

▶ EcoMATE™

Fuel consumption and carbon emission monitoring system for ships



KROHNE
Marine

- Compliant with the new EU regulation 2015/757 (MRV)
- Automatic calculation of emission and efficiency data
- Automatic reporting
- High accuracy flowmeters
- Fuel consumption, monitoring and logging





KROHNE Marine – The Marine centre of excellence within KROHNE Group

KROHNE Marine is a dedicated **expert division** with more than **60 years of experience** in the marine business. Through this long-term and close partnership with our customers we have gained **extensive knowledge** in what it takes to deliver high quality products and solutions to ship owners, operators and yards. Our systems are installed on **all kinds of vessels**, from the smallest bulk carriers to the most complex tankers.

We offer a **wide range** of intelligent solutions and instruments for monitoring liquids on-board ships. So the including **EcoMATE™** – your **reliable everyday tool** for fuel consumption and bunkering monitoring. KROHNE Marine recognises that every organisation is unique with its own internal requirements; hence the EcoMATE™ is developed with the focus on it being **easy to use, flexible and transparent while providing a unified fleet** solution.

EcoMATE™ – The whole picture at a glance

EcoMATE™, the electronic fuel management system (EFMS), is specifically designed for **real time monitoring** of fuel consumption and bunkering and is the solution of choice for many major shipping companies.

For you as a fleet owner: Regardless of the vessel type, once implemented EcoMATE™ provides the whole picture you need to gain **full control** of fuel consumption, emissions and bunkering. All data is visualised, documented and reported and you don't have to be on board – EcoMATE™ is a **remote, cloud-based** solution that can be accessed onshore.

For you as a ship personnel: In combination with the high-performance KROHNE OPTIMASS Coriolis mass flowmeters,

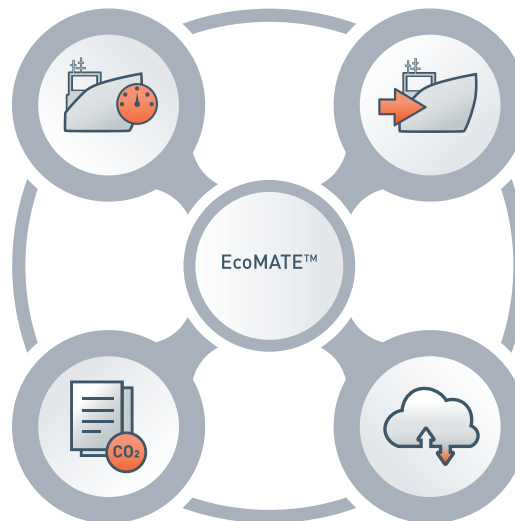
EcoMATE™ gives you **detailed information** on fuel consumption by measuring the supply and return lines to the main engine and other consumers on-board and provides automated **emission reports**, for different fuel types.

In order to keep track of fuel oil costs and to be able to verify the amount of fuel oil received during a bunkering operation, the EcoMATE™ system also gives an overview of all corresponding flow readings.

EcoMATE™ is a 100% in-house product consisting of **4 software modules**.

1

EcoMATE™ Fuel Consumption
for continuous measurement and monitoring of fuel consumption on board ships



2

EcoMATE™ Bunkering
for verification of bunker quantities received through the bunker line

3

EcoMATE™ MRV & IMO DCS
For carbon emission monitoring, calculation and reporting acc. to EU regulation and MARPOL

4

EcoMATE™ Cloud
for automatic transmission of data to shore for fleet reporting and monitoring

