Instromet

TURBINE GAS METER
SM-RI-X

GENERAL

The INSTROMET SM-RI-X turbine meter is an integrating flow meter for the measurement of gases. The volume of gas passed through the meter, at the operating pressure and temperature, is indicated on a counter in units of volume (m^3 or cuft). The volume registered can be converted to a reference volume (Nm^3) by application of a volume integrator such as the INSTROMET electronic flow computers and electronic volume correctors. The SM-RI-X turbine meter is based on the proven SM-RI concept and incorporates the patented X4X® flow conditioner. Its superior characteristics are maintained in practical, non-ideal installations. The SM-RI-X turbine gas meter is approved for custody transfer applications according to EEC Directives and by many other international approval authorities.

GENERAL TECHNICAL DATA

Pressure ratings	:	PN 10 to PN 100 and ANSI 125 to ANSI 600. Higher pressure ratings on request.
Nominal diameters	:	50 mm (2") to 600 mm (24"). Larger sizes on request.
Flow rates	:	Up to 25,000 m^3/h (line conditions).
Measurement range	:	20:1 minimum at atmospheric conditions*.
Installation	:	Up to 200 mm (8") horizontal or vertical on request, over 200 mm horizontal only.
Repeatability	:	0.1 %
Measuring accuracy	:	0.2 Qmax → Qmax: ± 0.5% Qmin → 0.2 Qmax: ± 1% (see page 3)
Temperature range	:	-10° C to + 65° C. Other temperature ranges on request.

*Some smaller size meters have reduced ranges.

APPLICATIONS

The standard SM-RI-X meter is suitable for all non-corrosive gases such as natural gas, propane, butane, air, nitrogen, ethylene, hydrogen etc. Special construction can be supplied for use with corrosive gases.
The SM-RI-X turbine meters are widely used for custody transfer of natural gas. They are also used for industrial loads, in distribution stations, major supply stations and as master reference meters.

CONSTRUCTION

The main parts of the SM-RI-X turbine gas meter are:

1. Meter body (length = 3 x D)
2. Measuring mechanism including turbine wheel
3. Inlet flow conditioner X4X® (patented)
4. Mechanical drive and magnetic coupling to bring turbine wheel rotation outside the pressure body
5. Mechanical counter for registering the volume measured
6. Oil lubrication system for the turbine wheel shaft bearings

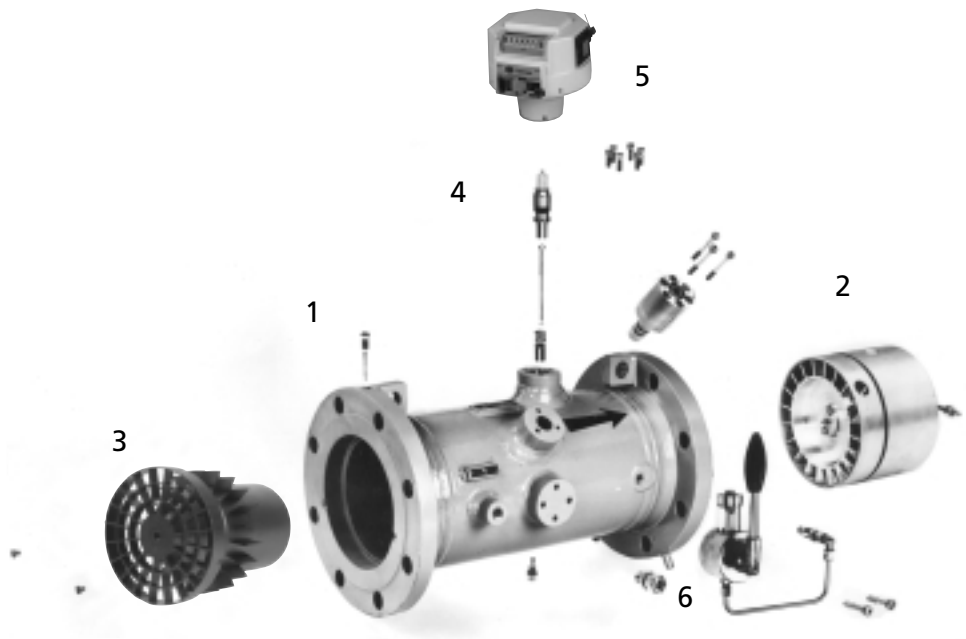


fig. 1

OPERATING PRINCIPLE

The flowing gas enters the meter through a built-in flow conditioner (1) that conditions the flow profile and increases the gas velocity. The gas continues along the flow channel (2) and enters the turbine rotor. The turbine rotor blading (3) is designed with overlap to give complete guidance to the flowing gas and extract the maximum energy at low gas velocities. The turbine wheel's angular velocity is proportional to the average gas velocity flowing through the meter. The gas exits the turbine rotor through a flow ring and an expanding exit channel to minimize pressure losses. The rotation of the turbine rotor is transmitted via a gear train and transferred from the pressurized meter body to the counter (5) by a gas tight magnetic coupling (4). The follower magnet of the magnetic coupling drives the counter to register volumes metered at the operating conditions.

