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Hoffer Flowmeters
Overview 101 – The Basics

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Presentation Overview

1. Hoffer history & overview of capabilities
2. Benefits of Hoffer turbine flowmeters
3. Comparison to other “turbine flowmeters” and how Hoffer is unique

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Section 1 -

History of turbine flowmeters & overview of capabilities

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Initial development of turbine flowmeters was for fuel measurement on aircraft.

Circa 1980's thru 2015

POTTER AERONAUTICAL

Developed turbine flowmeters in 1940's

Licensed by Potter:

Kent Meter (UK)
(Kent / AMCO)

DANIEL
(Part of Emerson Process Management)

Barton
(Part of Cameron)

Smith Meter
(FMC Smith)

Brooks Instruments
(Owned by American Industrial Partners Capital Fund)

Founded by former Potter employees:

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Flow Technology, Inc.
(Owned by Roper)

Spin Off Companies:

SPONSLER
(Part of Liquid Control Group)

Flow Measurement Systems Inc.
(Out of Business)

Others:

EMCO
(Part of Spirax Sarco)

Invalco
(Part of FMC Technologies)

FISCHER PORTER
(Part of ABB Process Automation Systems)

COX Instruments
(Part of Badger Meter)

Blancett Flow Meters
(Part of Badger Meter)

AW FLOW METERS
(Part of TASI Group)

NuFlo
(Part of Cameron)

Industrial Turbine Flow Meter Companies – Circa 2020

Markets company is active in:

FTI Flow Technology, Inc.	Industrial, Oil & Gas, Automotive, Aerospace, Military and Steel
Blancette & Cox	**Blancett** - Industrial, Oil & Gas, Sanitary (food, beverage, and pharmaceutical). **Cox** - Automotive
Turbines, Inc.	Industrial, Oil & Gas, and Cryogenic
KEM & Litremeter	**KEM** - Oil & Gas, Automotive, Chemical **Litremeter** - Oil & Gas, Automotive, and Mining
Cameron - Nuflow	Industrial, Oil and Gas

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Markets company is active in:

Industrial, Oil & Gas, Automotive, Aerospace, Steel and Sanitary (food, beverage, & pharmaceutical), Power Gen, Military and Cryogenic

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Fast forward 7 decades and turbine flowmeters remain a viable flow solution!

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- Privately-held corporation located in Elizabeth City, NC.
- Noted manufacturer of turbine flowmeters for liquid, gas and cryogenic flow measurement.

CERTIFICATE

TUV Rheinland of North America, Inc.
295 Foster Street, Suite 100, Littleton, MA 01460

TÜVRheinland®
Precisely Right.

Hereby certifies that:

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Hoffer Flow Controls, Inc.

107 Kitty Hawk Lane
Elizabeth City, NC 27909
USA

has established and maintains a quality management system for the

Design, Manufacture, Sales, and Service of Flowmeters and Associated Electronics

An audit was performed and documented in Report No 3185.
Proof has been furnished that the requirements according to

ISO 9001:2015

are fulfilled.
Further clarification regarding the scope of this certificate and the applicability of ISO 9001:2015 requirements may be obtained by contacting TRNA.

Certificate Registration No.

74 300 3185

Certificate Issue Date
December 9, 2021

Certificate Expiration Date
December 8, 2024

Reissue Date: 11/03/2021

Certification of Management Systems

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Quality Systems

- ASME Certified Welders
- Full Material Traceability
- Full Range of QA Service Available
  - Hydrostatic Testing
  - Dye Penetrant Testing
  - X-Rays
  - NACE Compliance
  - Ultrasound

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Regulatory Standards

Our systems meet or exceed the following standards:

- ISO 9001
- PED 97/23/EC
- Hand Book 44 USA
- OIML, R-81-World
- CSA – Canada
- NIST - USA
- PTB – Germany
- CE Standard – Europe
- Dantest - Denmark

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Vertically integrated manufacturing facilities including…

- Machine Shop
- Fabrication Shop
- Hydrostatic & Dye Penetrant Shop
- Electronic Assembly & Test Shops
- Flow Meter Calibration Shop

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Today Hoffer is recognized as the World Leader in

Turbine Meter Technology

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Some of the major markets served….

