



VFF Flowmeters for Chemical Injection



LITRE METER

Specialist flow measurement engineering

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Technical Data



The VFF has successfully metered for over 35 years with fluids such as oils, hydraulic fluids, corrosion / wax / scale / hydrate inhibitors, pour point depressants, demulsifiers, biocides, oxygen scavengers, etc. Meter bodies are produced in a variety of high grade materials which offer excellent chemical & environmental resistance.

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

The meters range in size from the smallest standard stock size, LF03 - 18 L/hr max, to the largest, HF40 – 40 L/min max. Higher flow rate meters are manufactured to special order.

An extensive range of meter construction offers pressure ratings from 0 to 1380 bar (20,000 psi) suitable for most common applications, and special higher pressure rating designs are manufactured up to 2500 bar.

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 2,500 bar (36,000 psi).
- * Available materials of construction: 316L, Duplex F51 (UNS S31803), Super Duplex F53 (UNS S32750)/ F55 (UNS S32760), 6Mo F44 (UNS S31254), Hastelloy (UNS N10276) & Titanium.
- * Connections: NPT, Autoclave, ANSI & API flanges, Grayloc Hubs, Galperti Hubs, Techlok hubs. More on request.
- * Communications: 4-20mA HART, Pulse, MODBUS, Foundation Fieldbus, dependent on electronics & certification requirements.
- * Compact
- * Very Low Flow Measurement
- * Tolerant of particulate up to 100+ microns
- * Single Moving Part
- * Large Viscosity range, from methanol upwards
- * Measures pulsing flow accurately.
- * Preserves Molecular Integrity of fluid
- * Pressure independent measurement
- * Ultra High Pressure Capability
- * Low Maintenance, Highly Durable, Proven since 1986
- * Available in Exd and Exi specification.
- * Accuracy better than $\pm 1\%$ of reading, and repeatability $\pm 0.1\%$ of reading

Applications

- * Chemical Injection, Litre Meter has successfully supplied over 5,000 flow meters within the chemical injection flow meter market measuring fluids from 0.3 cSt to 100,000 cSt; flows between 0.008 l/hr to 19,800 l/hr and at pressures of up to 2,500 bar.
- * Hydraulic line monitoring for well control valves and leak detection
- * Wash water measurement and general metering of low and high viscosity fluids
- * Subsea Chemical injection and hydraulic fluid measurement



Internals:

Constructed of either Nitronic-60 or Titanium (for the LF03, LF05 & LF15 size) to achieve the lowest flow and widest turndown possible. Chambers and rotors are PVD coated. Coatings are applied by physical vapour deposition. A hard metal chromium nitride base layer provides surface hardness and appropriate support for the carbon (WC/C) which is laid over. The WC/C coating provides excellent protection against adhesive wear. Its low coefficient of friction reduces the risk of surface fatigue (pitting) and fretting corrosion, vastly

Seal:

There is a pressure seal between the meter body and cap and two seals internally. The seals are in FEP-covered FPM and in higher pressure versions Inconel and FEP

Connections:

NPT threaded connections are standard for lower pressure versions, and Autoclave Medium Pressure fittings (cone & thread) are standard for higher ratings. ANSI & API flanges in raised face and ring type joint are also available. Hubs such as Grayloc, Galperti, Techlok are optional.



- Internal Chamber and Rotor

Accuracy: 1% of reading, requires linearisation. Provided by all Litre Meter instrumentation.

Viscosity: 0.3 – 100,000 cSt or greater.

Turndown: Consult calibration table

Temperature rating: -40°C - 100°C with remote mounted electronics. For direct mount versions see next page. Higher temperature special versions are available on request.

Filtration: A 100 micron filter is advisable for 100% long life serviceability. For LF03 & LF05 size, a 40 micron filter is recommended.

Sensor Options

Reed Sensor - standard

This reed switch sensor package comes in a robust stainless steel 316L enclosure which is easy to install within the VFF range. The sensor has two reed switches to enable redundancy and optional reverse flow detection.