EcoMATE™ System

Highlights

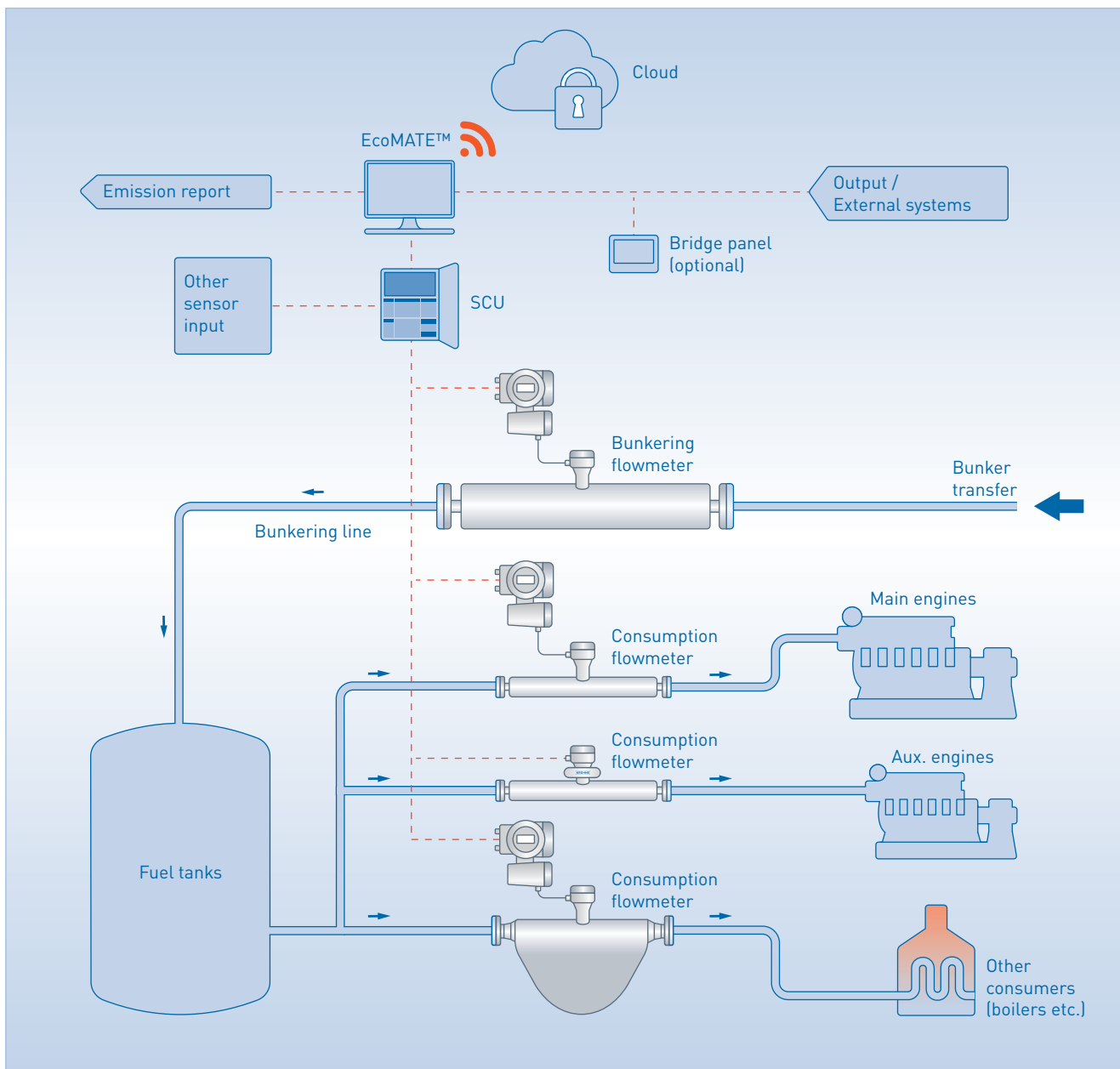
- Enables shipowners to monitor all vessel types within the fleet with a single integrated tool
- Accommodates both manual and online data entry to monitor operational data per voyage
- Conducts data quality checks and validations
- Creates vessel-based annual reports with automated emission calculation (e.g. CO₂)
- Configurable model with various fuel consumers
- Fuel type definitions with emission factors
- Optimised for use with KROHNE OPTIMASS Coriolis mass flowmeters
- Collects data from external systems
- Creates voyages with events
- Logging of historical data
- Full data integrity
- Reports
- Automatically interfaced with a cloud solution for onshore personnel

A basic setup will consist of one or several flowmeters, mounted inline with the fuel supply line or bunkering line.

Once implemented, the EcoMATE™ software takes care of data acquisition, logging, calculations, monitoring and reporting.



For all kinds of vessels





EcoMATE™ Fuel Consumption module

1

Accurate measurements and monitoring of your fuel consumption is crucial to obtain full control over the use of your fuel. The EcoMATE™ software in combination with **highly accurate measuring results** from OPTIMASS Coriolis mass flowmeters monitors and stores detailed information about fuel usage and generates reports that allow you to see the **real detailed picture**.