- Oil & Gas Upstream and Downstream
- Cryogenics
- Pharmaceuticals & Biotech
- Military
- Aerospace
- Automotive Manufacturing & Racing
- Power Production
- Food & Beverage

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Turbine Flow Meters

- Turbine flow meters measure the velocity of the moving fluid.
- They are typically applied in relatively clean, low to mid-viscosity applications.

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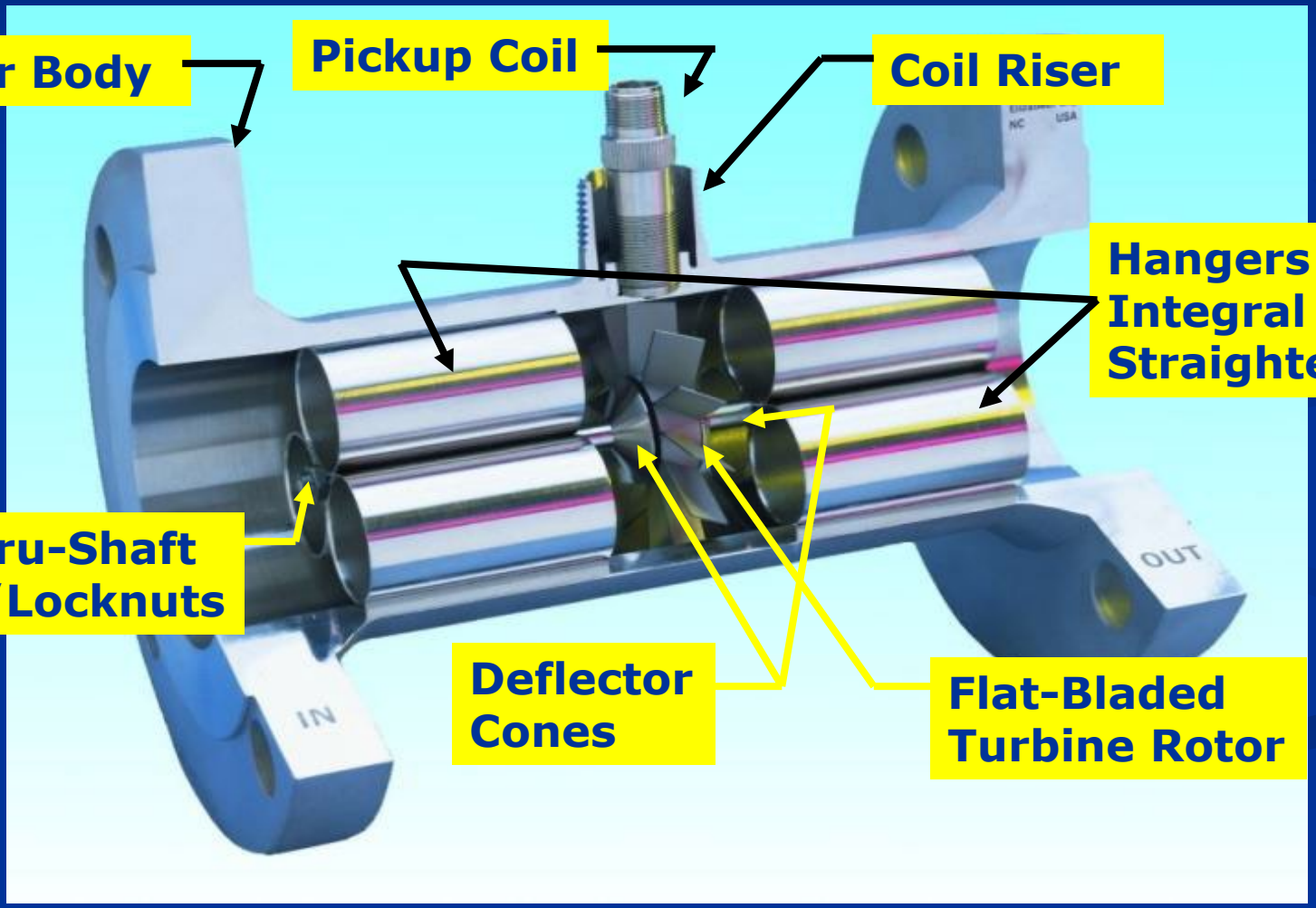
Basic Principle of Operation



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Basic Definitions

LINEARITY: A measure of the accuracy of the device which is the maximum percentage deviation from the average K-Factor.

