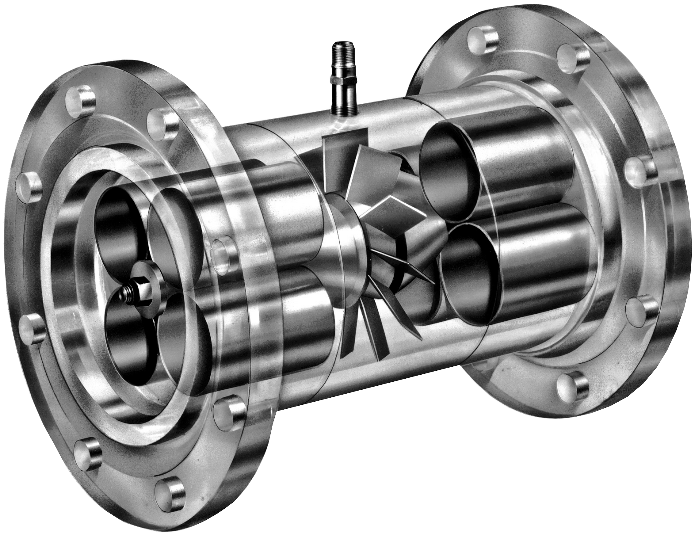
BARTON®

7000 Series Liquid Turbine Meters

Models 71xx, 72xx, & 73xx



Barton® 7000 series turbines are designed for a broad range of precise liquid measurement applications. Based on 35 years of turbine manufacturing, this built-to-order series features a range of sizes, materials, bearing systems, and options.

Features

- Linearity:
  Better than ± 1% of reading over linear flow range of fractional size meters. Better than ± 0.25% of reading over linear flow range of meters 1-in. size and above.
- Repeatability:
  ± 0.02% of reading.
- Compact and efficient:
  Compared to other metering techniques, Barton® turbine meters are able to handle a larger flowrate in a smaller meter and with a lower pressure drop. With the use of reduced diameter block valves and meter runs,substantial installed cost savings are achieved.
- Self-flushing design:
  Longer sustained accuracy.
- High frequency digital output:
  Easy interface with digital equipment.
- Wide rangeability:
  Eliminates parallel runs and the cost of extra valves and strainers.
- Symmetrical bi-directional design:
  Ideal for reverse flow applications, accuracy and flow capacities are the same in either direction. Electronic options provide instantaneous flow direction sensing.
- Wide temperature and pressure ranges:
  Measurement options for hot hydrocarbon to cryogenic applications.
- High quality bearings:
  Wear resistant tungsten carbide sleeve bearings standard on 71xx/73xx meters and self-lubricating, precision stainless steel bearings (dry lubricant impregnated ball separators on 72xx meters).
- Low mass design:
  The small lightweight rotor hubs both ensure fast response to process flow changes and reduced bearing load and wear. On meters above 2-in. (50 mm) the hub is either hollow or indented to further reduce the rotating mass.
- Low maintenance:
  True fluid thrust design hydrodynamically balances the rotor during operation. This unique design eliminates the need for mechanical thrust leveling. This low friction design both improves metering linearity and reduces wear and maintenance.

Rotor Design

As a truly precise instrument, all components including the rotors in the 7000 series are individually fabricated from industrial bar and sheet stock. A range of housing, bearing, blade, shaft and trim, and shrouded bar (73xx series only) materials assures chemical and wear resistance, as well as pressure containment integrity.

Custom rotor blade pitch angles can be specified if specialized flow capacities are required for a particular meter size. In certain circumstances this can provide tremendous savings by providing the ability to change the capacity of a metering facility without having to incur the cost to change piping, strainers and valves.

The rotors in the 7100 and 7200 series turbines produce a pulse as each blade passes a fixed point on the turbine housing. On the 7300 series a shroud or rim is fixed to the outer parameter of the rotor blade tips. In addition to adding strength,closely spaced Hi-Mu metal bars (welded into slots in the shroud) produce many more pulses for each rotor revolution. This high-resolution output is ideal for pipeline custody transfer and leak detection systems. This feature is also valuable when testing a large capacity turbine with a small volume prover, a situation that would otherwise produce only a few pulses during a calibration run.

Finally all Barton® rotors are machined to be both balanced and concentric in the meter-housing bore. By ensuring a constant space between the housing and the rotor, meter linearity is improved though a wide range of process fluid viscosities.

