

Hoffer Engineering Guide for Liquids



Accurate, Versatile, Economical...

www.hofferflow.com

Principle of Operation:

Hoffer inline turbine flowmeters are velocity measuring devices, which is to say they measure the average velocity of a fluid flowing through the body of the meter. See **Illustration 1** for details on the construction of the Hoffer inline turbine flowmeter. Mounted within the body of a Hoffer liquid turbine flowmeter is a vaned rotor. The rotor is centered on a shaft and allowed to rotate by means of bearings. The shaft is supported in the housing by tube bundles that also provide a measure of flow conditioning for the fluid stream.

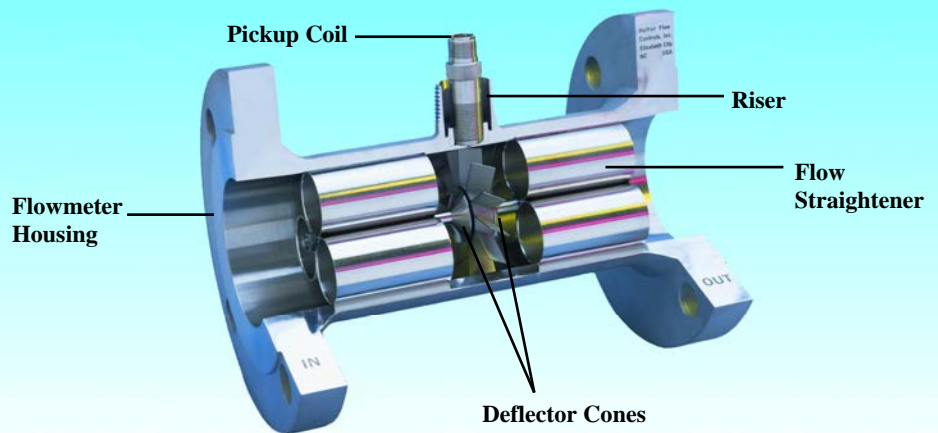
The rotor is made from a ferromagnetic material or contains a magnet within the hub of the rotor. Liquid flowing through the meter body engages the rotor forcing it to rotate. The rotational velocity of the rotor is proportional to the average linear velocity of the liquid flow stream. This rotational velocity is transformed into an electrical frequency signal by means of a non-intrusive sensor or coil threaded partially into the body of the meter aligned with the rotational circumference of the rotor. Being in close proximity to the ferromagnetic or magnetic rotor creates an electromagnetic coupling with the coil. The output frequency of the coil then is directly proportional to the rotational velocity of the rotor. This frequency can then be converted to a flow rate indication or scaled signal by dividing the frequency by the meter's scaling or K-factor (e.g. pulses per gallon or pulses/liter). The K-factor is established by factory calibration of the flowmeter at the time of manufacture.

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Performance Characteristics:

The general performance characteristics of a Hoffer turbine flowmeter are illustrated in **Figure 1**. For liquids with a viscosity in the range of approximately 0.8 to 2 centistokes (cstks.), the turbine meter will produce an output signal that is typically linear to within $\pm 0.5\%$ of reading or better over

Illustration 1 • Turbine Flowmeter Cutaway



a turndown range of 10:1. The meter will produce an output signal that is typically repeatable to within $\pm 0.1\%$ of reading over a turndown range of 20:1 to as wide as 100:1 depending on the coil used and the type bearing used. Accuracy and flow range specifications are given for each size and coil type combination are given in the individual meter series datasheets.

Sizing:

When selecting a specific size Hoffer inline turbine flowmeter, **Table 1** may be used as a general guide for the linear and repeatable (extended) flow ranges for the type coil to be used. These ranges shown are applicable for viscosities of typically 0.8 to 2.0 cstks. Consult the specific meter series product data sheets to confirm applicable flow ranges. For higher viscosities it is generally recommended that only the linear flow ranges of the flowmeters be used in selecting a specific meter size. If using a turbine flowmeter over its repeatable flow range it is necessary to linearize the flow signal over the calibrated repeatable flow range by using a signal transmitter, flow display or flow computer with the ability to perform the linearization.