By benchmarking fuel consumption between ships, optimisation will be on everybody's agenda. Benchmarking based on emissions may also be part of the future for charterers choosing shipping companies. The EcoMATE™ is designed to fulfil coming requirements from IMO or other authorities.



EcoMATE™ Bunkering Verification module

2

Fuel oil costs represent the biggest share of a vessel's total operating cost. To verify the amount of fuel oil delivered during a bunkering operation, you need accurate and reliable measurements.

The EcoMATE™ system measures the flow in your bunkering line. A typical installation will consist of a flowmeter mounted in the bunkering line linked to an EcoMATE™ workstation, usually located in the control room. Supporting equipment like pressure sensors, venting and regulation valve may be recommended depending on the installation.

During the bunkering process **trend graphs** give you a good overview of all values. On the monitor, you can follow the **exact amount of fuel oil** taken on-board. Reports showing **total bunker quantities received** and **verification of density** can be printed and emailed to a shore station. Linked to the bunkering mass flowmeter, the EcoMATE™ software takes care of **data acquisition, logging, calculations and monitoring**. All relevant data is **logged and stored** in the system database.

High measuring accuracy comes from the right instrumentation

Bunker quantities measured by volume are dependent on temperature, density and possible contents of air. The EcoMATE™ system utilises **Coriolis mass flowmeters** which offers **continuous monitoring** of mass flow rate, density and temperature throughout the entire bunkering operation. Measuring mass directly secures high accuracy and a more efficient bunkering process. The presence of excessive **air content in the fuel oil will be indicated** to allow rectification.



EcoMATE™ MRV & IMO DCS module

3

KROHNE Marine has developed a certified and dedicated MRV & IMO DCS module for EcoMATE™ to help crew, owners and operators to **comply with emission reports** in a correct, easy and effective manner. Utilising the EcoMATE™ MRV&IMO DCS module, the user can save time and effort, being assured that **transparent and accurate** emission reports are generated that meets the EU and IMO regulation. EcoMATE™ also seamlessly incorporates a set of features easing the daily operation and daily reporting requirements based on voyage or vessels mode.

EcoMATE™ is certified and compliant with method **A through C (MRV)** in one bundle. This enables shipping companies to utilise a single tool that may include multiple types of monitoring methods.

The first step

EU (MRV) and IMO DCS are mandatory requirements, being the first step in the process to measure, analyse and reduce CO₂ emission from the shipping industry.



What is MRV?

MRV is short for Monitoring – Reporting – Verification and is related to CO₂ emission. The regulation (EU) 2015/757 applies to ships, regardless of flag, greater than 5,000 GT on commercial voyages into, out of or between European Union ports. It requires pervoyage and annual monitoring of CO₂ emissions, as well as other key performance indicators, including quantities of cargo carried and miles travelled. The monitored data will be reported per ship to an approved notifying body for verification before it is handed over to EU.

What is IMO DCS?

Starting from 1st January 2019, ships of 5,000 Gross Tonnage (GT) or above shall collect fuel consumption data, hours underway and distance travelled according to procedures, systems and responsibilities to be documented in a Data Collection plan (DCP) within the Ship Energy Efficiency Management Plan (SEEMP) Part II.

The DCP shall be prepared in accordance with the 2016 Guidelines for the Development of a Ship Energy Efficiency Management Plan adopted by Resolution MEPC.282 (70), and shall be submitted to the Flag Administration or any organization authorized by 1st September 2018 for a review that must be completed by 31st December 2018.

