

## IFOA Integral Flow Orifice Assembly

### Introduction

The IFOA integral flow orifice assembly is used in conjunction with a Foxboro electronic or pneumatic differential pressure transmitter. This combination uses the differential pressure created by the orifice to measure liquid, gas, and steam flow in 1/2, 1, and 1 1/2 in (approximately 15, 25, and 40 mm) pipes. When the highest accuracy is required, the associated piping (meter run) is supplied welded to the assembly body.

In addition, the very low flow-rate measuring capability of the 1/2 in size can be further extended by using an orifice plate with a jewel insert. These inserts have a very precise bore, which can be as small as 0.0508 mm (0.002 in).

The orifice assembly is installed in the process line and becomes part of the piping. The transmitter can either be bolted directly to the orifice assembly body (close-coupled); or, if the optional remote connectors are used, the transmitter can be mounted away from the orifice assembly (remote connected).

This instruction covers only the integral orifice assembly. For details on the particular transmitter used with the assembly, refer to Table 1.

### Reference Documents

*Table 1. Reference Documents*

Transmitter Series	Transmitter Instruction
IDP10	MI IDP10-X*
IDP25 or IDP50	MI IDP25-X/IDP50-X*
13A	MI 022-310
15A	MI 022-315
11DM	MI 022-410

\* X = A, D, F, P, T, or V per the applicable communications protocol



## Standard Specifications

For transmitter specifications, see the applicable transmitter instruction listed in Table 1.

### *Pressure-Temperature Rating*

Refer to Table 2 for the pressure-temperature ratings of the different types of end connections. If the process temperature is higher than the temperature rating of transmitter, remote pressure connectors are available to install transmitter away from the orifice assembly. However, temperature of the transmitter must not exceed its rating. The remote pressure connections are provided with the necessary bolts and gaskets (one set is supplied with the orifice assembly and another set is supplied with the transmitter). Interconnecting piping is supplied by the user.

### *Mounting*

The orifice assembly is inserted into the process line and becomes a permanent part of the piping.

The transmitter, a 3-valve bypass manifold, or the optional pressure connectors can be bolted directly to the orifice assembly.

The 3-valve bypass manifold permits the transmitter to be isolated from the process during calibration, servicing, or shutdown. The optional pressure connectors permit the transmitter to be mounted away from the orifice assembly and are required when seal liquid is used.

### *Process End Connections*

#### **Assembly WITHOUT Associated Piping**

Body halves bored for 1/2, 1, or 1 1/2 in pipe. Connections are NPT pipe tap, R<sub>c</sub> pipe tap, or prepared for socket welding; as specified.

#### **Assembly WITH Associated Piping Supplied**

1/2, 1, or 1 1/2 in pipe is welded to body. Outer ends are NPT, R threaded, prepared for welding, or flanged (ANSI Class 150, 300, or 500), as specified.

Pipe lengths are 18 pipe diameters upstream and 7 pipe diameters downstream.

### *Pipe Bores:*

See Table 3.

### *Remote Pressure Connectors (Optional Selection)*

1/2 NPT or R<sub>c</sub> 1/2 tap, as specified. Connectors are used when the process temperature is higher than the temperature rating of the transmitter.

### *Orifice Inlet Edge*

Quadrant inlet edge, bore diameter up to 1.5 mm (0.06 in).

Square inlet edge, bore diameter above 1.5 mm (0.06 in).

## Orifice Plate Thickness

4.24 mm (0.167 in)

## Orifice Plate Identification

One side of the handle has INLET and the plate material stamped on it; the other side has the part number and bore diameter.

## Pressure Taps

Corner pressure taps.

*Table 2. Pressure-Temperature Ratings<sup>(a)</sup>*

Assembly Line Size	End Connection	Pressure-Temperature Rating	
		MPa and °C	psi and °F
1/2	Welded	20.7 MPa from -40 to +40°C 15.9 MPa at 150°C	3000 psi from -40 to +100°F 2300 psi at 300°F
	Threaded	10.3 MPa from -40 to +40°C 8.1 MPa at 150°C	1500 psi from -40 to +100°F 1180 psi at 300°F
	Flanged <sup>(b)</sup>	Flange Rating up to 150°C max.	Flange Rating up to 300°F max.
1	Welded	13.8 MPa from -40 to +40°C 10.7 MPa at 150°C	2000 psi from -40 to +100°F 1550 psi at 300°F
	Threaded	10.3 MPa from -40 to +40°C 8.1 MPa at 150°C	1500 psi from -40 to +100°F 1180 psi at 300°F
	Flanged <sup>(b)</sup>	Flange Rating up to 150°C max.	Flange Rating up to 300°F max.
1 1/2	Welded	9.9 MPa from -40 to +40°C 7.7 MPa at 150°C	1440 psi from -40 to +100°F 1120 psi at 300°F
	Threaded	9.9 MPa from -40 to +40°C 7.7 MPa at 150°C	1440 psi from -40 to +100°F 1120 psi at 300°F
	Flanged <sup>(b)</sup>	Flange Rating up to 150°C max.	Flange Rating up to 300°F max.