K-FACTOR: The number of output pulses the flowmeter produces per engineering unit of the volume throughput.

REPEATABILITY: A statement of the ability of a measuring device to display the same value of a measured variable under identical conditions.

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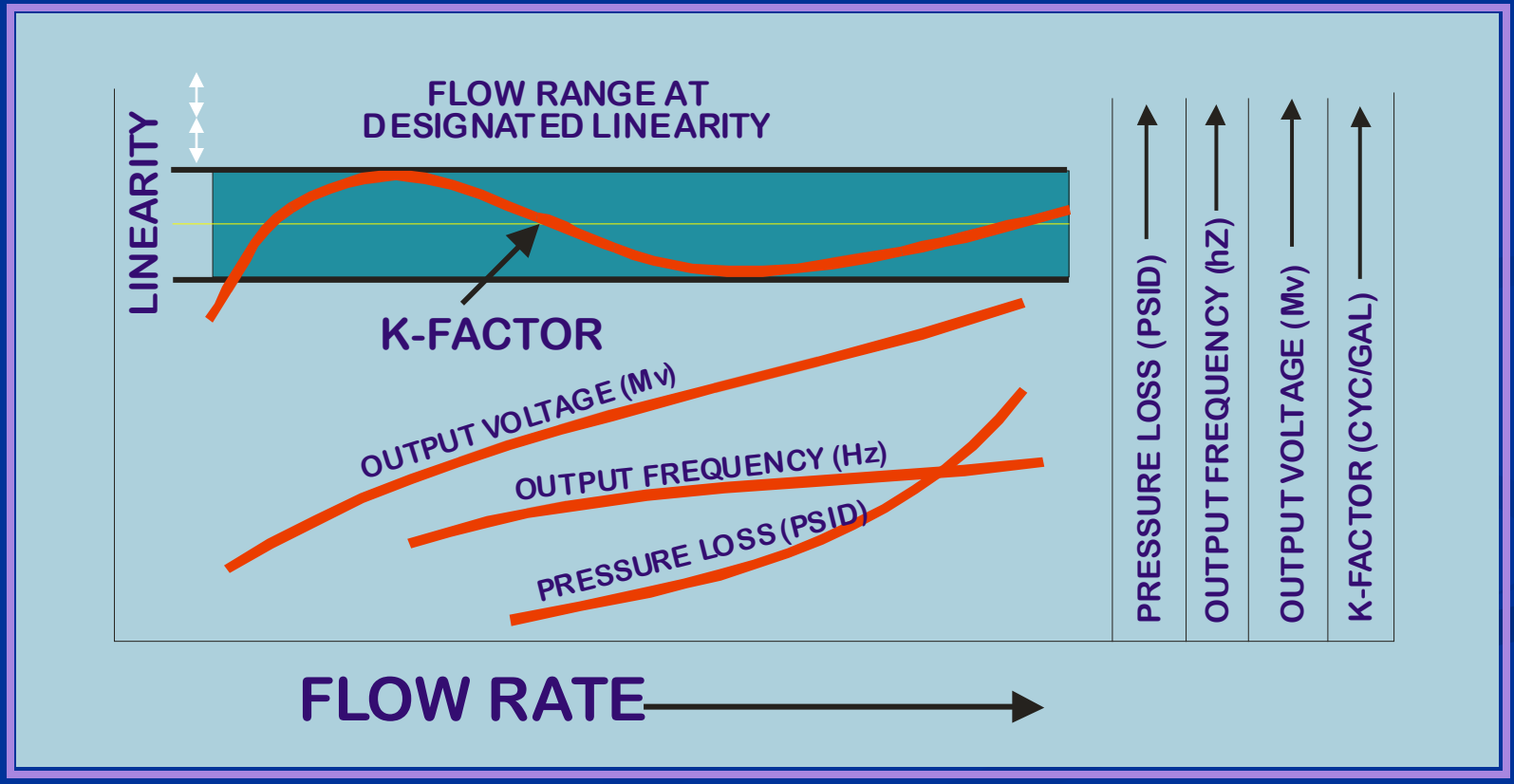
Turbine Flowmeter Performance Characteristics



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Section 2 -

Benefits of
Hoffer turbine flowmeters

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Why use a Hoffer turbine meter?