Bearing Choice

The maintenance frequency of any turbine is usually determined by the durability of the bearing. In addition to the hydrodynamic effect (see Unique Design section) that significantly extends the life of bearings on Barton® turbines, a choice of styles and materials assures a durable meter fit for the purpose.

Barton® 7100 and 7300 series use a two piece journal sleeve type bearing:

- Tungsten carbide is the standard bearing material. Due to its very hard nature, it is ideal for slurry applications or where pipe scale, oxides and other abrasives will be present. The two piece design makes the bearing resistant to damage by mechanical shock that may tend to crack other types of bearings.

  In applications where the process temperature is expected to exceed 300°F (150°C) one of the two sleeves should be optionally specified to be vacuum brazed in place. This technique secures the bearing for use in temperatures in excess to 990°F (530°C). The mechanical tolerances in the tungsten carbide bearing makes it suited for temperatures as low as -160°F (-75°C).
- For non-lubricating services or applications where Tungsten Carbide is subject to chemical attack, Carbon Graphite bearings are available for meter sizes 3-in. and smaller. For larger meters, other materials such as Rulon or Silica are optionally available.

Barton® 7200 series meters employ oversized twin ball bearings:

- Suitable for both lubricating and non-lubricating services, these bearings are the preferred choice provided that the process piping and fluids are free of any solids.
- Each bearing is constructed from 440C Stainless Steel and includes self-lubricating internal components. This standard bearing is suited for temperatures from -440°F to +570°F (-260°C to +300°C) making it suitable for a wide range of applications including cryogenics.
- Provided there is no wear on the rotor surfaces,replacing the bearings in the field will restore the original factory calibration.

Operation

As liquid passes over the diffuser section (see Figure 1), it is accelerated onto a multi-blade hydrodynamically balanced turbine rotor. The rotor speed is proportional to the volumetric flowrate. As the rotor turns,a reluctance type pickup coil (mounted on the meter) senses the passage of each blade tip and in-turn generates a sine wave output (with frequency directly proportional to the flowrate). Additional coils can be added in-phase for metering redundancy and API level “B” fidelity techniques as defined in API MMPS Chapter 5, Section 5. Coils can also be arranged out-of-phase for flow direction sensing.

The pickup coil can drive a variety of instruments including flow rate indicators, totalizers, pre-amplifiers or flow computers/RTUs. Pre-amplifiers are used to transmit the coil signal over extended distances to remote mounted instruments. All turbine instruments can be local or remote mounted and are available with intrinsically safe or explosion/ flame proof or weatherproof approvals.

Unique Design

The unique true fluid thrust bearing design eliminates the need for mechanical thrust bearings by nulling the downstream thrust produced by the flowing stream. This is done by developing a differential pressure (DP) across the rotor that opposes the flow, where P2 is greater than P1 (See Fig. 1).

This DP, essentially acting upon the hub area of the rotor, generates a force in the upstream direction. This force lifts the rotor from the downstream diffuser and causes the rotor to float between the diffusers.

The turbine is designed to permit axial movement of the rotor along its axis of rotation over a distance equal to L =a +b, where the "L"clearance is minimum at the minimum flow rate and maximum at the maximum flow rate. This axial movement of the rotor is used as a servo feedback mechanism to effect a true balance of forces acting on the turbine.

A counter current flow (Vcc) develops in a series of holes drilled in the hub of the rotor. This patented design creates a null balance component that results in a true force balance. The rotor positions itself some distance "L"as a function of flow rate and total imposed drag upon the rotor.

In addition, a secondary counter current flow is produced that flows through the rotor bearings. This cools the bearing and flushes away any foreign particles.

The result is reduced bearing drag, improved bearing life, greater reliability, and higher performance.