Installation:

Turbine flowmeters measure the average velocity of the flowing stream and this requires that the velocity profile of the fluid stream be symmetrical across the internal diameter of the flowmeter body when it engages the rotor. In order to assure that the flowing stream's velocity profile is symmetrical, it is necessary to provide straight runs of pipe into and out of the flowmeter. For most applications, a length equal to 10 diameters of the nominal turbine meter inlet size upstream and 5 diameters of the nominal turbine meter inlet size downstream of the meter are adequate to assure this condition. For flowmeters with nominal inlet piping sizes less than 1", 10" of upstream and 5" of downstream straight piping are recommended. For applications requiring the best accuracy, such as custody transfer or legal-

Figure 1 • Turbine Flowmeter Performance Characteristics

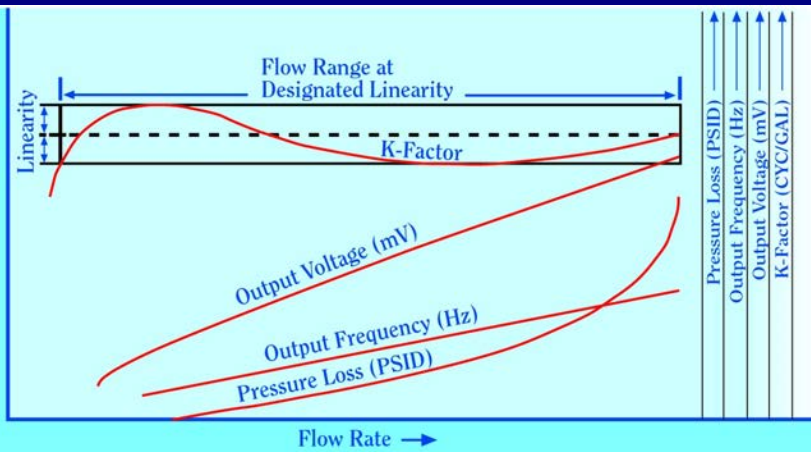


Table 1 •

Liquid Size Selector Chart for Standard HO Series Turbine Flowmeters

Flowmeter Size	MAGNETIC PICKUP COIL				MODULATED PICKUP COIL			
	Diameter (inches)	Linear Range (US GPM)	Linear Range (LPM)	Repeatable Range (US GPM)	Repeatable Range (LPM)	Linear Range (US GPM)	Linear Range (LPM)	Repeatable Range (US GPM)
1/4*	.35-3.5	1.3-13.2	.25-4.5	.95-17	.35-3.5	1.3-13.2	.0625-4.5	.24-17
3/8*	.75-7.5	2.8-28.4	.3-9	1.1-34	.75-7.5	2.8-28.4	.075-9	.28-34
1/2	1.25-9.5	4.7-36	.6-12	2.3-45	1.25-9.5	4.7-36	.12-12	.45-45
5/8	1.75-16	6.6-60.6	.9-20	3.4-75.7	1.75-16	6.6-60.6	.2-20	.75-75.7
3/4	2.5-29	9.5-110	1.5-35	5.7-132.5	2.5-29	9.5-110	.35-35	1.3-132.5
1	4-60	15-227	2-75	7.6-284	4-60	15-227	.75-75	2.8-284
1-1/4	6-93	23-352	3-115	11.4-435	6-93	23-352	1.15-115	4.35-435
1-1/2	8-130	30.3-492	5-175	19-662	8-130	30.3-492	1.75-175	6.6-662
2	15-225	56.8-852	11-275	42-1041	15-225	56.8-852	2.75-275	10.4-1041
2-1/2	25-400	95-1514	15-500	56.8-1893	25-400	95-1514	5-500	19-1893
3	40-650	151-2460	20-800	76-3028	40-650	151-2460	8-800	30.3-3028
4	75-1250	284-4731	50-1500	189-5678	MCP not recommended in 4" and larger sizes			
5	140-2000	530-7570	100-2500	379-9463				
6	200-2900	757-10977	125-3600	473-13626				
8	330-5200	1249-19682	270-6400	1022-24224				
10	650-8000	2460-30280	540-9800	2044-37093				
12	1400-12000	5299-45420	800-15000	3028-56775				
NOTE:	Performance enhancement techniques are routinely applied to produce larger linear and usable flow ranges. Consult with the applications group at Hoffer with your requirements.							

