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PURPOSE OF THIS DOCUMENT

The purpose of this document is to provide you with an overview of the installation and wiring of the VN2000 Compact Insertion Meter. For information on basic configuration, see the *VN2000 Transmitter User Manual* supplied with the meter or download the manual at www.badgermeter.com.

IMPORTANT

*Read this manual carefully before attempting any installation or operation.
Keep the manual in an accessible location for future reference.*

UNPACKING AND INSPECTION

Upon opening the shipping container, visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts, or any other sign of damage that may have occurred during shipment.

NOTE: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the purchaser.

Storage

If the meter is not scheduled for installation soon after delivery and must be stored:

- After inspection, re-pack the meter into its original packing.
- If the meter being stored has been previously installed, remove all process fluids and corrosives.
- Store in a clean, dry site free of mechanical vibration, shock and chemical corrosives.

SAFETY

Safety Symbol Explanations

DANGER

INDICATES A HAZARDOUS SITUATION, WHICH, IF NOT AVOIDED IS ESTIMATED TO BE CAPABLE OF CAUSING DEATH OR SERIOUS PERSONAL INJURY.

WARNING

INDICATES A HAZARDOUS SITUATION, WHICH, IF NOT AVOIDED COULD RESULT IN SEVERE PERSONAL INJURY OR DEATH.

CAUTION

INDICATES A HAZARDOUS SITUATION, WHICH, IF NOT AVOIDED IS ESTIMATED TO BE CAPABLE OF CAUSING MINOR OR MODERATE PERSONAL INJURY OR DAMAGE TO PROPERTY.

Safety Precautions

CAUTION

IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.

PRODUCT LABEL

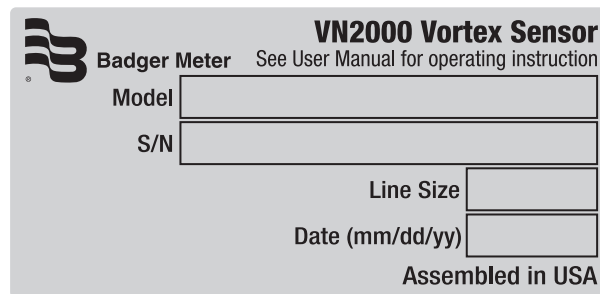


Figure 1: VN2000 meter label

INTRODUCTION

The VN2000 Compact Insertion Vortex Flow Meter measures the volumetric flow rate, mass flow rate or BTU/energy of steam, gas or liquids over a large flow range. The meter is a heavy duty design engineered to stand up to the most abusive environments inside and outside the pipe.

Principles of Operation

An everyday example of a vortex shedding phenomenon is a flag waving in the breeze: the flag waves due to the vortices shed by air moving across the flagpole. Within the flow meter, as flowing fluid moves across the tiny strut or “bluff bar”, vortices are shed on a smaller scale. The frequency of the vortices shedding is proportional to the fluid velocity.

Through the use of an internal RTD, the flow meter software compensates for changes in temperature, to achieve an accurate mass flow measurement.

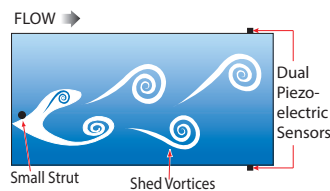


Figure 2: Vortex shedding

Sensor Operation

Two piezoelectric pressure-sensing crystals are mounted internally in the insertion vortex meter in proximity to the vortex-generating element, called the shedder bar. Two sensors sense the vortex signals. The crystals convert the pressure pulses created by the vortices into voltage signals without the need of excitation current or voltage. The sensor crystals are never in contact with the fluid. The piezo crystals are encapsulated in a stainless steel module.

Calibration Factor

The frequency at which vortices are shed is a linear function of fluid velocity, and therefore, a measure of flow. In the range covered by the particular flowmeter, vortex frequency is insensitive to specific gravity, viscosity, and temperature of the fluid, and depends only upon the width (d) in inches and shape of the flow element, and the inside diameter (D) of the pipeline in inches.

The frequency is $F = SV/d$

Where:

F = Karman vortex frequency

S = constant (Strouhal Number)

V = fluid velocity at the flow element

D = face width of the element

INSTALLING A VN2000 METER

The Badger Meter VN2000 Insertion Vortex Meter is designed to operate under a wide variety of conditions. To ensure its longevity of operation, precautions should be taken before and during its installation.

Preinstallation Considerations

Selecting the Installation Site

The meter requires a minimum of 10 straight diameters upstream and 5 straight unobstructed diameters of downstream piping. One diameter is equal to the internal pipe diameter. This is necessary to ensure regulated formation of vortices.

