ISO 5167-5 CONE-METER ENGINEERING

V-Cone Flow Meter
Product & Selection Guide

Principle · ISO route · Calibrated route · Sizing · Installation

Self-conditioning center-body differential-pressure flow-meter package

ISO standard route	Calibrated route	Typical services
DN50–DN500	Extended scope / lower uncertainty	Liquid · Gas · Steam

Final performance is confirmed from the approved process data and metrology route.

1. Product Overview

A V-Cone flow meter is a differential-pressure primary element with a centrally supported cone. The annular restriction accelerates the fluid and creates a measurable pressure difference between the upstream pipe wall and the downstream cone-body pressure tap. The center-body geometry conditions the approaching velocity profile before the differential pressure is measured.

Why select it: The design supports compact meter runs and a stable DP signal in many real piping layouts. Its open annular path can reduce deposit sensitivity in suitable services, while retaining familiar DP transmitters, manifolds, compensation and flow-computer architecture.

Two documented metrology routes

Route	Use when	Performance basis
ISO 5167-5 standard geometry	Geometry, D, β, ReD, pressure ratio, flow condition and installation are inside the standard envelope	Published coefficient and uncertainty for the covered uncalibrated geometry
Individually calibrated package	Lower uncertainty, extended size/geometry or operation outside the ISO envelope is required	The individual calibration certificate and approved project calculation

Typical project value

- Compact natural-gas and process-gas metering skids.
- Refinery, petrochemical, steam and boiler-feedwater lines.
- Large-diameter utility or process pipelines.
- Retrofit projects where the available piping layout must be reviewed carefully.

2. Measurement Principle and Key Definitions

The mass-flow equation follows the ISO 5167 differential-pressure framework. Flow is determined from the differential pressure, discharge coefficient, expansibility factor, fluid density and the annular throat area defined by the cone and pipe diameters.

Item	Definition / ISO basis
Diameter ratio	$\beta = \sqrt{(1 - dc^2/D^2)}$, where dc is the cone diameter and D is the upstream pipe bore
Discharge coefficient	C = 0.82 for the ISO 5167-5 uncalibrated geometry
Expansibility factor	$\varepsilon = 1 - (0.649 + 0.696\beta^4) \times \Delta p/(\kappa p_1)$, subject to $p_2/p_1 \geq 0.75$
Permanent pressure loss	$\Delta\omega = (1.09 - 0.813\beta) \times \Delta p$
Pressure taps	Upstream pipe-wall tap and downstream cone-body tap

Important: V-Cone β is not dc/D. It is derived from the annular flow area. Using the wrong definition produces an incorrect flow coefficient and invalid sizing.

Required flow condition

- The pipe is full and the fluid is single phase.
- The flow is subsonic and non-pulsating within the stated standard basis.
- Fluid properties and density are defined at the selected calculation condition.
- Gas and steam sizing includes pressure, temperature, compressibility and isentropic exponent data.

3. ISO 5167-5:2022 Standard Envelope

Parameter	Uncalibrated ISO 5167-5 cone-meter scope
Pipe inside diameter D	50 mm ≤ D ≤ 500 mm
Diameter ratio β	0.45 ≤ β ≤ 0.75
Pipe Reynolds number	$8 \times 10^4 \leq ReD \leq 1.2 \times 10^7$
Discharge coefficient	C = 0.82
Relative expanded uncertainty of C	5% with coverage factor k = 2
Pressure ratio	$p_2/p_1 \geq 0.75$ for the stated expansibility correlation
General flow condition	Full-pipe, single-phase, subsonic and non-pulsating

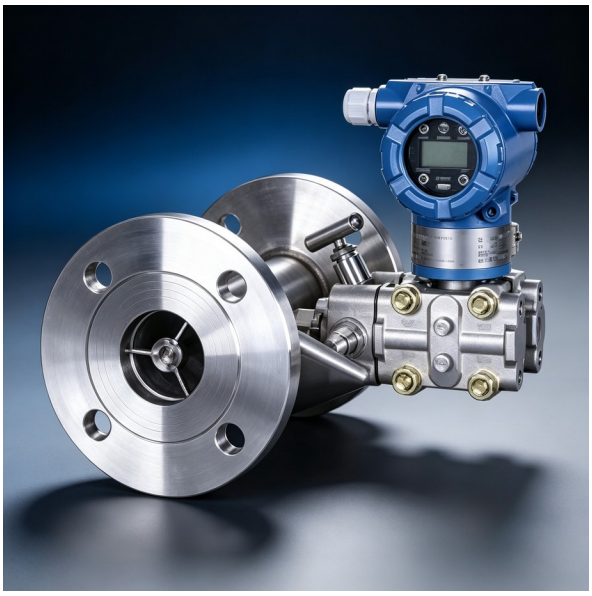
Geometry controls

Feature	Requirement / engineering significance
Upstream cone frustum	Included angle 22.5° ± 5°; smooth transition and correct profile are essential
Downstream cone frustum	Included angle 64° ± 2.5°
Cone support	Structural integrity and geometry must be maintained through manufacturing and service
Pressure openings	Clean, dimensionally controlled and free from burrs or blockage
Pipe condition	Roundness, bore, surface condition and alignment form part of the metering installation

Boundary rule: Do not apply the published uncalibrated coefficient outside the complete ISO envelope. Use an individual calibration and documented approval basis when size, geometry, Reynolds number, installation or required uncertainty falls outside that envelope.