for-trade, a flow straightening tube bundle in the upstream section is normally required to eliminate any rotation of the flow stream about its axis of flow. Hoffer offers a complete line of installation kits and flanged flow straightening sections that provide the required straight runs of piping in and out of the flowmeters as an option and meet API and AGA design criteria for custody transfer applications as well. Consult factory with your specific requirements.

A strainer is generally recommended for installation upstream of the straight run section in order to prevent debris from entering into or damaging the flowmeter. Specific maximum particle sizes and recommended strainer sizes for each size of turbine meter are given in **Table 2**. A typical installation schematic for a uni-directional turbine flowmeter is shown in **Figure 2**. The bypass flow loop shown in Figure 2 is optional but provides a convenient method for removing the meter from the line for servicing without the necessity of shutting down the flow. For liquid service, it is recommended that the turbine meter and straight run sections be installed in a horizontal plane

relative to ground level. They may also be installed in a vertical or slanted line with the flow direction being up through the flow meter. Vertical or slanted downflow installations are not recommended due to the difficulty in maintaining the line full of liquid and the probability of accelerating bearing wear. Turbine flowmeters should always be installed in positive pressure lines and will not perform well under vacuum flow conditions. Adequate back pressure is required downstream of the flowmeter in order to assure that the flowmeter will remain completely full of liquid during measurement operations and to prevent fluid cavitation. Normally a minimum back pressure of 5 to 10 PSIG is sufficient to prevent cavitation. For more volatile, low density liquids such as hydrocarbon based liquids, the minimum required back pressure can be calculated as follows:

$$P(b) = (2 \times \Delta P) + (1.25 \times P(e))$$

Where:

P(b) = minimum required back pressure in PSIG

ΔP = pressure drop through the turbine flow meter at the maximum flow rate for the liquid being measured in PSIG

