas applications

SynEnergy – Supervisory and visualisation software

SynEnergy is a supervisory and process visualisation software package for metering systems based on HTML5 secure web technology. It collects data from field devices and offers full, intuitive control over the entire metering system. Being web based, it enables secure access from any geographical location, putting all necessary information at your finger-tips.

- Offers high performance Human Machine Interface for industrial processes
- Dashboard with critical KPIs for maximum situational awareness
- Scalable installation from single PC to redundant server networks
- Flexible solutions for continuous monitoring and reporting
- Fully prepared for integration of any device, including IoT and IIoT
- Integrated CalSys instrumentation validation software



LNG-Quality Release System (L-QRS) – Software solution for efficient LNG loading operations

The KROHNE L-QRS is a quality measurement software system for real-time product release of LNG loading, using on-line measurements and certified statistical calculations, including quality and outlier calculations. Providing the instant availability of the certificate of quality avoids costly sample handling, laboratory tests and retrospective corrections of the bill of lading and quality certificates. The system is certified by NMi, the independent internationally accredited institute, and compliant with ISO 8943, GPA 2172, ASTM 4784 and GIIGNL. It combines Analyser Management and Data Acquisition (AMADAS) functionality, using control charting techniques and statistical process control to determine the performance, availability and maintainability of the process analysers – and other critical instruments – to ensure the best results and availability at all times.

- Instant availability of both certificate of quality and bill of lading, based on real-time quality measurement
- Certified by NMi and compliant with ISO 8943, GPA 2172, ASTM 4784, GIIGNL
- Automated instrument validation and statistical process control according to international standards
- Energy calculations, loading mass balance and billing reports on vapour returns
- Integration with plant management and control systems (DCS, PI, LIMS, ERP, etc)

CalSys – Analyser Management and Data Acquisition System (AMADAS)

CalSys uses control charting techniques and statistical process control to determine the performance, availability and maintainability of a broad variety of process analysers and other critical instruments. In this way, CalSys supports operators to achieve optimal efficiency in the maintenance of gas chromatographs, process analysers, gas detectors, CEMS (Continuous Emission Monitoring Systems), laboratory analysers and similar equipment.

- Plant-wide performance of analytical equipment and vital instrumentation, according to ASTM 3764, ASTM 6299 and OP 97-30425
- Auditability and traceability through Control Charting techniques, embedded decision rules, statistical process control and historical trending
- Minimised interference to the instrumentation, thereby increasing the availability of instruments and improving process control, while reducing maintenance effort
- Well-guided and structured analyser validation – from manual up to fully automated procedures

Pipeline management solutions – From basic leak detection to predictive modelling

PipePatrol is a leading edge solution for safe and efficient pipeline management. It offers a comprehensive suite of modules for leak, theft and line-break detection as well as batch tracking and monitoring of tightness and lifetime stress.
Pipeline operators can select single software applications or complete customised solutions.

The unique technology behind PipePatrol can be complemented by a wide range of instruments and field data acquisition systems from KROHNE and partners. PipePatrol interfaces seamlessly with SCADA and other control systems. The pipeline management solutions also cover management of the whole project, from consultation to integration and service support, by KROHNE.

- Complete and high-sensitivity protection of oil, gas, water and multi-product pipelines
- From single software applications to full packages including instrumentation (flowmeters, pressure transmitters, temperature assemblies), cyber-security and field data acquisition
- Comprehensive services: e.g. consultancy regarding the operation and design of pipelines, manual offline analysis of pipeline processes, 24/7 hotline, post-theft analysis, leak testing, maintenance contracts

Technology highlight

E-RTTM pipeline leak detection

E-RTTM
pipeline leak detection

A leading mathematical model for continuous internal monitoring of pipelines. Integrated in our PipePatrol system, compares measurement data from the actual pipeline with those of a simulated "virtual pipeline" in real time. If the model detects a discrepancy, a leak signature analysis using leak pattern recognition determines whether it is a leak, or still safe, with outstanding accuracy.

