Appendix B – Hydrogen Mass Flow Meter Evaluation for Heavy-Duty Fueling

Hydrogen Mass Flow Meter Evaluation for Heavy-Duty Fueling

Purpose: Technical summary supporting evaluation of a hydrogen mass flow meter for heavy-duty fueling up to 30 kg/min and an MMQ of 3.0 kg.

Meter Specification

- Measuring range: 0.4 to 0.8 kg/min (±2%)
- Measuring range: 0.8 to 30.0 kg/min (±0.5%)
- Maximum flow: 30.0 kg/min (1,800 kg/h)

Performance Table

Flow (kg/min)	Flow (kg/h)	Accuracy
0.4	24	±2.0%
0.8	48	±0.5%
1	60	±0.5%
5	300	±0.5%
10	600	±0.5%
18	1080	±0.5%
30	1800	±0.5%

30 kg/min Evaluation

At 30 kg/min the meter is operating at its rated maximum flow while remaining within the specified ±0.5% accuracy band.

MMQ = 3.0 kg

Time to deliver 3.0 kg at 30 kg/min:
3.0 / 30 = 0.1 minute = 6 seconds.

Measurement Uncertainty

At ±0.5% accuracy:
• 3 kg delivery: ±0.015 kg (±15 g) • 30 kg delivery: ±0.150 kg (±150 g) • 100 kg delivery: ±0.500 kg (±500 g)

Advancement in High-Flow Hydrogen Mass Measurement

Recent advances in Coriolis mass flow meter technology have significantly improved the ability to accurately measure hydrogen under the demanding pressure and flow conditions associated with vehicle fueling. Improvements in flow-tube design, vibration sensing, digital signal processing, pressure and temperature compensation, and high-pressure construction have enabled increasingly accurate direct mass measurement of hydrogen. Published research has demonstrated Coriolis meter operation under hydrogen-refueling conditions approaching 70 MPa, while other testing has shown measurement errors approaching ±0.5% at moderate-to-high flow rates. These technological developments provide the foundation for a new generation of heavy-duty hydrogen dispensing systems designed for substantially higher flow rates, including equipment rated up to approximately 30 kg/min with ±0.5% accuracy. Such capability represents a significant advancement over traditional light-duty hydrogen fueling equipment and supports the development of commercial measurement requirements specifically addressing high-flow, heavy-duty vehicle fueling. Following are specifications from two mass flow meter manufacturers demonstrating achievement of these requirements for high flow, heavy-duty vehicle fueling.

HB-44 Technical Considerations

The meter specification supports heavy-duty hydrogen dispensing up to 30 kg/min. A 3 kg MMQ is achieved in approximately six seconds while the meter remains in its highest accuracy range. Additional system considerations include dispenser design, thermal management, pressure drop, vehicle acceptance rate, and safety.


Hydrogen Components
Coriolis Mass Flowmeter
H70
HF
MF
NF
H35
MF
NF
H70
TATSUNO
Coriolis Flow Meter for hydrogen gas
NF/MF
Intergral Type
TATSUNO
Hydrogen
A lineup that can be selected according to the purpose of use.
Suitable for high flow rate measurement.
Separate Type
TATSUNO
In Innovation, In Reliable Services

Coriolis Mass Flowmeter
Integral Type / Separate Type

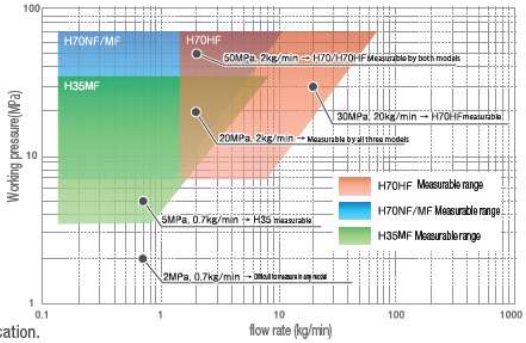
High-precision measurement of various fluids is possible.
- High accuracy ±0.5%.
- High-pressure gases ranging from 5 to 120MPa, and various liquids.

Wide range and low pressure loss.
- Flowmeter lineup range from 10~1920 kg/h with various bore diameters to suit different applications.

Complies with various safety certifications.
[Explosion-proof]
- Ex bd id IIC T4 Gb compliant.
- IECEx, ATEX, Japan domestic explosion-proof, China NEPSI, Korea KOSHA, North America ETL certification.

[High-pressure safety]
- Capable of passing KHK facility tests, North American ETL certification.

■ Coriolis flowmeter for hydrogen gas (integrated type) Measurable range



Extensive installation track record.
- Delivered domestically as well as to the United States, China, South Korea, and other countries.
- Incorporated and utilized in hydrogen dispensers, hydrogen production and shipping equipment, experimental research equipment, etc.