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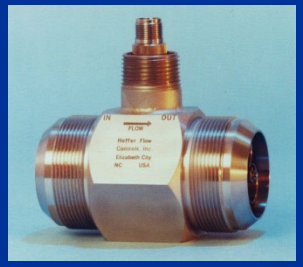
Providing "Application Specific" flow solutions for our customers is the key.

Mini-Flowmeters for low flow liquid and gas applications.

"Premier Natural Gas Series" for custody transfer of natural gas.

HO Series with MS Flared fittings commonly used in industry.



Sanitary Flowmeters for food, beverage, pharmaceutical and bio-tech.

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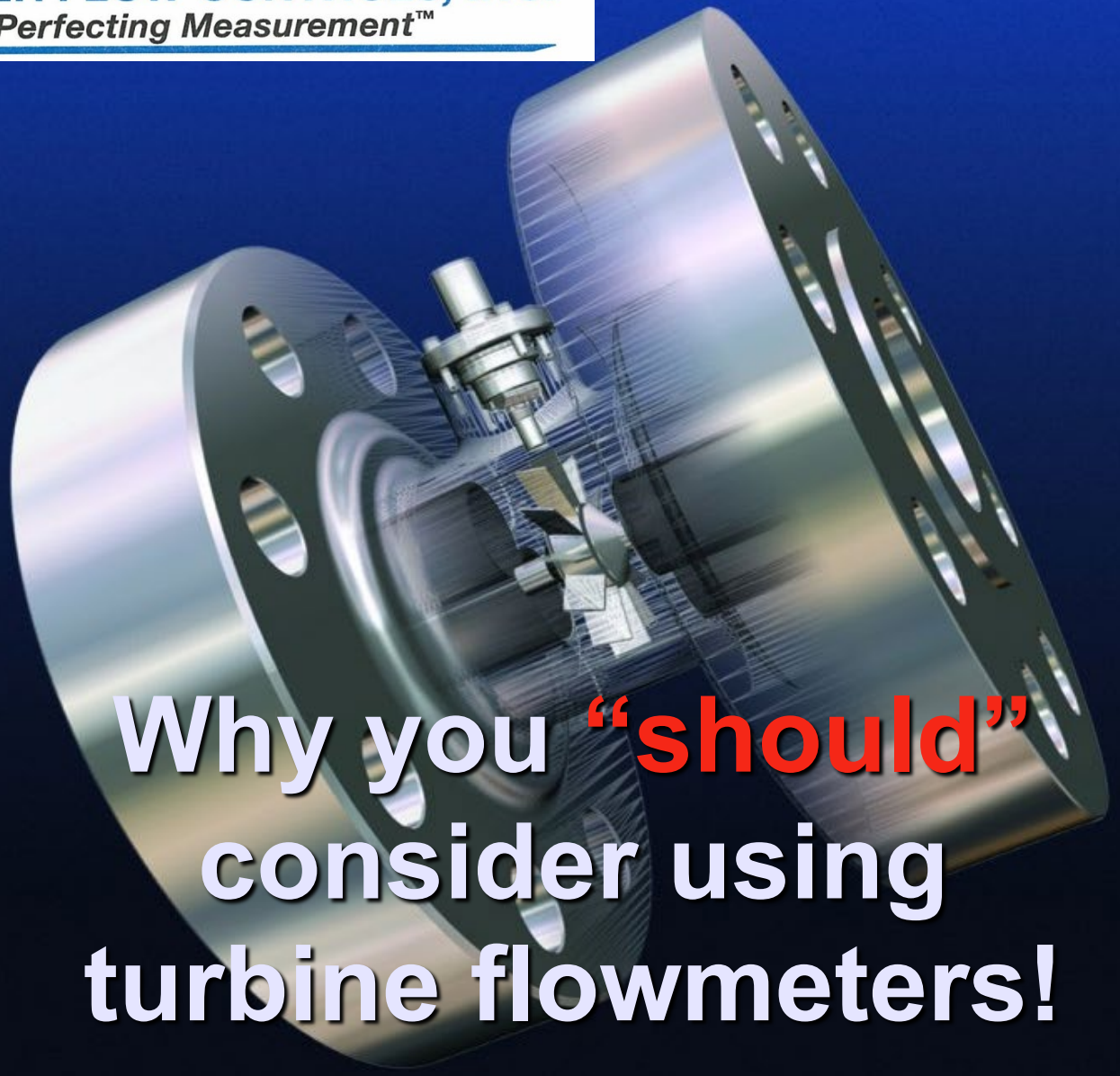