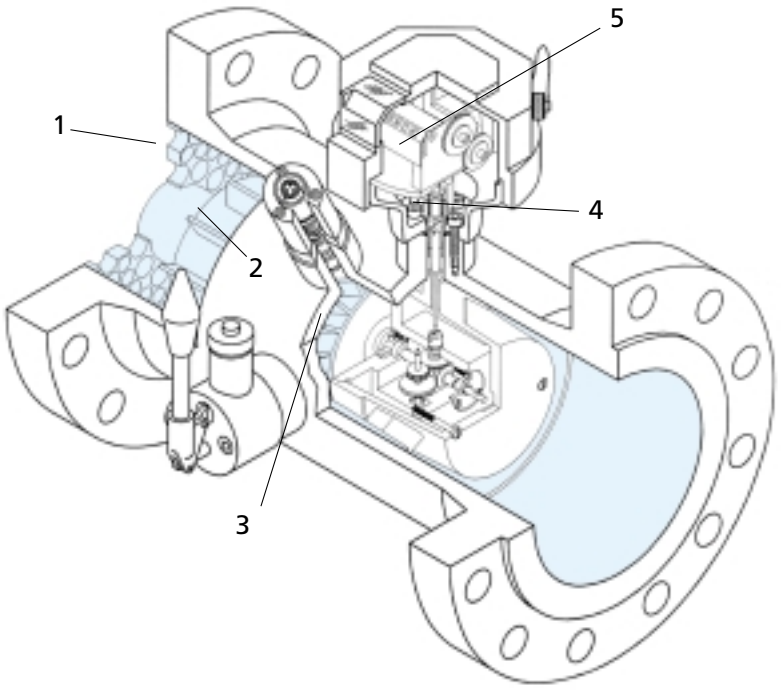


fig. 2

MEASURING RANGE

The measuring range of the SM-RI-X determined for atmospheric conditions meets with, and generally exceeds, European and all major international standards.

At higher operating pressures the measuring range of the turbine meters will increase since the required kinetic energy transfer to the turbine rotor occurs at lower velocities. The following equation may be used to estimate the minimum flow rate of the meter for various operating conditions.

$$Q = Qm \sqrt{\frac{P(atm)}{P} \times \frac{1.29}{\rho}}$$

Q	=	minimum capacity under operating conditions
Qm	=	minimum capacity for meter accuracy - see table page 6
p	=	operating pressure of the meter in bar absolute
p(atm)	=	atmospheric pressure in bara (1.01325 bara)
ρ	=	Density of the gas at atmospheric pressure - see table page 7

ACCURACY / TYPICAL CALIBRATION CURVE

Each SM-RI-X turbine gas meter is tested with atmospheric air to traceable calibrated references. The INSTROMET error limits are half those allowed by EU standards, OIML recommendation R32 and ISO 9951. For pressures of 8 bar and above, meters calibrated within even narrower limits are available. Optionally, meters can be calibrated with natural gas at pressures up to 64 bar, using test installations traceable to primary standards.

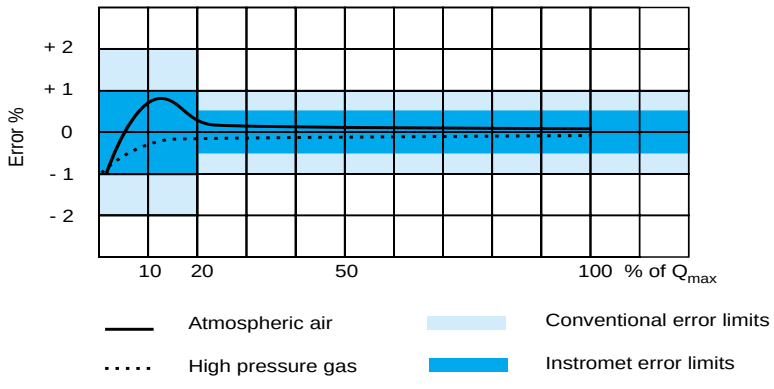
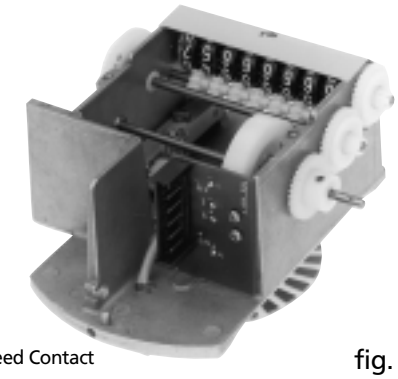


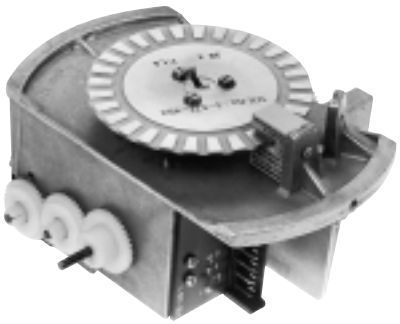
fig. 3 Typical calibration curves of SM-RI-X meter

METER INDEX, PULSERS

Multi-Index fig. 4



LF Reed Contact fig. 5



HF Slot Sensor fig. 6

Standard Multi-Index

The standard index is a multi-index as shown, fitted with a reed contact to provide a low frequency pulse. (Impulse values see page 6)

The impulse is accessed through an electrical connection. The counter is readable over a 90° field of vision and has 8 digits.