(a) Low Temperature limit (of the IFOA) is -40°C (-40°F). The highest low temperature limit of any component of the system (IFOA, piping, or transmitter) is the allowable rating of the system. For example, if the low limits of the IFOA, piping, and transmitter are -40°C (-40°F), -50°C (-58°F), and -30°C (-22°F) respectively, the low limit of the system is -30°C (-22°F).

(b) Pressure correspond to ANSI Class 600 flange ratings unless otherwise noted.

*Table 3. Pipe Bore With and Without Associated Piping*

Assembly Line Size	Pipe Schedule	Pipe Bore			
		With Associated Piping <sup>(a)</sup>		Without Associate Piping <sup>(b)</sup>	
		mm	in	mm	in
1/2	40	16.76	0.660	15.80	0.622
1	40	27.76	1.093	26.64	1.049
1 1/2	80	39.65	1.561	38.10	1.500

(a) When piping is supplied by the company, the ID of both ends of the pipe at the orifice assembly is precision bored to the indicated diameter.

(b) When piping is supplied by the user, the nominal ID of commercial pipe is indicated.

## Flow Specifications

If a standard-bore orifice plate and the upper-range process flow rate is specified, the differential pressure range is not a standard one. If the upper-range process flow rate and a standard differential pressure range is specified, the orifice plate bore is not a standard one.

When the integral orifice assembly and a d/p Cell transmitter are ordered together, using process flow data supplied by the user (such as temperature, pressure, Reynolds number, specific gravity, desired maximum and normal flow rates, and so forth), a specification sheet containing integral orifice, transmitter, and calibration data is supplied with the orifice assembly.

To determine the approximate value of either the flow rate, or its corresponding differential pressure, when one of these values is known, use the FlowExpertPro software program. If higher accuracy is required, refer to TI 037-087 or the Flow Measurement Engineering Handbook by R.W. Miller (Part Number B0150YW) or contact Global Customer Support.

## Installation

### Orifice Assembly Installation Dimensions

See DP 022-333.

### Installation Notes

1. A transmitter (Figure 1) can be installed with or without a bypass manifold between the orifice assembly and the transmitter. However, it is recommended that a 3-valve bypass manifold be installed. This permits process flow to continue uninterrupted while the transmitter is being serviced.
2. If the orifice assembly has socket-weld end connections, corresponding ends of the pipe must be machined to the applicable OD listed in Table 4. Depth of socket weld connections is 12.70 mm (0.500 in).
3. For details about installation of pressure connectors, see “Installation of Optional Pressure Connectors” on page 6.

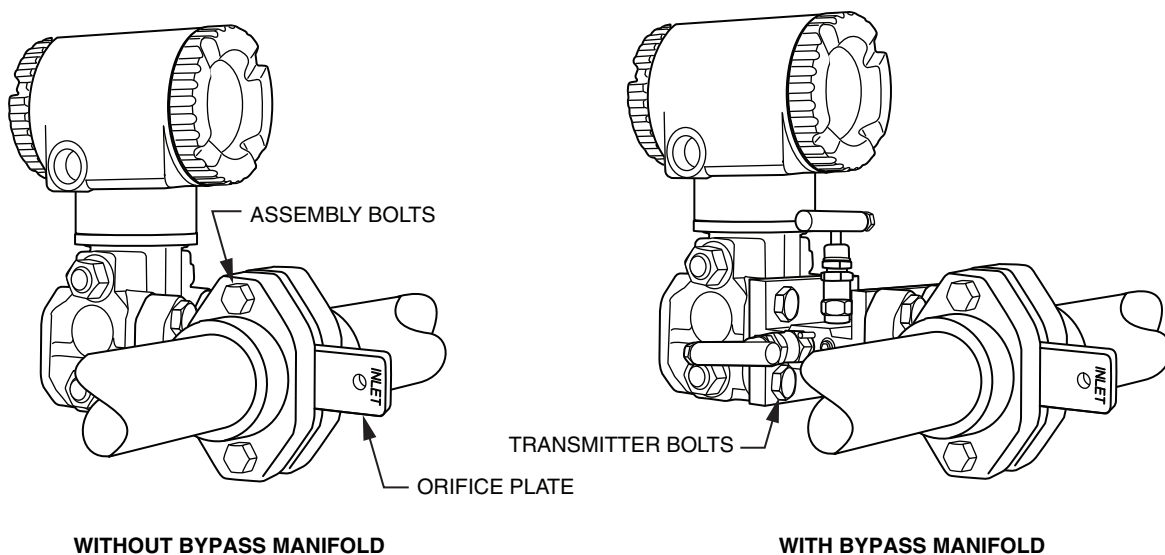
*Table 4. Pipe OD for Socket-Weld End Connections*