Why you "should" consider using turbine flowmeters!

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Turbine Meter Advantages – *Performance*

- High degree of accuracy (+/-.25% of reading) and great repeatability (+/-.1%)
- Suitable for "custody" transfer

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Turbine Meter Advantages – *Response Time*

- Fast, dynamic response time
- Measured in milliseconds!
- Commonly used for rocket propulsion

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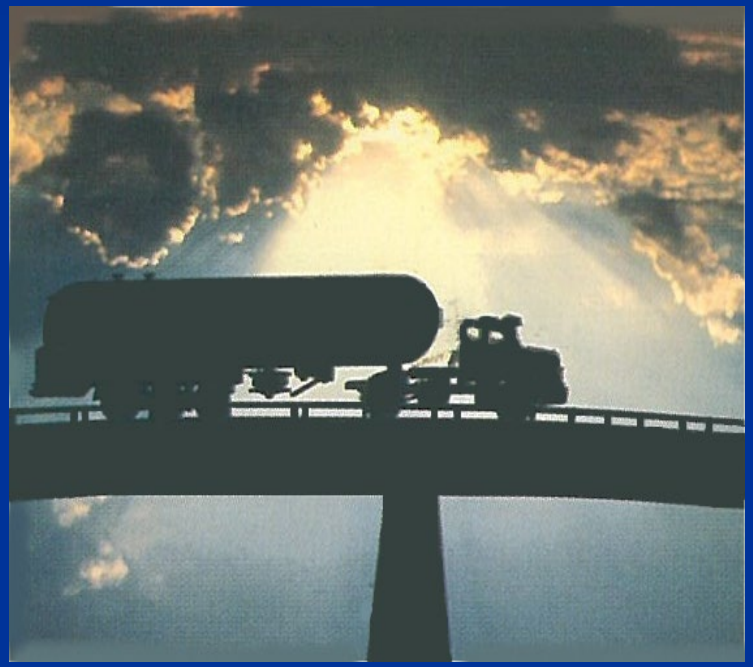
Turbine Meter Advantages – *Shock, vibration & temp extremes*



- We pioneered the use of turbine flowmeters on cryogenic delivery trucks in the 1970's
- Suitable for installation on trucks subject to shock & vibration
- Subject to wide operating temperature extremes
- Our flow system is the "cash register" on many bulk delivery cryogenic trucks domestically and internationally

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Turbine Meter Advantages – *Reliability*

- Metering control fluid on a BOP
- Hoffer replaced "leaking" mag meters
- High "internal" & "external pressures"

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Turbine Meter Advantages – *Robust Design*

- **Flowmeter "internals" redesigned to meet "high shock" and "vibration" MIL standards for US Navy.**

- **Hoffer has supplied multiple size turbine flowmeters built to meet MIL-STD-901D (shock-high impact) and MIL-STD-167-1 (vibration) for the US Navy.**