- Choose a site with minimal mechanical vibrations.
- Do not install the transmitter and cables in close proximity with large transformers, arc-welding equipment, large electric motors, or similar industrial equipment that emits excessive electromagnetic interference
- Avoid areas of extreme temperature change. The signal conditioner works ideally between temperatures of 32...140° F (0...60° degrees C).
- Avoid areas of high humidity or corrosive atmosphere, where possible.
- When installing the meter, choose a site that is accessible and allows ease of wiring and maintenance.

Piping Guidelines

Straight Run Piping Requirements	Upstream Pipe Diameters	Downstream Pipe Diameters
One 90° elbow before flow meter	10	5
Two 90° elbows before flow meter	15	5
Two 90° elbows out of plane before flow meter	30	5
Reduction before flow meter	10	5
Regulator, valve or header before flow meter	30	5
Tee connection before flow meter	30	5

Table 1: Piping requirements

If the minimum straight run is not possible, install the meter with 80% of the straight run upstream and 20% downstream.

To provide the high accuracy of flow measurement specified on the identification sheet, piping and installation instructions must be followed carefully.

- The pipe immediately upstream and downstream of the flow meter must be straight, of sufficient length and free of obstructions. See *Table 1* for exact dimensions.
- If recommended piping cannot be found, use straightening vanes on vortex meters.
- Locate any valves downstream of the meter.
- Before installing the meter, make sure nothing (such as weld beads or flange gaskets) protrudes from the internal wall of the pipe that could interrupt the flow stream and affect the reading.

Temperature Taps

For BTU/Energy Meters: Install temperature transducers in accordance with the manufacturer's specifications and 2.5...3.5 diameters from the downstream side of the meter body.

Orientation

The VN2000 insertion meter uses dual piezoelectric sensing elements with no moving parts. This eliminates wear and allows for vertical or horizontal pipe installation. For vertical pipes, the meter can be located in any position.

For horizontal pipe orientations, install the meter above the centerline of the pipe. To prevent condensate from running into the mounting assembly or pipe assembly, mount the flow meter at 0...80° off of the top center of the pipe. For high temperature applications, avoid mounting the transmitter over the pipe to keep it out of the path of heat rising from the pipe. Insulate all pipes surrounding the meter.

Installation Procedure

The flow meter is shipped completely assembled, tested and ready to install and operate in its permanent location.

Prepare the Pipe

These instructions assume the pipe has been fitted with a user-provided Weldolet and the provided mounting assembly welded over a 1-1/2 in. hole.

1. Make sure the insertion bar is removed from the mounting assembly before welding.
2. Position the 1-1/2 in. Weldolet over a 1-1/2 in. hole in the pipe. Make sure the Weldolet is level to the pipe and the arrow.
3. Weld the Weldolet over the hole. Make sure it is centered exactly over the hole.
4. Insert the mounting assembly into the Weldolet. Turn the mounting assembly until the arrow is pointing directly down the pipe in the direction of the flow.
5. Tack, then weld the mounting assembly to the Weldolet. Make sure the mounting assembly is welded completely around into the Weldolet to prevent leaking.
6. Weld the mounting assembly evenly in place over the Weldolet.

IMPORTANT

There is a sensor mounted on the end of the insertion probe. Do not stand the meter on its end. Be careful not to hit or push this end, or damage to the sensor may occur.

