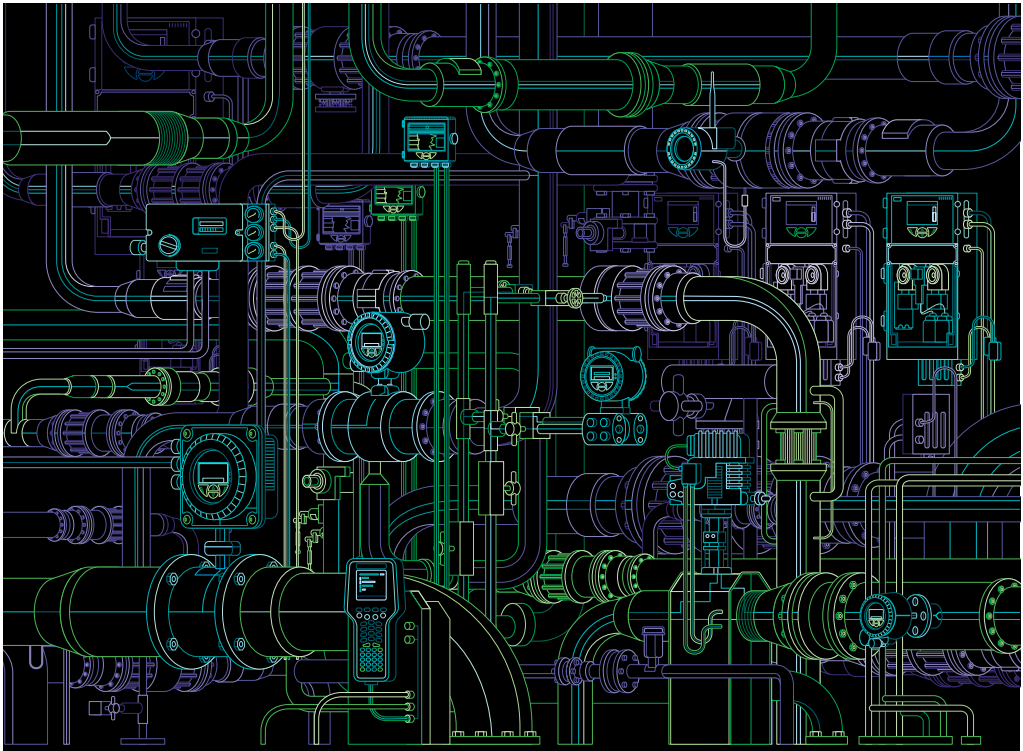

Variable area flowmeters
Basics and practice

Power and productivity
for a better world™

Design: ABB Automation Products GmbH

Handbook for Variable Area Flowmeters

ABB Automation Products GmbH

Introduction

For decades Variable Area flowmeters have become established in industrial measurement technology with an economical, mature measurement principle. The large variety of instrument designs, their repeatability and independence from supply power requirements for local indication provide a suitable solution in almost every flow metering application for liquids, gases and steam.

The ABB-Program includes, a line of metal meter tube flowmeters particularly suited for high pressure and temperature applications, for aggressive and opaque fluids and for steam metering. Also offered is a line of glass meter tube flowmeters (the solution for extremely low pressure conditions) including float designs for viscous fluids or high flowrates in the smaller sizes. The purge flowmeters in both lines are available with a differential pressure regulator to maintain a constant flowrate even when there are pressure variations. The smallest flow ranges required in laboratory applications and high flowrates in industrial applications can be satisfied with ABB instruments.

This new “Handbook for Variable Area Flowmeters“ is a practical guide for the user with selection criteria for real applications (see Check List/Parameter Questionnaire), correction factors, Accuracy Classes, corrosion resistance tables and much more. A separate flyer with actual pictures demonstrate the application versatility.

Answers are provided to frequently asked questions about this measurement principle (see Page 20) and we have incorporated a preferential quick ship program for the most popular instrument versions.

We hope that this Handbook provides you with a practical selection guide; naturally our sales team is always ready to provide you with any personal assistance you may require.

Content

1 General Fundamentals and Details

1.1 Measurement Principle

In VDI/VDE-Directive 3513 the Variable Area flowmeter principle is described as follows:

The Variable Area flowmeter is an instrument for metering the flowrate of liquids and gases in a pipeline. It includes a vertically oriented conical tube, whose diameter is larger at the top than at the bottom, through which the fluid flows upward and in which a vertically moving float is positioned.

The height of the float in the tube increases as the flowrate increases in such a manner that the resistance to the flow is always balanced by the weight of the float and remains constant regardless of the flowrate.

The height of the float in the tube is a measure of the flowrate. The value of the flowrate can be read from a scale.

1.2 Basic Design

In its simplest form the design of the Variable Area flowmeter consists of metering elements (see Fig. 1-1). Float (1), meter tube (2) and flowrate scale (3), including fittings (5), flanges or couplings for installation in the pipeline and sealed with gaskets and O-Rings (7).