4. Product Configurations

Compact integrated V-Cone flow meter



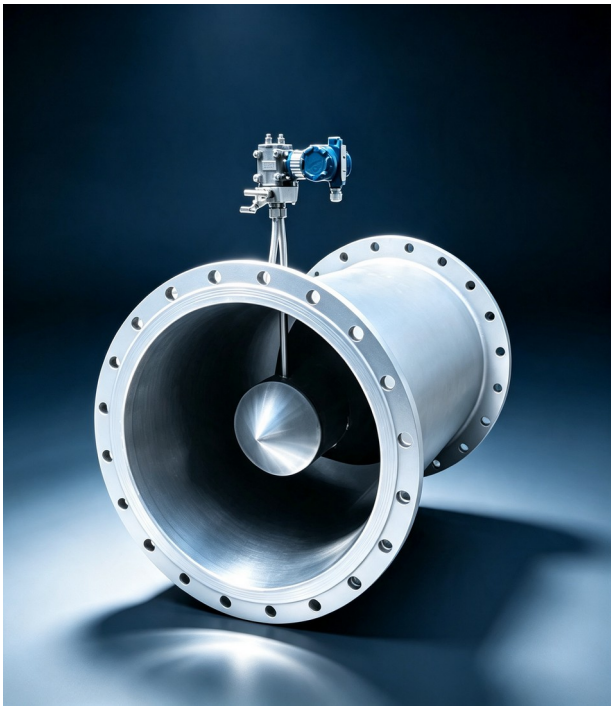
Compact integrated V-Cone meter with differential-pressure transmitter and manifold

A direct-mounted transmitter and manifold reduce impulse-line volume and simplify skid integration. This arrangement is selected after checking process temperature, access, vibration, condensate or gas management, hazardous-area requirements and maintenance clearances.

Configuration options

Option	Typical project decision
Direct or remote transmitter	Selected from temperature, vibration, accessibility and impulse-line requirements
DP-only or compensated system	Pressure and temperature inputs added for gas or steam mass-flow calculation
Flanged, welded or meter-run body	Selected from pressure class, maintenance philosophy and piping code
Local / digital output	4–20 mA, HART or project-specified communication through the selected transmitter

5. Large-Diameter Engineered Packages



Large-diameter integrated V-Cone meter for utility and process pipelines

Large meter bodies require coordinated mechanical, metrological and installation engineering. Shizhong confirms the cone support, pressure taps, pressure class, material, wall thickness, welding, NDE, lifting arrangement and calibration basis against the approved project data.

Review checklist

- Design code, design pressure/temperature, corrosion allowance and material traceability.
- Pipe inside diameter, roundness, upstream/downstream bore matching and flange alignment.
- Cone support strength, thermal expansion, vibration and transport restraints.
- Welding procedure, NDE, pressure test, cleaning and preservation requirements.
- Lifting points, installation orientation, transmitter stand and maintenance access.
- Individual calibration plan when required by geometry, uncertainty or contractual specification.

6. Sizing and Selection Workflow

1. Define the fluid, composition, phase and normal operating state.
2. Confirm minimum, normal and maximum flow with operating pressure and temperature at each point.
3. Confirm pipe size, schedule, measured inside diameter, material, pressure class and design code.
4. Set the required output, transmitter range, compensation method, target uncertainty and turndown.
5. Check β, ReD, differential pressure, pressure loss, pressure ratio and straight-run availability.
6. Choose the ISO standard route or the individually calibrated route and document that decision.
7. Approve the calculation sheet, dimensional drawing, data sheet, inspection plan and calibration scope.

Minimum RFQ data

Data group	Required information
Process	Fluid/composition; phase; density/viscosity; solids or condensate; corrosive constituents
Flow	Minimum, normal and maximum; volumetric/mass/standard condition; expected future range
Pressure & temperature	Operating minimum/normal/maximum plus design pressure and design temperature
Piping	DN/NPS; schedule; actual bore if available; material; rating; orientation; available straight runs
Disturbances	Bends, tees, reducers, expanders, valves, compressors, pumps and their distances
Instrumentation	DP range; compensation; output/protocol; hazardous area; enclosure and cable entry
Quality	Target uncertainty; calibration points; NDE; hydrotest; certificates; documentation language

7. Straight Runs and Installation

Straight-run requirements are disturbance- and beta-dependent. They are not a universal zero-diameter claim. For the bend configurations covered by ISO 5167-5, use the values below and review any different disturbance against the standard and the approved project basis.