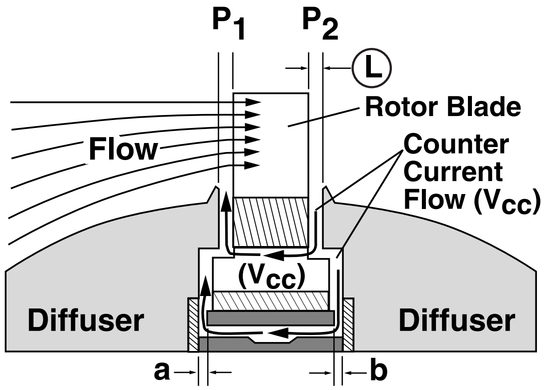
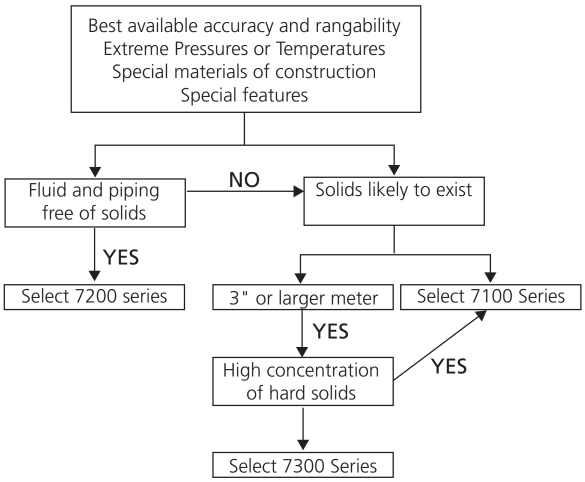


Figure 1 — Counter Current Flow

Model Selection

To determine the correct turbine meter size for a particular liquid application,perform the following steps:

1. **Determine flowrate**
   (maximum and minimum at line conditions) in GPM or m^3 /hr.
2. **Select meter series:**



3. **Select meter**
   Choose the meter size with a maximum rated flow rate value closest to the flow rate determined in Step 1.
   For Specific Gravity (SG) values of 1.0, use Table 1 (71xx & 72xx).
   For SG values of 0.8, use Table 2 (73xx).
   For other SG values,compute the minimum linear flow rate, using the following formulas:

- For 71xx/72xx (w/SG = 1)

$$\textbf{Min. Linear Flowrate} = \frac{1}{\sqrt{SG}} \textbf{ x Rated Min. Linear Flowrate}$$

- For 73xx (w/SG = 0.8)

$$\textbf{Min. Linear Flowrate} = \frac{0.8}{\sqrt{SG}} \textbf{ x Rated Min. Linear Flowrate}$$

4. **Determine estimated pressure drop**
   In water applications (at 60 °F), use the appropriate Pressure Drop Chart (on page 5) to determine the pressure drop for the model selected in Step 2.
   For liquids other than water,calculate the pressure drop using the following formula:

$$\Delta P = (\mu)^{1/4} \text{ x } (SG)^{3/4} \text{ x } \Delta P_{H_2O}$$

where, ΔP = pressure drop
SG = specific gravity
μ = absolute viscosity in centipoise

Model Selection Example

Given a maximum flowrate of 50 USGPM of a liquid with a specific gravity of 1.2 and a viscosity of 1.0, size a meter and determine the minimum linear flowrate and pressure loss.

Assume a sleeve bearing is preferable.

1. **Determine flowrate** (given)-50 USGPM
2. **Select meter**
   Choose the meter size with a maximum rated flow rate value closest to (and higher than)the flow rate determined in Step 1.
   The meter with the closest maximum linear flowrate to 50 GPM is the 7101 (1-inch) on the 71xx Table 1.

$$\textbf{Min. Linear Flowrate} = \frac{1}{\sqrt{SG}} \textbf{ x Rated Min. Linear Flowrate}$$

$$\textbf{Min. Linear Flowrate} = \frac{1}{\sqrt{1.2}} \textbf{ x 3.7 = 0.913 x 3.7}$$

$$\textbf{Min. Linear Flowrate = 3.38 USGPM}$$

3. **Calculate minimum flowrate**
   for given specific gravity (1.2):
4. **Determine estimated pressure drop**
   Using the Pressure Drop Chart (on page 6), the pressure drop for a Model 7101 meter operating in water is:
   $\Delta P_{H_2O} = 2.95$
   The actual pressure drop for a Model 7101 meter operating in a fluid with a SG =1.2 is calculated as follows:

$$\Delta P = (\mu)^{1/4} \text{ x } (SG)^{3/4} \text{ x } \Delta P_{H_2O}$$
$$= (1)^{1/4} \text{ x } (1.2)^{3/4} \text{ x } 2.95$$
$$= 1 \text{ x } 1.146 \text{ x } 2.95$$
$$= 3.38 \text{ PSID}$$