Assembly Line Size	Machine Pipe End OD to	
	mm (+0, -0.13)	in (+0, -0.005)
1/2	20.32	0.800
1	32.39	1.275
1 1/2	47.24	1.860

**⚠ CAUTION**

When welding piping to the body, do not use more heat than necessary. Excess heat could distort the body causing leaks.

4. If the associated piping (meter run) is supplied with the orifice assembly, straight pipe runs of approximately 18 pipe diameters upstream and 7 pipe diameters downstream are welded to assembly body. These pipe runs can minimize the effects of moderate flow disturbances. With severe flow disturbances or if associated piping is not supplied, see Table 5 for required straight runs of pipe.
5. If the process fluid must not come in contact with the transmitter, transmitter lines can be filled with a suitable seal liquid. With steam flow, a water seal must be used. However, when a seal liquid is used, pressure lines are required (the transmitter cannot be mounted directly to the orifice assembly body). Instead, optional pressure connectors must be used (see typical installations in Figures 2 and 3).  
The seal liquid (or water) is added to system through filling tees in the piping. To prevent unequal heads on the two sides of transmitter, filling tees must be at same elevation and the transmitter must be in a vertical position (topworks above body).
6. With a horizontal flow line, position orifice assembly so that with gas applications, connections to the transmitter are from the top of the line; with liquid or steam applications, connections are from the side of the line.



*Figure 1. Typical Transmitter and Integral Flow Orifice Assemblies*

7. With a vertical flow line, the flow should be:  
Upward for clean or corrosive liquids and clean, noncondensable gases, and  
Downward for condensable or dirty gases and vapor (steam).
8. With gas applications where a seal liquid is not used, mount the transmitter above the process line (with or without pressure lines) to facilitate draining condensate.
9. If process fluid contains entrained gas (with liquid flow) or droplets of liquid (with gas flow), the flow line should be vertical.

10. Before the assembly bolts are tightened, check that the side of the orifice plate labeled **INLET** faces upstream.

Tighten the two body bolts and the four transmitter (or pressure connector) bolts to a torque of approximately 81 N·m (60 lb·ft) with no lubrication, or 68 N·m (50 lb·ft) with lubrication. Tighten bolts gradually and uniformly.

## Installation of Optional Pressure Connectors

1. Two pairs of pressure connectors and bolts are required; one pair is supplied with the orifice assembly, and the other pair is supplied with the transmitter (see Figures 2 and 3). Connections for pressure piping are tapped for either 1/2 NPT or R 1/2, as specified.

The pair of connectors supplied with the orifice assembly have threaded mounting holes and bolt to the orifice body assembly. The pair of connectors supplied with the transmitter have clearance mounting holes and bolt to the transmitter.

Pressure piping is supplied by the user.

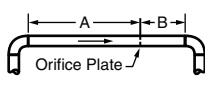

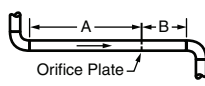
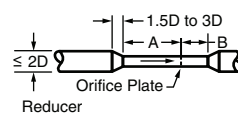
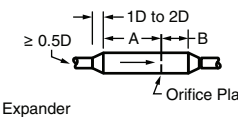
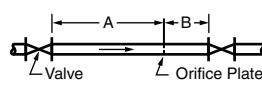
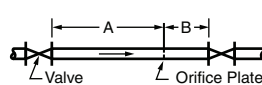
2. If the orifice assembly is installed in a horizontal line, the assembly should be positioned so that:

With gas applications, connections are at the top of the line;

With liquid or steam applications, connections are at the side of the line.