Possible Index Options:

- LF double pulser (Reed contact)
- HF pulser (Slot sensor)
- HF double pulser (Slot sensor)
- HF/LF pulse combinations
- Anti-fraud reed contact
- Mechanical drive - (Type 25 H7 according to DIN 33800)
- Reverse current barrier
- Remote read-out of counter via HART protocol (Digitur)
- "Cryo" index extension to prevent icing problems in meters operating with sub-zero temperature gas
- Drying agent option (aluminium silicate)
- Tropical operation
- Polyepoxy coated material - for corrosive environment

Connector Options

Standard:
Pins 1 and 4 = LF Reed contact
Pins 3 and 6 = HF slot sensor
or according to customer's requirements

All connector combinations are indicated on the type plate.

HF PROXIMITY SENSOR - TURBINE WHEEL/REFERENCE WHEEL

HF Reprox Proximity Sensor fig. 7

Each turbine gas meter equipped with an aluminium turbine wheel can be fitted with a Reprox probe type pulse sensor. As each turbine blade passes the proximity sensor a pulse is produced, the number of which is proportional to the speed of the wheel and thus the quantity of gas can be determined (for pulse values see page 6).

A proximity sensor can also be fitted above a toothed reference wheel fitted on the main shaft. These impulse values are identical to the values produced by the turbine blades. The electrical separation between the hazardous and non-hazardous areas is accomplished by an intrinsically safe isolation amplifier, type Mk 15-PRN-Ex0/K11.

DIFFERENT TURBINE GAS METER MODELS

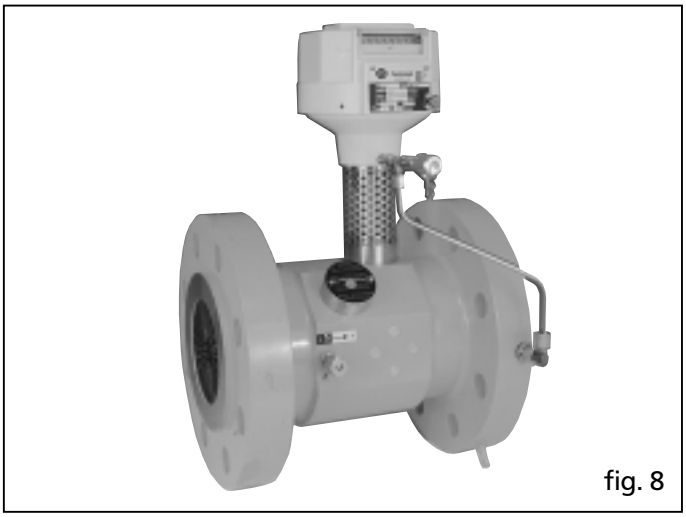


fig. 8

SM-RI "Cryo" to measure sub-zero temperature gas.

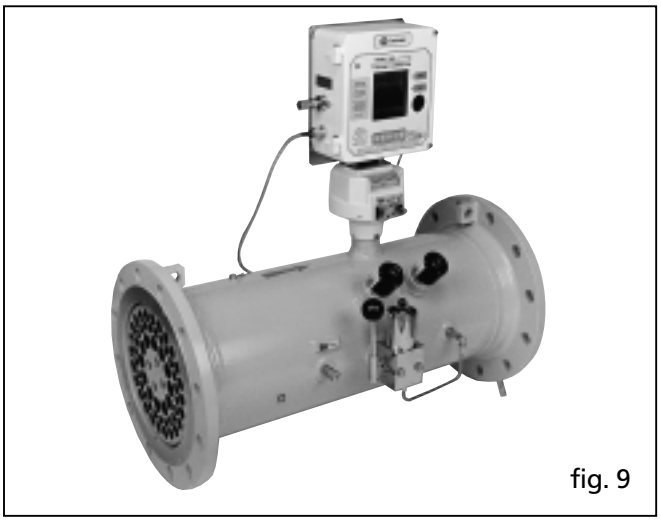


fig. 9

SM-RI-X with Model 999 electronic volume corrector.

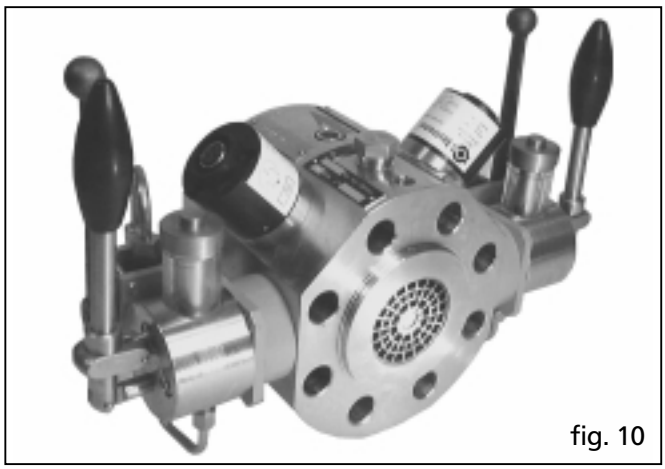


fig. 10

SM-RI-P high pressure turbine gas meter for the measurement of ethylene with a very high density.