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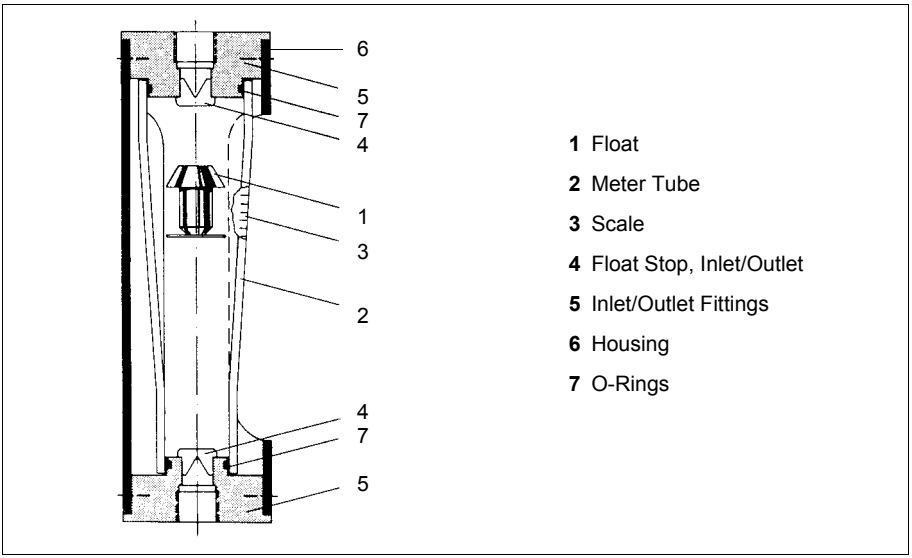


Fig. 1-1: Basic Design, Glass Tube Flowmeter

The float travel is limited by float stops (4) and the meter tube is surrounded by a protective housing (6).

The flowrate scale for glass tube flowmeters is located directly on the meter tube. Variable Area flowmeters generally have a flow range of 1:12.5, which corresponds to a percent range from 8 to 100 %.

If the mechanical, thermal or corrosion properties of glass tubes are not adequate in certain applications, metal meter tubes can be used. The height of the float, which is a measure of the flowrate, is then transmitted externally to the meter tube using a float position detector system (see Fig. 1-2).

The application of converters having electrical analog output signals (0/4...20 mA) can also be used for flow control or for remote indication and recording. In addition, alarm conditions can be signalled.

The data sheets corresponding to the individual Variable Area models include construction details, technical specifications, materials used and dimensions together with flowrate tables. The flowrate tables always indicated the maximum flowrate for the specific meter size and the various meter tube / float combinations.

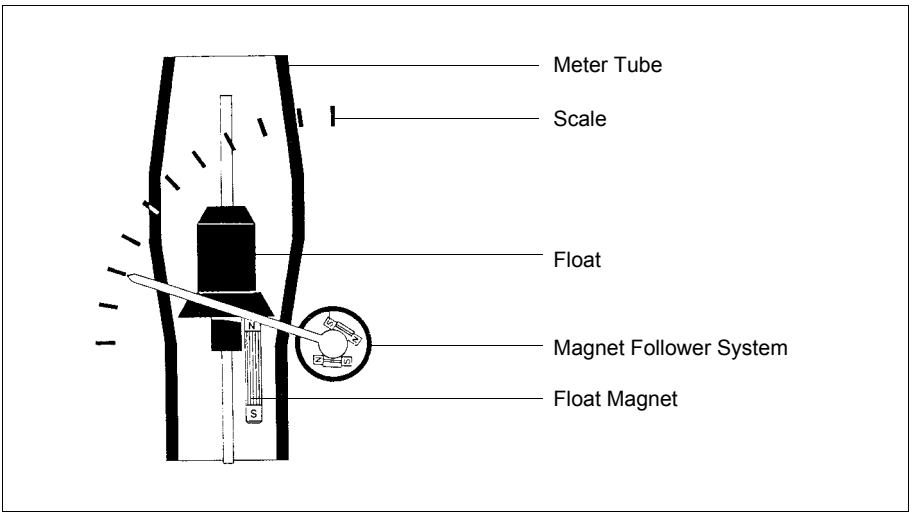


Fig. 1-2: Basic Design, Metal Cone Variable Area Flowmeter

The listed flowrates are generally based on a stainless steel float material No. 1.4301 [304] (density ρ_f = 8.02 g/cm^3) and are for liquids or water (density ρ = 1 g/cm^3, viscosity η = 1 mPa s) or for gases or air at normal conditions (t_n = 0 °C; p_n = 1.013 bar (a)).

1.3 Determination of the Meter Tube/Float Combination

The precision manufacture of the meter tubes and floats allows, based on Directive VDI/VDE 3513, simplified calculations for volume or mass flowrates.

The software package **Flow Tools** is available from ABB for flowmeter selection as a function of the existing conditions for the metering application. With this program it is possible to select the optimal flowmeter by considering the actual operating conditions. This program is available upon request.

1.4 Viscosity Effects (1/2” to 2”)

The float shapes are designed to be essentially independent of the viscosity over a wide range. This means that within this range the viscosity of the fluid can change without any change in the flowrate indications. The flowrate tables for the Variable Area flowmeters include a column entitled VIN in which the Viscosity Influence Number is listed.