71xx Model Selection

Model	Meter Size (nominal) In.	Meter Size (nominal) mm	Minimum Repeatability US GPM	Minimum Repeatability m3/hr	Flow Range Linear Range (water) Minimum US GPM	Flow Range Linear Range (water) Minimum m3/hr	Rated Maximum US GPM	Rated Maximum m3/hr	Maximum Extended Range* US GPM	Maximum Extended Range* m3/hr	Meter Output (nominal) Pulses/ gal.	Pulses x 1000/m3	Frequency (Hz)
7182	1/4	8	0.15	0.034	0.25	0.06	2.5	0.57	3	0.68	49,000	12,944	2,040
7183	3/8	10	0.3	0.068	0.5	0.12	5	1.14	6	1.36	18,600	4,914	1,550
7184	1/2	15	0.55	0.13	0.9	0.23	10	2.27	12	2.73	12,600	3,329	2,100
7185	5/8	18	0.85	0.19	1.4	0.37	16	3.65	20	4.54	7,700	2,034	2,050
7186	3/4	20	1.5	0.34	2.5	0.64	28	6.35	35	7.95	3,220	851	1,500
7101	1	25	2.2	0.50	3.7	0.84	60	13.6	75	17.0	1,350	357	1,350
7146	1-1/2	40	5	1.14	8	1.8	130	29.5	160	36.4	380	100.4	823
7102	2	50	9	2.05	15	3.4	240	54.5	300	68	230	60.8	920
7103	3	80	30	6.82	57	13	700	159	875	199	70	18.5	816
7104	4	100	50	11.4	88	20	1,250	284	1,500	354	30	7.9	625
7106	6	150	120	27.3	230	52	3,000	682	3,750	852	8.7	2.3	435
7108	8	200	220	50.0	400	91	5,400	1226	6,750	1,533	3.7	1.0	333
7110	10	250	400	91.0	700	159	8,200	1862	10,250	2,328	2.5	0.66	340
7112	12	300	550	125.0	970	220	12,000	2725	15,000	3,407	1.6	0.42	320

*Note: Operating continuously in Extended Range will reduce the bearing life by approximately 25%.

72xx Model Selection

7282	1/4	8	0.15	0.034	0.25	0.06	2.5	0.57	3	0.68	41,000	10,831	1,708
7283	3/8	10	0.3	0.068	0.5	0.12	5	1.14	6	1.36	15,500	4,095	1,291
7284	1/2	15	0.55	0.13	0.9	0.23	10	2.27	12	2.73	10,500	2,774	1,750
7285	5/8	18	0.85	0.19	1.4	0.37	16	3.65	20	4.54	6,400	1,691	1,706
7286	3/4	20	1.5	0.34	2.5	0.64	28	6.35	35	7.95	2,700	713	1,260
7201	1	25	2.2	0.50	3.7	0.84	60	13.6	75	17.0	1,100	291	1,110
7246	1-1/2	40	5	1.14	8	1.8	130	29.5	160	36.4	320	84.5	693
7202	2	50	9	2.05	15	3.4	240	54.5	300	68	190	50.2	760
7203	3	80	30	6.82	57	13	700	159	875	199	59	15.6	688
7204	4	100	50	11.4	88	20	1,250	284	1,500	354	25	6.6	520
7206	6	150	120	27.3	230	52	3,000	682	3,750	852	7.2	1.9	360
7208	8	200	220	50.0	400	91	5,400	1226	6,750	1,533	3.1	0.8	279
7210	10	250	400	91.0	700	159	8,200	1862	10,250	2,328	2.1	0.55	287
7212	12	300	550	125.0	970	220	12,000	2725	15,000	3,407	1.3	0.34	260

