Flowmetrics, Inc.
"Where Quality is Measurable"

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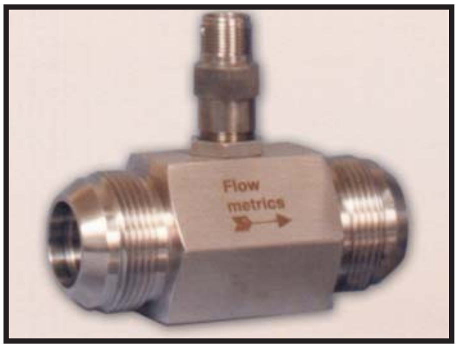
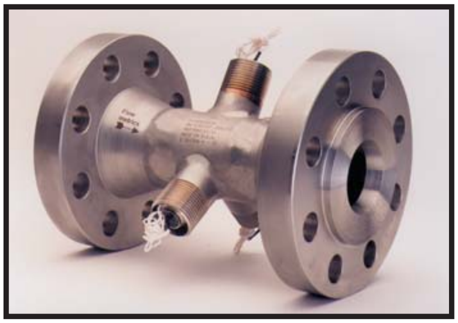
Turbine Flowmeters:
FM Series



AN/MS Flare Connection

NPT Connection



ANSI Flanged Connection

Tri-Clover Connection

Applications:

- **Aerospace and Automobile fuel consumptions**
- **Natural gas in industrial applications**
- **Hydraulics**
- **High temperature, High pressure and High shock**
- **Ultrapure water in pharmaceuticals**
- **Petrochemicals**
- **Batching, Mixing and Hyginic**
  Example: Breweries, Distilleries and Dairies, where the flowmeter is steam cleaned.
- **Custody transfer**
- **Cryogenics**

Features:

FM Series turbine flowmeters provide exceptionally reliable digital outputs. These flowmeters are being used for a wide variety of liquid and gas flow sensing applications.

FM Series range in size from 1/2 inch to 12 inches, offers a high turn-down with minimum uncertainty and very repeatable output.

The turbine flowmeter is ideal, if the liquid to be metered has a viscosity of 500 cst or less for 2 inch and larger flowmeter, and 200 cst for smaller than 2 inch flowmeter.

The turbine flowmeter has a quick response time as the rotor has low inertia and suitable for measuring fluctuating flow. For pulsating flow, digital readout should be used and the counting period should be long, compared with the frequency of the flow pulsations.

If the flow is in the form of one jet, for example while measuring a short single discharge, the pulsing rate of the flowmeter should be high. Bearing wear is usually increased with pulsating flow.

Operation:

Turbine flowmeter is a volume sensing device, which tranduces liquid or gas flow. The design is based on a freely suspended turbine rotor, which is rotated by the flow of liquid or gas through the meter body. An external pick off senses the passing of each rotor blade, generating a frequency output. The frequency is directly proportional to the velocity of the fluid, which in turn is proportional to the flow rate of the fluid.

Either a magnetic or modulated carrier (RF) pickup coupled with pre-amplifier (signal conditioner) can be used to sense the rotational speed of the turbine rotor and provide electrical output that is proportional to the flow rate. The advantage of RF pickup is that it extends the flow range by eliminating drag on the rotor. The RF pickups are mostly used on low flow flowmeters.

Calibration:

NIST traceable calibration are performed on the fluid being used in most cases and on a simulated blend in some cases.

Operating Conditions:

To prevent cavitation occurring at the outlet end of a turbine flowmeter, a minimum operating pressure is required by the flowmeter. This should be ($3\Delta P + 1{\cdot}3\ V_p$) in which ΔP is the pressure loss across the flowmeter and V_p is liquid vapor pressure. The pressure loss in a turbine flowmeter is approximately proportional to the square root of the flowrate and also increase with the viscosity of the fluid. FM Series flowmeters are designed to give a pressure drop of 3 to 10 psid when used with water. For other liquid, the pressure drop across the flowmeter can be estimated by using the following equation:

$$\Delta P = \Delta P_{H_2O} \times \mu^{.25} \times SG^{.75}$$

Where:

μ = Absolute viscosity in centipoise=Kinematic Viscosity (cst) x SG

SG = Specific gravity of the Liquid

ΔP_{H_2O} = Pressure drop for water from chart. See Figure-1

Installation:

Generally, misalignments, upstream and downstream valves, T junctions and multiple bends can introduce a distorted velocity profile, vortices and swirl which have a significant effect on the flowmeter output. If the flowmeter is mounted at an angle, bearing load is changed and accuracy can be affected. The turbine flowmeter is sensitive to velocity profile changes and to swirl.

An optimum installation is where a fully developed profile is attained before entry to the flowmeter. The best flow pattern is obtained by using 10x Diameter upstream and 5x Diameter downstream, as well as a flow straightener.

See Figure-2

The flow through the flowmeter should always be controlled by means of a valve mounted downstream of the flowmeter.