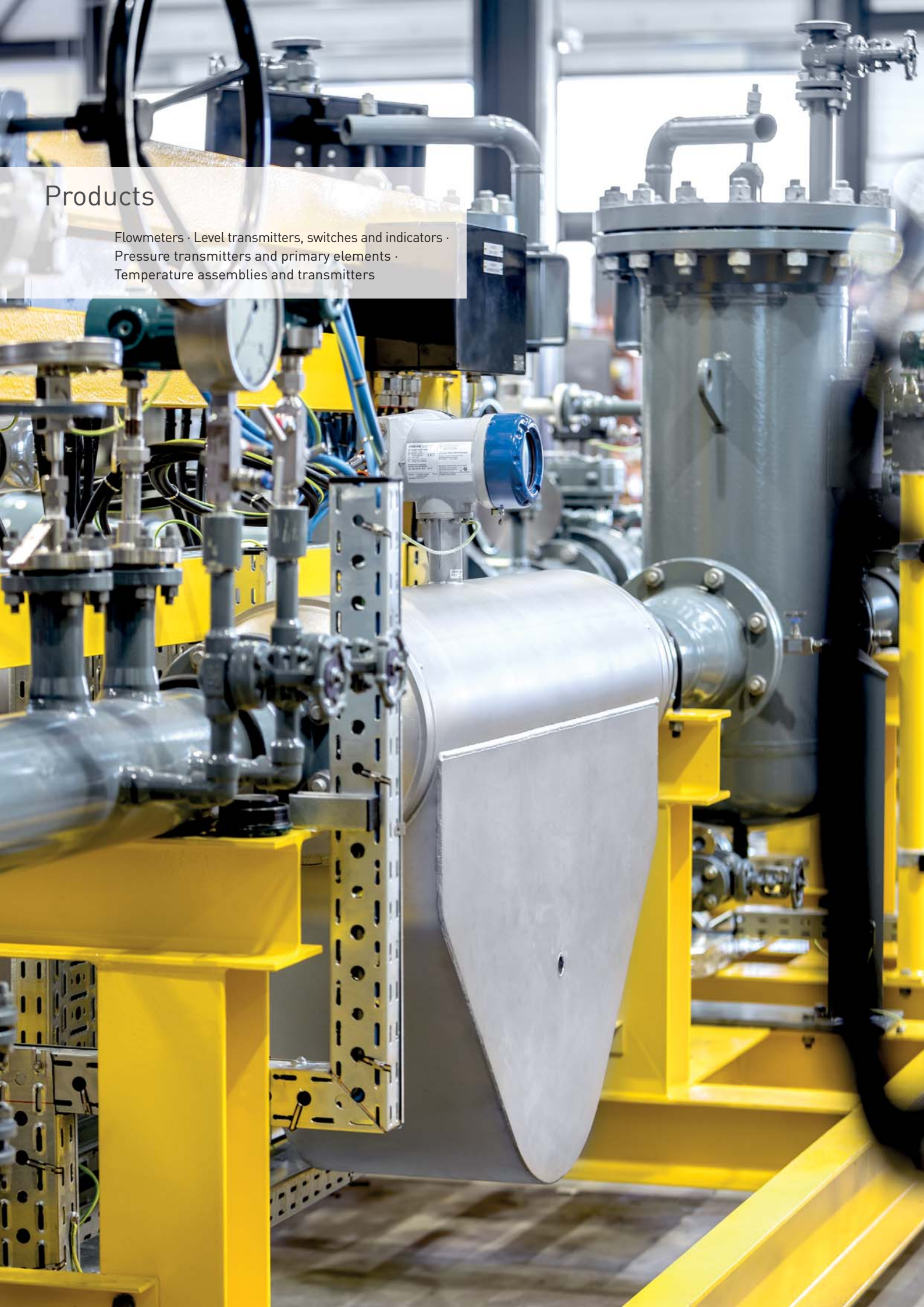
PipePatrol offers the following modules:

- PipePatrol Leak Detection and Localisation – meets API 1130, API 1175, German TRFL standards and CSA Z662, and can be independent or integrated with existing system
- PipePatrol Theft Detection – for fast and reliable identification and localisation of unauthorised or illegal product discharges
- PipePatrol Tightness Monitoring – for detection of small or gradual leaks
- PipePatrol Predictive Modelling – simulation tool to predict pipeline conditions from current operating and manually definable static data
- PipePatrol Stress Monitoring – for evaluation and documentation of lifetime stress
- PipePatrol Pump Monitoring – control cabinet solution for the monitoring of the essential mechanical, electrical, and hydrodynamic measurement values
- PipePatrol Batch Tracking – for determination of the position of a batched product, and to identify the mixing zone in multi-product pipelines
- PipePatrol Line Break Detection – for efficient and instant detection of pipeline ruptures, especially for high consequence areas
- PipePatrol Data Acquisition and Transmission – particularly safe communication, fulfilling the latest safety standards
- PipePatrol Cyber Security – for maximum safety level with stateful inspection firewall and deep packet inspection

Best practice

A 31.5 km / 19.6 miles long multi-product pipeline connects the Heide refinery in Hemmingstedt, Germany to the tank farm. The pipeline transports 9 refined liquid hydrocarbons with different densities and viscosities in both directions, creating the possibility of mixed phases. In order to comply with TRFL requirements, the company looked for a second independent system to monitor for leaks. KROHNE commissioned, configured and calibrated the PipePatrol system on site. The leakage rate was approx. 5 m^3/h / 176.5 ft^3/h, PipePatrol detected all leaks within 30 s and sent out the alarms within 60 s. The location of the leaks was accurate to within 400 m / 437 yds or around 1% of the entire pipeline length. Owing to this outstanding performance, the Heide refinery decided to purchase additional PipePatrol systems to equip a total of five pipelines.