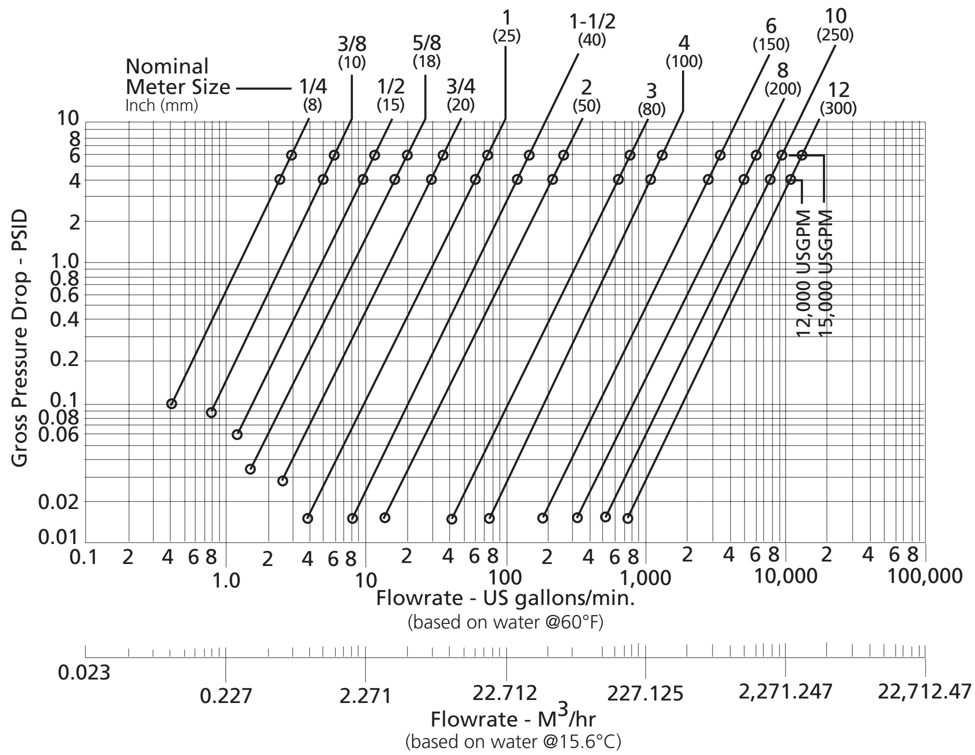
*Note: Operating continuously in Extended Range will reduce the bearing life by approximately 25%.

73xx Model Selection

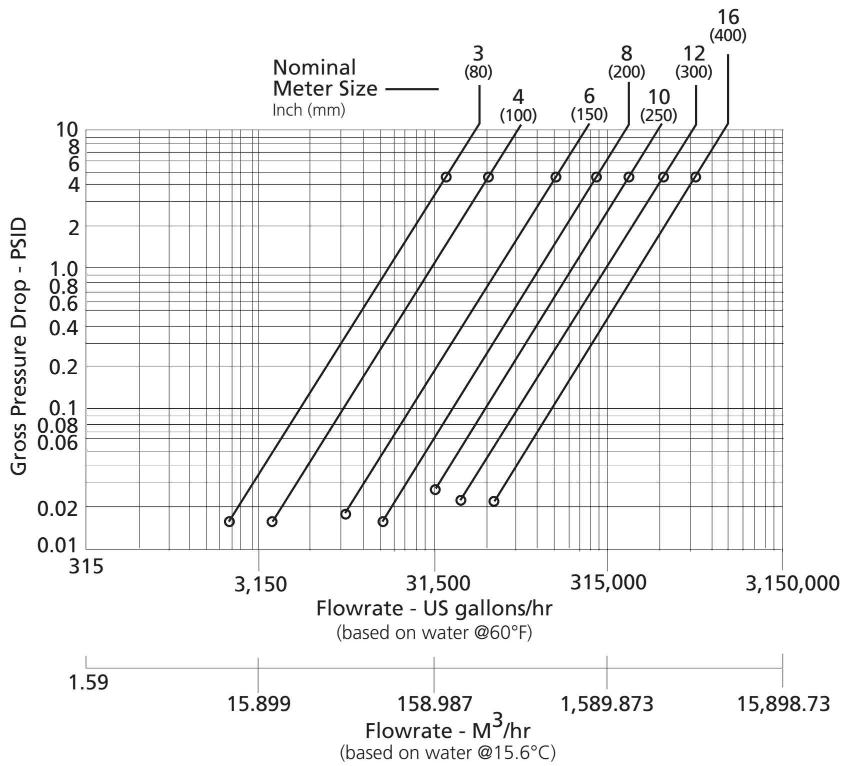
7304	4	100	51	12	85	20	1,250	284	1,557	354	1,000	6,290	495
7306	6	150	1135	31	225	52	3,000	681	3,750	852	1,000	6,290	1,190
7308	8	200	225	51	396	90	5,400	1226	6,750	1,533	500	3,145	1,070
7310	10	250	435	99	725	165	8,200	1862	10,250	2,328	200	1,258	650
7312	12	300	603	137	1005	230	12,000	2725	15,000	3,407	200	1,260	955
7316	16	400	1035	235	1760	400	19,200	4361	24,000	5,451	100	629	760

*Note: Operating continuously in Extended Range will reduce the bearing life by approximately 25%.