Specifications:

Accuracy	Liquid Service* (Based on water @ ambient conditions)	Gas Service* Based on air @ 14.7 PSIA and 70˚F
Calibration Accuracy of Primary Standard directly traceable to NIST	± .05% of Reading	± .3% of Reading
Repeatability	± .05% of Reading	± .1% of Reading
Linearity over Normal Range—10 : 1 turn-down	± .5% of Reading	± 1% of Full Scale

*** Consult factory for performance on other liquid or gas.**

Material of Construction-(standard):

Supports, Shaft, Cones and Housing — 316SS
Rotor — 17-4PH or 430F
Bearing — 440C SS Ball Bearing
— Tungsten Carbide (sleeve)
— Ceramic (sleeve)

Other materials are available upon special order.

Operating Pressure Range:

5000 psi (standard)
(Defined by size and end connection)

Pressure Drop:

Liquid — Maximum 10 psid in 10:1 flow rate range, based on water at 70˚ F

Gas — Maximum 12 inches of water column in 10:1 flow rate range, based on air at STP

Filtration:

Ball Bearings — 10 to 100 micron (less filtration for 2" and larger size flowmeter)

Sleeve/Journal Bearings — 50 micron

Temperature Limits:

Magnetic or Modulated - Carrier Pickups --------------	- 430˚F to 400˚F (Standard)
--------------	- 430˚F to 800˚F (High Temp)
440C SS Ball Bearing ---------	- 450˚F to 400˚F
Ceramic Journal Bearing -----	- 100˚F to 800˚F
Tungsten Carbide- Journal Bearing ----------------	- 100˚F to 1000˚F

Electrical Output:

Magnetic pickup — 30 mv peak to peak at minimum linear rate

Modulated carrier pickup coupled with pre-amplifier/signal conditioner (.3 mH to 1 mH) } TTL/CMOS, fanout of 5TTL/CMOS loads, open collector, 0-10 VDC pulse Note: Requires 8-30VDC input power

Electrical Connection:

MS Connector — MS-3102A -10SL-4P—2 pin
MS-3102A -10SL-3P—3 pin

Mating Connector is supplied with flowmeter

Explosion Proof—2, 3 or 5 wires pigtails per NEC specification

Table-I

Gas	Chemical Formula	Gas Constant "R"	Density* Lb/ft³	Molecular Weight "M"
Acetylene	C_2H_2	59.35	.06724	26.036
Air		53.34	.07493	28.970
Ammonia	NH_3	90.73	.04399	17.032
Argon	A	38.68	.10320	39.950
Carbon Dioxide	CO_2	35.11	.11380	44.010
Carbon Monoxide	CO	55.17	.07236	28.010
Chlorine	Cl_2	21.791	.18330	70.914
Ethane	C_2H_6	30.068	.07868	51.390
Ethylene	C_2H_4	55.09	.07249	28.052
Helium	He	386.04	.01035	4.003
Hydrogen	H_2	766.53	.00521	2.016
Hydrogen Sulfide	H_2S	45.33	.08811	34.086
Methanol	CH_4O	48.23	.08280	32.042
Methane	CH_4	96.33	.04143	16.043
Methyl Chloride	CH_3Cl	30.61	.13052	50.488
Nitrogen	N_2	55.16	.07236	28.016
Nitric Oxide	NO	51.497	.07755	30.008
Nitrous Oxide	N_2O	35.11	.11379	44.016
Oxygen	O_2	48.29	.08269	32.000
Propane	C_3H_8	35.05	.1139	44.094
Sulfur Dioxide	SO_2	24.12	.16573	64.070

* At Standard conditions of 14.7 PSIA and 70°F

Sizing Gas Flowmeters:

Turbine flowmeters measure the **actual volume** of fluid passing through the meter. Hence, when measuring a gas flow, the rotational speed of the turbine rotor (frequency) is proportional to the actual volumetric flow rate of the gas.

To convert the equivalent standard flow rate (SCFM) to actual flow rate (ACFM) or vice versa, the following sizing procedure is recommended.

A standard cubic foot of gas is the amount contained in a one cubic foot at one atmosphere (14.7 PSIA) and 70˚F

For Perfect Gas:

$$ACFM = SCFM \times \frac{Ps}{Pa} \times \frac{Ta}{Ts} \qquad (A)$$

where:

ACFM = Actual Cubic feet per minute
SCFM = Standard Cubic feet per minute
Ps = Standard pressure=14.7 psia
Pa = Operating pressure=psig + 14.7
Ts = Standard Temperature=70˚F + 460
Ta = Operating Temperature=˚F + 460

For Real Gas:

Real gas deviates from the perfect gas laws, equation (A). Real gases act like perfect gases when temperature and pressure are close to normal atmospheric conditions. When the pressure is increased or the temperature decreased the gas molecules are pushed closer and space occupied by the molecule becomes a larger percentage of the total volume. This results in a change in pressure, temperature, volume relationship and characterized by a compressibility factor "Z". This factor modifies gas laws as follows.

$$ACFM = SCFM \times \frac{Ps}{Pa} \times \frac{Ta}{Ts} \times \frac{Za}{Zs} \qquad (B)$$

where:

Za=Compressibility factor at operating conditions
Zs=Compressibility factor at standard conditions

Density:

$$\rho = \frac{144\ Pa}{RTa} \qquad (C)$$

where:

ρ = Density in Lbm/ft^3

R = Gas Constant (Refer Table-I)

$$= \frac{\text{Universal Gas Constant}}{\text{Molecular Weight}} = \frac{1545.32}{M}$$

Mass Flow:

$$M = \rho Q \qquad (D)$$

where:

M=Mass flow rate in Lbm/min
Q=Volumetric flow rate in ft^3/min=ACFM

Flow Velocity:

$$Q = \overline{V}A \qquad (E)$$

where:

$\overline{V}$ = Average flow velocity in ft/min
A = Cross sectional area of the pipe in ft^2

Note: If using flow units other that ft^3/min or lbm/min, use appropriate conversion formulae.