Reed Sensor Key Features:

- 316L SS Housing
- Simple apparatus - 0.01W
- Reverse flow detection
- Redundancy built in
- Tested for over 1 billion pulses
- Environmentally tested per BS EN 13628-6: 2006
- Temperature rated to -20 to +75°C, (Dependent on instrument and area classification)
- Available with the 2 or 4 wire FlowPod and other instruments.
- 0.001– 50 Hz detection rate

Field Sensor - optional

The Field sensor package come in the same robust stainless steel 316L housing as the reed sensor so they are interchangeable with one another. However, the field sensor enables the output resolution of the VFF meter to be increased by 10x and can still detect reverse flow.

Field Sensor Key Features:

- As above but:
- Low power 2.5 - 24Vdc - 0.0015W
- 0.001 - 10 Hz detection rate





FlowPod

FlowPod is Litre Meter's latest flow indication display unit. Utilising state-of-the-art technology, the FlowPod comes in a compact and lightweight flameproof Stainless Steel enclosure that is only 85mm in diameter and weighs in at just 1.6kg. The FlowPod is one of the smallest flow displays for the Chemical Injection industry on the market today. The back-lit display with high contrast, large flow rate indication and totalizer digits enables the display to be easily read at a distance in poorly lit conditions. The FlowPod comes equipped with a Memory Card facility. LM-MC has been developed for 2-wire low powered systems. The LM-MC enables calibration data to be easily swapped without having to remove the FlowPod from the installation or perform difficult calibration curve changes on site. The LM-MC has data logging capabilities to enable recalibration to be tailored to the flow rate of the meter as specified by the client. The FlowPod can be controlled without having to power down by using HART commands or by the integrated magnetic switches that allow for simple programming and menu selection. The display can either be direct or remote mounted using a suitable armoured signal cable or conduit. The standard specification includes HART 7 protocol output on a two or four wire 24Vdc powered system.



Key features

- * Exd- CSA(US): Class I Div I (B,C,D), AEx d IIC T5 Gb
CSA(CAN): Class I Div I (B,C,D), Ex d IIC T5 Gb
ATEX: Ex db IIC T5
IECEX: Ex db IIC T5
- * IP66/IP68 dual certified
- * Ambient temperature: -40 to +75°C
- * 2 or 4 wire 4-20mA HART v7 programming and monitoring
- * Compact lightweight 316 steel housing
- * Rotatable through 360° for optimised viewing angle
- * 2 sensing options - standard and hi-res - both with bidirectional sensing
- * Removable LM-MC storage card for data logging & offsite programming
- * Local programming
- * Resettable and non-resettable Totalizer
- * Batch control
- * Power: 12 – 30Vdc

Display features

Pulsing Input Indicator: This pulses at low flow as a visual check of flow rate.

Total Digits: A total of 8 digits with the option to display: non resettable total, a resettable total and the resettable reverse flow total.

Rate Digits: The large 5 digits display the real time flowrate. The large digits and high contrast allow this to be easily read from a distance in poor light conditions.

Units: The option to display the flow rate and total in many different units, depending on your requirements.

Flow range usage: Analogue flow rate display in 20 steps - programmable.

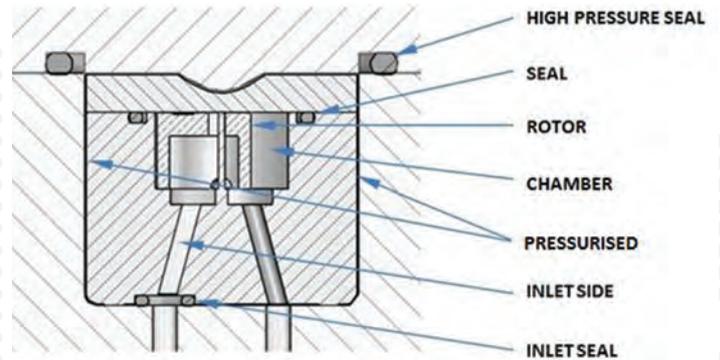
Status options: Identifies which mode is active as well as providing status messages.



