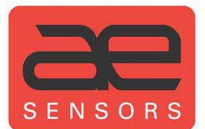


# TRICOR Coriolis Mass Flow Meters

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Fuel consumption measurement



**Measure  
Monitor  
Analyze  
Optimize**



# We understand the requirements of the maritime industry



Tanker



Bulk carrier



Container



OSV/PSV

Many years of experience and expertise in the area of automation technology and instrumentation makes us the ideal partner for flow measurement technology in the maritime industry. We offer you field tested and proven solutions, that meet rules and regulations - and help you **save money**. To accurately measure fuel consumption based on mass flow is becoming key for ship owners and operators in a field, where fuel consumption contributes most to the total costs. Accurate mass flow measurement with a TRICOR Coriolis Mass Flow Meter helps ship owners, operators and charterers to better control costs, decrease fuel consumption and as a consequence increase competitiveness of your fleet. With class leading density measurement and competitive pricing you should get the quickest possible return of investment.

How can you reduce the running costs of the vessels you operate? In our opinion there are 4 steps to improve your vessel performance.

**The advantage** of the four step approach is the fact, that you can decide, depending on budgets, when and whether you implement step 1 to step 4. Only with accurate flow information about your fuel consumption and with versatile monitoring systems you are able to conclude actions for sustainable optimization of your vessel performance and thus to save money.

**Step 1: Measure**



**Step 2: Monitor**



**Step 3: Analyze**



**Step 4: Optimize**





## Measure

With a TRICOR Coriolis Mass Flow Meter you compare “apples with apples”. Since the measuring principle is independent of temperature and pressure, you get the **correct reading of your fuel consumption**, based on mass flow rate.

Coriolis Mass Flow Meters operate with two parallel tubes with coils that cause them to oscillate at their resonance frequency. Should a measurement flow enter the measuring tube, Coriolis forces are the result. Coriolis forces appear in oscillating systems when a mass moves towards or away from a rotational axis. They act on the inlet and outlet side in the opposite direction and minimally deform the measuring tubes. The deflection of the measurement tubes is captured by sensors on the inflow and outflow side. These two sensors measure a phase shift that is proportional to the mass flow.

The resonance frequency of the tubes varies depending on the density of the medium to be measured. This effect is used to measure the density of the medium.

## Benefits of Coriolis Mass Flow Meters

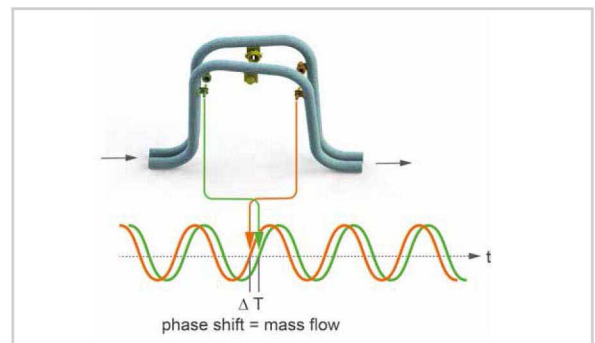
- All in one mass flow and density meter
- Direct mass flow measurement
- Real time density measurement for fuel quality control
- No moving parts
- No upstream and downstream piping required
- Replaces all kind of volume based flow meters
- Excellent repeatability in order to determine actions for process/engine optimization
- Maintenance free

## And TRICOR Coriolis Mass Flow Meters go one step further:

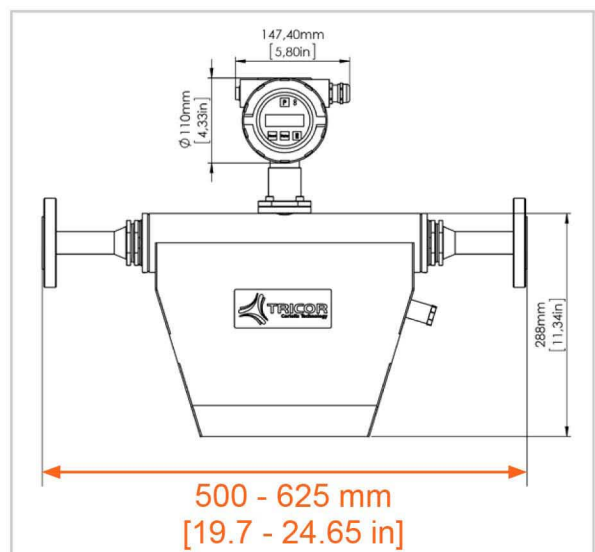
- Outstanding density measurement performance
- Customized meters for your requirement
- Calibration according DIN EN ISO/IEC 17025:2005 for various oils, traceable to national and international standards
- Density Range:  $650 \text{ kg/m}^3 - 1000 \text{ kg/m}^3$
- Viscosity Range:  $1 \text{ mm}^2/\text{s} - 100 \text{ mm}^2/\text{s}$



TRICOR Coriolis product family




Principle of operation



Customized meter dimensions:  
TRICOR Coriolis Mass Flow Meter TCM 028K

Certificate Number: 14-031232473-0JA-CPJ  
02MAH/2015



***Confirmation of Product Type Approval***

Please refer to the "Service Restrictions" shown below to determine if Unit Certification is required for this product. This certificate reflects the information on the product in the ABS Records as of the date and time the certificate is printed.