Sample Sizing Problem #1

With constant operating pressure and temperature:

Size Flowmetrics flowmeter model for 160 to 1500 SCFM of oxygen at 145 psig and 100˚ F.

Step 1. Determine maximum flow rate using equation (A)

Pa = 145 + 14.7 = 159.7 psia

Ta = 100 + 460 = 560˚R

$$ACFM = 1500 \times \frac{14.7}{159.7} \times \frac{560}{530}$$

$$= 145.89$$

Step 2. Determine minimum flow rate using equation (A)

$$ACFM = 160 \times \frac{14.7}{159.7} \times \frac{560}{530}$$

$$= 15.56$$

Using Table-I select model FM-24 with flow range 15—150 ACFM

Sample Sizing Problem #2

With varying operating pressure and temperature:

Size Flowmetrics flowmeter model for 1.25 to 2.50 Lb/min of air with pressure range of 40 to 130 psig and temperature range of 60˚F to 78˚F

Step 1. Determine maximum and minimum density using equation (C)

$$\rho = \frac{144Pa}{RTa}$$

where:
R = 53.34 (From Table-I)
Pa =130 + 14.7 = 144.7 psia (max)
Pa = 40 + 14.7 = 54.7 psia (min)
Ta = 78 + 460 = 538˚R (max)
Ta = 60 + 460 = 520˚R (min)

$$\rho(max) = \frac{144 \times 144.7}{53.34 \times 520} = .751 \text{ Lb/ft}^3$$

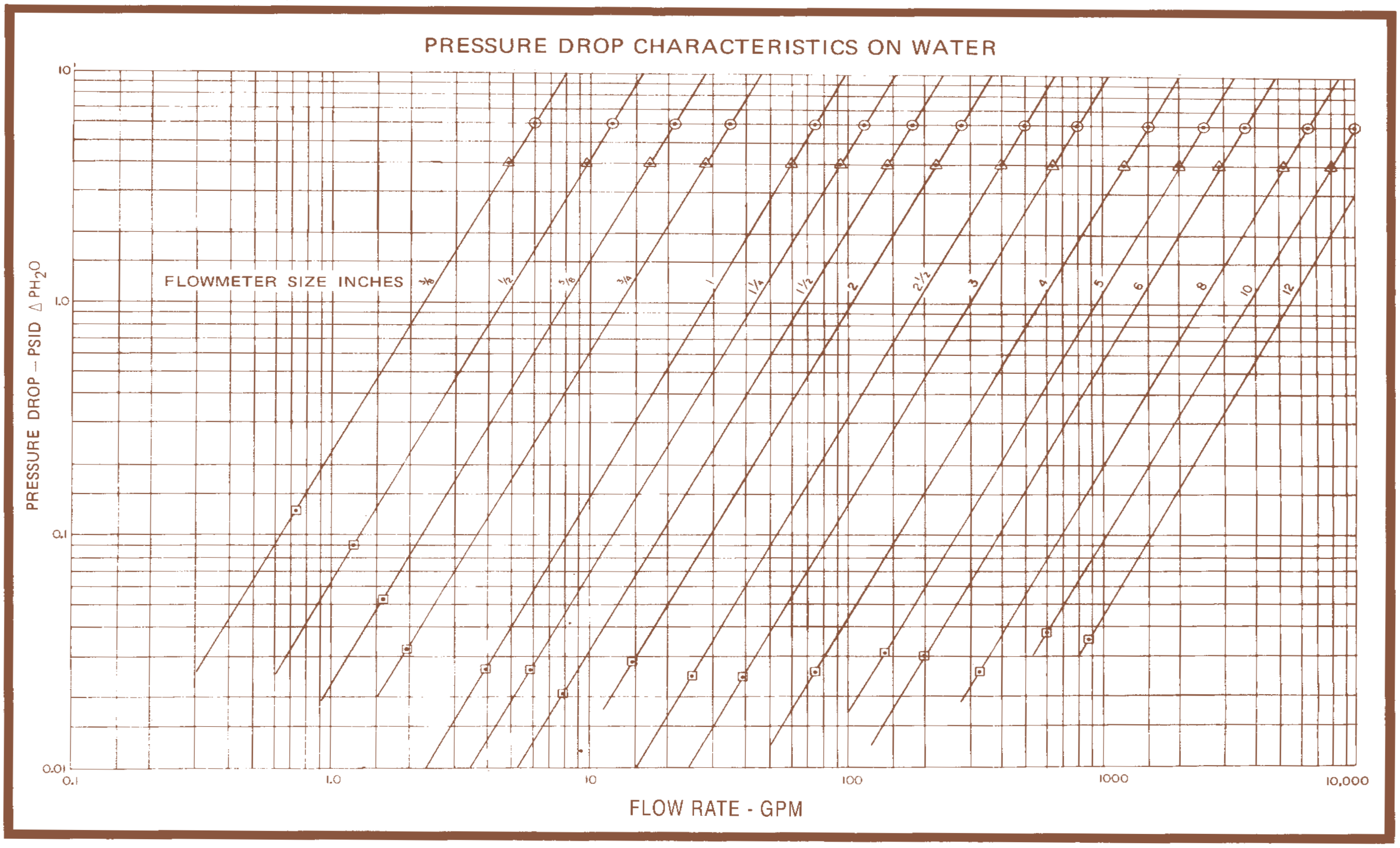
$$\rho(min) = \frac{144 \times 54.7}{53.34 \times 538} = .275 \text{ Lb/ft}^3$$