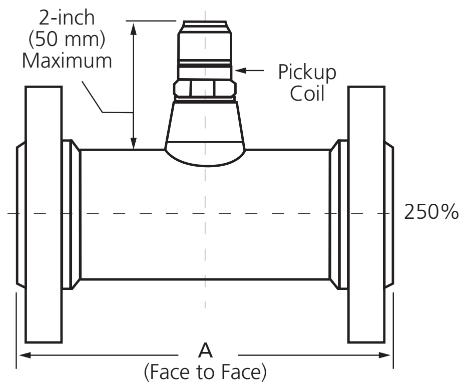
71xx/72xx Pressure Drop



73xx Pressure Drop

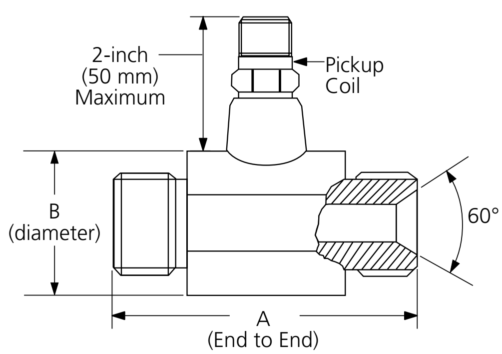


Dimensions

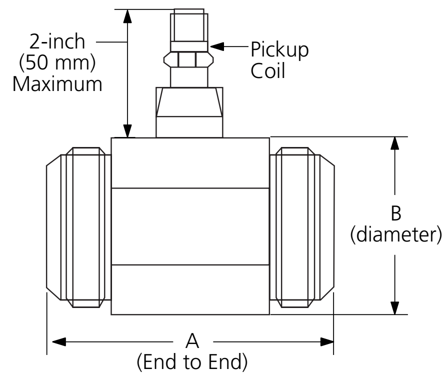


73xx Model (Flanged)	Face to Face Dimension (A)			
	ANSI Rating			
	Up to 600, 900, & 1,500		2,500	
	Inch	mm	Inch	mm
7303	10	254	10	254
7304	12	305	12	305
7306	14	356	14	356
7308	16	406	16	406
7310	20	508	20	508
7312	24	610	24	610
7316	32	813	–	–

71xx/ 72xx Model (Flanged)	Face to Face Dimension (A)					
	ANSI Rating					
	1,500		900 & 1,500		2,500	
	Inch	mm	Inch	mm	Inch	mm
7x82	5	127	7	178	7	178
7x83	5	127	7	178	7	178
7x84	5	127	7	178	7	178
7x85	5.5	140	7	178	7	178
7x86	5.5	140	7	178	7	178
7x01	5.5	140	8	203	8	203
7x46	6	152	9	229	9	229
7x02	6.5	165	9	229	9	229
7x03	10	254	10	254	11	279
7x04	12	305	12	305	12	305
7x06	14	356	14	356	16	406
7x08	16	406	16	406	18	457
7x10	20	508	20	508	22	559
7x12	24	610	24	610	24	610



x Model (Flanged)	Thread (BBSP)	Dim. (A)		Dim. (B)	
		Inch	mm	Inch	mm
7x82	1/2	2.75	70	1.125	28.6
7x83	1/2	2.75	70	1.125	28.6
7x84	1/2	2.75	70	1.125	28.6
7x85	3/4	2.75	70	1.25	32
7x86	3/4	3.25	83	1.25	32
7x01	1	3.5	89	1.5	40
7x46	1-1/2	4.375	111	2.25	57
7x02	2	4.75	121	2.75	70
7x03	3	8	203	5.5	140



x Model (Flanged)	Thread (UNF)	Dim. (A)		Dim. (B)	
		Inch	mm	Inch	mm
7x82	3/4"–16	2.5	64	1.125	28.6
7x83	3/4"–16	2.5	64	1.125	28.6
7x84	3/4"–16	2.5	64	1.125	28.6
7x85	7/8"–14	2.75	70	1.25	32
7x86	1-1/16"–12	3.25	83	1.25	32
7x01	1-5/16"–12	3.5	89	1.5	40
7x46	1-7/8"–12	4.375	111	2.25	57
7x02	2-1/2"–12	4.75	121	2.75	70
7x03	3-1/2"–12	8	203	5.5	140

Specifications

Pressure Rating	The following are standard pressure ratings manufactured to ASME B31.1 and B31.3 and European PED standards. Higher pressure ratings are also available. For flanged meters the pressure rating will be the lower of the flange rating or the meter body.	