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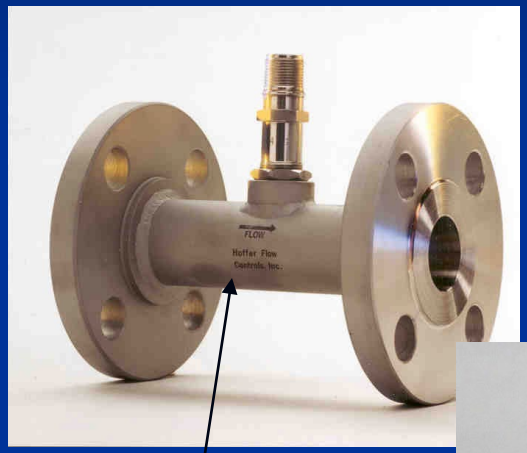
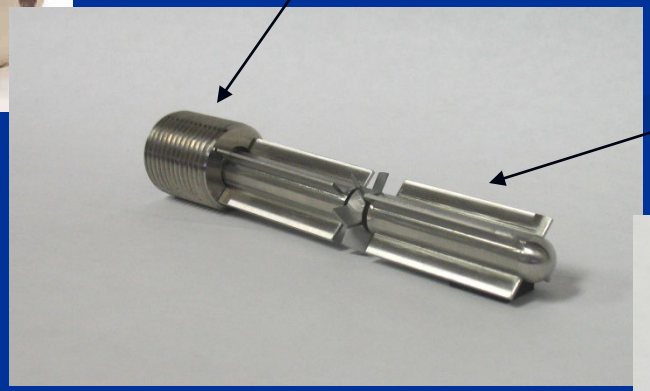
Turbine Meter Advantages

Robust Design

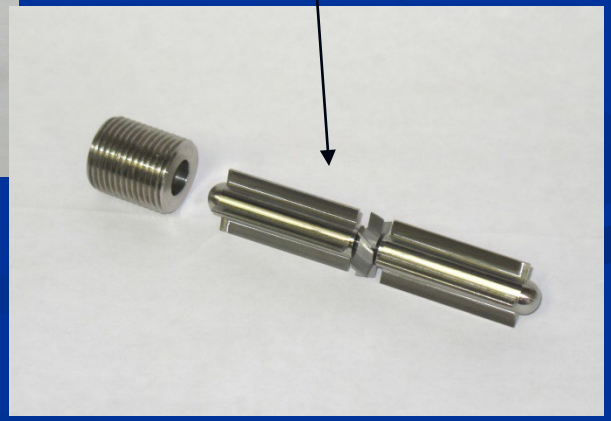


Flowmeter Housing

Threaded insert secures flowmeter internals inside meter housing



Three Piece Construction



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Turbine Meter Advantages – *Wide Rangeability*

- Flowmeters can be configured to provide repeatable flow ranges with up to 100:1 turndown ratios.

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Liquid Size Selector

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)	Repeatable Range (LPM)
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.

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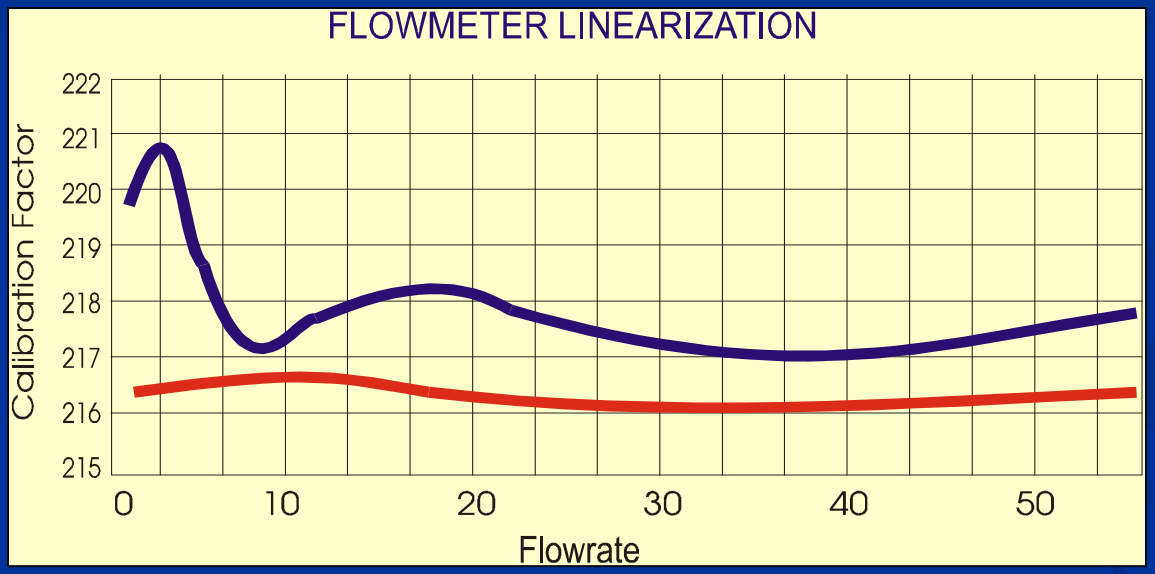
PLOT OF TURBINE FLOWMETER CALIBRATION "K-FACTORS" (pulses/gallon)



Turbine flowmeters are highly "repeatable" (+/-.1%).
"Smart" Electronics can correct for non-linearity of the flowmeter.