Step 2. Determine maximum and minimum volumetric flow rate using equation (D)

$$ACFM\ (MAX) = \frac{2.50 \text{ Lb/min}}{.275 \text{ Lb/ft}^3} = 9.09 \text{ ft}^3\text{/min}$$

$$ACFM\ (MIN) = \frac{1.25 \text{ Lb/min}}{.751 \text{ Lb/ft}^3} = 1.66 \text{ ft}^3\text{/min}$$

Using Table-I select model FM-8 with flow range 1—10 ACFM



⊙ = EXTENDED MAX. FLOW
△ = NOMINAL RATED FLOW
⊡ = MIN. LINEAR FLOW

Figure-1

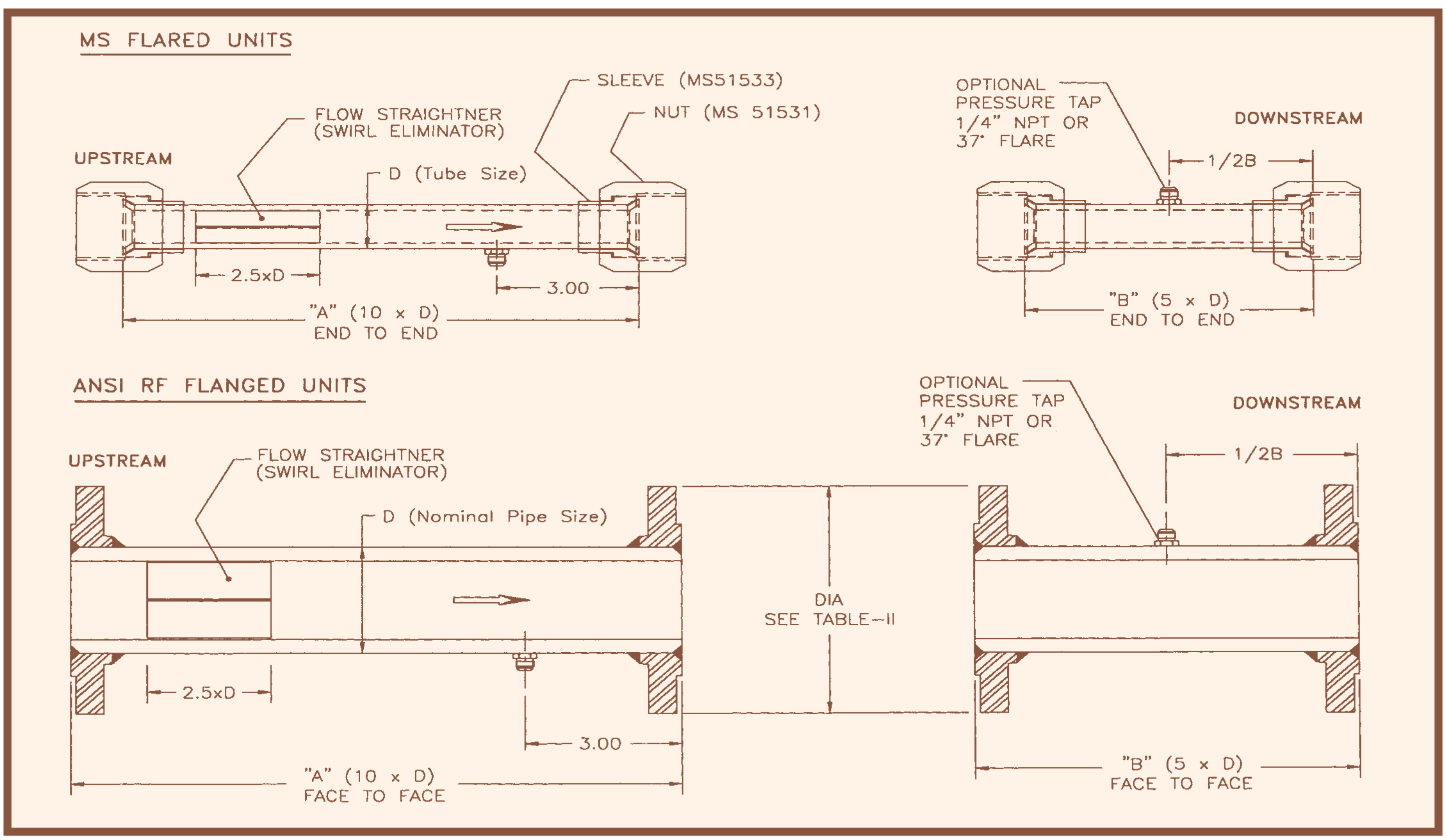


Figure-2

Model Number for Flow Straightners:

MS Flared Units:			For MS Flared or ANSI Flanged	
Tube Size	Upstream	Downstream	A	B
1/2”	FMMS-8U	FMMS-8D	5.00	2.50
5/8”	FMMS-10U	FMMS-10D	6.25	3.12
3/4”	FMMS-12U	FMMS-12D	7.50	3.75
1”	FMMS-16U	FMMS-16D	10.00	5.00
1 1/4”	FMMS-20U	FMMS-20D	12.50	6.25
1 1/2”	FMMS-24U	FMMS 24D	15.00	7.50
2”	FMMS-32U	FMMS-32D	20.00	10.00

ANSI Flanged Units:

Nominal Size	UPSTREAM				DOWNSTREAM			
	150#	300#	600#	900#	150#	300#	600#	900#
1/2”	FMF1-8U	FMF2-8U	FMF3-8U	FMF4-8U	FMF1-8D	FMF2-8D	FMF3-8D	FMF4-8D
3/4”	FMF1-12U	FMF2-12U	FMF3-12U	FMF4-12U	FMF1-12D	FMF2-12D	FMF3-12D	FMF4-12D
1”	FMF1-16U	FMF2-16U	FMF3-16U	FMF4-16U	FMF1-16D	FMF2-16D	FMF3-16D	FMF4-16D
1 1/4”	FMF1-20U	FMF2-20U	FMF3-20U	FMF4-20U	FMF1-20D	FMF2-20D	FMF3-20D	FMF4-20D
1 1/2”	FMF1-24U	FMF2-24U	FMF3-24U	FMF4-24U	FMF1-24D	FMF2-24D	FMF3-24D	FMF4-24D
2”	FMF1-32U	FMF2-32U	FMF3-32U	FMF4-32U	FMF1-32D	FMF2-32D	FMF3-32D	FMF4-32D
2 1/2”	FMF1-40U	FMF2-40U	FMF3-40U	FMF4-40U	FMF1-40D	FMF2-40D	FMF3-40D	FMF4-40D
3”	FMF1-48U	FMF2-48U	FMF3-48U	FMF4-48U	FMF1-48D	FMF2-48D	FMF3-48D	FMF4-48D
4”	FMF1-64U	FMF2-64U	FMF3-64U	FMF4-64U	FMF1-64D	FMF2-64D	FMF3-64D	FMF4-64D

Table II Flowrange

Liquid Service ①

Model Prefix	Nominal Size Inches	Normal Flow Range GPM	Extended Flow Range ② with Ball Bearing GPM	Extended Flow Range ② with Journal Bearing GPM	Approx. Max. Frequency (Hz) Over Normal Range	Approx. K-Factor Pulse/Gallon
FM-4-8	1/2	.25 - 2.50	.03 - 3	.12 - 3	2000	48000
FM-6-8		.50 - 5.00	.05 - 5	.15 - 5		25000
FM-8-8		.75 - 7.50	.08 - 8	.20 - 8		16000
FM-8		1.00 - 10.00	.10 - 10	.25 - 10		12000
FM-10③	5/8, 3/4	1.25 - 12.50	.15 - 15	.3 - 15		9600
FM-12	3/4	2 - 20	.25 - 25	.5 - 25		6000
FM-16	1	5 - 50	.60 - 60	1.00 - 60		2400
FM-20	1 1/4	9 - 90	1.00 - 100	1.50 - 100	1800	1200
FM-24	1 1/2	15 - 150	1.60 - 160	2.00 - 160	1500	600
FM-32	2	20 - 250	2.50 - 250	2.50 - 250	1300	300
FM-40	2 1/2	40 - 450	4.50 - 500	4.50 - 500	1200	160
FM-48	3	40 - 650	7.50 - 750	7.50 - 750	800	75
FM-64	4	80 - 1250	15 - 1500	15 - 1500	600	30
FM-96	6	250 - 3000	50 - 3500	50 - 3500	400	8
FM-128	8	500 - 5500	60 - 6000	60 - 6000	275	3
FM-160	10	800 - 8500	100 - 10000	100 - 10000	225	2.5
FM-192	12	1000 - 12000	150 - 15000	150 - 15000	200	1

Gas Service ④

		Actual Cubic Feet Per Minute (ACFM)				Pulse / Ft.^{3}
FM-4-8	1/2	.25 - 2.50	.2 - 3	N/A	**2000**	48000
FM-6-8		.50 - 5.00	.25 - 5			24000
FM-8-8		.75 - 7.50	.40 - 8			16000
FM-8		1.00 - 10.00	.50 - 10			12000
FM-10③	5/8,3/4	1.25 - 12.50	.60 - 15			9600
FM-12	3/4	2 - 20	1.00 - 25			6000
FM-16	1	5 - 50	1.50 - 60			2400
FM-20	1 1/4	9 - 90	2 - 100		1800	1200
FM-24	1 1/2	15 - 150	3 - 160		1500	600
FM-32	2	20 - 250	5 - 250		1300	300
FM-40	2 1/2	30 - 450	10 - 500		1200	160
FM-48	3	40 - 650	15 - 750		800	75
FM-64	4	80 - 1250	20 - 1500		600	30
FM-96	6	250 - 3000	70 - 3500		400	8
FM-128	8	500 - 5500	120 - 6000		275	3
FM-160	10	800 - 8500	200 - 10000		225	2.5
FM-192	12	1000 - 12000	300 - 15000		200	1