Product Lineup

Model	Separate Type		Integral Type		Integrated large-diameter
Pressure Class ※1	H35	H70	H35	H70	H70
Flow Rate ※1	NF		MF	NF/MF	HF
Maximum allowable pressure ※1	50MPa	120MPa	50MPa	96.3MPa	96.3MPa
Standard Flow Range ※2	10 ~ 60kg/h	10 ~ 300kg/h	10 ~ 270kg/h	10 ~ 648kg/h	96 ~ 1920kg/h
Appearance					
Applicable Fluid	Gas or Liquid				
Fluid Temperature Range	-40 ~ 85℃				
Accuracy	±0.5% of rate				
Dimensions (mm)	Detector: W200 × D75 × H185 Exchanger: W241 × D240 × H199.5		W162 × D100 × H210.5		W210 × D112.5× H210
Mass	Detector: 7.1kg / Exchanger: 5.2kg		4.5kg		6.7kg

※1: This is the case for hydrogen station compatible classification class. For other applications, please consult with us.
※2: For hydrogen gas 82MPa.

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PEI MEMBER

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RHEONIK.



RHM 06

Coriolis Mass Flow Meter for Batching Filling and Accurate Measurement

General Flow Control • Additive Dosing • Mixing and Batching
Chemical Injection • Package and Container Filling

Datasheet
V02.00
X.X.16
19.5.2026

GET FLOW MEASURED

RHEONIK.

Features



- Typical measuring range up to 36 kg/min (79.37 lb/min)
- Pressure ratings up to 1722 bar (24975 psi)
- Temperature ratings from -196 °C (-320 °F) to +350 °C (+662°F). Extended temperature ranges on request.
- Mass flow uncertainty down to 0.05%
- Repeatability down to 0.05%
- 4 kHz measurement updates when used with RHE40 series transmitters
- Accurately measure flow rates down to 100 g/min
- The Rheonik **AnyPipeFit Commitment** provides custom process connection type and size flexibility on any meter to suit your existing plant, saving time and expense on installation costs
- Compact design with minimal pipeline footprint
- Approved for use in hazardous areas
- SS 304 Stainless steel enclosure, SS 316L optional
- Integral and remote transmitter versions available

RHEONIK.

General specification overview

Nominal Flow (Qnom)*	25 kg/min (55.1 lb/min)
Maximum Flow (Qmax)*	36 kg/min (79.4 lb/min)
Typical Minimum Flow (Qmin)*	0.1 kg/min (0.22 lb/min)
Serial Tube / Single Path	Flow rates Q_{max}, Q_{nom} and Q_{min} for "serial" sensors will be 50% of the above listed parallel/ dual path version.
Operating Temperature	Fluid temperature range options cover from -196 °C (-320 °F) to +350 °C (+662°F). Extended temperature ranges on request. For integral transmitter versions please refer to transmitter datasheet
Ambient Temperature	Standard -50 °C (-60 °F) to +80 °C (+180 °F). High temperature versions available for oven installation up to +350 °C (+622 °F). Vacuum Chamber versions available for temperatures down to -260 °C (-430 °F).
Pressure Ratings	Up to 1722 bar (24975 psi) – depending on the material
Electrical Connection Sensor w/o Integral Transmitter	M20 x 1.5 standard cable entry for JM, SM terminal box versions Optional entry available : ½" NPT Max. cable length to remote RHE transmitter 100 m/330 ft.
Sensor Housing Materials	SS 304 (standard), SS 316L (optional) Coated aluminum terminal box, SS 316L terminal box (optional)
Housing Type	IECEX tested protection class IP66 (IP66 is mostly equivalent to NEMA 4X) Optional IP66-IP67 (IP67 declared by manufacturer, IP67 is mostly equivalent to NEMA 6)
Wetted Materials	Flow tubes SS 316L, Super Duplex, Alloy C22 Connection blocks SS 316L, seals FKM, FFKM, FVMQ, EPDM, HNBR Standard flanges SS 316Ti, other connections SS 316L Additional/customer specific materials available upon request
Process Connections	Nearly any - The Rheonik **AnyPipeFit Commitment** covers a wide range of process connections types and sizes. Consult factory for types/sizes not listed in this data sheet on the Mechanical Construction pages
Pressure Rating Compliance	Pressure Equipment Directive (PED). Others (e.g. CRN) on request.
Certifications and Approvals	ATEX / IECEx Approvals Zone 0, 1, 2, refer to Hazardous area certifications, p. 22 North American Approvals Cl. I, Div. 1, 2, Gr. A, B, C, D, Zone 0, 1, 2 Canadian Registration Number (CRN) OIML, MID custody transfer certification DNV, CCS approval for marine applications
Testing and Inspection	All sensors are hydro tested, calibrated and supplied with a traceable calibration certificate. Customized calibration and testing services are available
Project Documentation and QA, Services	Rheonik offers a full set of services for large and complex engineering projects. Typical services offered are, but not limited to: • Certificates of origin and conformity, mill certificates • Data books including WPS-WPQR, WPQ, NDT, test & quality plans, functional testing, calibration procedures, customized packing, factory acceptance etc. • Painting to project specification • Start up and commissioning services on/offshore
Options	Customization services for machine integration available upon request.

* At Q_{nom} pressure drop across a parallel tube sensor will be approximately 1.5 bar (21 psi) for H_20. Sensors can be operated at higher flow rates up to Q_{max} but pressure drop will be higher. Typical Minimum Flow Q_{min} is the recommended lowest flow rate for an accurate measurement. Sensors will measure flow rates lower than Qmin but uncertainty will increase beyond 1% of rate.
The flow rate specifications above relate to standard pressure, parallel tube, connection block sensor versions. Models with higher pressure ratings have increased wall thickness and will have higher pressure drops.