IN SITU INSPECTION AND SPIN TEST

Optionally a special port can be provided to allow visual inspection of the turbine wheel without removing the meter mechanism from the line. This port can also be used to test the conditions of the bearings by means of a spin test.

ELECTRONIC VOLUME CORRECTORS AND ASSOCIATED PRODUCTS

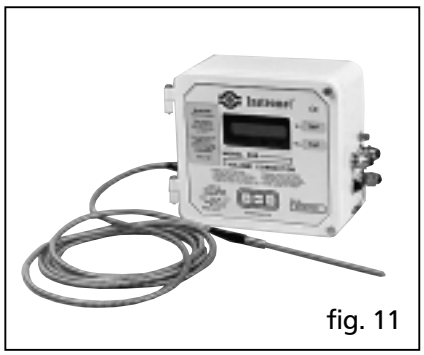


fig. 11

Model 555 or 999 Corrector

User configurable, highly accurate electronic volume corrector with an extremely versatile logging capability correcting for temperature and pressure.

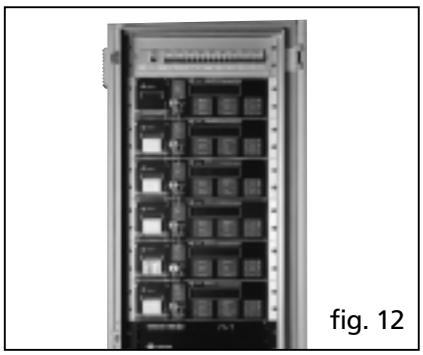


fig. 12

Series 793 Flow Computer

For remote calculation of flow quantity in base volume and energy without any additional error. Temperature and pressure are digitally read using a HART bus.


fig. 13

Tru-Therm Calorimeter

For real-time measurement. Provides total energy flow and gas quality at bare conditions.

MEASUREMENT RANGE/PRESSURE LOSS/PULSE VALUES

pipe size mm (inch)	G-rating	measurement range (m^3/h) Qmin - Qmax *1	pressure loss at Qmax natural gas ρ = 0.8 kg/m^3	m^3 per rev	LF pulses per m^3		HF-index Hz at Qmax	No. of turbine blades	HF *2 Signal reference wheel Hz at Qmax	Turbine wheel * 4	
					1	10				ALU	Delrin
50	G 40	13 - 65	3	0.1	10	100	136		1690 * 3	●	○
(2")	G 65	10 - 100	6.5	0.1	10	100	210	12	2600 * 3	●	○
80	G 100	8 - 160	3	1	1	10	105		1280 * 3	●	○
(3")	G 160	13 - 250	8	1	1	10	163	12	2000 * 3	●	○
	G 250	20 - 400	21	1	1	10	149		1800 * 3	●	–
100	G 160	13 - 250	2	1	1	10	98		1100 * 3	●	○
(4")	G 250	20 - 400	5	1	1	10	158	16	1760 * 3	●	○
	G 400	32 - 650	13	1	1	10	143		1570 * 3	●	–
	G 400	32 - 650	3.5	1	1	10	151		1180	●	○
150	G 650 ≤ 10 bar	50 - 1,000	8.5	1	1	10	232	20	1815	●	○
(6")	G 650 ≥ 10 bar	50 - 1,000	7.0	1	1	10	133		1060	●	○
	G 1000	80 - 1,600	16.5	1	1	10	213		1700	●	–
200	G 650	100 - 1,000	1.5	10	0.1	1	55		770	●	–
(8")	G 1000	80 - 1,600	3	10	0.1	1	85	20	1180	●	–
	G 1600	130 - 2,500	8	10	0.1	1	83		1060	●	–
250	G 1000	80 - 1,600	1.5	10	0.1	1	88		825	●	–
(10")	G 1600	130 - 2,500	4.5	10	0.1	1	142	24	1320	●	–
	G 2500	200 - 4,000	10	10	0.1	1	126		1200	●	–
300	G 1600	130 - 2,500	1.5	10	0.1	1	48		810	●	–
(12")	G 2500	200 - 4,000	5	10	0.1	1	76	24	1270	●	–
	G 4000	320 - 6,500	14	10	0.1	1	70		1175	●	–
400	G 2500	200 - 4,000	1.5	10	0.1	1	160		660	●	–
(16")	G 4000	320 - 6,500	5	10	0.1	1	256	24	1055	●	–
	G 6500	500 - 10,000	13	10	0.1	1	220		890	●	–
500	G 4000	320 - 6,500	1.5	10	0.1	1	130		530	●	–
(20")	G 6500	500 - 10,000	6.5	10	0.1	1	210	24	865	●	–
	G 10000	800 - 16,000	15	10	0.1	1	192		770	●	–
600	G 6500	500 - 10,000	1.5	100	0.1	0.1	48		470	●	–
(24")	G 10000	800 - 16,000	5	100	0.01	0.1	75	24	720	●	–
	G 16000	1,300 - 25,000	10.5	100	0.01	0.1	68		650	●	–

* 1: Measurement range 1:30 on request

* 2: Indicated HF frequencies are nominal values
Actual values are specific

* 3: HF sensor on reference wheel not available

* 4: ● Standard construction
○ Option / special design for PN10 / ANSI 125

A HF proximity switch or a HP calibration is only possible with aluminium turbine wheels.