Connection Size (Inches)	PSI	Bar
< 1	5000	345
1	4400	303
1 - 1/2	3200	220
2	2650	183
2 - 1/2	2250	156
3	1650	114
4	1350	93

Pressure ratings for 6”, 8”, 10”, 12” meters are specific to the application and are dependent flange connection, process fluid, process conditions, body material and construction detail.

End Connections	Flange	ANSI B16.5 (BS1560); DIN (BS4504); BS10
	Screw (up to 3-inch)	71xx/72xx: BSPP; UNF; NPT (80 mm). Others to special order.
	Bearing Type	71xx/73xx: - Sleeve 72xx: - Ball
Materials	Rotor Blades	71xx/72xx: 430 Stainless Steel 73xx: < 3"-430 SST,shrouded ≥ 3"-316 SST w/Hi-Mu bars
	Bearings	71xx/73xx: Tungsten Carbide 72xx: 440C SST, Self-lubricating
	Body/Flanges	73xx only: Carbon Steel with other materials available
	Internals	316 Stainless Steel. Others to special order.
	All other	316 Stainless Steel. Others to special order.
Temperature Range*	Standard: Optional:	-400°F to +450°F (-268°C to +232°C) (71xx/73xx only) -450° F to +850°F (-268°C to +454°C)
Pressure Drop	4 PSI (0.28 bar) at maximum flowrate. 7100/7200 series are based on water, 7300 series on 0.8 S.G.oil at 1.0 cSt.	
Linearity**	±1.0% for 1/4 and 3/8 inch sizes ±0.5% for 1/2, 5/8, and 3/4 inch sizes ±0.25% for 1-inch and larger sizes	
Repeatability	±0.02 of reading	
Output	Type	Sine wave
	Voltage	Varies with meter size and flowrate – typical values are: 71xx/72xx: 10- - 500 mV RMS on 1/4" (8 mm) and 0.5-5V RMS on 12" (300 mm) 73xx: 50-1000 mV RMS on 3" (80 mm) and 0.2 - 5 V RMS on 24" (600 mm)
	Frequency	Proportional to flow

*Note 1: Electronic equipment mounted directly on meter must be limited to -40°F/°C to +160°F (+71°C) at the equipment.Use remote mount electronics or electronics with termperatue extensions to avoid temperature extremes.

**Note 2: The % of reading values are over the linear flow range of the meter.Improved linearity performance can be achieved to the minimum repeatable rate through electronic linearization.Improved linearity is inherant to the meter over a portion of the upper range as follows (%of maximum capacity):
- 65%to 100%: Multiply error by 1/3

