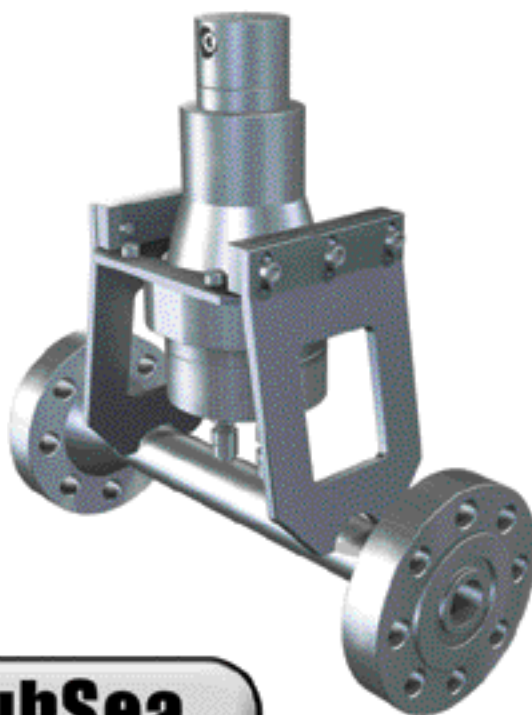
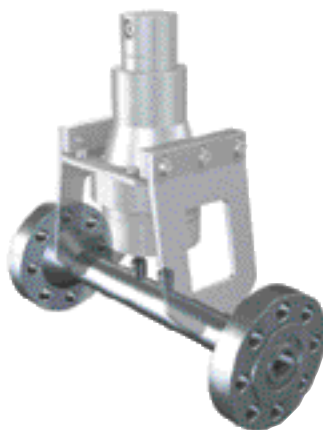


Flow measurement solutions for Oil and Gas



VRM
SubSea

The V-Cone Flowmeter



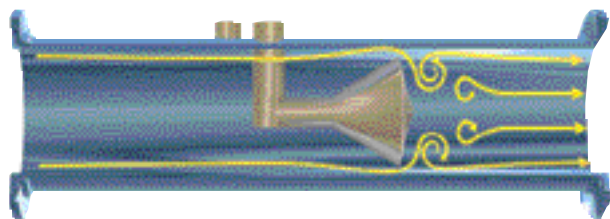
V-Cone Technology

The VRM SubSea flow measurement system utilizes McCrometer's innovative V-Cone® flowmeter technology, designed for high performance in the harsh environments and restrictive spaces encountered in oil and gas applications. This groundbreaking flowmeter measures the widest range of fluids, including wet gas, condensate, and dirty or abrasive flows, under the most challenging conditions. The V-Cone accurately measures wet gas flow between 100 and 90% gas volume fraction, and has been employed successfully in oil and natural gas production and distribution.

Flow Conditioning

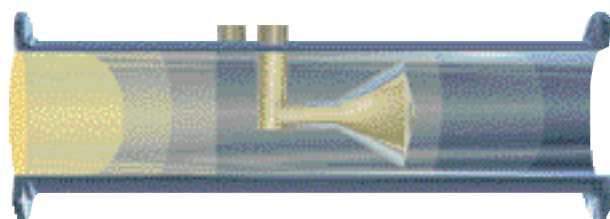
The V-Cone conditions the flow before measuring it, making long upstream or downstream pipe runs unnecessary, ensuring exceptional accuracy and repeatability. This characteristic also substantially reduces the footprint of the VRM SubSea and the extra piping required by other instruments in order to deliver stable and accurate readings.

The V-Cone shape generates a low amplitude, high frequency signal for excellent signal stability. The V-Cone's contour-shaped cone directs particulates away from the



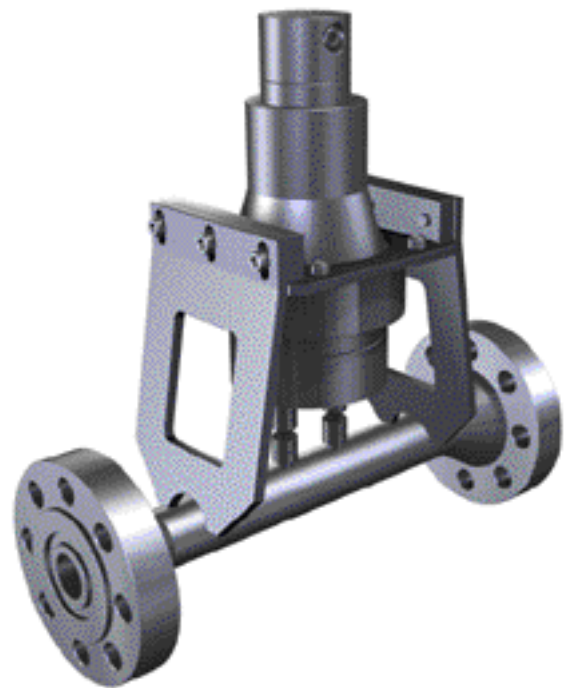
beta edge. As a result, the beta edge of the cone is not subject to wear by dirty fluids. Because it remains unchanged, V-Cones rarely, if ever, require recalibration.

Pipe flow is rarely ideal. Changes to the piping can disturb even a well-developed flow. The contoured shape and location of a suspended cone in the V-Cone overcomes this



by reshaping the velocity profile upstream. As the flow approaches the cone, the flow profile "flattens" toward the shape of a well-developed profile – even in extreme flow conditions.