Pursuant to the Rules of the American Bureau of Shipping (ABS), the manufacturers of the below listed product held a valid Manufacturing Assessment (MA) with expiration date of 15/10A/2020. The continued validity of the Manufacturing Assessment is dependent on completion of satisfactory audits as required by the ABS Rules.

As a Product Design Assessment (PDA) valid until 15/05P/2019 subject to continued compliance with the Rules or standards used in the evaluation of the product.

The above entire the product to be called Product Type Approval.

The Product Design Assessment is valid for products intended for use on ABS classed vessels, MCOUs or facilities which are in existence or under contract for construction on the date of the ABS Rules used to evaluate the Product.

ABS makes no representations regarding Type Approval of the Product for use on vessels, MCOUs or facilities built after the date of the ABS Rules used for this evaluation.

For continuity of specifications used in the Product ABS has evaluated for Type Approval, it is part of our contract that whether the standard is an ABS Rule or a non-ABS Rule, the Client has full responsibility for continued compliance with the standard.

**Product Name: Meter, Flowmeter**

**Model Name(s): Meter Model TCM-xxxx-xxx-xxxx-xxxx (Tricor Flowmeter + Transmitter), Remote Mount TCM-xxxx-xxx-xxxx-xxxx (Tricor Flowmeter + TC6Bxxxx-xxxx-xxxx-xxx (Tricor Transmitter/Electronics)**

**Presented to:**  
KEU KLUPPERS ELEKTROMECHANIK GMBH  
LEIBSTRASSE 5  
Germany

**Intended Service:** Fuel Consumption Measurement, Chemical Injection measurement.

**Description:** Flowmeter, Coriolis Mass Flow measuring System.

**Ter:** 3

**Rating:** Voltage: 90 V-240 VAC, 24 VDC; Power: 4 Watt; Suitable for Hazardous Area Classification: II 2D Ex d IIB G Ex d IIB G; II 2D Ex d IIB G Ex d IIB G; Class I, Div. 1, Groups A, C & D.

**Service Restrictions:** Unit Certification is not required for this product. If the manufacturer or purchaser require an ABS Certificate of Compliance with a specification or standard, the manufacturer should, in addition, inspect production standards and tolerances, must be clearly defined.

**Comments:** Duplicate PDA records issued with KEM Kumpers - Karlsruhe - Germany. The Manufacturer has provided a declaration about the use of the product in the last level of Adherence in this product. Each particular application and installation is to be specifically approved in drawings and relevant system, locations and environmental conditions. All electrical equipment intended for installation in hazardous areas are to be certified safe type tested on the date of the hazardous area at its location of installation. Certificates in this regard are to be presented to ABS Surveyor for verification on a

Basic Accuracy [Mass Flow]:	±0.1 % of flow rate
Mass Flow Repeatability:	±0.05 % of flow rate
Basic Accuracy [Volume Flow]:	±0.15 % of flow rate
Volume Flow Repeatability:	±0.05 % of flow rate
Zero Stability:	±0.01 % of full scale

Density Range:	up to 2500 kg/m <sup>3</sup> , 2.5 g/cm <sup>3</sup>
Density Accuracy:	Liquids ±1.0 kg/m <sup>3</sup> , ±0.001 g/cm <sup>3</sup>
Density Repeatability:	±0.5 kg/m <sup>3</sup> , ±0.0005 g/cm <sup>3</sup>

Process Temperature Range: standard:  
-40 °C ... +100 °C, -40 °F ... +212 °F  
optional:  
-60 °C ... +150 °C, -76 °F ... +302 °F  
-60 °C ... +180 °C, -76 °F ... +356 °F

Temperature Accuracy:  $\pm 1^{\circ}\text{C} \pm 0.5\%$  of reading  
 $\pm 1.8^{\circ}\text{F} \pm 0.5\%$  of reading

Temperature Repeatability:  $\pm 0.2\text{ }^{\circ}\text{C}$ ,  $\pm 0.36\text{ }^{\circ}\text{F}$

Tubes: 1.4404/AISI 316L  
Case: 1.4404/AISI 316L

ATEX:	Zone 1: Group IIB or IIC, T4 Zone 2: II 3G Ex nA IIC, T4 Gc
IECEX:	Zone 1: Group IIB or IIC, T4
cCSAus Ex:	Class I, Division 1: Group C, D, T4