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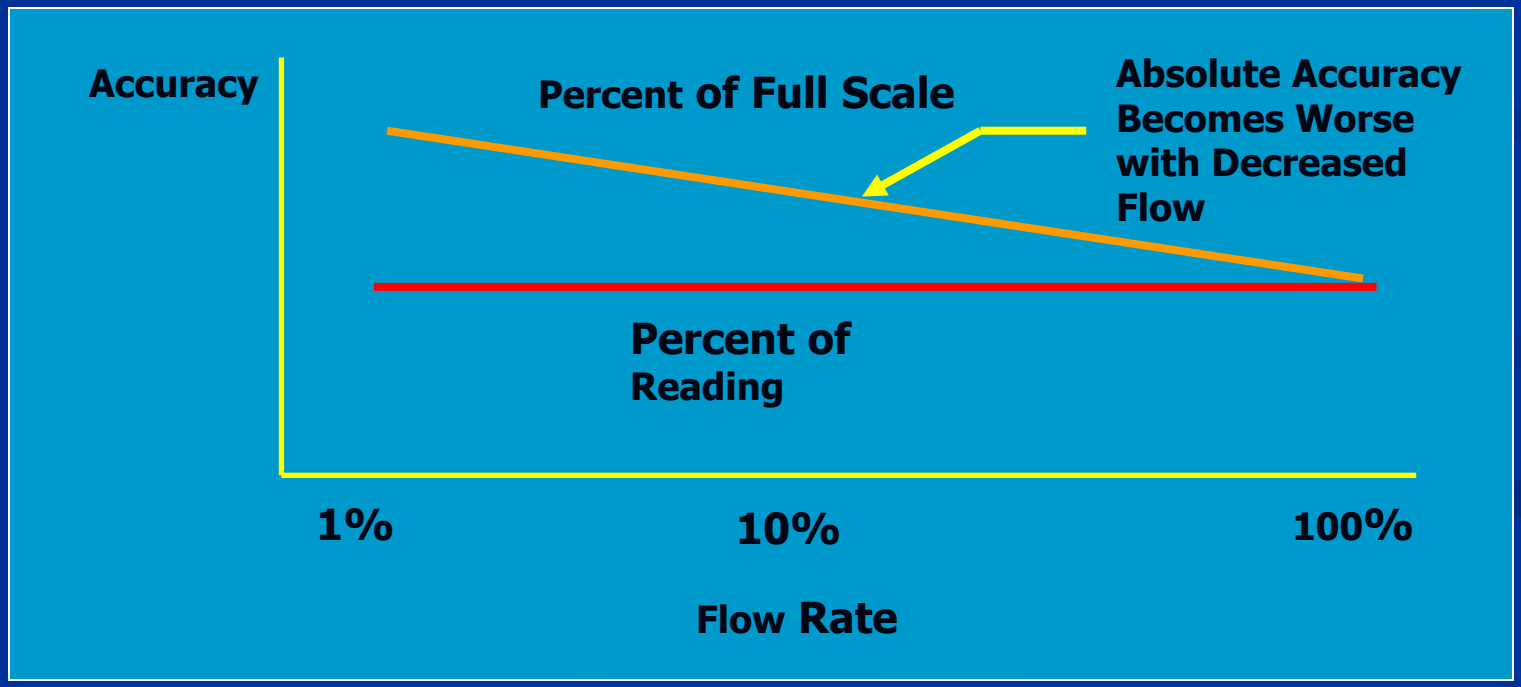
Turbine Meter Advantages –
Of Reading vs. Percent of Full Scale