Figure 2 • Typical Flowmeter Installation

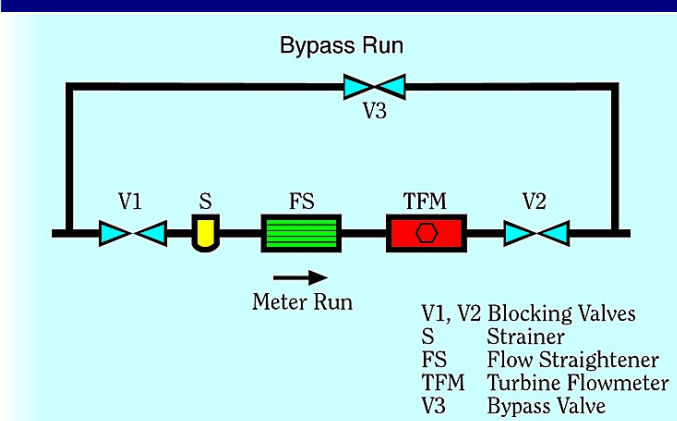
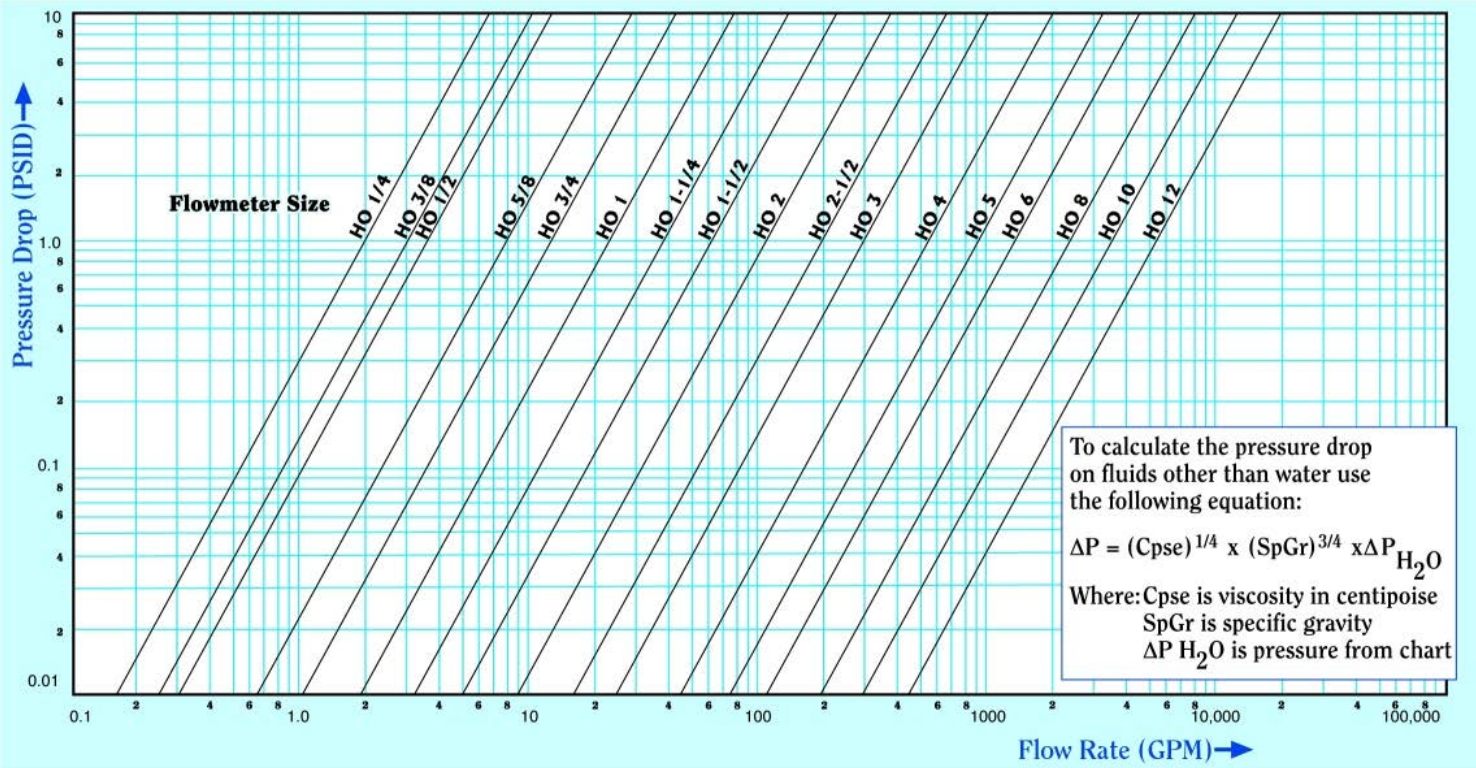


Table 2 • Recommended Strainer Sizes

Meter Size	Mesh Size	Particle Size Maximum (inches)
Mini-Flow Series		.0055
1/4" to 1/2"	100	.0055
5/8" to 1-1/4	80	.007
1-1/2 to 3"	40	.015
4 " to 12"	20	.031

Figure 3 • Pressure Drop Characteristics for HO Series on Liquid Service



P(e) = equilibrium vapor pressure of the liquid at the operating temperature in PSIA

Pressure Drop:

See **Figure 3** for pressure drop across the meters and the side-bar note for calculating pressure drop at viscosities other than 1 cstk.

Materials of Construction:

The materials of construction selection for a turbine meter usually are based upon chemical compatibility between the flowing liquid and wetted components of the meter. In the case of Hoffer turbine flowmeters, the wetted components include the meter body and the internals of the meter (internal flow straighteners, shaft, lock nuts or clips, rotor and bearings). For flanged flow meters, Hoffer employs a special manufacturing technique that prevents the flanges from coming into direct contact with the flowing liquid. Material selection for the flanges is at the discretion of the customer and/or compatibility with any external atmosphere or environmental conditions. The normal materials of construction for the meter bodies, flanges and internals are summarized in **Table 3**. Hoffer also offers custom materials of construction to meet specific requirements. For special material requirements, consult factory.