Covered disturbance	β < 0.60	β ≥ 0.60	Downstream
Single bend	3D upstream	6D upstream	At least 2D
Two bends in perpendicular planes	3D upstream	6D upstream	At least 2D

Valve caution: A partially closed valve must not be installed within 10D upstream. Put regulating valves downstream whenever the process and safety design allow.

Mechanical installation checks

- Match the meter arrow to the actual flow direction and respect the approved orientation.
- Center the meter body, avoid gasket intrusion and prevent pipe strain from loading the assembly.
- Verify upstream and downstream bore condition, alignment and absence of welding projections.
- Provide isolation, equalization, vent/drain and safe maintenance access for the transmitter manifold.
- Flush or clean impulse paths before commissioning and protect pressure openings from debris.

8. Impulse Lines for Liquid, Gas and Steam

Service	Preferred arrangement	Commissioning focus
Clean liquid	Transmitter below taps where practical; lines continuously slope to avoid trapped gas	Fill both sides completely; vent gas; confirm equal hydrostatic head
Clean gas	Transmitter above taps where practical; lines slope back to the process	Drain condensate; leak-test fittings; avoid liquid pockets
Steam	Matched condensate legs, seal/condensate pots where required, transmitter protected from temperature	Equalize levels and temperature; verify freeze/heat-trace strategy
Dirty or condensing service	Short, accessible paths with isolation, flushing or purge provisions as engineered	Check plugging risk and define a maintenance interval

DP transmitter range

A 10:1 flow turndown produces approximately a 100:1 differential-pressure span. The usable minimum therefore depends on transmitter performance, zero stability, density compensation, Reynolds-number validity and the required uncertainty. Wider published ranges must be verified by sizing and, where appropriate, calibration—not assumed from transmitter rangeability alone.

Commissioning sequence

1. Confirm tag, flow direction, design data, meter serial number and calibration basis.
2. Leak-test the pressure boundary and impulse connections according to the approved procedure.
3. Equalize and zero the transmitter under stable conditions.
4. Check pressure and temperature compensation, engineering units and flow-computer constants.
5. Verify plausible differential pressure across the expected operating range and record the baseline.

9. Application and Selection Guidance

Project need	Why V-Cone may fit	Engineering check
Compact metering skid	Center-body conditioning can reduce required meter-run length for covered disturbances	Actual upstream disturbance, β and access
Gas or steam mass flow	DP architecture integrates with pressure/temperature compensation	Composition, compressibility, wetness/condensation and impulse lines
Large process line	Engineered body can provide a robust annular primary element	Support, welding, NDE, lifting and calibration
Deposit-prone service	Open annular path can be less sensitive than a thin sharp edge in suitable duties	Solids size, coating, plugging, erosion and cleaning strategy
Lower uncertainty target	Individual calibration can establish meter-specific coefficients	Calibration facility, points, Re coverage and certificate scope

When another primary element may be preferable

- Use a standard orifice plate when a widely recognized, replaceable ISO 5167-2 element is the principal requirement.
- Use a Venturi tube when minimum permanent pressure loss is the dominant selection criterion and space is available.
- Use a wedge meter for viscous, crystallizing or difficult media that benefit from a segmental opening.
- Use a flow nozzle for high-velocity, high-pressure or high-temperature duties within its applicable standard basis.

10. Deliverables, Standards and Contact

Typical Shizhong deliverables

- Approved product data sheet and differential-pressure sizing calculation.
- General arrangement and process-connection drawing.
- Material, welding, NDE and pressure-test documentation as specified.
- Transmitter/manifold data and configuration sheet for integrated packages.
- Individual flow-calibration certificate when included in the approved scope.
- Installation, commissioning and maintenance instructions.

Standards basis

Reference	Use
ISO 5167-1:2022	General principles and requirements for differential-pressure devices
ISO 5167-5:2022	Cone-meter geometry, coefficient, uncertainty, installation and calibration route
GB/T 2624.5-2024	Chinese national standard identical to ISO 5167-5:2022; effective 1 June 2025
Project piping code	Pressure boundary, material, welding, NDE and testing requirements

Engineering note: This guide supports product selection. The approved calculation, drawing, data sheet, calibration certificate and contractual specifications govern the supplied meter.

Contact Shizhong

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Product page: https://www.shizhongflow.com/products/v-cone-flow-meters