Linearity and repeatability are expressed in terms of "percent of reading" rather than "percent of full scale" such as a pressure head measurement sensor



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Section 3 -

Comparison of Hoffer turbine flowmeters to "others" and how Hoffer is unique

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All "turbine flowmeters" are not created equal -

Some are plastic

There are many different designs of "Turbine meters"

Some are molded

Some are Aluminum

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Common Design Elements – for a "high performance turbine flowmeter"

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Rotor Construction –
Precision Machined

- All Rotor assemblies are precision machined.
- Hoffer does not use cast rotors.
- Cast rotors are "heavier" than rotors machined from solid bar stock. Heavier rotors means slower dynamic response to changes in flow rates.

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Rotor Construction –
Rotor Design

- Hoffer uses flat rather than curved blades on its rotors

- Curved blades are excellent for extracting the maximum amount of energy from a fluid stream which is why they are used in power and jet engine turbines. As a result, however, they also produce a higher pressure drop.

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Rotor Construction –
Rotor Design

- Flat bladed rotors result in a lower pressure drop
- Machined rotors can be "customized" with thicker blades for use in abrasive services
- The blade "length" may be adjusted to accommodate larger particulate. This approach is commonly utilized in the design of our oil patch flowmeters.

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Optimization of "flow range" -

Supplying various blade angles and rotor designs

- Hoffer provides four different blade angles (15, 20, 25 & 30 degree) for each size meter within our HO Gas product line to optimize the ideal flow range selection.
- The "steeper" the blade angle; the lower the flow rate capability.
- We offer "bladed" and "rim" type rotor assemblies.

  Rim rotors are typically specified for custody transfer applications and produce more "pulses" (better resolution).

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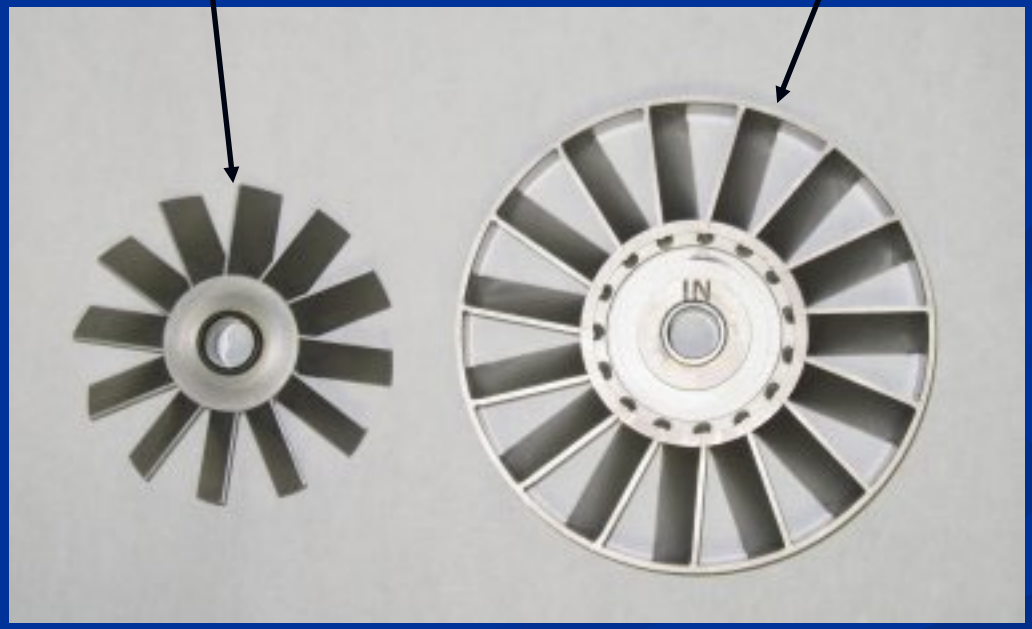
Bladed Rotor Assembly

Rim Rotor Assembly



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In conclusion, you should consider using a Hoffer turbine flowmeters if…

- Accuracy is important
- You need a robust flowmeter
- You require dynamic response to changes in flow conditions
- You require a wide flow range
- You have a specific "footprint" (space) in which the flowmeter must fit
- You want a flowmeter that is light in weight and easy to install

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Thank you for your time.