RAFFINERIE HEIDE



Products

Flowmeters · Level transmitters, switches and indicators · Pressure transmitters and primary elements · Temperature assemblies and transmitters

Process instrumentation – From single pressure or temperature transmitters to best-in-class custody transfer flowmeters

A lot has changed since Ludwig Krohne introduced his first variable area flowmeter in 1921. Today KROHNE offers a complete portfolio of instrumentation for flow, level, pressure and temperature measurement, either as individual instruments or as part of an MIV (Main Instrumentation Vendor) agreement.

KROHNE instrumentation can be found in up-, mid-, and downstream applications, with measurement uncertainties suitable for indicative to custody transfer applications. For most instruments, integrated self-diagnostics come as standard: they can warn the operator in the event of potential technical or process issues.

With a local presence in around 100 countries, site surveys, on-site start-up and commissioning, training and service are tasks typically carried out by a local team. Having a service engineer just around the corner means quick reaction times and minimal travel costs. To deal with complex questions, the local service engineer is in direct contact with KROHNE R&D and manufacturing organisation.

Process instrumentation

- **Ultrasonic flowmeters** for process and custody transfer measurement of crude and refined oil, natural gas and LNG
- **Coriolis mass flowmeters** with Entrained Gas Management (EGM™) enables measurement with gas volume fractions from 0-100%
- **Electromagnetic flowmeters** for all applications with conductive liquids
- **Variable area flowmeters** for simple and cost-effective measurement of gases or liquids without auxiliary power
- **Vortex flowmeters** for utility applications, advanced energy management and Safety Instrumented Systems (SIS)
- **Frequency Modulated Continuous Wave (FMCW) radar level transmitters** for non-contact measurement
- **TDR guided radar level transmitters** for basic and advanced contact level measurement
- **Vibration level switches** for point level detection and interface measurement
- **Level indicators** for continuous level measurement without power supply
- **Pressure transmitters and primary elements** for a wide range of industrial applications with liquids, gases and steam
- **Temperature assemblies and transmitters** for all applications

Flow measurement – Reliable values and process diagnostics, even under harsh conditions

Technology highlights

Flow computer built-in
Compensates for the effects of pressure and temperature or converts to standard volume for gas flows – saves on cost and installation efforts for an external device.

flow computer
built-in

EGM™ Entrained Gas Management
Helps to overcome problems caused by air or gas entrainments in a measured medium, even during a transition from a liquid to a gas phase and back – giving stable and continuous mass flow and density measurements in e.g. batch / loading / empty-full-empty applications.

EGM™
Entrained Gas Management

Ceramic durability
Sensors are permanently resistant to corrosive and abrasive media and also immune to temperature shocks.

ceramic
durability

KROHNE offers a complete product portfolio for flow measurement. As a manufacturer of a large variety of devices using different measurement principles, KROHNE has a flowmeter available for virtually all applications in the oil and gas industry.

Besides a comprehensive standard portfolio, KROHNE has some unique solutions for the oil and gas industry. Examples include high-temperature ultrasonic flowmeters for delayed coker feed measurement in refineries, Coriolis mass flowmeters for custody transfer measurement of cryogenic LNG and electromagnetic flowmeters for well water injection up to 1500 bar / 22000 psi.

Ultrasonic flowmeters for process and custody transfer applications

- ALTOSONIC series – dedicated custody transfer flowmeters for crude and refined oil, natural gas and LNG, full bore design without flow conditioner minimises the pressure drop
- OPTISONIC 8300 for high temperature gases and superheated steam up to +620°C / +1150°F and 200 bar / 2900 psi
- OPTISONIC 7300 for process gas measurement and high pressure applications such as gas lift
- OPTISONIC 3400 as reliable and cost-effective solution for virtually any liquid process application
- OPTISONIC 4400 for high pressure applications such as well water injection and high temperature liquid applications such as delayed coker feed

ALTOSONIC 5

ALTOSONIC V12

OPTISONIC 8300

OPTISONIC 7300


OPTISONIC 6300


OPTISONIC 4400 HT

OPTISONIC 3400

OPTISONIC 4400 HP

Best practice

Using an offshore Underground Gas Storage (UGS) facility, terminal operator Escal UGS required a cost-effective solution to control the flow of natural gas from the onshore storage terminal to the offshore platform and vice versa. For this application, KROHNE supplied OPTISONIC 7300 ultrasonic gas flowmeters, with a custom-designed 30" / DN 750 dual configuration flow tube to offer full redundancy without having to install a second meter in series. Using this dual path design, KROHNE could offer a cost-effective solution with a sufficiently low measurement uncertainty to optimise process control.