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 700bar, the cap moves by just 0.02mm in the centre. Increasing the bulk of the cap still produces this movement. The consequence was a fluid leak path that avoided the rotor's positive displacement, which impacted the meter's operation. This was equivalent to about a 3% inaccuracy at 700 bar. As a result, Litre Meter designed a special pressure balance chamber for its VFF flowmeters so it could operate at extreme pressure and low-flow rates. The pressure balance chamber acts as a barrier, protecting the internal measurement components of the instrument from high-pressure conditions, preventing them from expanding and contracting under immense pressure. All VFFs 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 maintains measurement accuracy
- * 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





Chemical Injection

Chemical injection is the process designed to assist in the production of oil. Various chemicals are injected into the crude oil to provide protection. For example, a scale inhibitor will prevent the build-up of scale on the pipes and fittings used to transport the oil on its journey.

Flowmeters monitor and control the amount of chemicals added to the crude oil. Biocide prevents the build-up of organisms in the pipe. Corrosion inhibitor is the most popular additive to be measured. There are various types depending on the type of main liquid. Pour point depressant is added to reduce the pour point, thereby making the oil easier to flow through the main pipelines. Most of the chemicals added tend to be at low flow rates, typically between 0.01 to 30 litres per hour (LF03 or LF05 flow rate range). LDHI, or Low Dosage Hydrate Inhibitor, has the highest injection rate, sometimes up to 17,000 litres per hour (V270). It is designed to inhibit water based mixtures which would otherwise have a tendency to freeze. Methanol is often used with the same effect. More exotic chemicals are used for similar purposes, all to reduce costs on the way to the refinery.

It is a little known fact that these chemicals contribute 30% of the cost of running an offshore platform. Control systems are often manually set from the flowmeter displayed value (either locally or from the SCADA system). There is a trend towards automating this process using control valves such as a SkoFlo. A typical turn-down ratio of 500:1 is measurable with a VFF positive displacement flowmeter.



Often the systems are relatively dynamic and need only slight adjustments from day to day, which is why manual control is still so popular.

20k measurement & metering subsea

It is important that the flow measurement system for the chemical scan cope with the pulsing nature of the pumps used and also with the high pressures that are encountered. These can be up to 1380 bar/20000psi/20ksi in modern systems injecting subsea.

Topsides injection is at lower pressures, typically from 200 to 6000 psi. There is also a trend towards measuring the chemicals subsea, i.e. underwater, rather than when the crude oil reaches the surface. Not only does the flowmeter have to work at high internal pressures of over 690bar, 10,000 psi, but also with external pressures up to 345bar/5000psi and more. Contact us with your application. We have hundreds of meters in use subsea. VFF meters meet all these requirements. Please see our separate brochures.

LF03 - Ultra Low Flow

Manufactured from Titanium with a max tolerance of 3 microns, the rotor and chamber combination achieve the lowest flow and widest turndown possible. Chambers and rotors are coated by physical vapour deposition (PVD). A hard metal chromium nitride base layer provides surface hardness and appropriate support for the carbon (WC/C) which is laid over. The WC/C coating provides excellent protection against adhesive wear. Its low coefficient of friction reduces the risk of surface fatigue (pitting) and fretting corrosion, vastly improving turndown and low flow capability.

The LF03 can be assembled into any connection type or size available on the market today or tomorrow.

Key Features:

Ultra Low Flow measurement- even lower than the LF05

Single moving component.



Key Features continued:

The LF03 comes in the same module size as the rest of the LF sub-range, so it can replace either the LF05 or LF15 with ease without having to break pipe connections, reducing costs, skid down time and labour.

The unique PBC design isolates pressure containment from measurement ensures accurate measurement from 1 bar to 1,000bar to 2,500 bar.

Increased output resolution compared to the LF05 and LF15

3 calibration options: standard, low flow and ultra-low flow

LF03 can measure down to 0.025 l/hour on 10cSt



Data and Calibration

The VFF ordering code is split into the options indicated in the sample code to the right.