3. Position vent screws and drain plugs on the transmitter so that trapped gases can be vented or condensate drained periodically.

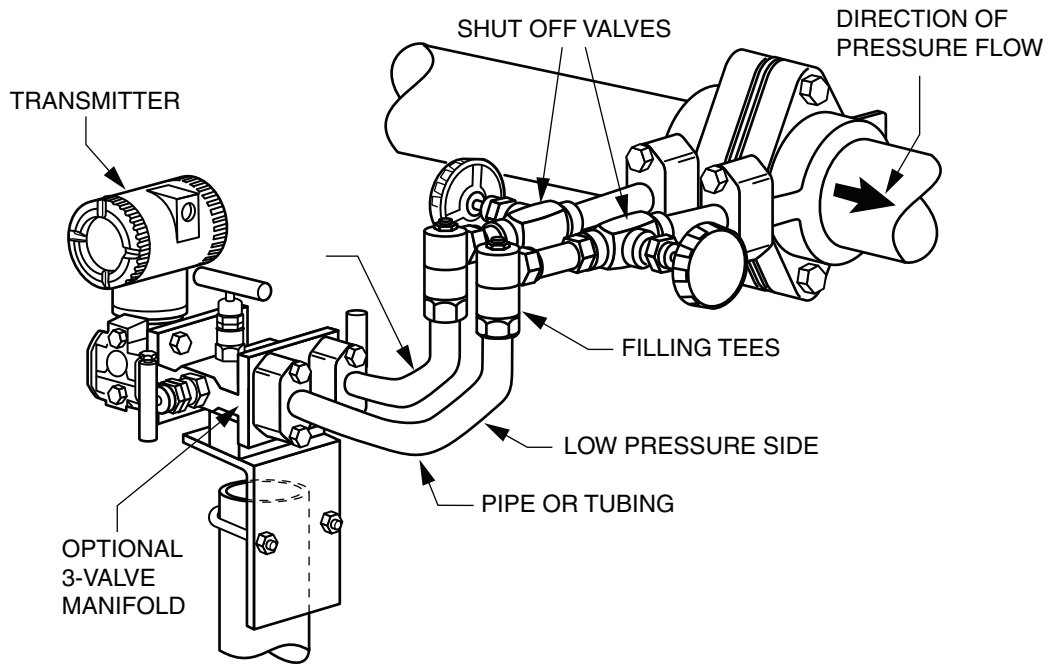
**Table 5. Required Lengths of Straight Pipe in Pipe Diameters**

Dimension	Upstream Disturbance	Required Length in Pipe Diameters for a $\beta$ of							
		$\leq 0.2$	0.3	0.4	0.5	0.6	0.7	0.75	
A	Direction Change	 <p>Single Elbow</p>	10	10	14	14	18	28	36
		 <p>Two Elbows in Same Plane</p>	14	16	18	20	26	36	42
		 <p>Two Elbows in Different Planes</p>	34	34	36	40	48	62	70
	Size Change	 <p>Reducer</p>	5	5	5	6	9	14	22
		 <p>Expander</p>	16	16	16	18	22	30	38
		 <p>Globe Valve, Fully Open</p>	18	18	20	22	26	32	36
		 <p>Gate Valve, Fully Open</p>	12	12	12	12	14	20	24
	B	Downstream length for all disturbances listed.	4	5	6	6	7	7	8

1. Dimensions A and B are upstream and downstream lengths respectively. Beta ( $\beta$ ) ratio =  $d/D$  = orifice bore/pipe bore.
2. If actual straight runs of upstream and downstream pipes are less than applicable values listed, but are at least half these values, add 0.5% to published flow coefficient uncertainty.
3. Interpolate pipe diameter lengths for intermediate Beta ( $\beta$ ) ratios.
4. Data is from ISO Standard 5167. For AGA requirements refer to Miller's Flow Measurement Engineering Handbook (Part Number B0150YW).

