LITREMETER
Specialist flow measurement engineering

20K VFF Flowmeters

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Flowmeters for 20,000 psi

Litre Meter have been manufacturing flowmeters since 1975 and has always concentrated on the extremes of metering typically at low flows and/or at high pressure. The VFF range has many uses in the oil and gas industry and meets the high specifications required. Outside of oil and gas, 2,500 bar meters are in service. The trend towards 20,000 psi ratings in the Gulf of Mexico has led to this brochure.
Since 1997 numerous VFF meters for 1,380 bar in Oil and Gas applications have been made and a reference list is provided overleaf.
The same design can be used on 22.5 ksi (1,550 bar) with little modification.
The breakthrough in the design philosophy came when we separated the measurement of the fluid from the pressure containment. We designed a measurement chamber that floats in the pressure vessel. This ensures accurate, pressure independent flow metering from 10 psi to 20,000 psi. The Pressure Balance Chamber is explained below.

Key Features

- Rotary Piston/ Oscillating Piston type flow meter with a single moving part provides robust and low maintenance technology.
- Suitable for low & high viscosity liquids at pressure ratings up to 4,000 bar (60,000 psi). 20,000 psi designs as standard.
- Available materials of construction: 316L (UNS S31603), Duplex F51 (UNS S31803), Super Duplex F53 (UNS S32750)/F55 (UNS S32760). 6Mo F44 (UNS S31254), Hastelloy (UNS N10276) & Titanium (UNS R50400 or R56400).
- Connections: Autoclave, Grayloc hubs, Galperti hubs, Techlok hubs. More on request.
- Communications: 4-20mA HART, pulse, MODBUS, Foundation Fieldbus, dependent on electronics and certification requirements.
- Compact
- Very Low Flow Measurement
- Tolerant of particulate up to 100+ microns
- Low pressure drop (<0.1 bar typical)

20K Flowmeters - Applications and Flow Rates

The VFF has successfully metered fluids such as oils, hydraulic fluids, corrosion / wax / demulsifier / pour point depressant /scale / hydrate inhibitors, biocides, oxygen scavengers, etc. for over 30 years. Meter bodies are produced in a variety of high grade materials which offer good chemical and environmental resistance.

Applications for flow-rates as low 0.00013 litres/min (0.19 litres/day) have been metered within the off-shore oil industry. The VFF flow meter provides exceptional rangeability with potential turndowns of up to 3000:1, dependent on operating viscosity (shown on last page).

The meters range in size from the smallest standard stock size, LF03 - 18 L/Hr max, to the largest V270 - 270 L/min max. Higher flow-rate meters are available to special order.

An extensive range of meter designs and materials offers pressure ratings to 20,000 psi (1,380 bar). Higher pressure rating designs are manufactured up to 4,000 bar (60,000 psi). 20,000 psi designs available, as standard, up to HF60 and special designs can measure higher flow rates.