American Bureau of Shipping: Certificate Number:  
14-HS1223473-PDA-DUP

RMRS: Russian Maritime Register of Shipping

Master Contract: 220043  
Date Issued: 2015-06-25

Issue No. 2      Certificate history  
Issue No. 2 (2014-12-18)  
Issue No. 1 (2015-03-04)  
Issue No. 2 (2015-12-18)

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# Typical Applications - TRICOR Coriolis Mass Flow Meters

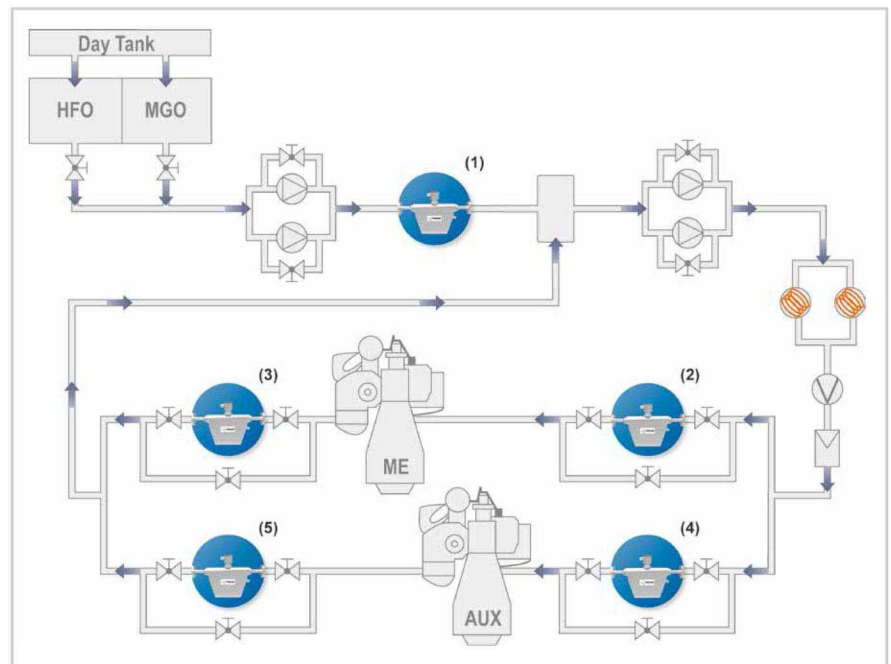


- (1) Total Supply from day tanks
- (2) Supply ME
- (3) Return ME
- (4) Supply AUX
- (5) Return AUX
- (6) Total return

ME (Main Engine)  
AUX (Auxiliary Engine)  
HFO (Heavy Fuel Oil)  
MGO<sup>\*)</sup> (Marine Gas Oil)

<sup>\*)</sup> represents just one of various other fuel oil options as an example

## Open & Closed loop recirculation



(1) Total Supply only

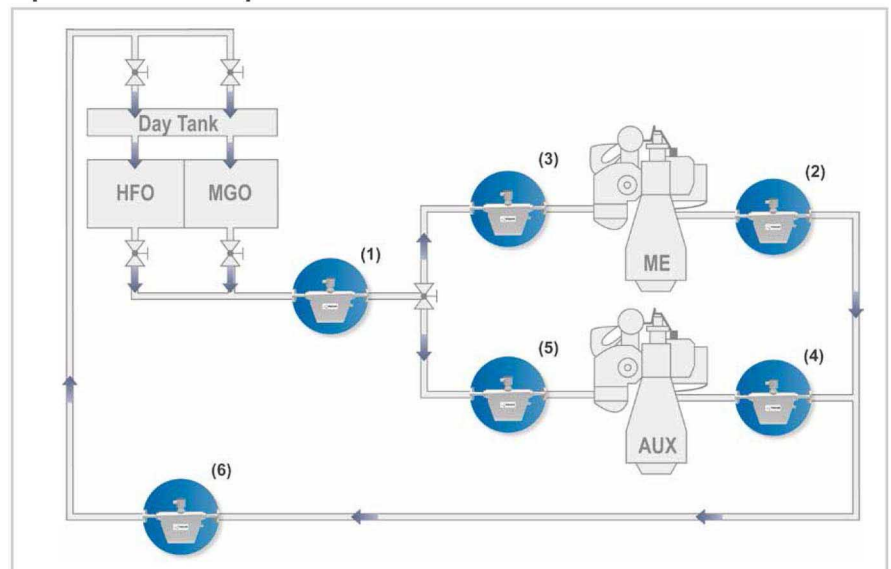


$(1) - \Delta (2 \text{ \& } 3) = \text{Total Consumption AUX}$  or  
 $(1) - \Delta (4 \text{ \& } 5) = \text{Total Consumption ME}$