EU MRV vs. IMO DCS

	EU MRV	IMO DCS
Applicability	Ships 5,000 GT and above calling any EU ports	Ships 5,000 GT and above sailing globally
First reporting period	2018 (1 Jan - 31 Dec) Reporting to verifier by end of January 2019	2019 (1 Jan - 31 Dec) Reporting to verifier by end of March 2020
Monitoring plan	<ul style="list-style-type: none"> • Separate document describing the methodology for data collection and reporting • Pre-defined format published by the European Commission (EC) • Subject to verification by an independent accredited verifier • Deadline for submission of Monitoring plan was 31 Aug 2017 	<ul style="list-style-type: none"> • Data collection and reporting methodology shall be described in a SEEMP Part II • SEEMP Part II is an integrated part of the Ship Energy Efficiency Management Plan, SEEMP • Conformation of compliance by Flag State/Recognised Organisation (RO) • Deadline for submission of SEEMP Part II was 31 Dec 2018
Reporting details	<ul style="list-style-type: none"> • Amount and emission factor for each type of fuel consumed in total • Total CO₂ emitted and additionally differentiated to aggregated CO₂ emitted <ul style="list-style-type: none"> - Voyages to and from EU ports - Voyages between EU ports - At berth • Total transport work <ul style="list-style-type: none"> - Time at sea and in port - Cargo carried • Average energy efficiency 	<ul style="list-style-type: none"> • Period of calendar year for which the data is submitted • Distance travelled • Amount of each type of fuel consumed in total • Hours underway under own propulsion • DWT to be used as cargo proxy
Reporting to	<ul style="list-style-type: none"> • European Commission: <ul style="list-style-type: none"> - Company reports annual emissions to the EMSA database ("THETIS MRV") - Annual report to be verified by an accredited verifier (such as DNV GL) 	<ul style="list-style-type: none"> • Flag State: <ul style="list-style-type: none"> - Annual emission report to be verified by Flag Admin./RO - Flag State (or RO) reports to IMO database
Disclosure	Data publicly available via the European Commission	Ship data will be kept confidential

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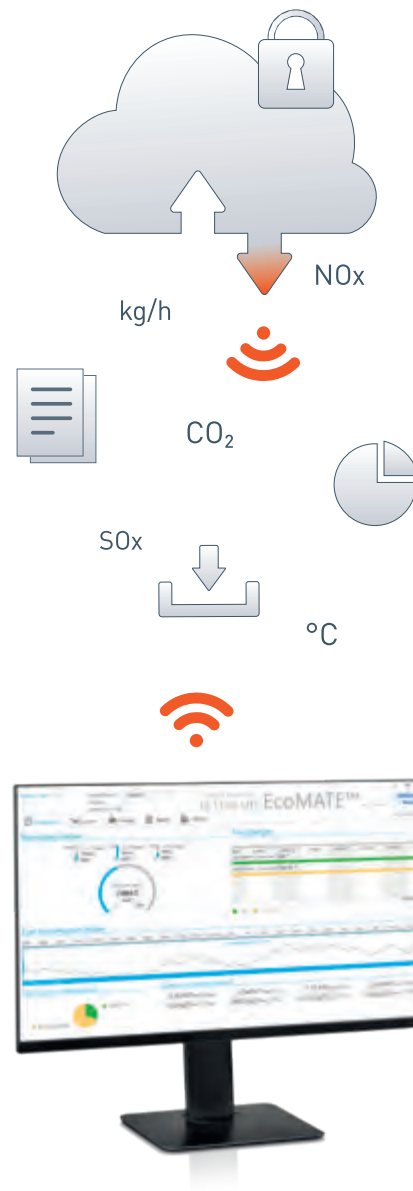
EcoMATE™ Cloud module

4

The EcoMATE™ Cloud is a shore based centralised **web reporting tool** for vessels running the EcoMATE™ system. The connected EcoMATE™ vessels automatically transmit data to the cloud, where you can **view, download and analyse** your data in a convenient dashboard summary. So all 4 modules of the EcoMATE™ system work together to give users full control and visibility over important fuel data.

See trends of fuel consumption or emission in correlation with temperature, speed and/or kilowatt thrust per vessel. **Compare vessels** for the same voyage sailed months apart or view bunker batch reports and the useful **notification messages** sent from the on-board EcoMATE™ system.

You can easily **analyse and report actual measured data** from each vessel down to individual fuel consumer level.



Reporting tool

The EcoMATE™ reporting tool includes **easy to read charts** and **graphs**. User-friendly presentation makes comparison of day to day numbers a simple task. The software helps users make better decisions and keep **better cost management**.