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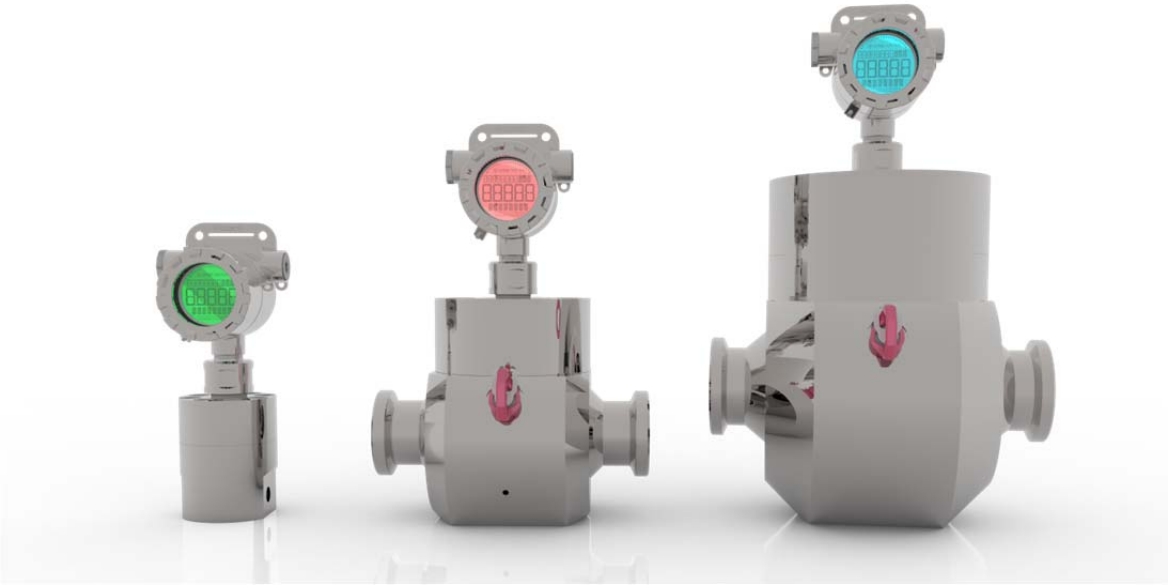
20K Flowmeters - Meter Sizes

The VFF meter is not just one size, one specification. It's a comprehensive range of carefully engineered devices to meet today's standards in the most demanding oil & gas arenas. It's truly a Versatile Fluids Flowmeter. In the illustration below, the smallest meter is typically housing an LF05 or LF15 rotor and chamber with FlowPod instrument and Autoclave Engineers MP connections. The middle unit is a medium size meter, say, VFF4 with hub connections and FlowPod display. The right-hand meter also has hubbed connection sizes, FlowPod display but is larger to accommodates the HF60 rotor and chamber



Pressure Balance Chamber

What Is a Pressure Balance Chamber?

Extensive testing by Litre Meter in 2005 proved that leaks occur over the top of the rotor at higher pressures. This is due to minute distortions of the cap. For example, at 700 bar the cap moves by just 0.02mm in the centre. Increasing the bulk of the cap still produces this movement. The effect on meter performance was the creation of a leak path for fluid that avoided the positive displacement of the rotor. This was equivalent to about a 3% inaccuracy at 700 bar. As a result of this Litre Meter designed a pressure balance chamber for its VFF flowmeters so it could operate at extreme pressure and at low flow rates. The pressure balance chamber acts as a barrier, protecting the internal measurement components of the instrument from the high pressure conditions, preventing them from expanding and contracting under the immense pressure. **NO DISTORTION MEANS ACCURATE MEASUREMENT AT ANY PRESSURE**. All VFFs over 414 bar are fitted with this technology. It is identified by the letters PBC in the calibration certificate.

Key Benefits:

- No distortion of the chamber at higher pressures.
- Enables selection of optimal materials for the chamber to match the rotor i.e. PVD coated stainless steel or titanium.
- Enables selection of optimal materials for the pressure vessel.
- Enables construction of a duplex bodied flowmeter.
- Interchangeable PBC for simplified sparing.
- Calibration can be performed at low pressure.

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Flow ranges and references

All VFF flowmeters are custom calibrated across the customer specified min – max flow conditions and working viscosity. The minimum flow rates achievable are dependent on fluid viscosity. To see the achievable calibration ranges for each meter size please consult the table below. We can offer meters that range from 0.005 L/hr to 3,600 L/hr at 20 ksi pressures to best suit your applications and with exceptional turndowns.