Escal UGS
Proyecto Castor

OPTIMASS 1400

OPTIMASS 3400

OPTIMASS 6400

OPTIMASS 7400

OPTIMASS 2400

Coriolis mass flowmeters for all process and custody transfer applications, even with rapid temperature and media changes

- Custody transfer approvals as per OIML R117, R137, MI-005, MI-002, API and AGA
- Up to 4600 t/h / 169021 lb min with 16" OPTIMASS 2400
- Custody transfer approval for LNG, from ship loading to fuel pumps
- Entrained Gas Management (EGM™) enables continuous measurement over a wide range of gas volume fractions and complex flow conditions
- Straight tube OPTIMASS 2400 and 7400 enable installation area to be minimised
- Secondary containment up to 150 bar / 2175 psi
- Materials such as Super Duplex, and custom flanges such as Greyloc and Galperti available

Best practice

The Spanish company Bahía de Bizkaia Gas (BBG) operates a plant for the reception, storage, regasification and loading of LNG. BBG were searching an accurate and reliable method of measuring LNG and BOG with flow rates from 15...186 t/h / 551...6834 lb/min, which had CT and ATEX approval and also conformed to MID MI-005. The meters were also required to integrate with a flow computer for CT metering. KROHNE engineered, produced and integrated a complete CT cryogenic system as part of a ship loading system, which included OPTIMASS 6400 flowmeters and SUMMIT 8800 flow computers.

Electromagnetic flowmeters for all applications with conductive liquids

- High pressure well water injection systems up to 1500 bar / 22000 psi full rating with OPTIFLUX 4000
- Abrasive drilling mud with OPTIFLUX 5000 using a ceramic liner
- Produced water and water treatment applications with OPTIFLUX 2000 / 4000
- Process water and other auxiliary applications in oil refineries with OPTIFLUX 2000 / 4000

OPTIFLUX 2300

OPTIFLUX 4300

OPTIFLUX 5300

Best practice

For a leading exploration and production company on the Arabian Peninsula, KROHNE provided several hundred OPTIFLUX 4300 electromagnetic flowmeters for well water injection applications. Combining proven reliability with pressure ratings up to 1500 bar / 22000 psi meant a variety of applications could be covered with a single type of instrument, minimising spare part electronics and training requirements for the local service teams.

H250 M40 H250 M40R

Variable area flowmeters for simple and cost-effective flow measurement of gases or liquids even without auxiliary power

- Sample flow measurement in analyser and sampling systems
- High pressure injection of demulsifiers, hydrate and corrosion inhibitors up to 1400 bar / 20000 psi
- Nitrogen purging for inertisation of storage vessels, engines and pumps
- Glycol, amine and fuel gas measurement in gas processing
- Seal gas monitoring on turbo-compressors

DK32

DK37

Best practice

A leading international manufacturer of turn-key compression systems for natural gas was looking for measurement devices (IECEx-i) to determine the amount of nitrogen used (3.0 to 30 kg / 6.6 to 66 lbs per hour) in order to ensure a continuous gas flow over the gas seals. All of the information was to be transferred to a DCS via FOUNDATION™ fieldbus communication. KROHNE supplied over 300 units of the H250 M40 variable area flowmeter in an intrinsically safe design with NPT process connection and FOUNDATION™ fieldbus interface for the direct integration into the communications network.

Vortex flowmeters for utility applications, advanced energy management and Safety Instrumented Systems (SIS)

- Natural gas flow measurement to determine energy consumption and loss of efficiency due to soot formation in burners
- Steam flow measurements, plus direct energy calculations from the integrated pressure and temperature transducers
- Associated gas measurement to determine oil well production output
- Various gas measurements in refinery processes, such as off-gas, sour gas, hydrogen and compressed air
- Nitrogen blanketing gas for tank storage applications
- Net heat metering for steam and water
- Safety-related measurement in SIL applications
- Remote installation allows the separation between signal converter and flow sensor to 50 m / 164 ft, when the flow sensor is mounted in an inaccessible area

Best practice

A multinational oil and gas company explores for and refines raw oil and natural gas in Northern Serbia. To monitor the natural gas consumption, the customer was looking for cost-effective gas flowmeters (ATEX zone 1 Ex ia) to be mounted in more than 70 bypass lines. The temperature and pressure measurement (4...60 barg / 58...870 psig) was also to be part of the solution. OPTISWIRL 4200 devices were chosen, as a cost-effective alternative to mechanical gas flow meters. They are maintenance-free and feature integrated temperature and pressure compensation. No additional instrumentation was therefore required to compensate for the unsteady parameters of the medium.

