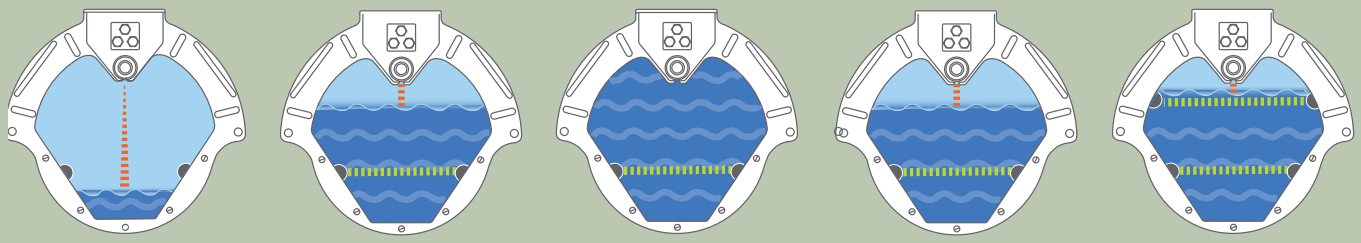
WHY THE CARTRIDGE METER?

A Comparative Analysis

The Cartridge Meter is the first open channel flowmeter to utilize hybrid technology. The new technology combines a traceable U.S. Bureau of Reclamation flume/level system for low flow applications with the more accurate EPA proven transit-time chordal velocity method for high flow applications. This new hybrid technology system allows for precise and highly accurate flow measurement during extremely low flows, high flows, surcharges, reverse flows, stagnation and non-uniform hydraulic profiles.

Permanent And Portable Open Channel Flow Monitoring Under All Conditions

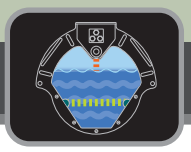


LOW FLOW | HIGH FLOW | SURCHARGE FLOW | REVERSE FLOW | NON-UNIFORM FLOW

OPEN CHANNEL FLOW MEASUREMENT

PROBLEM: Flow measurement in partially full pipes and open channels has never been easily accomplished. Problems have ranged from questionable theory to real maintenance issues encompassing fouled sensors, sediment and plugging. The "point velocity" and "line velocity" theories that imply a velocity measured on the fluid surface or near the pipe wall can be substituted for the average velocity throughout the cross-section of the pipe have always been significantly challenged. In addition, flow sensors that sit in the invert of the pipe or hang from the top have made installation difficult, while providing a place for rags and other debris to accumulate. The accuracy of these single technology flowmeters are only consistent within a specific or prescribed range of conditions. If conditions change, the stated accuracy ratings are no longer valid.

SOLUTION: Hybrid Technology Cartridge Meters combine two distinct technologies in order to achieve maximum efficiency for monitoring of flow under all conditions.

HYBRID TECHNOLOGY  CARTRIDGE METER

LOW FLOW
Accuracy: ±1-5%
Turndown: 60:1

During periods of minimal flow (Zero to 1/3 pipe I.D.), measurements are achieved through a highly efficient combination of a trapezoidal flume and ultrasonic level sensor.

HIGH FLOW
Accuracy: ±1-2%
Turndown: 60:1

During periods of maximum flow (1/3 to full pipe I.D.), measurements are achieved through proven area-velocity methods that combine an ultrasonic level sensor with transit-time velocity sensors.

SURCHARGE FLOW
Accuracy: ±1-2%

An optional non-contact Surcharge Monitor provides for continuous measurement of accurate flow data during intermittent periods of surcharged conditions.

REVERSE FLOW
Accuracy: ±1-2%
Turndown: 3:1

Reverse flows, during abnormal or surcharge conditions, are measured by the bi-directional transit-time velocity sensors in combination with a single or dual level sensor.

STAGNATION
Application: 1/3 Pipe To Full Surcharge

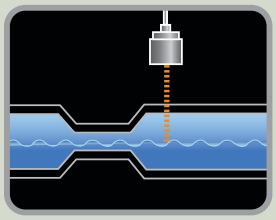
In the event of a blockage or stoppage of flow, the velocity sensors will report a "zero flow" condition.