Table 3 • Materials of Construction for Hoffer Turbine Flowmeters

Component:	All Inline Turbine Meter Series Except Teflon®	Teflon® Series
Body:	316/316L Dual Rated Standard	316/316L Dual Rated, Non-Wetted Shell with PTFE Liner
Flanges:	Carbon Steel , 316/316L Dual Rated	316/316L Dual Rated with PTFE Flange Faces
Internals (Except bearings & Rotors)	316/316L Standard	PTFE. Shaft is a PTFE/PEEK (Poly-Ether-Ether-Ketone) Blend. For liquids not compatible with PEEK, consult factory.
Rotors:	17.4-PH (Standard), Nickel 200, 430 SS	PTFE
Bearings:	Hybrid Ceramic, Self-Lubricated Ball Bearing Type with 440C Races & Shields, Hard Carbon Composite Sleeve & Journal Type or Tungsten Sleeve & Journal Type	PTFE/PEEK (Poly-Ether-Ether-Ketone) Blend. For liquids not compatible with PEEK, consult factory

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Table 4 • Bearing Selection

	Hybrid Ceramic Ball Bearing	Hard Carbon Composite Sleeve	Tungsten Carbide Sleeve
Temperature Range:	-400°F to +300°F (-240°C to +149°C)	-40°F to +450°F (-40°C to +232°C)	-450°F to +850°F (-268°C to +454°C)
Requires Lubricating Liquid?	No	No	Recommended*
Use in Sanitary Series?	No	Yes	Yes
Use in Dirty/Abrasive Service?	No	Moderate	Best
Use in Viscous Service?	Yes	No	Only if Abrasive
General Corrosion Resistance:	Good	Best	Poor
Extended Flow Range Service?	Best	Fair-Lubricity Dependent	Fair-Lubricity Dependent

Note: Temperature range of meter will also be limited by coil temperature range. See Table 8 on page 6.

Bearing Selection:

A specific bearing type is selected first on chemical compatibility with the flowing liquid. Other considerations include lubricity of the liquid, operating temperature of the liquid, presence of any solids in the liquid, whether the meter will be sitting stagnant or drained with a potentially corrosive liquid or atmosphere in the meter, viscosity and desired operating flow range. The Hoffer factory will confirm any bearing selection for a specific application. Refer to **Table 4** as a guideline for bearing options excluding the standard Teflon® bearing used with the Teflon® Series meter.

*Tungsten carbide sleeve bearings are used on non-lubricated applications primarily for oilfield service applications such as sand and cement slurries.