OPTISWIRL 4200 Dual

OPTISWIRL 4200 C

OPTISWIRL 4200 F

Level measurement – Safe measurement of tank contents, even for processes with rapidly changing conditions

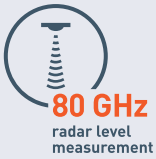
Since KROHNE brought its first mechanical level meter to market in 1955, the product porfolio has been growing steadily. Today, KROHNE offers a comprehensive range of level transmitters, indicators and level switches based on mechanical and electrical principles, and tailored for the oil and gas market.

Optimised performance and safety, even in the most challenging applications, e.g.:

- High and low process temperatures and pressures
- Agitated and corrosive liquids as well as in tanks with significant condensation
- Interface detection and measurement
- Low-reflective and abrasive solids measurement in dusty environments

Technology highlights

80 GHz radar level measurement



The 80 GHz technology used in the OPTIWAVE series is the most recent and versatile radar technology for level measurement of liquids and solids. Over an identical distance, it presents a highly focused beam with a smaller diameter than lower frequency radars, ideal for applications with high and narrow vessels even in the presence of internal obstructions.

Frequency Modulated Continuous Wave (FMCW) radar level transmitters for non-contact measurement

- Lens, drop and horn antennas for measuring ranges up to 100 m / 328 ft
- Accuracy from ±2 mm / ±0.08"
- Processes with rapidly changing levels (⩽60 m/min / ⩽196.85 ft/min)
- Measure through tank roofs made of non-conductive materials
- Dielectric constants as low as 1.4
- Quick setup assistant for easy commissioning
- Empty tank spectrum function eliminates interference reflections caused by tank interior

OPTIWAVE 5200 F

OPTIWAVE 5400 C

OPTIWAVE 7400 C

OPTIWAVE 7500 C

Best practice

A lubricant producer processes and stocks lubricant oil in storage and process tanks of various shapes and dimensions. The customer needs a technology to accurately and reliably track the exact content of each tank for optimised process and stock inventory incl. automated data transmission to a control room.

12 OPTIWAVE 7500 C 80 GHz radar level transmitters with G 1 1/2 A thread connection and DN40 (1.5") antenna are installed on the process tanks and measure the level of the agitated oil surface. They are unaffected by physical property variations like changing density, viscosity or conductivity. Owing to their high signal dynamics and small beam angle, they are able to measure low reflective medium with great accuracy, even in the presence of agitators.

OPTIFLEX 7200 C

OPTIFLEX 7200 F

OPTIFLEX 8200 C

OPTIFLEX 8200 F

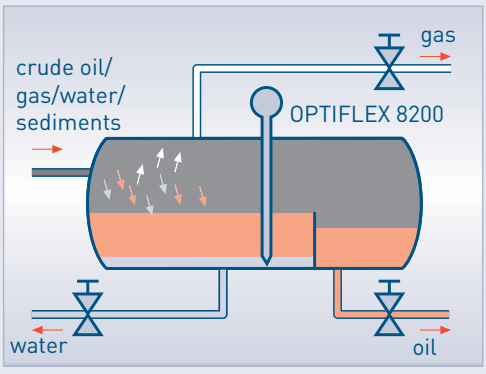
TDR guided radar level transmitters for basic and advanced contact level measurement

- SIL 2/3-compliant according to IEC 61508 for safety-related systems
- 2-wire 4...20 mA (HART® 7) with second output (current or switch / relay)
- Accuracy from ±2 mm / ±0.08"
- Interface measurement starting at 50 mm / 1.97"
- Large choice of probes to cover all applications
- Double ceramic seal system for dangerous products
- Various converter and electronic versions to facilitate access to the device
- Reversed interface measurement
- FF / PA and HART® communication
- Specific algorithm for low reflective media

Best practice

Petroleum refineries use crude oil separators to separate hydrocarbons from water and other unwanted components. To prevent water from entering the oil skimmer or oil entering the water evacuation system, the water interface level of the separator needs to be continuously regulated.

The ATEX-approved OPTIFLEX 8200 detects the water interface below the oil layer with excellent reliability and accuracies down to ±2 mm / ±0.08". The measured data are automatically and continuously transmitted to a control room via HART® communication. This keeps the water level as low as possible and optimises the process and stock management of the refinery.