NON-UNIFORM FLOW
Accuracy: ±1-2%
Turndown: 60:1

Dual Path Cartridge Meters provide for highly accurate measurement of average velocity under asymmetrical, surcharged, and backflow conditions.

TECHNOLOGY COMPARISON

FLUME w/ LEVEL SENSOR



CONDITIONAL FLOW MONITORING: Flumes, in order to maintain accuracy, require non-turbulent flow conditions.

INSTALLATION DEPENDENT ACCURACY: Both the flume and level sensor must be precision aligned with one another and perfectly level in two directions. Improper installation can increase the flow measurement error by as much as ±15%.

COST INTENSIVE INSTALLATION: Flumes, depending upon their size and environment, in conjunction with an independent level sensor, are expensive and time consuming to install aside from their civil engineering requirements.

MAINTENANCE PRONE OPERATION: Depending upon construction, certain types of flumes may become susceptible to various forms of debris becoming lodged within their respective throats.

±5% OVERALL ACCURACY RATING: Flume/level sensor combinations, due to difficult installation considerations, on average carry a ±5% accuracy rating throughout their entire flow measurement range.

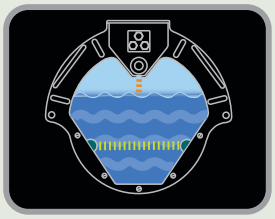
LIMITED RANGE MEASUREMENT: Flumes will lose their ability to measure flow at upstream depths exceeding 75% of the conduit inside diameter. Backwatering, due to surcharge or submerged conditions, can violate flume design assumptions by as much as 400%.

REVERSE FLOW CONDITIONS: Flume/level sensor combinations are incapable of detecting conditions of reverse flow.

STAGNANT FLOW CONDITIONS: Periods of stagnation or zero flow are mistakenly recognized as flow.

SURCHARGE CONDITIONS: During heavy, wet weather conditions, monitoring of flow ceases to function.

CARTRIDGE METER



FLOW MONITORING UNDER ALL CONDITIONS: Low flow, high flow, surcharges, reverse flow, stagnation, non-uniform flow.

GUARANTEED INSTALLED ACCURACY: A single stainless steel cartridge, pre-sized, pre-aligned and pre-programmed, arrives at the site as a fully integrated unit.

FULLY OPERATIONAL IN 30 MINUTES: Each Cartridge is a pre-engineered, field ready system designed for “out of the box” installation.

MAINTENANCE-FREE OPERATION: “Above the flowstream” level sensors and non-fouling velocity sensors remain free from the ongoing maintenance problems of sediment, fouled sensors and accumulated debris.

PRECISION DUAL RANGE ACCURACY: Low Flow Accuracy: ±1-5% (actual rate). High, Surcharge, Reverse and Non-uniform Flow Accuracy: ±1-2% (actual rate). Overall Turndown 60:1.

IN-HOUSE FLOW LABORATORY: Each Cartridge Meter is flow tested, calibrated and certified prior to shipment. Calibrations are directly traceable to NIST Standards.

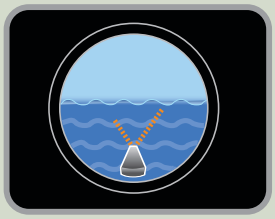
DESIGNED TO GOVERNMENT AGENCY STANDARDS: The hybrid design is based upon extensive open channel metering field tests conducted by the EPA and the U.S Bureau of Reclamation.

DATA COLLECTION: The Cartridge Meter is provided with an onboard datalogger capable of seamlessly interfacing with third party software suppliers or a factory integrated Excel software package.

WIRELESS MONITORING: Optionally provided for portable applications. (Range: 100 ft./30m).