$\Delta (2 \text{ \& } 3) + \Delta (4 \text{ \& } 5) = \text{Total Consumption}$

## Open & Closed loop without recirculation



$(1) - (6) = \text{Total Consumption}$



$\Delta (2 \text{ \& } 3) + \Delta (4 \text{ \& } 5) = \text{Total Consumption}$

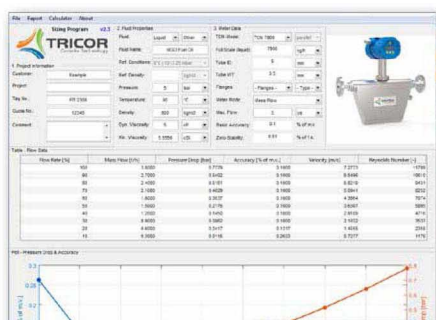
## Conclusion

There are various setups possible depending on your budget. Fuel consumption and engine performance are optimized by how accurately you measure, monitor, analyze and optimize.



# TRICOR Coriolis Mass Flow Meters - Typical Applications

Metric Tons [MT/h]	Fuel Oil Density @ 900 kg/m <sup>3</sup> Viscosity @ 5-15 cSt Pressure Drop 1 bar/14.5 psi	Fuel Oil Density @ 900 kg/m <sup>3</sup> Viscosity @ 180 cSt Pressure Drop 1 bar/14.5 psi	Fuel Oil Density @ 900 kg/m <sup>3</sup> Viscosity @ 380 cSt Pressure Drop 1 bar/14.5 psi
Cylinder Oil	TCM 0325		
Mass Flow Rate [max]	0.17		
Cylinder Oil	TCM 0650		
Mass Flow Rate [max]	0.44		
Main/Auxiliary Engine	TCM 1550	TCM 1550	TCM 1550
Mass Flow Rate [max]	0.73	0.15	0.075
Main/Auxiliary Engine, Boiler	TCM 3100	TCM 3100	TCM 3100
Mass Flow Rate [max]	1.8	0.58	0.29
Main/Auxiliary Engine, Boiler	TCM 5500	TCM 5500	TCM 5500
Mass Flow Rate [max]	1.9	0.41	0.20
Main/Auxiliary Engine, Boiler	TCM 7900	TCM 7900	TCM 7900
Mass Flow Rate [max]	3.2	1.1	0.53
Main/Auxiliary Engine, Boiler	TCM 028K	TCM 028K	TCM 028K
Mass Flow Rate [max]	12.3	7.5	4.1
Main/Auxiliary Engine	TCM 065K	TCM 065K	TCM 065K
Mass Flow Rate [max]	39.2	32.8	21.4
Bunkering	TCM 230K	TCM 230K	TCM 230K
Mass Flow Rate [max]	122.0	97.6	88.0



## How to select the meter for your application

Use our sizing program.



See full specification of the meter:  
[www.tricorflow.com/applications-industries/tricor-coriolis-flowmeters-marine/#downloads](http://www.tricorflow.com/applications-industries/tricor-coriolis-flowmeters-marine/#downloads)



Send us your request through our Marine Questionnaire.

Providing visibility to users by collecting information from equipment for routine and ongoing monitoring; TRICOR Coriolis Mass Flow Meter provide **exact and reproducible data**, that enable you to adjust machines, pumps and valves precisely. Collect the flow information in a monitoring system and start comparing fuel consumption by consumers. Since the crew is key to determine what internal and external influences affect the fuel consumption of the vessel, visualization of flow data is a first step to identify where there is potential for fuel savings. With a Vessel Performance Monitoring system you compare historical data with existing data of your vessel. Setting a benchmark for expected fuel consumptions in conjunction with engine performance provides you with all the data for complete **optimization**.



## Monitor

- Monitor vessel fuel consumptions
- Compare noon-to-noon fuel consumption
- Reduce workflow process using centralized displays
- Customer pre-set alarms limits
- Data needed from Mass Flow Meters and GPS sensors

## Analyze

- Compare historical SFOC performance vs. baseline
- Optional trend lines available
- Customer pre-set alarm limits
- Data needed from Mass Flow Meters and engine control

## Optimize

- Get accurate flow information
- Monitor fuel consumption and engine performance
- Submit your voyage report with accurate data
- Analyze vessel performance
- Optimize vessel performance with sustainable data



VPS Dashboard - ME



VPS Dashboard - Main

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

Accurate data is crucial to obtain control over the use of your fuel. Dependable measurements allow you to see the real detailed picture and give potential for significant savings in fuel consumption. Based on this knowledge you will optimize your vessel performance and this leads you to a **fast return on investment**.