Level indicators for continuous level measurement even without power supply

- Rugged stainless steel design – low or no maintenance
- Flaps housed in a hermetically-sealed glass tube (IP68)
- Highly visible level indication works without power supply
- Wide temperature and pressure range: -196...+400°C / -321...+752°F, max. 344 barg / 4989 psig
- Measuring ranges from 0.3 m / 1 ft up to 5.5 m / 18 ft (longer on request)
- Use of two independent transmitters with different measurement technologies permits totally redundant measurement and predictive maintenance
- Easy to install, safe and no commissioning

BM26A-5000 with FMCW transmitter

BM26A-8000 Bl with TDR transmitter

BM26A-1000

BM26A-6000 / BM26A-7000

BM26A-8000 TWIN with TDR transmitter

OPTISWITCH 3100

OPTISWITCH 5100

OPTISWITCH 5200

OPTISWITCH 5300

Vibrating level switches for point level detection and interface measurement

- Rugged oscillating fork, high abrasion resistance
- Exactly reproducible switching point without adjustment
- Continuous self-diagnostic checks (e.g. cable corrosion / breakage)
- Measurement independent of media properties such as viscosity, dielectric constant (ε_r) or electrical conductivity
- Unaffected by adhesions (foam), pressure and temperature changes or external vibrations
- Detection of solids with density ≥0.008 kg/l / 0.5 lb/ft³
- Detection of liquids with density ≥0.5 kg/l / 31.2 lb/ft³
- Wide temperature and pressure range: -196...+450°C / -321...+842°F, max. 160 barg / 2320.6 psig
- Recurring test as per WHG via test button (with SU 501)
- Detection of solids in water
- Functional safety: up to SIL 2 in a single channel architecture, and up to SIL 3 in a multiple channel, redundant architecture

Pressure measurement – Always the right pressure, any time, any process

The OPTIBAR product series from KROHNE offers a complete portfolio of pressure instrumentation for pressure, flow, level, density and interface applications.

The combination of high-end technologies with proven designs provides the ultimate reliable, safe and easy to use instrumentation package.

Ceramic diaphragms, differential pressure with total 3D linearisation, full coverage of all materials and process connection standards are all combined with a state-of-the-art modular smart converter platform.

Technology highlights

Total 3D linearisation

total 3D linearisation

For robust and accurate differential pressure measurement, even under changing process conditions, each OPTIBAR DP 7060 differential pressure transmitter is linearised in 3 dimensions during calibration: differential pressure, ambient temperature and static pressure are taken into account in combination. Since the full specified operating range is covered, the most stable and accurate measurement under all process conditions is guaranteed.

Process pressure transmitters and primary elements for a wide range of industrial applications with liquids, gases and steam

- Pressure transmitters with metallic or ceramic diaphragm technology for measuring ranges up to 1000 bar / 14500 psi
- Differential pressure transmitter with full 3D-technology, delivering optimum performance under ever changing process conditions
- Wide material selection with Hastelloy C-276, Super Duplex, tantalum and 316L NACE MR0103 / 0175 approved materials
- Approved for use in hazardous areas and safety-related applications up to SIL 2/3
- Full range of DP flow primary elements available: such as orifice plates, venturis and cone meters with ISO 17025 accredited calibration

OPTIBAR PC 5060

OPTIBAR PM 5060

OPTIBAR MR 6300

OPTIBAR DP 7060

OPTIBAR DP 7060
with orifice meter run assembly

Best practice

Oleon is part of the Avril Group, a manufacturer in the oil and protein sectors. The customer stores esters in several tanks. The ester is covered with a layer of inert gas (nitrogen) to protect it against oxidation. There is a slight gauge pressure in the tank (between 0...25 mbarg / 0...0.36 psig), which the customer must continuously monitor. OPTIBAR PC 5060 C were installed in the top of the tank. Mechanical screw or flange connections allowed the customer to keep the existing thread and thus avoid having the tank re-certified. The sturdy ceramic diaphragm of the OPTIBAR PC 5060 is resistant to oxidation and corrosion in chemical surroundings. It protects the device from product vapours while ensuring reliable and accurate measurement. Furthermore, the OPTIBAR pressure capability allows it to cover extended ranges while remaining immune to an overload of 5 times the measuring range.

Temperature measurement – Flexible adaptation to all kind of applications

KROHNE temperature assemblies and transmitters are as versatile as your requirements and specific applications need them to be.

Our OPTITEMP line covers a wide range of electrical temperature instruments for industrial temperature measurement.

Alongside standard applications, we offer special designs for multipoint measurements, applications for cryogenic to high temperatures, aggressive media, high pressures or high flow rates.

Technology highlights

SmartSense insulation monitoring

Temperature assemblies with Pt100 or thermo-couple sensors can produce erroneous measurements due to humidity in the measuring insert, e.g. caused by wear, corrosion or cracks.
OPTITEMP temperature transmitters with SmartSense monitor the temperature sensor and warn of any isolation errors.