Available standard reports:

- Fuel consumption report
- User defined report per consumer
- Annual emission report according to MRV/IMO DCS regulations
- Voyage report
- Transport work, energy efficiency, total fuel consumption and emission data per consumer for a specific voyage
- Bunker report
- Summary



Interface

The EcoMATE™ system offers interface to applications such as **AMS**, **vessels performance** systems, **reporting** systems and a variety of others. EcoMATE™ also interfaces **all relevant types** of sensors, flowmeters, GPS, LOG and other NMEA values to view on-board and in the owner's office. These interfaces make EcoMATE™ vital in the work-flow process and allow the data collection system to operate in the most efficient manner possible.

The scope of our interface capabilities enables EcoMATE™ to minimise your risk, maximise your technology investment and deliver the best total system to fit your organisation. These work-flow improvements **bring complex technologies together** to simplify compatibility, interoperability, and centralised information management.



Details on all interfaced consumers are available in an overall system layout view

Reports of consumption, emission and other key data are generated by selecting report type and desired time period

Service at KROHNE Marine

Your demands – our mission

Through its highly dedicated employees and decades of experience KROHNE Marine can offer a **variety of solutions** based on the customers need and operational requirements:

- Standalone software packages (e.g. interfaced with existing flowmeters)
- KROHNE Coriolis mass flowmeters for integration with existing systems on-board
- Package of computer, software and flowmeters for installation by crew or yard
- Full turnkey solution
- Service, support and training

Turnkey solution from one source

KROHNE Marine offers you turnkey solutions in the spheres of **measurement, electrical installation and system integration**. They yield direct benefits such as effectiveness, efficiency and ease of use.

Our **experienced project engineers** take responsibility for a total solution and provide input throughout the entire process: from consultancy and design to maintenance and service. The installation can be done during voyage or even during port stay – **no need for off-hire**.

Service network

To support you and your operations, our **worldwide network of service stations** is trimmed to provide you high quality and right support at any time.

Taking advantage of KROHNE Marine “one stop shop” will ease your communication and improve our teamwork constantly. Allowing for even greater trust and peace of mind!

Case study: Fuel balance calculation for large client

- Task: transfers between on-board tanks, consumption of main engine, auxiliary engines and burners/water boilers for a vessel fuel balance calculation (marine diesel oil, heavy fuel oil and mixtures of both)
- For a proof of concept (POC) testing, KROHNE Marine delivered a complete measuring and monitoring solution, including system engineering, piping, mechanical and electrical installation
- Key points were overall accuracy achieved, response time during pilot stage, fulfilment of timelines and availability to clients inquiries
- After successful POC phase, the customer decided to equip a major part of the fleet with the KROHNE Marine solution



KROHNE OPTIMASS Coriolis mass flowmeters

OPTIMASS flowmeters have significant advantages over other flow measurement methods as they **directly measure mass flow, liquid density and process temperature** independently of each other. Mass flow and density combine to calculate volume flow if required.

The measuring devices picks up the flow **quickly and accurately even with quick changes** in the medium, such as temperature shifts or density jumps.

All flowmeters are designed using open tube measuring principles, with **no moving parts or internal obstructions**. This ensures no maintenance during the complete lifecycle of the instruments. In addition, pressure loss over the instruments is minimal. OPTIMASS flowmeters will provide reliable readings and save maintenance costs. The design eliminates the risk of clogging, thereby reducing the risk of engine loss.


EGM™ – Entrained Gas Management






OPTIMASS flowmeters with EGM™ technology give more stable, continuous and repeatable measurements even with entrained air in the fluid.

The EGM™ technology ensures that the flowmeters continue to measure where competitions flowmeters would halt or reset.

EGM™ technology makes OPTIMASS flowmeters perfectly fit with the EU MRV requirement of data continuity and validity.



	OPTIMASS 1010
	
	For universal applications and process control, with Modbus communication
Measuring accuracy	Liquid: ±0.15% Gas: 0.35% Density: ±2 kg/m ³
Nominal range	48...170000 kg/h
Process temp.	-40...+130°C; -40...+266°F
Custody transfer	-
Highlights	<ul style="list-style-type: none"> • Twin straight tubes with optimised flow divider for minimum pressure loss • Direct digital communication via Modbus RTU over RS485 • Optional EtherNet/IP™ interface • Extensive sensor and process diagnostics (incl. NE 107) • Maintenance free, fully welded measuring tubes with no moving parts