A temperature well in the meter housing is available for meters 80 mm (3") and larger.
For the connection of pressure sensors (e.g. for a volume corrector) a "Pr" point is integrated in the meter body.

Meters larger than 600 mm (24") and other variations to the above specifications are available by special request.

MEASUREMENT OF VARIOUS GASES

Applicable to clean dry gases from -10° C to +65° C. Other temperature ranges by special request.

S = Standard Materials
T = Corrosion resistant coated body and internals (except plastic and stainless steel parts)
1) = Special o-rings
2) = Special lubrications
3) = Special turbine wheels
4) = Except food industry
5) = For super-critical Ethylene and Propylene use SM-RI-P
6) = For oxygen special conditions apply

NOTE:

- For wet gases, a special coating can be applied to the body's inside surfaces
- For corrosive environment, external surfaces and index head can be coated
- For higher or lower temperatures special lubrication and materials can be supplied

Gas	Formula	Density at 0° C 1.013 bar (kg/m³)	Meter housing	Remarks
Natural gas	CH_4	0.8	S	
Acethylene	C_2H_2	1.17	T	CRC coated
Ammonia	NH_3	0.77	S	1) 2)
Argon	Ar	1.78	S	
Butane	C_4H_{10}	2.70	S	
Biogas	—	—	T	1) 2) 3)
Ethane	C_2H_6	1.36	S	
Ethylene	C_2H_4	1.26	S	1) 5)
Freon 12 (gas)	CCl_2F_2	5.66	S	1) 2)
Helium	He	0.18	S	higher Qmin
Carbon Dioxide	CO_2	1.98	S	4)
Carbon Monoxide	CO	1.25	S	
Air	$N_2 + O_2$	1.29	S	
Methane	CH_4	0.72	S	
Pentane	C_5H_{12}	3.46	S	
Propane	C_3H_8	2.02	S	
Propylene (gaseous)	C_3H_6	1.92	S	1) 5)
Sewer/Manure gas	—	—	T	1) 2)
Town gas	—	—	S	
Sulphide gas	—	—	T	1)
Nitrogen	N_2	1.25	S	
Hydrogen	H_2	0.09	T	higher Qmin
Oxygen (pure)	O_2	1.43	S	1) 2) 6) special constr.
Sulpher dioxide	SO_2	2.93	T	1) special constr.
Hydrogen sulphide	H_2S	1.54	T	1) 2)

PRESSURE LOSS FORMULA

The average pressure loss (see table page 6) of the SM-RI-X turbine meter using atmospheric natural gas with a relative density of 0.6 and measured at one (1) diameter upstream to one (1) diameter downstream of the meter on straight pipe of the same size as the meter.

The pressure loss across the SM-RI-X for various gases and other operating pressures may be approximated from the following equation.

$$\Delta P_2 = \Delta P_1 \bullet \frac{d}{0.6} \bullet \left(\frac{Pm}{Patm}\right) \bullet \left(\frac{Q}{Q\,max}\right)^2 [mbar]$$

ΔP2 = Pressure drop at Pm and Q- mbar
ΔP1 = Pressure drop at Qmax (see table page 6)
Pm = Operating pressure absolute
Catm = Atmospheric pressure 1.013 bara
Q = Instantaneous flow rate in m³/h
Qmax = Max. flow rate in m³/h
d = Relative density of the gas (air = 1)

HOW TO ORDER

In order to provide the meter best suited for your application, please provide the following information:

- Pipe diameter
- Gas flow quantity, min & max
- Gas flow direction
- Operating pressures, min & max
- Operating temperatures, min & max
- Ambient temperatures, min & max
- Type of gas
- Flange class, DIN or ANSI
- Type of Index - pulse options
- Proximity Switch(es) - Turbine, reference wheel
- High Pressure Calibration required ?
- Metrological and/or materials certificates required.

INSTALLATION GUIDELINES

- The SM-RI-X fulfills all the requirements of the European and major international directives, standards and guidelines, in particular those of OIML, ISO and DVGW.
- With the integrated X4X® (patented) flow straightener, the SM-RI-X eliminates the effect of perturbations on gas measurement and satisfies the exacting requirements of the International Standard ISO 9951 with only 2 x diameter of upstream piping. This permits the design of very compact installations without a significant effect on accuracy.
- The superior performance of the X4X flow straightener was confirmed by tests carried out by a number of European gas transmission companies. Copies of this report are available on request.