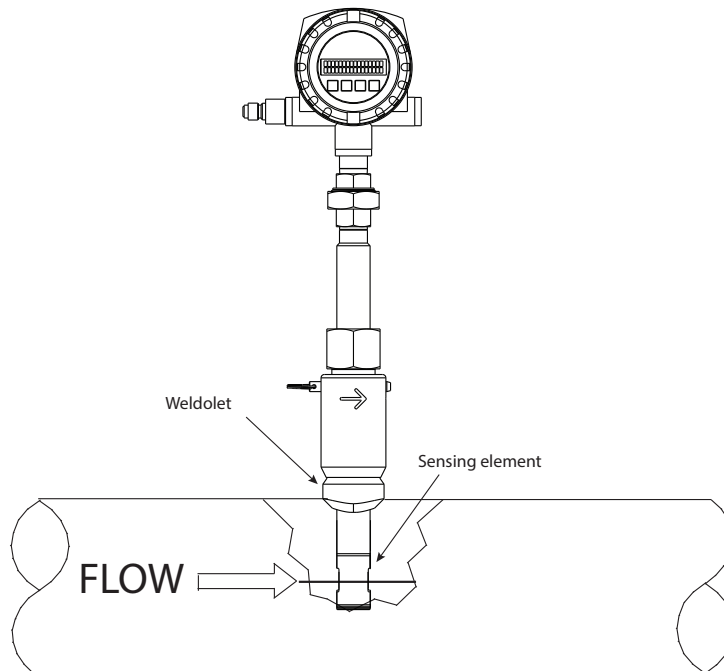


Figure 3: Calculate insertion depth

Install the Meter

1. The O-rings on the meter are greased with a non-petroleum product (silicone synthetic grease ONLY). Please check to see that grease has not been removed due to packing and shipping. If there is minimal grease on O-rings, they must be re-greased before inserting into mounting assembly. Use at least one to two full packets of high temperature silicone synthetic grease on the O-rings before inserting the flow meter. Make sure the grease is evenly spread on all around O-rings and surrounding locations.
2. Insert the probe into the hole in the mounting assembly. Push hard until the meter bottoms out inside the mounting assembly.
3. Rotate the probe until the notch in the probe aligns with the hole in the mounting assembly. You should see a complete hole through the mounting assembly before installing the alignment pin.

IMPORTANT

You must make sure the alignment hole is completely clear with no O-rings showing. If O-rings are showing, do not insert the alignment pin because the pin may cut the O-rings and eventually cause leaking.

4. Rotate the bar until the cutout in the bar lines up with the hole in the mounting assembly and screw down the mounting assembly nut..
5. Insert the alignment pin completely through the mounting assembly and lock it in place **before applying pressure to the pipe line.**

NOTE: The pin can only be inserted with no pressure in the line and is automatically locked under pressure. This is a safety feature that eliminates the accidental removal of the pin and the insertion bar under pressure. The mounting assembly nut will also provide another safety feature that will not allow the meter to come out of the pipe.

When the alignment pin has been inserted, the flow meter finds the precise insertion depth and aligns the vortex element into the stream of flow.

WIRING A REMOTE TRANSMITTER

To wire remote electronics, use the supplied cable with the multi-pin connectors. The cable is a double-sided, molded cordset with a single-keyway, threaded connection. The cable ends are the same. See the VN2000 Transmitter user manual for instructions on installing, wiring and troubleshooting the transmitter.

IMPORTANT

Do not hook up electronics with the power on.

TROUBLESHOOTING

Screen is blank (No display)	Verify that you have 24V DC.
	Verify that power polarity is correct (Black +24V DC & Blue -24V DC).
Screen shows no flow rate during flow	Press Menu until you see <i>Low Flow Cutoff</i> . Lower this number until you can see a flow rate. Check to make sure the arrow in the mounting assembly is pointing down the pipe in the direction of the flow.
Flow rate is erratic	Check to see what is installed upstream of the flow meter. Other instruments or devices before the flow meter can shed vortices of their own causing a disruption in flow reading.
	Check to see what size hole is drilled into the pipe for insertion. If an existing hole larger than 1.5 inch was used, the larger hole can create turbulence directly above the flow sensor.
Flow rate seems incorrect	Review the program settings and make sure the correct line size is chosen for your application. If this is a multi-variable MASS unit, make sure the correct pressure and temperature is being displayed on the screen. If this is a fixed MASS unit, make sure the correct operating pressure is entered into the electronics for calculations.

Table 2: Troubleshooting

SPECIFICATIONS

	Uncertainty	
	Volumetric Flow	Repeatability
Liquids	±1.0% of reading	±0.25% of reading
Steam	±1.0% of reading	±0.25% of reading
Gas	±1.0% of reading	±0.25% of reading
	Mass or Heat Flow	Repeatability
Liquids	±1.0% of reading	±0.25% of reading
Steam	±1.0% of reading	±0.25% of reading
Gas	±1.0% of reading	±0.25% of reading
Velocity – Liquid	1.32...32 ft/s (0.402...9 m/s)	
Velocity – Gas	cube root (140/p) ft/s... 300 ft/sec (91 m/sec)	
Reynolds Range	10,000...7,000,000 depending on fluid density	
Straight Run Pipe	Upstream 10 diameters; downstream 5 diameters with one 90° elbow before the meter	
Pipe sizes	2...24 in. (DN50...DN600)	
Fluid temperature	-250...400° F (-120...204°C)	
Maximum Pressure	1000 psi (68.9 bar)	
Wetted Materials	Stainless steel 304L	
Connections	1-1/2 in. carbon steel mounting assembly Sealing assembly: Two ethylene propylene O-rings	