SmartSense
insulation monitoring

Temperature assemblies and transmitters for oil and gas applications

- Assemblies with integrated resistance (RTD) or thermocouple (TC) sensor with ASME or DIN style thermowells with different optional coatings
- Compact and cable sensors from versions with built-in transmitters to mineral insulated cable designs
- Rail, remote or head mounted transmitters from cost-effective analog to fully digital, programmable variants with enhanced diagnostics

OPTITEMP TT 33

OPTITEMP TT 51

OPTITEMP TRA-T30
OPTITEMP TCA-T30

OPTITEMP TRA-TF56
OPTITEMP TCA-TF56

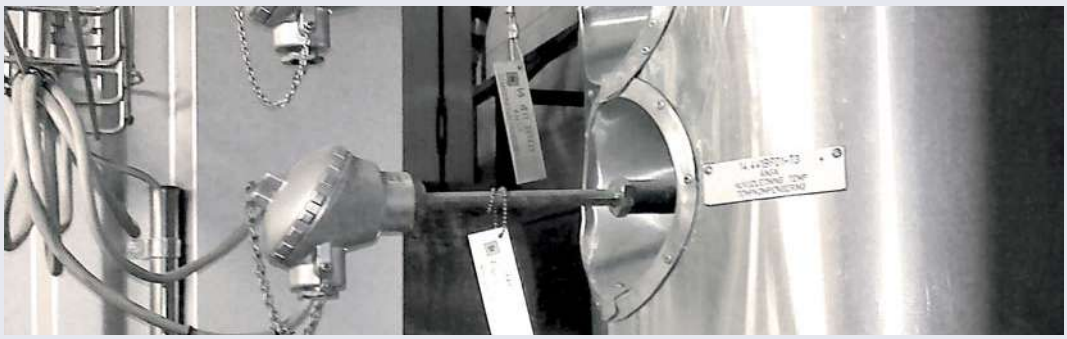
OPTITEMP TRA-S12
OPTITEMP TCA-S12

OPTITEMP TCA-P61

OPTITEMP TCA-P65

Best practice

To safeguard the processes and productions which depend on steam, the steam temperature had to be measured at several points in the plant network. Therefore a total of over 50 weld-in OPTITEMP TRA-T30 with OPTITEMP TT 50 C were used. Owing to the high pressure and the flow velocity, form F weld-in assemblies were chosen. This design keeps the risk of thermowell breakage as a result of vibration induced by vortex shedding to a minimum. The steel 1.4571 thermowell material is resistant up to +400°C / +752°F under the given conditions of use.



Services

Solution related services · Product related services · Training · Service, configuration and ordering tools

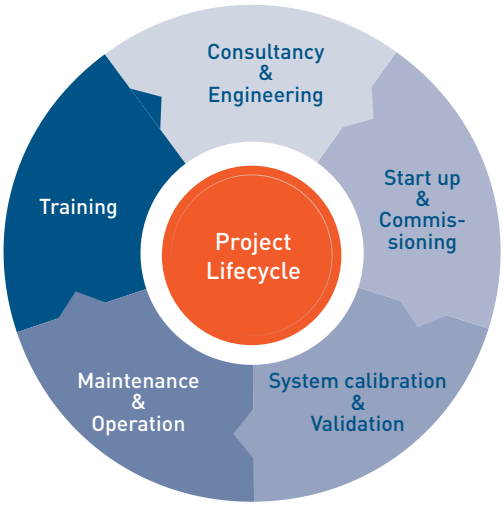
Services –
At your side, every step of the way

KROHNE engineers might be involved as early as the FEED phase of a project. Combining their oil and gas background with detailed knowledge of KROHNE products and solutions, they help customers reduce project uncertainty, risk and cost at a very early stage. In-house CFD (Computational Fluid Dynamics) analysis of piping layouts can be offered to optimise the performance and footprint of an installation.

During construction, KROHNE offers assistance with measurement uncertainty calculations and metrological accreditation with local authorities should custody transfer measurements be necessary. During start-up and commissioning, KROHNE engineers can be on-site for direct support. Once operational, periodic inspection, validation and Service Level Agreements are available.

In-house seminars on a variety of topics, such as SIL functional safety, custody transfer measurement standards, (re-)calibration requirements and pipeline leak detection, can be organised in close co-operation with the target audience. In addition, KROHNE offers a completely free eLearning platform called KROHNE Academy online which contains a wealth of information on industrial process-related instrumentation and solutions.

With a local presence in around 100 countries, service is typically available from just around the corner. This means quick reaction times and minimal travel costs. To deal with complex questions, the local service organisation is in direct contact with KROHNE knowledge centre and manufacturing organisation.



Services for the entire project lifecycle

- **Consultancy and engineering**
  Pre-sales support starting at the planning phase through to final quotations and technical details
- **Start up and commissioning**
  Commissioning services including 24h telephone hotline as part of a Service Level Agreement
- **System calibration and validation**
  Periodic inspection, validation, recalibration and revamp service, including environmental and metrological certification
- **Maintenance and operation**
  Scheduled maintenance, emergency response, remote support and spare parts management
- **Training**
  Starting from online training courses through to tailormade in-house trainings

Solution related services – Keeping an eye on the big picture

KROHNE offers a comprehensive service package for the entire lifecycle of its metering or monitoring solutions. From design concept, the consideration of legal requirements i.e. for custody transfer or functional safety loops, to on-site commissioning and support.