Possible Installation Configurations

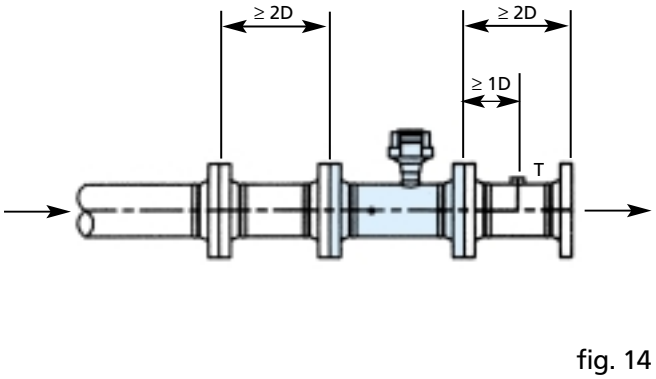


fig. 14

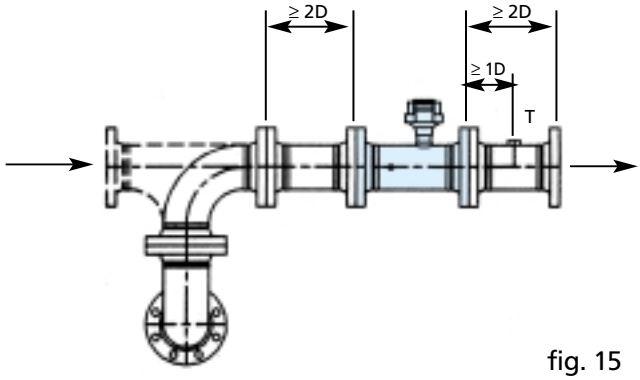


fig. 15

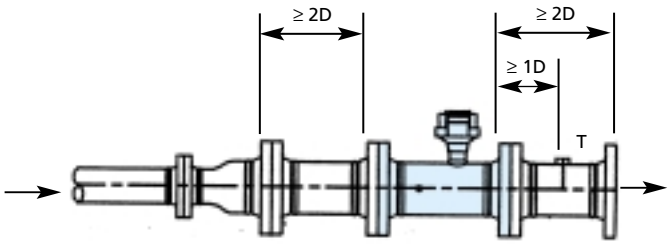
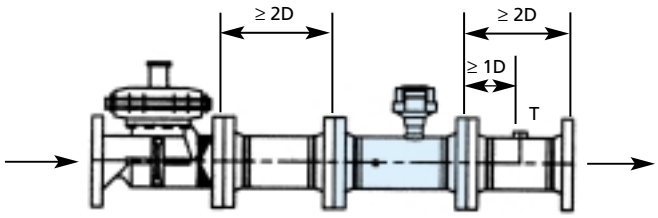


fig. 16



For heavily jetting regulators it is recommended that a sieve plate be installed at the exit of the regulator for optimum performance.
fig. 17

The gas piping must be clean and free of sand, dirt, metal filings, and other foreign particles and liquids. It is recommended that a filter of 5 micron mesh be installed upstream of the meter.

Position the gaskets with care, ensuring that there is no protrusion into the flow which would cause a disturbance to the flow.

Tighten the bolts evenly and with equal force.

The Multi-index can be rotated up to 350° for easier reading.

Slowly pressurise the installation, to prevent overspeeding or damaging the meter. Bringing the meter into service should also be done slowly.

LUBRICATION

The frequency of lubricating a meter depends on the operating conditions. A meter operating in dirty gas needs to be lubricated more often than a meter operating in clean gas.

Under normal conditions meters should be lubricated 2 to 3 times a year.

Recommended quantity of oil:

50/80 mm (2/3") meters	0.2	cc
100 mm (4")	" 2	"
150 mm (6")	" 3	"
200 mm (8")	" 4	"
250 mm (10")	" 5	"
300 mm (12")	" 6	"
400 mm (16")	" 8	"
500 mm (20")	" 10	"
600 mm (24")	" 12	"

Lubricating oil: ISOFLEX PDP 38.
For special applications contact Instromet for advice.

Special lubrication systems are available minimising the risk of pollution of the oil.

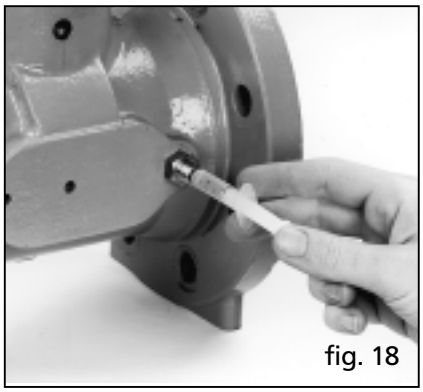


fig. 18

Oil Injection-System

Supplied with 50 mm (2") to 200 mm (8") meters with a pressure rating of PN 10/16 and ANSI 125.

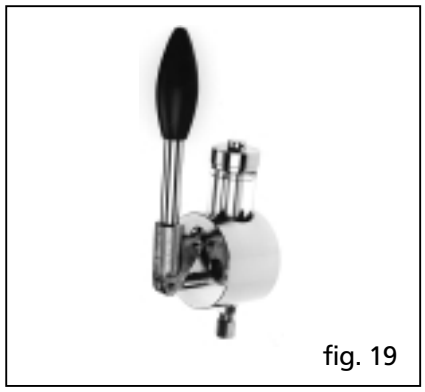


fig. 19

Small Oil pump

Standard on 100 mm (4"), 150 mm (6") and 200 mm (8") meters in all pressure ranges up to 100 bar. 0.5 cc per stroke.