TECHNOLOGY COMPARISON

DOPPLER w/ PRESSURE CELL



CONDITIONAL FLOW MONITORING: Doppler sensors are unable to accurately measure low level flows (below 3"), thereby greatly reducing their usefulness during the high incidences of minimum flows encountered in sanitary sewer systems. Additionally, since the velocity needs to be higher than the critical velocity at which particles settle, Doppler sensors are incapable of measuring flow traveling below .5ft/sec. Due to a design limitation referred to as "Range Bias ", a large potential for error also exists in conduits larger than 24 inches.

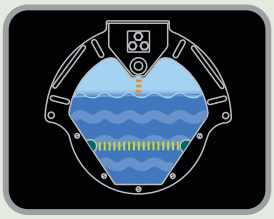
VELOCITY DEPENDENT ACCURACY: High flow velocities create a local region of low pressure directly above the sensor probe, causing errors in level measurement. Additionally, pressure transducers have a tendency to drift with varying temperature.

MAINTENANCE PRONE OPERATION: Recommended installation procedures for Doppler/Pressure Cell probes are to install the sensor at the invert of the pipe. This location is highly susceptible to accumulation of debris, grease, silt and various other media prone to accelerating sensor fouling.

REQUIRES IN-SITU CALIBRATION: Since Doppler sensors do not include all velocity points in the cross-sectional area of the conduit, or know from where in the cross-section the signals are returning, the average velocity cannot be directly measured. For this reason, a series of site-specific calibrations are required in order to obtain a site-specific correction factor. If conditions were to suddenly change, the accuracy of the ensuing flow data would be in question.

USBR WATER MEASUREMENT MANUAL: "Non-uniformity of particle distribution in the pipe cross-section results in a computed mean velocity that is incorrectly weighted. Therefore, the meter accuracy is sensitive to velocity profile variations and to distribution of acoustic reflectors in the measurement section. Unlike other acoustic flowmeters, Doppler meters are affected by changes in the liquid's sonic velocity. As a result, the meter is sensitive to changes in density and temperature. These problems make Doppler flowmeters unsuitable for highly accurate measurements."

CARTRIDGE METER



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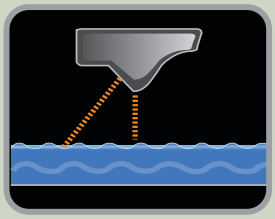
TECHNOLOGY COMPARISON

RADAR w/ LEVEL SENSOR



CONDITIONAL FLOW MONITORING: Radar sensors require flow velocities in excess of 0.75ft/sec. and are generally not capable of accurately measuring low flows.

SURFACE-ONLY FLOW MEASUREMENT
Doppler sensors, utilizing Radar technology, randomly measure "velocity points" only on the surface of the media in order to ascertain a mean velocity value. The sensing region does not include any points below the surface in the cross-sectional area of the conduit. Therefore, since average velocity is not measured directly, it must be extrapolated from the point measurements taken on the surface.

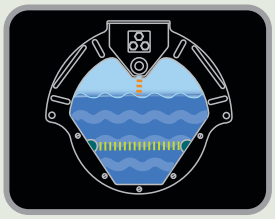
USBR WATER MEASUREMENT MANUAL: "DESIGN OF OPEN CHANNEL METERS IS COMPLICATED BY THE POTENTIAL ERRORS INTRODUCED BY A VARIABLE WATER SURFACE."

UNIFORM FLOW ACCURACY REQUIREMENT:
Applications require uniform flow conditions for accurate measurement. A variable water surface will introduce the potential for measurement errors. Uniform surface flow profiles are an unlikely condition for any sewer.

Most flowmeters are installed on an incoming line in order to measure the most uniform flow. Flow passing through a manhole is usually disturbed. Therefore, taking flow measurements in a manhole channel is risky, especially when encountering higher flows or surcharges. This is because the depth-velocity relationship within the manhole does not accurately represent the depth-velocity relationship inside the pipe.

REQUIRES IN-SITU CALIBRATION: Radar technology flowmeters require on-site velocity profile calibrations in order to obtain site-specific correction factors. If conditions were to suddenly change at the specific site being measured, the accuracy of the ensuing data would be questionable, requiring that the in-situ calibration process be repeated.

CARTRIDGE METER



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