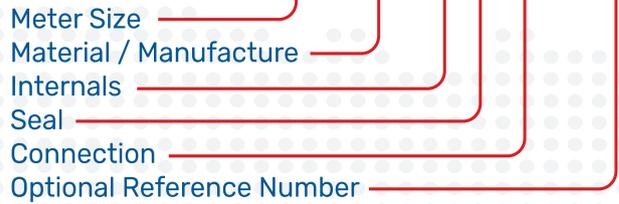
Below are the ranges, materials and types available and their associated maximum pressure ratings.

VFF meters are calibrated over 10 points on actual customer working fluid viscosity. Minimum flow rates are dependent on viscosity. Consult the below tables for more information.

Code	Material
SS	316L Stainless Steel (UNS S31603)
44	F44 6Mo SS Body & Cap (UNS S31254)
51	F51 Duplex Body (UNS S31803) & F44 Cap (UNS S31254)
53	F53 Super Duplex Body (UNS S32750) & F44 Cap (UNS S31254)
55	F55 Super Duplex Body (UNS S32760) & F44 Cap (UNS S31254)
HA	Hastelloy Body & Cap (UNS N10276)
TI	Titanium (UNS R50400)

Code	Manufacturing Method
B B	Body - Not Forged / Cap - Not Forged
F B	Body - Forged / Cap - Not Forged
F F	Body - Forged / Cap - Forged
C S	Custom Specification

LF05-SSBB-TA-V-1/2N-?????



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.

Minimum Flow Rate Measurable at Viscosity, L/hr

		1cP	1.5cP	2.5cP	7.5cP	10cP	25cP	50cP	250cP
LF03 18 L/hr max	Standard	0.6	0.33	0.12	0.075	0.06	0.038	0.026	0.012
	Low Flow	0.4	0.22	0.08	0.05	0.04	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	0.3	0.125	0.1	0.063	0.042	0.03
	Low Flow	1	0.55	0.2	0.083	0.05	0.042	0.028	0.02
	Ultra Low Flow	0.4	0.22	0.125	0.052	0.025	0.02	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
VFF4 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

		1cP	1.5cP	2.5cP	7.5cP	10cP	25cP	50cP	250cP
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
V125 125 L/min	Standard	12	6.5	2.09	1.67	1.26	1.02	0.79	0.63
	Low Flow	7.9	4.3	1.39	1.12	0.84	0.68	0.53	0.42



Size	Range
LF03	0 - 18 L/hr
LF05	0 - 30 L/hr
LF15	0 - 90 L/hr
MF30	0 - 180 L/hr
VFF4	0 - 400 L/hr
VFF8	0 - 800 L/hr
HF20	0 - 20 L/min
HF40	0 - 40 L/min
HF60	0 - 60 L/min
V125	0 - 125 L/min
V270	0 - 270 L/min