① Data is based on measurement taken with water at 70˚ F
② Requires pre-amplifier / signal conditioner
③ AN = 5/8, NPT = 3/4
④ Data is based on measurement taken with air at 70˚ F and 14.7 psia

Model Numbering System:

FM-8	M	T1	A	LD	-1	B	1	P	XXXX

FM-8 – Model Prefix
See Table-II
For Flow Range

M – Process Connections:
M=AN or Male MS 37˚ Flare
(1/2” to 2” nominal size)
N=Male NPT
(1/2” to 6” nominal size)
SA=Tri-Clover (1/2” to 2”)
HB=Hose Barb (1/2” to 2”)
GR=Grayloc®
RE=Reflange®
F1=150 # ANSI RF Flange
F2=300 # ANSI RF Flange
F3=600 # ANSI RF Flange
F4=900 # ANSI RF Flange
F5=1500 # ANSI RF Flange
F6=2500 # ANSI RF Flange
P1=DIN Flange PN16
P2=DIN Flange PN40
P3=DIN Flange PN100
P4=DIN Flange PN160
P5=DIN Flange PN250
P6=DIN Flange PN400
C61=SAE Code 61
C62=SAE Code 62

T1 – Calibration:
T1=10 points, Normal 10:1 range
T2=20 points, Normal 10:1 range
T3=10 points, extended range
T4=20 points, extended range
T5=Universal Viscosity Curve
T6=Reynolds no. Cal.
Specify min/max temp. & pressure

A –
A=Air
G=Gas
W=Water
S=Solvent
B=Oil blend*
*Viscosity must be provided with oil blend calibration

LD – Pick-ups:
LD=Magnetic
LDI=Intrinsically Safe-Magnetic
LDH=High Temp.-Magnetic
RF=Modulated Carrier
RFI=Intrinsically Safe-RF
RFH=High Temperature-RF
DM=Digi-Pulse-Magnetic
DR=Digi-Pulse-RF
DMI=Intrinsically Safe-DM
DRI=Intrinsicalls Safe-DR
RFT=RF pickup with built-in RTD
LDT=Mag. Pickup with built-in RTD

-1 – Pick-up Electrical Connection:
-1=MS3106A-10SL-4P, 2 pin
-X=2 wire pigtails, explosion proof
-2=MS3106A-10SL-3P, 3 pin ⎤ For Digi-Pulse
-Y=3 wire pigtails, explosion proof ⎦
-Z=5 wire pigtails, explosion proof ⎤ For RFT & LDT Pickup
-4=MS3116F-8-43, 4 pin ⎦

B –
B=3/4” Mounting Boss
C=1” Mounting Boss

1 – Bearings:
1=440C SS Ball Bearing
2=Tungsten Carbide journal
3=440C SS Ball Bearing with self lubricating retainers
4=Ceramic journal
5=Special

P –
P=Pressure port per MS 33656-4
Q=Pressure port 1/4” NPTF
Otherwise leave blank

XXXX – Special Construction
Designated by factory

Table III - Dimensions:

Model Prefix	Nominal Pipe Size	A	B Hex or OD	150 # C	150 # D	300 # C	300 # D	600 # C	600 # D	900 # C	900 # D	1500 # C	1500 # D	2500 # C	2500 # D
FM-4-8 to FM-8	1/2”	2.45	1.000	5.00	3.50	5.00	3.75	5.00	3.75	5.50	4.75	CONSULT FACTORY			
FM-10	3/4”	2.72	1.375	5.50	3.88	5.50	4.63	5.50	4.63	5.50	5.13				
FM-12	3/4”	3.25	1.375	5.50	3.88	5.50	4.63	5.50	4.63	7.00	5.13				
FM-16	1”	3.56	1.625	5.50	4.25	5.50	4.88	5.50	4.88	8.00	5.88				
FM-20	1 1/4”	4.06	1.875	6.00	4.63	6.00	5.25	6.00	5.25	8.00	6.25				
FM-24	1 1/2”	4.59	2.125	6.00	5.00	6.00	6.13	6.00	6.13	9.00	7.00				
FM-32	2”	6.06	2.750	6.50	6.00	6.50	6.50	6.50	6.50	9.00	8.50				
FM-40	2 1/2”	7.00	2.875	7.00	7.00	7.00	7.50	7.00	7.50	10.00	9.63				
FM-48	3”	10	3.500	10.00	7.50	10.00	8.25	10.00	8.25	10.00	9.50				
FM-64	4”	12	4.500	12.00	9.00	12.00	10.00	12.00	10.75	12.00	11.50				
FM-96	6”	14	6.625	14.00	11.00	14.00	12.50	14.00	14.00	14.00	15.00				
FM-128	8”			16.00	13.50	16.00	15.00	16.00	16.50	16.00	18.50				
FM-160	10”	N/A		20.00	16.00	20.00	17.50	20.00	20.00	20.00	21.50				
FM-192	12”			24.00	19.00	24.00	20.50	24.00	22.00	24.00	24.00				