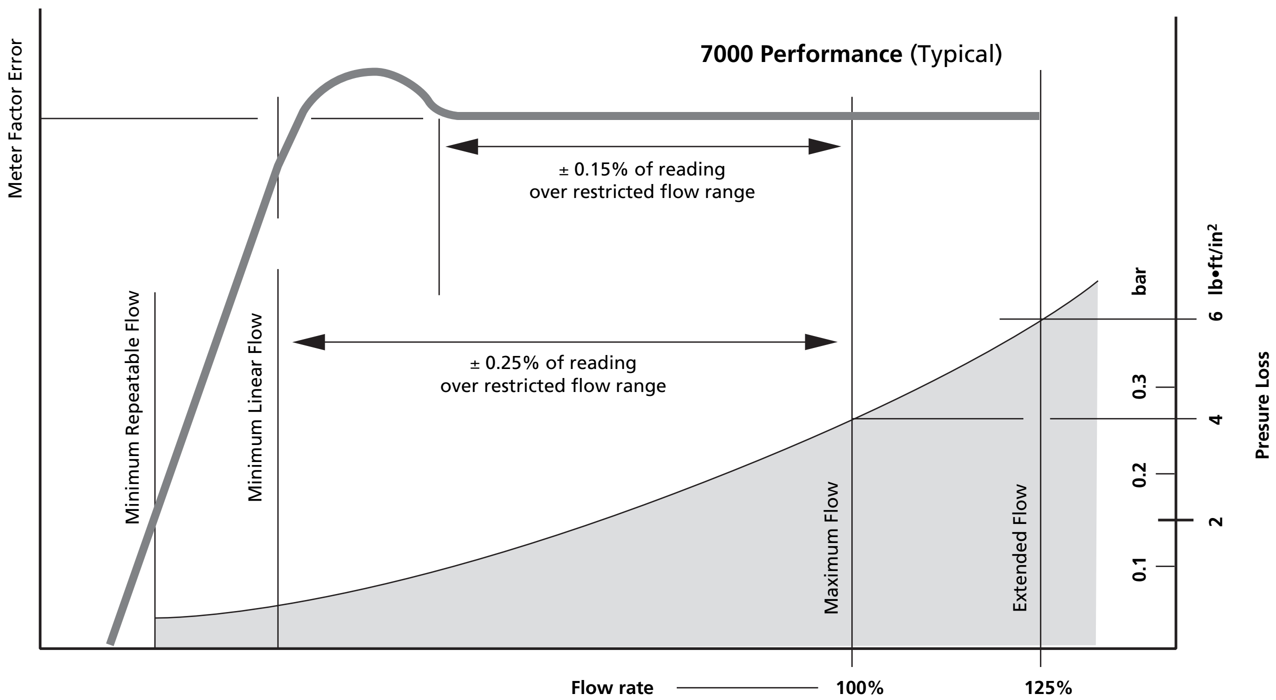
Performance & Calibration

The average K-factor for each turbine is determined by using water as the calibration media. Standard calibrations test six different flow rates in addition to two repeatability points (10 and 20 point calibrations are optionally available). For meters 3-in. or smaller the entire capacity range of each meter is examined. For meters larger than 3-in. only the lower portions of the flow capacities are tested. Although the lower flow capacities are more meaningful and critical to test, optional testing can be ordered to verify performance at higher flows. Value in testing the complete range of a meter and obtaining additional data points is usually only recognized when electronic linearization is being applied to achieve the best possible system accuracy.

Meter linearity indicates that no data point will exceed the average of all the data points within the linear meter capacity as per ISA standard RP31.1.

All meters should be installed with upstream filtration to isolate the meter from damage from foreign objects in the piping system. All meters should be isolated from gas "slugs" which can cause damage by over-speed and water hammer.

The linearity of turbine meters is adversely effected by high fluid viscosities with smaller diameter meters affected more than larger meters. Calibrating on a fluid with the same or similar viscosity and density characteristic will provide data to allow for electronic linearization, which will eliminate the degradation in accuracy.



Installation

To ensure accurate operation, the turbine meter should be installed in a straight length of pipe of the same diameter as turbine meter, at least 10 diameters upstream and 5 diameters downstream.

71xx/73xx Meter Size

71xx/73xx Meter Size (nominal) In.	mm	Mesh Size	Maximum Particle Size (microns)
3/8	9.5	170	88
1/2	12.7	120	120
3/4 to 1	19.1 to 31.8	45	350
1-1/2 or larger	38.1 or larger	18	1000*

* Note: 7100 series turbines in this size range can be used with larger particles provided few particles are in the 1.1 to 3 mm size.

For fluids with suspended particles entrained,filtration should be used. The applicable filter should be selected according to ISA Standard RP31.1 or per table above.

All fluids in use with 7200 series turbines should be free of particles larger than approximately 10 microns.

All transmission cables should be installed in such a manner that they do not run in close proximity to power cables, other signal cables, or where electrical noise may interfere with transmission. Follow common wiring installation practices, use quality cable (twisted pair, shielded with ground wire).

Companion Electronics

The following NuFlo™ electronic instruments are available to complement the 7000 Series Turbine Meter:

- 818A/818EU Preamplifiers
- MC Series Rate Totalizers
- Scanner Family of Flow Computers

MEASUREMENT SYSTEMS
Formerly: NuFlo Measurement Systems • Barton Instrument Systems • Caldon, Inc.

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