Consultancy and engineering

- Support with the creation of planning documentation (tenders, diagrams, communication)
- Custody Transfer (CT) support
- CFD simulations
- Scope planning and definition
- Cost estimates and budgets
- Planning of quality standards and risk identification

Start up and commissioning

- Start-up assistance
- FAT / SAT support
- Plant / Site audits

System calibration and validation

- Calibration service
- Meter verification
- On-site support
- Offshore support

Maintenance contracts

Service Level Agreements (SLAs) consisting of:

- Spare parts management
- Emergency response and on-site repair
- Maintenance, remote support
- 24/7 service hotline

Product related services – Attention to every detail

Whenever KROHNE instrumentation is installed, we will be there to provide the best possible service, from on-site analysis and workflow recommendations through to the installation and commissioning.

Product related services

- On-site planning
- Meter calibration and verification
- Rental service for e.g. ultrasonic clamp-on flowmeters
- Flexible warranty arrangements from simple warranty extensions of single instruments up to a full project
- Exchange service, e.g. local recertification or meter exchange
- Repair
- Service hotline and remote service
- Support on offshore facilities incl. instrumentation upgrades and retrofitting
- Field service incl. renewal of local custody transfer approvals (e.g. in acc. with MID)
- Revamps

Training –
From online courses to tailormade workshops

KROHNE Academy and Service Academy

KROHNE Academy is a series of seminars organised in collaboration with leading automation companies. Taking place in various countries, it addresses key operating issues, from plant safety to ways of increasing efficiency and controlling costs, and highlights possible solutions. Should your interest be more towards working "hands-on" with our devices, then our Service Academy is what you are looking for.

KROHNE Academy online

KROHNE Academy online is an online eLearning platform focusing on industrial process instrumentation. It comprises electronic learning content with full audio, explaining measuring technology without relating it to specific manufacturers. Register now for free and start your training at academy-online.krohne.com

Tailormade workshops

To fully address individual training needs, KROHNE organises tailormade training sessions at any time, virtually anywhere in the world. All aspects starting from device-specific courses or legal aspects relating to custody transfer metering or functional safety (SIL) are covered.

Functional safety seminar at KROHNE headquarters, Duisburg, Germany

Service, configuration and ordering tools – Little helpers with a big impact

myDevice – Smart service tools

myDevice is the new tool suite tailored to the needs of users and operators of KROHNE process instrumentation. It comprises a number of smart service tools for the complete lifecycle of a measuring point and ensures

- Simple and quick device commissioning
- Field device verification incl. test reports
- Monitoring and trend analysis
- Convenient management of all device-specific assets
- Knowledge transfer through online training courses and tutorial videos

krohne.com/mydevice

Configure It – Online selection and order platform for complete KROHNE quotations

- Easy selection of any spare part needed
- Integration into specific portal or marketplace
- CAD models (IGES / STEP, DWG) of most KROHNE devices for e.g. direct import into virtually any CAD system

krohne.link/conf-en

Visit krohne.com/mydevice and learn more about:

- Wireless parametrisation and commissioning of field devices
- Verification with highest test depth without process interruption
- Reliable information on device health
- Detailed reports for proof test documentation of safety loops (IEC 61508, 61511)
- Device-specific assets via serial number or AutoID acc. to DIN SPEC 91406
- Step-by-step video tutorials
- 24/7 online course availability

KROHNE Oil & Gas –
Products, Solutions and Services for the Oil and Gas Industry

Process instrumentation

- Flowmeters, flow controllers and accessories
- Level transmitters, switches, indicators and accessories
- Pressure transmitters, primary elements, diaphragm seals and accessories
- Temperature assemblies, sensors, transmitters and accessories

Metering and monitoring solutions

- Custody transfer metering systems
- Metering control systems
- Sampling and analyser systems
- Provers and master meters
- Wet gas and wellhead flow measurement
- Supervisory and validation software
- Pipeline management solutions

Services

- Expert consultation during the design phase
- On-site commissioning and training
- Service Level Agreements
- Periodical inspection and validation
- In-house seminars and workshops
- Metrological accreditation according to local legal requirements
- Measurement uncertainty calculations as per GUM
- CFD (Computational Fluid Dynamics) analysis of instrumentation and piping layout

Contact

Head office
KROHNE Messtechnik GmbH
Ludwig-Krohne-Str. 5
47058 Duisburg
Germany
Tel.: +49 203 301 0
Fax: +49 203 301 103 89
oilandgas@krohne.com
www.krohne.com/oilandgas

Global companies and representatives
The current list of all KROHNE contacts and addresses can be found at:
www.krohne.com