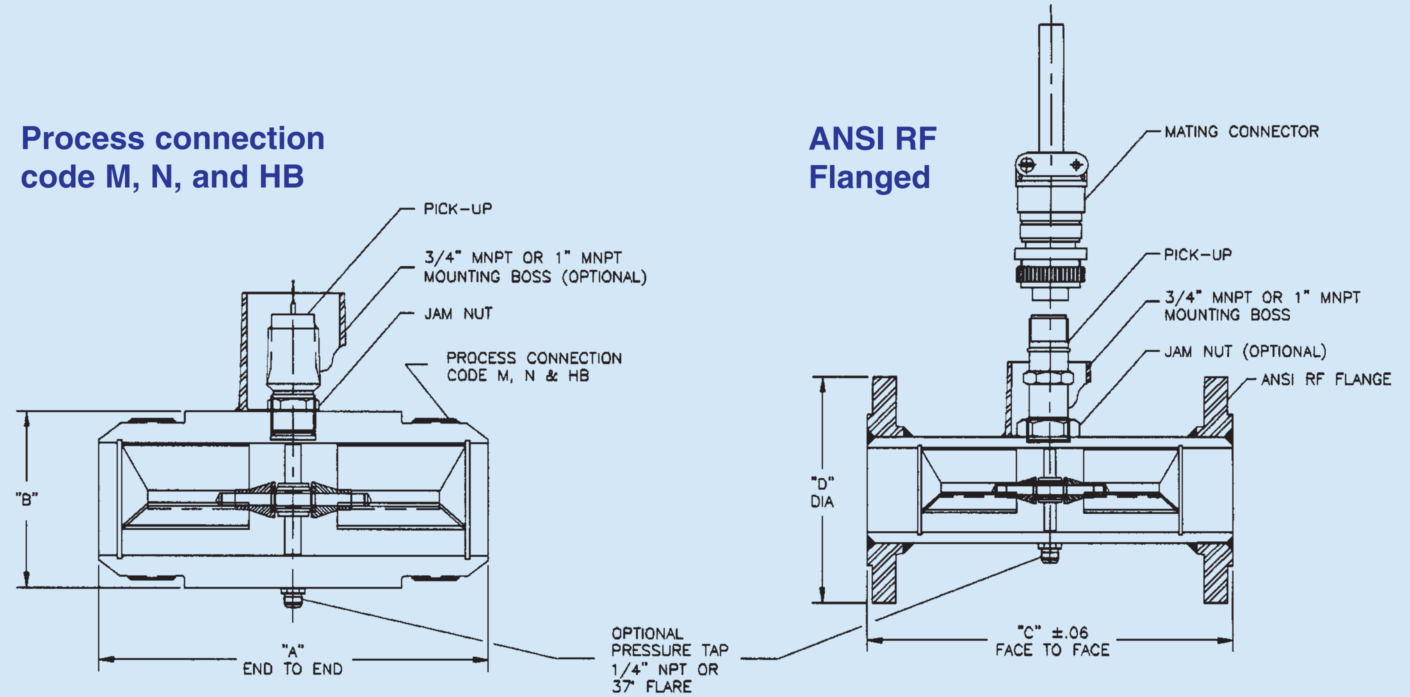
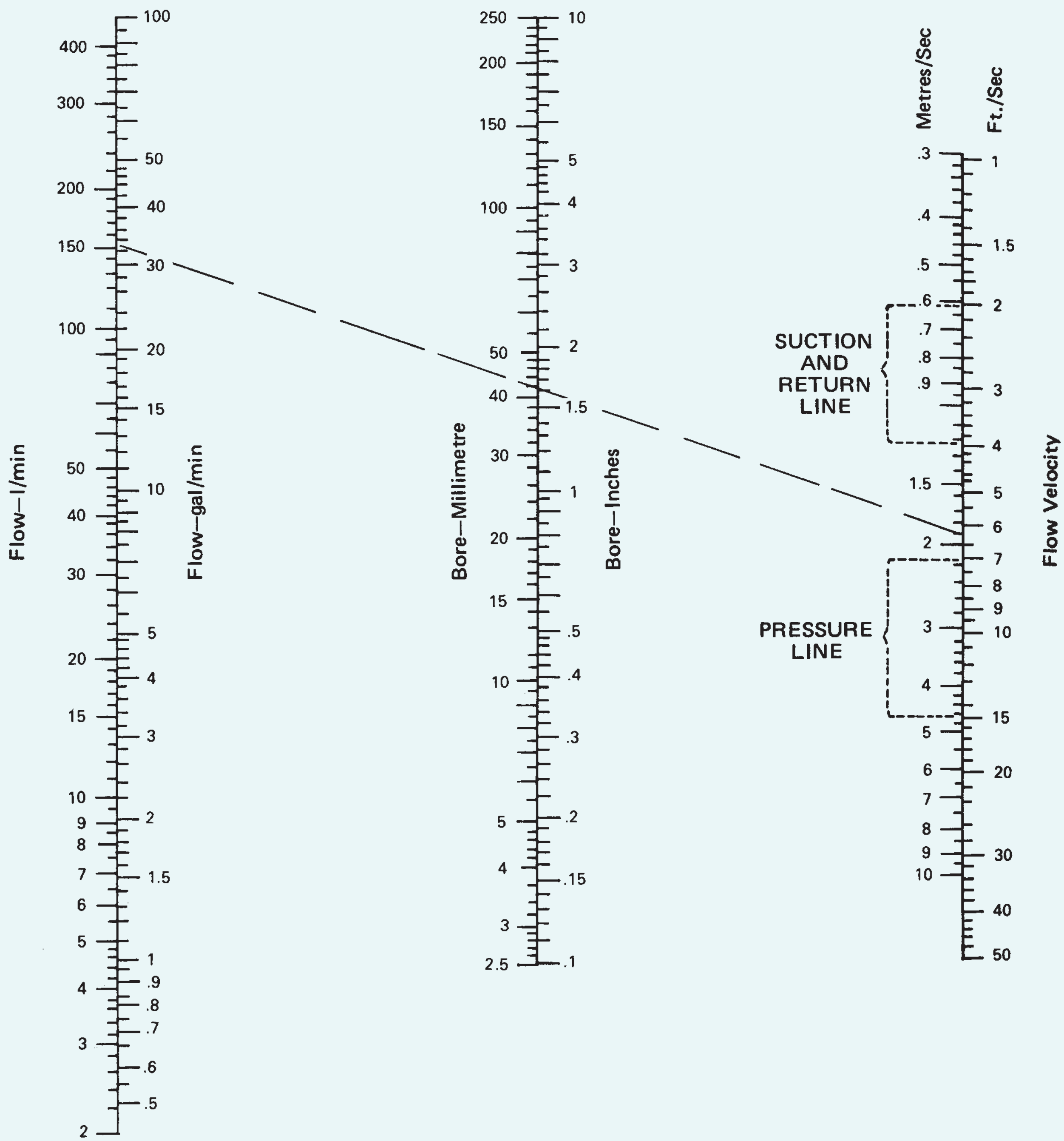