Measurement Options	Sensors				
Volumetric flow rate	Dual piezo vortex sensors				
Mass flow rate based on velocity and temperature	Dual piezo vortex sensors RTD embedded in sensor: 100 Ohm, 3 wire				
BTU/Energy	Dual piezo vortex sensors RTD embedded in sensor: 100 Ohm, 3 wire External 100 Ohm RTD input				
Units of measure	Units Base	Steam	Liquids	Gases	Energy Meter
	English	Pounds (LB) Tons (TON) Cubic Feet (FT³) Gallons (GAL)	Pounds (LB) Tons (TON) Cubic Feet (FT³) Gallons (GAL) Oil Barrels (BBL)	Pounds (LB) Tons (TON) Cubic Feet (FT³) U.S. Gallons (GAL)	British Thermal Units (BTU) Tons (TON)
	Metric	Kilograms (KG) Tonnes (TNN) Cubic Meters (M³) Liters (LTR)	Kilograms (KG) Tonnes (TNN) Cubic Meters (M³) Liters (LTR)	Kilograms (KG) Metric Tonnes (TNN) Natural Cubic Meters (Nm³) Natural Liters (Nlt)	—
	Actual English	—	—	Pounds (LB) Tons (TON) Actual Cubic Feet (Acf) U.S. Gallons (GAL)	—
	Natural Metric	—	—	Kilograms (KG) Metric Tonnes (TNN) Actual Cubic Meters (Am³) Actual Liters (Alt)	—
Units of measure are used for flow rate, mass flow rate, heat/energy flow rate; volume total, mass total, heat/energy total					
Measurement interval	Second, minute, hour, day				

Table 3: Specifications

PARTS LIST

If the meter was installed, then removed, replace the O-rings before reinstalling the meter. Instructions are included with the O-Ring Replacement Kit.

VNC O-Ring Kit PN VNA-RNG-VNC Contents

O-ring, ethylene propylene with 90 durometer (quantity 2)	22650-078
Silicone grease	68559-001

Table 4: Parts list

PART NUMBER CONFIGURATION

Model		Pipe Line Size (used for meter configuration only)		Material		Mounting Assembly Kit		Process Temperature & Pressure		Certification		Measurement		Transmitter Type		Cable Length		Fluid & Pipe Type		Display		Communication/Output		Testing & Tagging	
VN2000 Compact Insertion Vortex Meter Kit		VC		C		S		S		W		V		E		WW		C		S		S		G	
2 inch		A020																							
3 inch		A030																							
4 inch		A040																							
5 inch		A050																							
6 inch		A060																							
8 inch		A080																							
10 inch		A100																							
12 inch		A120																							
14 inch		A140																							
16 inch		A160																							
18 inch		A180																							
20 inch		A200																							
22 inch		A220																							
24 inch		A240																							
Standard ¹																									
Standard																									
None																									
Volumetric flow rate																									
Mass flow, temperature																									
Heat energy/BTU (not available for sensor replacement) ²																									
Integral, 24V DC																									
Remote, 24V DC																									
None (integral/meter mount or replacement sensor)																									
10 feet/3 m (remote transmitter) ³																									
30 feet/9 m (remote transmitter) ³																									
Liquid-Chilled (not available with Measurement option V)																									
Liquid-Heating (not available with Measurement option V)																									
Liquid (available with Measurement option V only)																									
Steam																									
Gas																									
Standard																									
4-20 mA and Pulse Output																									
Modbus RTU																									
BACnet MS/TP																									
Standard Testing																									

1.) Includes weldable outlet and mounting assembly with pin

2.) One internal temperature sensor and one external temperature sensor

3.) Specify cable length from sensor to transmitter. Transmitter power 10 foot cable included.

Metric Pipes

Model		Pipe Line Size (used for meter configuration only)		Material		Mounting Assembly Kit		Process Temperature & Pressure		Certification		Measurement		Transmitter Type		Cable Length		Fluid & Pipe Type		Display		Communication/Output		Testing & Tagging	
VN2000 Compact Insertion Vortex Meter Kit		VC		C		S		S		W		V T E		E F		WW AB AF		C H L S G		S		S M B		G	
50 mm		D050																							
80 mm		D080																							
100 mm		D100																							
150 mm		D150																							
200 mm		D200																							
250 mm		D250																							
300 mm		D300																							
350 mm		D350																							
400 mm		D400																							
450 mm		D450																							
500 mm		D500																							
550 mm		D550																							
600 mm		D600																							

¹ Includes weldable outlet and mounting assembly with pin.

² One internal temperature sensor and one external temperature sensor.

³ Specify cable length from sensor to transmitter. Transmitter power 10 foot cable included.

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