OPTIMASS 1400 F	OPTIMASS 2400 F	OPTIMASS 6400 F	OPTIMASS 7010	OPTIMASS 7400 F
				
<p>For universal applications and process control</p>	<p>Dual or four straight tube design for bulk flows for custody transfer up to DN400; 16"</p>	<p>The standard high-performance meter up to DN250; 10"</p>	<p>For advanced applications, with single straight measuring tube and Modbus communication</p>	<p>For advanced applications, with single straight measuring tube</p>
<p>Liquid: $\pm 0.15\%$ Density: $\pm 2 \text{ kg/m}^3$ ($\pm 0.2 \text{ kg/m}^3$)</p>	<p>Liquid: $\pm 0.1\%$ (optional: $\pm 0.05\%$) Density: $\pm 1 \text{ kg/m}^3$ ($\pm 0.2 \text{ kg/m}^3$)</p>	<p>Liquid: $\pm 0.1\%$, (optional $\pm 0.05\%$) Gas: $\pm 0.35\%$ Density: $\pm 1 \text{ kg/m}^3$ ($\pm 0.2 \text{ kg/m}^3$)</p>	<p>Liquid: $\pm 0.1\%$ Gas: 0.35% Density: $\pm 2 \text{ kg/m}^3$ ($\pm 0.5 \text{ kg/m}^3$)</p>	<p>Liquid: $\pm 0.1\%$ Gas: 0.35% Density: $\pm 2 \text{ kg/m}^3$ ($\pm 0.5 \text{ kg/m}^3$)</p>
<p>48...170000 kg/h</p>	<p>1560...4600000 kg/h</p>	<p>5...1500000 kg/h</p>	<p>400...2500 kg/m³</p>	<p>400...2500 kg/m³</p>
<p>-40...+130°C; -40...+266°F</p>	<p>-45...+130°C; -49...+266°F</p>	<p>-200...+400°C; -328...752°F</p>	<p>-40...+150°C; -40...+302°F</p>	<p>-40...+150°C; -40...+302°F</p>
<p>-</p>	<p>OIML R117, Inmetro, NTEP, MI 005, MI 002</p>	<p>OIML R117, OIML R137, Inmetro, NTEP, MI 005, MI 002</p>	<p>OIML R117, Inmetro, NTEP, MI 005</p>	<p>OIML R117, Inmetro, NTEP, MI 005</p>
<ul style="list-style-type: none"> • Direct measurement of fuel mass flow, density and temperature • Twin straight tubes with optimised flow divider for minimum pressure loss • Best-in-class price/performance ratio • Immunity to crosstalk: resistant to installation and process effects • Maintenance free, fully welded measuring tubes with no moving parts 	<ul style="list-style-type: none"> • Direct measurement of fuel mass flow, density and temperature • Twin or four straight tube design with optimised flow splitter for minimum pressure loss • Highest OIML accuracy class of 0.3 for custody transfer (CT) • Multiproduct capabilities – measurement of residual and heavy fuel oil in the same pipe • Measuring Instruments directive (MID) 2004/22/EC certificate available • Immunity to crosstalk: resistant to installation and process effects • Maintenance free, fully welded measuring tubes with no moving parts 	<ul style="list-style-type: none"> • Direct measurement of fuel mass flow, density and temperature • Twin bent tube design with optimised flow splitter for minimum pressure loss • Highest OIML accuracy class of 0.3 for custody transfer (CT) • Immunity to crosstalk: resistant to installation and process effects • Maintenance free, fully welded measuring tube with no moving parts 	<ul style="list-style-type: none"> • Single straight tube design • Direct digital communication via Modbus RTU over RS485 • Optional EtherNet/IP™ interface • Extensive sensor and process diagnostics (incl. NE 107) • Maintenance free, fully welded measuring tubes with no moving parts 	<ul style="list-style-type: none"> • Single straight tube design • Fast and completely digital signal processing • Highest OIML accuracy class of 0.3 for custody transfer (CT) • Extensive sensor and process diagnostics (incl. NE 107) • Integrated temperature measurement • Optional PED approved secondary pressure containment up to 100 barg • Immunity to crosstalk: resistant to installation and process effects • Maintenance free, fully welded measuring tubes with no moving parts

KROHNE – Process instrumentation and Measurement solutions

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

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