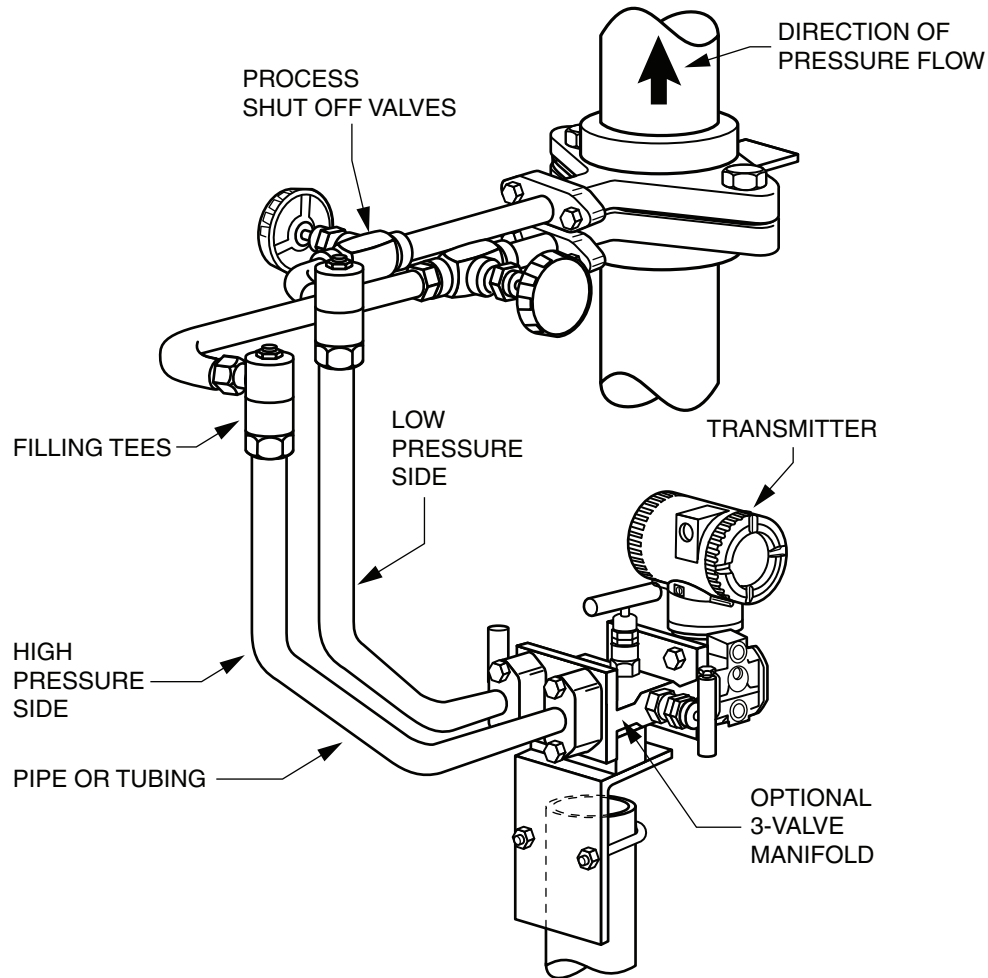
## Typical Installations with Pressure Lines

Typical tubing size is 10x1 mm or 0.375 in; typical valve sizes are 8 mm or 1/4 in (liquid and gas flow), and 15 mm or 1/2 in (steam flow). For more details see Miller's Flow Measurement Engineering Handbook.



*Figure 2. Typical Piping for Horizontal Process Line When Seal Liquid is Required*





*Figure 3. Typical Piping for Vertical Process Line When Seal Liquid is Required*

## Operation

### **CAUTION**

All bolts and screws (orifice assembly, pressure connector, transmitter body, vent, drain, and so forth) must be tight before pressure is applied to the transmitter.

## Filling the System With Seal Liquid

If the process fluid must not come in contact with the transmitter, the transmitter lines must be filled with a suitable seal liquid. The procedure to do this follows:

1. If the transmitter is in service, follow the procedure “Taking the Transmitter Out of Operation” on page 11.
2. Close both process shutoff valves
3. Open all three valves on the bypass manifold.

4. Remove plugs from the filling tees and pour in seal liquid (water, with steam flow).
5. Partially open transmitter vent screws until all air has been forced out of the transmitter body and lines. Close the vent screws.

**⚠ WARNING**

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When venting pressure from the transmitter, wear suitable protective clothing and use care to prevent possible injury from process material, temperature, and/or pressure.

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6. Refill tee connections. Reinsert the plugs. Close the bypass valve. Check for leaks.

**— NOTE**

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To prevent loss of seal liquid and contamination of process fluid, never open both process shutoff valves and manifold shutoff valves if the bypass valve is open.

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7. Follow the procedure “Putting the Transmitter Into Operation” on page 10.

## Transmitter Zero Adjustment

Refer to the procedure in the applicable transmitter instruction listed in Table 1.