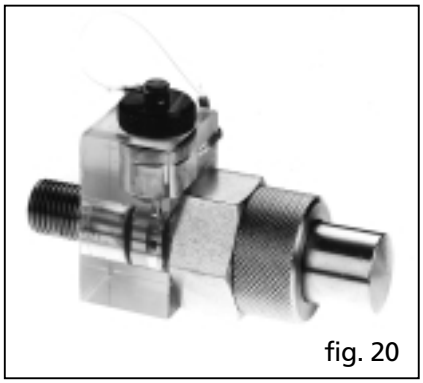


fig. 20

Push Button Pump

Standard on 50 mm (2") and 80 mm (3") meters in pressure ranges up to 100 bar. 0.1 cc per push.

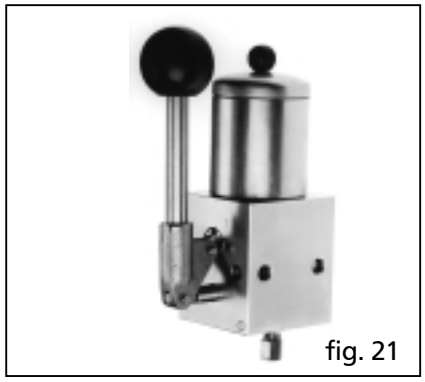


fig. 21

Large Oil Pump

Standard on 250 mm (10") meters and larger in all pressure ranges up to 100 bar. 1 cc per stroke.

HIGH PRESSURE CALIBRATION FACILITY

Instromet possesses a unique high pressure calibration facility, approved by the Dutch legal metrology service NMi. Systematic testing of meters with high pressure natural gas gives Instromet a powerful tool to further improve its turbine meters within the frame-work of its ISO 9001 approval.

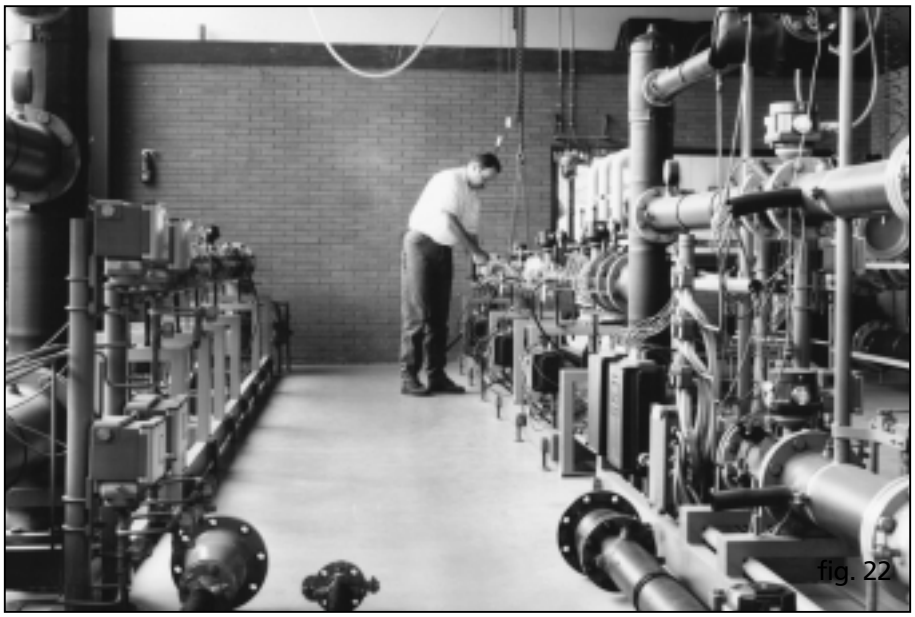


fig. 22

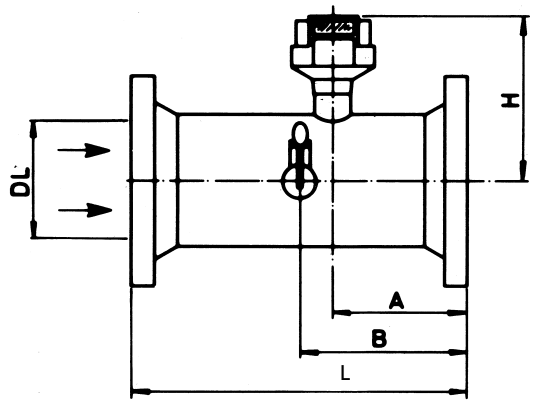
fig. 22
Instromet Natural Gas High Pressure Calibration Facility in Utrecht, The Netherlands