The VRM SubSea is a flow measurement system designed to satisfy the extreme demands of the sub sea environment. It combines the proven functionality, accuracy and reliability of McCrometer's V-Cone® technology with the sophisticated capabilities and rugged performance of READ Matre Instruments' Sensor. This advanced flow measurement system outperforms traditional DP devices by providing higher accuracy, better repeatability and increased installation flexibility, as well as reduced maintenance. The unique flow-conditioning capabilities of the VRM SubSea translate to reduced pipework and stable measuring conditions. Lower CAPEX and OPEX costs, low maintenance requirements and long term reliability virtually assure higher profitability and substantial cost savings over the life of the equipment. The VRM SubSea Flow measurement: technology you can trust.



READ Matre Instruments is a premier manufacturer of sensors for the oil and gas sub sea market. Located on the west coast of Norway, the company roots go back to the early nineteen-fifties when it manufactured alarm systems for fishing and cargo ships. In 1988, READ Matre Instruments introduced a line of precision instrumentation for sub sea applications. Since then it has produced high-quality sensors for the sub sea market that have earned a reputation for excellent performance and reliability. Since their initial deployment a remarkably large number of READ Matre Instruments' sub sea sensors have performed and continue to perform flawlessly.

Today, READ Matre Instruments AS manufactures transmitters based on two decades of experience in the industry. READ Matre Instruments is committed to build high quality transmitters according to customer requirements by utilizing its long term market experience.



READ Matre Instrument AS facilities at Rubbestadneset, Norway

Forty five years ago, McCrometer was founded by a group of engineers committed to the development of innovative high quality solutions. Today this solutions-oriented approach still guides the company. A core group of application engineers, researchers and designers put their knowledge of flow physics and real-world operating dynamics into developing some of the most accurate, innovative and trusted flowmeters available today.

The VRM SubSea's V-Cone technology is an example of this unique approach and reflects McCrometer's goals of coupling design excellence with high-quality manufacturing techniques and world-wide deployment capabilities.



McCrometer's Company Headquarters in Hemet, California

Maintenance Free

With no moving parts to replace or maintain, the V-Cone offers long term performance with low operating costs. In addition, the meter never needs recalibration, so once installed, it can operate unattended for years. The contoured aerodynamic shape of the cone profiles the flow in the pipe without impacting it against a sharp beta edge. Instead, a boundary layer forms along the cone, directing fluid away from the beta edge. The V-Cone beta edge does not change its dimension, thus allowing extremely long useage without physical re-calibration.

The DP Sensor



Curve Fit Calibration

The READ Matre Instruments' differential pressure transmitter has proven its capabilities for sub sea use for many years. The differential pressure sensor is made from a state-of-the-art transmitter for high line pressure, up to 860 bar (12473 psi) with excellent accuracy. The use of a single crystal silicon in the sensing element results in low temperature influence and excellent stability.

Electron Beam Welding

The differential pressure sensor and housing are built as an integral unit utilizing advanced manufacturing techniques. All weldings in the housing and casing are done using electron beam technology for clean and reproducible high integrity weld joints. EB technology helps avoid contamination and increases accuracy. It permits effective welding of dissimilar metals, and pipes and materials with large differences in thickness.

Decreased manufacturing time and reduced wastage of material have resulted in significant costs reductions, better turnaround and optimized delivery schedules.

Elastomer-free Sealing

The sensor unit and housing are free from the possibility of sea water ingress and the subsequent damage to the sensors and transmitters due to the absence of elastomer seals.



READ Matre Instrument's EB Welding Unit

Specifications VRM SubSea

V-Cone®

Standard beta range:

from 0.45 to 0.80

Piping Installation Requirements:

Only 0-3 diameters upstream and 0-1 diameters downstream required depending on adjacent fittings

Sized and calibrated for customer application

No moving parts

ASME B31.3 construction available

Variety of construction materials:

Including Stainless Steel; Duplex; 6 Mo etc. To Norsok and other International standards 3.1B or 3.1C Certification can be provided

Line sizes:

2" (50mm) to 10" (250mm)

Types of flow measured:

Clean, dirty or disturbed liquid or gas flows; dry or wet gas;

condensate; abrasive flows

Accuracy

Up to +/-0.5%

Repeatability

+/-0.1%

Turndown

10:1, Typically

Operating temperature

Depends on materials of construction

Operating pressure

Depends on materials of construction

Head loss

Low headloss, varies with beta ratio

Process connector

Flanged; hub or weld-end; others on request

DP Transmitter/Casing

Pressure

Diff. Pressure Range:

0-320/ 0-1300 mbar

Maximum Line/Test Pressure:

860 bar

Accuracy:

+/- 0.1% of span, including hysteresis, linearity and repeatability

For spans greater than 1/10 or URL

Stability (drift):

+/-0.1% of URL for 24 months

Line Pressure effect 0-500 bar:

+/- 0.2% of URL/100bar, Zero Shift

- 0.2% of cal. span/ 100 bar, Span Shift

Temperature effect 0-500 bar:

+/- $\frac{0.25 * \text{Span} + 0.05 * \text{URL}}{1400}$ mbar/°C From -40 to + 85°C

Electrical

Supply voltage:

24 Vdc (10.5 - 32 VDC)

Interface:

2 wire 4-20mA (Hart)

RS485

CanOpen

General Conditions

Ambient Temperature:

-40 to 85°C

Limits on temperature are related to static pressure as follows:

500 bar static pressure -33°C

Operating Temperature:

-40 to 120°C

Storage Temperature:

-20 to 70°C

Maximum test pressure:

860 Bar

Shock:

30 g Half sine, 11msec.

Vibration:

5g 25-1,000 Hz

Mechanical

Cable Interface to suit:

Tronic, Ocean Design, Bennex Omnitec, JIC

Process connection

Project Related

Housing Material:

Duplex

other materials on request

Process Material:

Hastalloy C22/Inconel/Duplex

Hyperbaric pressure:

3000 m

High Pressure Containment:

1035 bar (15000 PSI)

Maximum Test Pressure:

860 bar (12470 PSI)



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