## Transmitter Calibration

1. For transmitter calibration procedures, refer to the applicable transmitter instruction listed in Table 1.
2. Two points determine transmitter calibration: zero flow (with zero differential pressure), and a flow rate related to upper-range value (with its corresponding differential pressure).
3. To determine an approximate upper-range calibrating value, use one of the following:
  - ◆ The flow specification data sheet shipped with your product
  - ◆ The FlowExpertPro software program
  - ◆ TI 037-087
  - ◆ Miller’s Flow Measurement Engineering Handbook.

If you need more help, contact Global Customer Support.

## Putting the Transmitter Into Operation

The following procedure explains how to sequence the valves in your flow measurement piping or bypass manifold to ensure that your transmitter is not overranged and that seal liquid is not lost.

**— NOTE**

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This procedure assumes that the process shutoff valves are open.

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1. Close both the upstream and downstream manifold valves
2. Open the bypass valve.
3. Slowly open the upstream valve

4. Close the bypass valve.
5. Slowly open the downstream manifold valve.

## Taking the Transmitter Out of Operation

The following procedure explains how to sequence the valves in your flow measurement piping or bypass manifold to ensure that your transmitter is not overranged and that seal liquid is not lost.

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### — NOTE

This procedure assumes that the process shutoff valves are open.

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1. Close the downstream manifold valve
2. Close the upstream manifold valve
3. Open the bypass valve
4. Carefully open the vent screw to release any residual pressure before disconnecting lines.

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### **⚠ WARNING**

When venting pressure from the transmitter, wear suitable protective clothing and use care to prevent possible injury from process material, temperature, and/or pressure.

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## Maintenance

Periodically the orifice plate (Figure 4) should be removed from the assembly and inspected. To provide clearance to remove or install the orifice plate, withdraw the two assembly bolts so that they are clear of the orifice plate, and loosen the four transmitter bolts.

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### **⚠ CAUTION**

Bolts furnished are high strength per ASTM A193, Grade B7. Do not substitute with lesser strength bolts.

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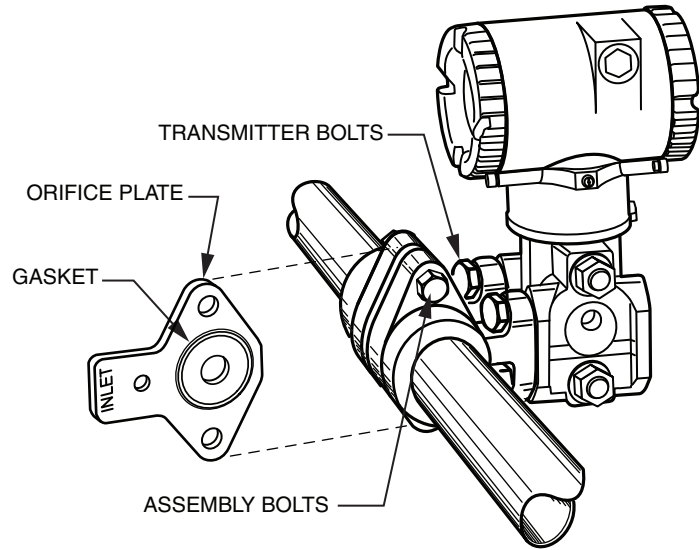
For best results, the inlet edge of the orifice should be free of nicks, scratches, etc., and the corner of sharp-edge orifices should not reflect light. If any of these indications of wear are present, the orifice plate should be replaced to prevent degradation of the measurement. If there is dirt on the upstream side, carefully clean the plate.

While the orifice plate is out of the assembly, it is recommended that the process piping be inspected and cleaned of any dirt deposits.

Periodically the transmitter (or pressure connectors) should be removed to expose the pressure tap holes. Clean the holes and remove any dirt deposits.

When handling the orifice plate, use care not to nick the sharp upstream edge. Before reinstalling the plate, carefully pry out the gasket from each side and insert new gaskets. When reinstalling the plate, ensure that side labeled **INLET** faces upstream.

Tighten the two assembly bolts and the four transmitter (or pressure connector) bolts to a torque of approximately 85 N·m (60 lb·ft) with no lubrication, or 68 N·m (50 lb·ft) with lubrication. Tighten bolts gradually and uniformly.



*Figure 4. Removing an Orifice Plate*

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Vertical lines to the right of text or illustrations indicate areas changed at last issue date.