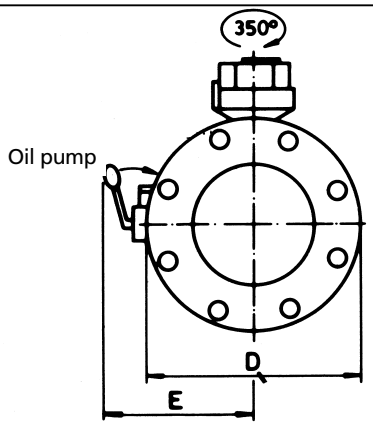
DIMENSIONS AND WEIGHTS

Sizes mm (inch)	G-Rating	A	B	E	H	Over-all length	Pressure rating	Body material	Wgt. kg.	Pressure rating	Body material	Wgt. kg
50 (2")	40 65	60	N.A.	N.A.	235	150	ND 10/16 ANSI 125/150 ND 10/16 ND 25/40 ND 64	GGG 40 St	10 10 20 20 23	ND 100 ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	26 18 20 20 20
80 (3")	100 160 250	96	N.A.	N.A.	205	240	ND 10/16 ANSI 125/150 ND 10/16 ND 25/40 ND 64	GGG 40 St	15 15 26 26 30	ND 100 ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	34 24 28 28 28
100 (4")	160 250 400	120	130	210	218	300	ND 10/16 ANSI 125/150 ND 10/16 ND 25/40 ND 64	GGG 40 St	28 28 30 38 40	ND 100 ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	46 35 42 42 50
150 (6")	400 650 1000	180	180	247	273	450	ND 10/16 ANSI 125/150 ND 10/16 ND 25/40 ND 64	GGG 40 St	44 44 42 50 72	ND 100 ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	87 48 66 77 98
200 (8")	650 1000 1600	240	240	273	298	600	ND 10 ND 16 ANSI 125/150 ND 10 ND 16 ND 25	GGG 40 St	70 70 70 77 77 89	ND 40 ND 64 ND 100 ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	98 125 161 91 117 135 155
250 (10")	1000 1600 2500	300	360	327	314	750	ND 10 ND 16 ND 25 ND 40 ND 64 ND 100	St	90 95 108 128 156 220	ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	108 148 170 236 236
300 (12")	1600 2500 4000	360	390	352	338	900	ND 10 ND 16 ND 25 ND 40 ND 64 ND 100	St	120 130 150 180 240 340	ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	160 210 240 290
400 (16")	2500 4000 6500	480	510	395	380	1200	ND 10 ND 16 ND 25 ND 40 ND 64	St	350 380 410 460 510	ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	400 460 490 580
500 (20")	4000 6500 10000	600	630	445	431	1500	ND 10 ND 16 ND 25 ND 40	St	550 600 640 690	ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	650 800 830 980
600 (24")	6500 10000 16000	720	750	495	482	1800	ND 10 ND 16 ND 25	St	900 950 1000	ANSI 150 ANSI 300 ANSI 400 ANSI 600	St	1050 1300 1350 1500

N.A. = Not Applicable St = Steel GGG 40 = Ductile Iron

DIMENSIONS





Meter length L equals 3 x the nominal pipe diameter DL.
For A, B, E and H see table on page 10.

fig. 23

MATERIAL SPECIFICATIONS

Body:	Meter with DIN flanges: Connection DN 50 - DN 200, PN10/16 Ductile Iron GGG 40 Connection DN 50 - DN 600, PN10-PN 100 Steel [DN 50, (2") - flangeless] Meter with ANSI flanges: Connection DN 50 - DN 200, (2"- 8") ANSI 125/150 Ductile Iron GGG 40 Connection DN 50 - DN 600, (2"- 24") Steel [DN 50, (2") - flangeless] ANSI 150 - ANSI 600 Meter bodies are constructed in accordance with many pressure vessel codes. The standard construction is in accordance with the Dutch Stoomwezen Code.
Turbine wheel:	Meters sized 150 mm (6") and smaller with a working pressure to 10 bar (ANSI 150) can be fitted with either an aluminium or a delrin turbine wheel. An aluminium turbine, machined from solid stock, is standard for all other sizes and pressures.

Surface coating:	Ductile iron: phosphate, primer, top coat Steel: sand blasting, primer, top coat
Bearings:	Stainless steel
Shafts:	Stainless steel
Magnetic coupling:	Ferroxdure magnets in stainless steel bushing and aluminium hubs
Screws and bolts:	Stainless steel
Meter module:	Aluminium
O-rings:	Viton® / NBR
Gears:	In contact with gas: Polyacetal resin and stainless steel; in the index: Polyacetal resin
Oil pumps:	Chrome plated brass or steel
Index head:	Aluminium

Note: Special materials available on request. The internals can be coated for service with corrosive gases.

FURTHER INFORMATION

Publications by INSTROMET:

- Turbine Gas Meter Handbook.
- P-Meter Handbook (Ethylene).
- SM-RI Turbine Gas Meters - Installation and Maintenance Instructions.
- Systems Handbook.
- Regulator Station Handbook

International Reference Material:

- ISO 9951: 1993, Measurement of gas flow in closed conduits - Turbine meters.
- OIML R6, General specifications for gas volume meters.
- OIML R32, Rotary piston meters and turbine gas meters.
- AGA Report No. 7, Measurement of fuel gas by turbine meters.

Products & services:

- Ultrasonic gas meters
- Turbine gas meters
- Rotary gas meters
- Insertion gas meters
- Electronic volume correctors
- Flow computer systems
- Calorimeters
- Gas chromatographs
- Supervisory Systems
- Gas filters
- Gas pressure regulators
- Safety shut-off valves
- Telemetering systems
- Electronic metering and control systems
- Calibration and test installations
- Complete gas measurement and control stations
- Commissioning, servicing, training and consulting

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