Figure-3

PIPE SIZE NOMOGRAM



Example: To find the pipe bore size consistent with a flow rate of 150 l/min (33 gal/min) and flow velocity 2 M/sec. (6.5 Ft./sec). Connect flow rate to flow velocity and read bore on centre scale.
Answer: 40mm (1.6″).

Table IV:

Viscosity conversion factors						
Saybolt universal seconds	Engler degrees	Absolute viscosity, centipoises,† also relative viscosity	Kinematic viscosity, poises per g per cc, *n*/*d*	Redwood admiralty seconds	Saybolt Furol seconds	Redwood No 1 seconds
32	1.08	1·41	0·0141			30
34	1·14	2·19	0·0219			31
36	1·19	2·92	0·0292			33
38	1·25	3·63	0·0363			34
40	1·31	4·30	0·0430			36
42	1·37	4·95	0·0495			38
44	1·43	5·59	0·0559			39
46	1·48	6·21	0·0621			41
48	1·53	6·81	0·0681			43
50	1·58	7·40	0·0740			44
55	1·73	8·83	0·0883			48
60	1·88	10·20	0·1020			53
65	2·03	11·53	0·1153			57
70	2·17	12·83	0·1283			61
75	2·31	14·10	0·1410			65
80	2·46	15·35	0·1535			69
85	2·59	16·58	0·1658			73
90	2·74	17·80	0·1780			77
95	2·88	19·00	0·1900			81
100	3·02	20·20	0·2020	10	15	86
110	3·31	22·56	0·2256	11	16	94
120	3·60	24·90	0·2490	12	17	102
130	3·69	27·21	0·2721	13	18	111
140	4·19	29·51	0·2951	13	18	119
160	4·77	34·07	0·3407	15	20	136
180	5·35	38·60	0·3860	17	22	153
200	5·92	43·10	0·4310	19	23	170
225	6·64	48·70	0·4870	21	26	191
250	7·35	54·28	0·5428	23	28	212
300	8·79	65·40	0·6540	28	32	254
350	10·25	76·49	0·7649	32	37	296
400	11·68	87·55	0·8755	37	42	338
450	13·00	98·60	0·9860	42	47	380
500	14·00	109·6	1·096	46	52	422
550	16·00	120·7	1·207	50	56	465
600	17·00	131·7	1·317	55	61	507
650	19·00	142·7	1·427	60	66	549
700	20·00	153·7	1·537	64	71	591
800	23·00	175·8	1·758	74	81	676
900	26·00	197·8	1·978	83	91	760
1000	29·00	219·8	2·198	92	101	845
1500	43·00	329·9	3·299	138	150	1267
2000	58·00	439·9	4·399	184	200	1690
2500	72·00	549·9	5·499	230	250	2112
3000	87·00	659.9	6·599	276	300	2535
3500	101.00	769.9	7.699	322	350	2957

†Values in this column must be multiplied by the specific gravity of the fluid at the temperature of the measurement to complete the conversion.