SEE RIGHT FOR THE MINIMUM FLOW RANGE

Selected Recent Oil and Gas Contracts

Project	Portion	Primary	Region	Scope	Year	Qty
Nawara	Infill drilling		Nawara USA	VFF4 1"2500 x2 HW443	2022	2
RP Cartagena	Chemical Injection	Repsol	Spain	LF03 flanged	2022	1
NK			GOM	LF03x12, Kalrez seals	2022	12
Jasmine	Scale Inhibitor Equipment	Chrysaor	UK	LF15 x1, replacing VFF2561	2022	1
ETAP	CI tank chemical fill	BP	UK	HM 1", RT30	2022	1
Shenandoah	Flow sensing on subsea CI panel	Beacon	GOM	15x 20k LF5	2022	15
Kaikias Subsea Tieback - Ursa MC-809 Platform A	Chemical Injection	Shell	GOM	LF03 x2, replacements	2022	2
LDPE plant	Lubricant		ME	LF03 2500bar	2022	1
Abigail over FPF-1	Chemical skid	Ithaca	North Sea	LF03x2 MF30 x 2 replacements	2022	4
Jasmine	Chemical Skid	Chrysaor	North Sea	LF15 @690bar	2022	1
NK	Acetic Acid Injection	Total	West Africa	VFF4, 1"300 x2	2022	2
Skarv	Chemical Skid	BP	North Sea	replacement for VFF1811	2022	1
Dunbar	Methanol skid	Total	North Sea	VFF4 760bar	2021	1
	Chemical Distribution Panel		North Sea	LF15 LF03 MF30	2021	5
Seagull ETAP	Sulphate Reduction Package	Wood	North Sea	LF03 316, VFF4 F44,Ti	2021	3
L4PN		Total	North Sea	LF03 x1	2021	1
Triton FPSO	Scale Inhib	Dana Petroleum	North Sea	LF15	2021	1
Corrib, Bellanaboy Bridge Gas Terminal	CI	Vermilion	Ireland	LF15, ANSI 2500	2021	6
Subsea Industrialisation	Chemical Injection		Europe	LF15 subsea	2021	1
Modernization Project	Amine Regen and Tail Gas Treating	Bapco	Bahrain	LF03 x3 wafer	2021	3
Alba	Chemical Injection	Chevron	North Sea	LF15 F112	2021	1
Shah Deniz	Chemical Injection	BP	ME	LF15 replacing MF30 1.5GR11	2021	1
Shah Deniz	Chemical Injection	BP	ME	V125 upgrade 3GR25	2021	1
LL12-18872	Chemical Injection	LNG Canada	North America	LF15 x2, LF15 Hastelloy ANSI150	2021	3
	Chemical Injection		ME	LF03 x2, LF05	2021	4
	Chemical Injection		North Sea	LF15 x3 titanium	2021	3
Martin Linge	MEG Injection Flow	Equinor	Norway	V125 in F55 with 2IN14 Techlok	2021	1
Ichthys	Phase 2a CPF Topside	Inpex	Australia	V125 x 4 flanged	2021	4
Modernization Project	Tail Gas Treating Unit	Bapco	Bahrain	LF03 x8 wafer	2021	8
Mars Perdido	Chemical Injection	Shell	GOM	LF03 x1	2020	1
Anchor Subsea	Chemical Injection	Chevron	GOM	V95 20k HF60 VFF8 1.5GR11	2020	9
LDPE plant	Lubricant		ME	LF03 2500bar x2	2020	2
Mad Dog	Hydraulics		GOM	HF20 x 8 1380bar	2020	8
NK	Portable CI unit		GOM	VFF8 x 2 22k, 1517bar	2020	2
Nawara	CPF Chemical Injection	ETAP OMV	Tunisia	1 LF03	2020	1
Nawara	CPF Chemical Injection	ETAP OMV	Tunisia	LF03 x6	2020	6
Nawara	CPF Chemical Injection	ETAP OMV	Tunisia	LF03 x2	2020	2
Lucius	Chemical Injection	Anadarko	GOM	3 LF03, FlowPods	2020	3
Lucius	Chemical Injection	Anadarko	GOM	6 LF05, FlowPods	2020	6
Lancaster Development Project			North Sea	LF03 etc	2019	10
NK	Chemical Injection	First E&P	West Africa	LF15 x6, LF05 x18	2019	24
Buckskin Tieback	Subsea CI Package	Anadarko	GOM	MF30 x9, LF03 x6	2017	15
Tahiti, Vertical Expansion	Chemical Injection Skid	Chevron	GOM	LF03, VFF8, LF15 Grayloc 1GR4	2017	15
West Nile Delta	PD Flowmeters	BP	Mediterranean	V400, V270, HF60, VFF8, LF03	2017	13
West Nile Delta	Chemical Injection Skid	BP	Mediterranean	2, LF15 x 4, MF30, VFF4, VFF8 x 2	2016	15
TempaRossa		Total	Italy	12 flanged meters	2016	12
Coulomb		Shell	GOM	LF15 x 4, VFF4 x 4, LF05 x 4	2015	12
Huangyan Phase II	CPF Chemical Injection		East China Sea	LF05x13, F018	2015	13
NK		COOEC	China	LF05 x20, 3/4" & 1/2"#1500	2015	20

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