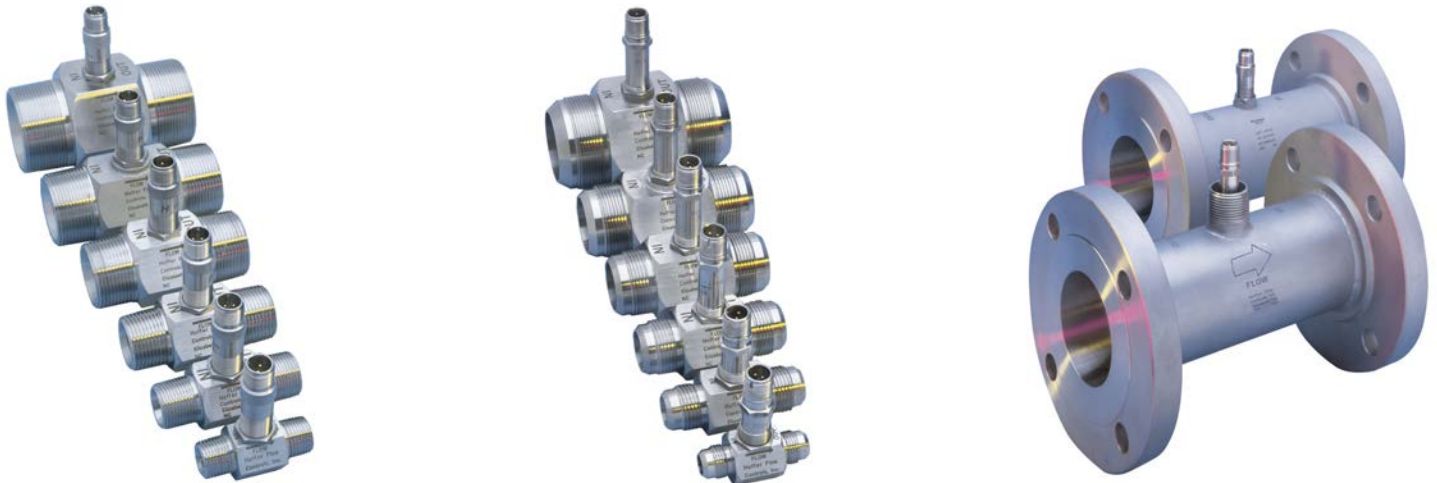


Table 5 • Pressure Rating for the NPT Series

Meter Size	End Fitting Size	Face/Face Length		Working Pressure	
		inches	cm	PSIG	BARG
1/4"	1/2"	2.45	6.22	6000	413.7
3/8"	1/2"	2.45	6.22	6000	413.7
1/2"	1/2"	2.45	6.22	6000	413.7
5/8"	3/4"	2.75	6.99	6000	413.7
3/4"	3/4"	3.25	8.26	4400	303.38
1"	1"	3.50	8.89	3850	265.45
1¼"	1¼"	3.875	9.84	3850	265.45
1½"	1½"	4.375	11.11	3500	241.32
2"	2"	4.75	12.06	3000	206.85
2½"	2½"	6.062	15.40	1100	75.84
3"	3"	7.50	19.05	1500	103.42
4"	4"	10.00	25.4	1500	103.42

Table 6 • Pressure Rating for the MS Flared Series

Meter Size	MS(37°) Flared End Fittings	Face/Face Length		Working Pressure	
		inches	cm	PSIG	BARG
1/4"	MS33656-8	2.45	6.22	5000	344.75
3/8"	MS33656-8	2.45	6.22	5000	344.75
1/2"	MS33656-8	2.45	6.22	5000	344.75
5/8"	MS33656-10	2.75	6.99	5000	344.75
3/4"	MS33656-12	3.25	8.26	4400	303.38
1"	MS33656-16	3.50	8.89	4300	296.48
1¼"	MS33656-20	3.88	9.84	3600	248.22
1½"	MS33656-24	4.38	11.11	3600	248.22
2"	MS33656-32	4.75	12.06	1800	124.11

Corporate History



Hoffer Flow Controls brings over 50+ years of experience designing and manufacturing quality turbine flowmeters and related process measurement and control instrumentation. Our initial experience was in the field of cryogenic flow measurement. Today our reputation in this field is synonymous with quality.

Tens of thousands of Hoffer turbine flowmeters are on the job today throughout the world in applications ranging from oil well fracturing to food processing. Providing turbine flowmeters of varying configurations is our specialty. Our broad line of state-of the art electronics enable Hoffer to handle a variety of flow applications routinely. Totally new designs from Hoffer allow for near custom applications for a wide range of process operations which include indicating, blending, batching and flow control.

Ordering Information

Please supply the following basic information so that Hoffer Flow Controls can evaluate your application and correctly size the appropriate Hoffer turbine flowmeter.

1. Description of fluid or gas to be metered.
2. Operating flow rates.
3. Viscosity (if applicable).
4. Operating temperature range.
5. Operating pressure range.
6. Line Size.
7. End connection preference.
8. Functional Description.

A detailed application form to request a quotation is available on our web site at www.hofferflow.com.

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The specifications contained herein are subject to change without notice and any user of said specifications should verify from the manufacturer that the specifications are currently in effect. Otherwise, the manufacturer assumes no responsibility for the use of specifications which may have been changed and are no longer in effect.



Hoffer Flow Controls Quality Management System



HO-EG-LIQ-101.