Minimum Flow Rate Measurable at Viscosity, L/hr

		1 cP	1.5 cP	2.5 cP	7.5 cP	10 cP	25 cP	50 cP	250 cP
LF03 - 18 L/hr max	Standard	0.6	0.33	0.12	0.075	0.060	0.038	0.026	0.012
	Low Flow	0.4	0.22	0.08	0.05	0.040	0.025	0.017	0.008
	Ultra Low Flow	0.2	0.09	0.05	0.03	0.025	0.016	0.015	0.005
LF05 - 30 L/hr max	Standard	1.5	0.83	0.30	0.125	0.100	0.063	0.042	0.03
	Low Flow	1.0	0.55	0.20	0.083	0.050	0.042	0.028	0.02
	Ultra Low Flow	0.4	0.22	0.125	0.052	0.025	0.020	0.015	0.008
LF15 - 90 L/hr Max	Standard	3.75	2.1	1.5	1.13	0.75	0.53	0.3	0.03
	Low Flow	2.5	1.38	1	0.75	0.5	0.35	0.2	0.02
	Ultra Low Flow	1	0.55	0.4	0.3	0.2	0.14	0.08	0.008
MF30 - 180 L/hr Max	Standard	12	6.6	3.6	2.4	1.2	1.1	0.9	0.3
	Low Flow	8	4.4	2.4	1.6	0.8	0.7	0.6	0.2
VFF4 - 400 L/hr max	Standard	14	7.4	4	3.2	2.4	2	1.5	1.2
	Low Flow	9	5	2.7	2.1	1.6	1.3	1	0.8
VFF8 - 800 L/hr Max	Standard	45	25	8	6.4	4.8	3.9	3	2.4
	Low Flow	30	16.5	5.3	4.3	3.2	2.6	2	1.6

Minimum Flow Rate Measurable at Viscosity, L/min

		1 cP	1.5 cP	2.5 cP	7.5 cP	10 cP	25 cP	50 cP	250 cP
HF20 - 20 L/min Max	Standard	2	1	0.33	0.27	0.2	0.16	0.13	0.1
	Low Flow	1.3	0.7	0.22	0.18	0.13	0.11	0.08	0.07
HF40 - 40 L/min Max	Standard	4	2	0.66	0.53	0.4	0.33	0.25	0.2
	Low Flow	2.5	1.4	0.44	0.35	0.27	0.22	0.17	0.13
HF60 - 60 L/min Max	Standard	6	3	0.99	0.8	0.6	0.49	0.38	0.3
	Low Flow	3.8	2.1	0.66	0.53	0.4	0.33	0.25	0.2

Areas of key significance:

- Extended experience in measuring 20,000 psi in Oil & Gas applications.
- World leaders in low flow and high pressure measurement.
- High or low viscosity fluids flow measurement.
- The Chemical Injection Flow Measurement Specialists.

Project	Portion	Primary	Region	Scope	Year	Installed	Application
150116 HS3	Hydraulic fracturing	NA		VFF4 1380bar, F53 duplex	2016	Sweden	Water, 0.24-6 l/min
NK		NK	North Sea	HF40 1137bar	2015	North Sea	2 to 40 l/min, 2.4cSt
NK		NK	North Sea	VFF8 1380bar x 2	2014	North Sea	0.5-10 l/min, 1cP
NK		NK	North Sea	HF40 1137bar	2014	North Sea	2 to 40 l/min, 2.4cSt
NK	Well testing	Schlumberger	Angola	VFF8 x 2	2013	Angola	0-16 l/min, 1cSt
NK	Well testing	Schlumberger	Angola	VFF8 1380bar x 3	2012	Angola	1 cSt, 0-10 l/min, Methanol
NK	Well testing	Schlumberger	Angola	VFF8 1380bar	2008	Angola	3cSt, 3.7-10 l/min & 0.7-1.6 l/min
Erskine		Chevron Texaco	North Sea	VFF8 1380bar	1997	North Sea	Wax measurement, 7cSt, 0.2-10 l/m

Future developments:
Litre Meter have already provided meters for 2,500 bar (36,000 psi). Offshore models at 22.5 ksi and 25 ksi are designed. Versions at 30 ksi, 40 ksi and 50 ksi are road-mapped. Litre Meter continues to innovate in the field of flow measurement. Recent successes include the LF05 and LF03 size meters, a new meter sensor, the FlowPod instrument and the FlowLabPro calibrator series. In the near term, expect to see lower flow capabilities, more calibrators and a low flow meter for any liquid type.

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