If the calculated VIN-Number is lower or exactly the same as the value in the flowrate table in the instrument specifications, the measured values are not affected by viscosity.

$$VIN = \eta \cdot \sqrt{\frac{(\rho_f - 1) \cdot 1}{(\rho_{f1} - \rho_1) \cdot \rho_1}}$$

η = Dynamic viscosity of the fluid [mPa s]
ρ_f = Density of the float in the flowrate table (ρ = 8.02 g/cm^3)
ρ_{f1} = Density of the float actually used
ρ_1 = Density of the fluid

1.5 Density Effects

Table 1-1 is used to correct the indicated flowrate value for Variable Area flowmeters used to meter gases when the normal density of the actual gas is different from the normal density used for the calibration (same operating conditions).

Example

The existing flowmeter was calibrated for air, normal density 1.293 kg/m^3 and is to be used to meter Nitrogen, normal density 1.25 kg/m^3.

In the column for Air where it meets the row for Nitrogen, the factor 1.02 (enclosed in a box) is found. The values indicated by the Variable Area flowmeter must be multiplied by this factor when metering Nitrogen.

Information:
Actual normal density higher: Factor < 1
Actual normal density lower: Factor > 1

When the operating temperature or the operating pressure changes, the multiplication factors to correct the readings can be calculated using the following equations:

Normal or Weight Units	Actual Volume Units at Operating Conditions
$K_p = \sqrt{\frac{p_2}{p_1}}$	$K_p = \sqrt{\frac{p_1}{p_2}}$
$K_t = \sqrt{\frac{t_1}{t_2}}$	$K_t = \sqrt{\frac{t_2}{t_1}}$

K_p = Correction factor for pressure
K_t = Correction factor for temperature
p_1 = 1.013 bar (a) + calibration pressure in bar
p_2 = 1.013 bar (a) + actual operating pressure in bar
t_1 = 273 K + calibration temperature in °C
t_2 = 273 K + actual operating temperature in °C

Calculation of the Correction Factors for Liquid Density Changes

Volume Flowrate

$$K_F = \sqrt{\frac{(\rho_{f1} - \rho_2) \cdot \rho_1}{(\rho_{f1} - \rho_1) \cdot \rho_2}}$$

Mass Flowrate

$$K_F = \sqrt{\frac{(\rho_{f1} - \rho_2) \cdot \rho_2}{(\rho_{f1} - \rho_1) \cdot \rho_1}}$$

K_F = Correction factor
ρ_{f1} = Density of the float which is actually used
ρ_1 = Density of the calibration fluid
ρ_2 = Density of the actual fluid

1.5.1 Normal Density Correction Table for Volume Units (Meter Tube Sizes 1/2'' to 2'')

Gas existing / actual	Normal Density kg/m³ for 0 °C and 1013 mbar	Acetylene	Ammonia	Ammonia diss.	Argon	Butane	Chlorine	Natural Gas	Helium	Carbon Dioxide	Carbon Monoxide
Acetylene	1.17	1	0.81	0.566	1.23	1.51	1.66	0.84	0.39	1.3	1.04
Ammonia	0.77	1.232	1	0.697	1.52	1.86	2.04	1.04	0.48	1.6	1.27
Ammonia diss.	0.374	1.77	1.43	1	2.18	2.67	2.93	1.5	0.69	2.3	1.83
Argon	1.78	0.81	0.66	0.458	1	1.22	1.34	0.68	0.32	1.05	0.84
Butane	2.67	0.66	0.54	0.374	0.816	1	1.1	0.56	0.26	0.86	0.66
Chlorine	3.214	0.603	0.49	0.341	0.74	0.91	1	0.51	0.235	0.78	0.62
Natural Gas	0.83	1.19	0.963	0.67	1.46	1.79	1.97	1	0.46	1.54	1.23
Helium	0.178	2.56	2.08	1.45	3.16	3.87	4.25	2.16	1	3.34	2.65
Carbon Dioxide	1.98	0.77	0.624	0.435	0.948	1.16	1.27	0.65	0.3	1	0.79
Carbon Monoxide	1.25	0.967	0.785	0.547	1.19	1.46	1.6	0.82	0.38	1.26	1
Krypton	3.74	0.56	0.454	0.316	0.69	0.845	0.927	0.47	0.22	0.73	0.58
Air	1.293	0.95	0.77	0.54	1.17	1.44	1.58	0.8	0.37	1.24	0.98
Methane	0.717	1.28	1.04	0.72	1.58	1.93	2.12	1.08	0.5	1.66	1.32
Neon	0.9	1.14	0.925	0.645	1.41	1.72	1.89	0.96	0.44	1.48	1.18
Propane	2.019	0.761	0.618	0.43	0.94	1.15	1.26	0.64	0.295	0.99	0.79
Propylene	1.915	0.78	0.634	0.44	0.96	1.18	1.296	0.66	0.305	1.02	0.81
Oxygen	1.43	0.905	0.734	0.51	1.12	1.37	1.5	0.76	0.35	1.18	0.93
Sulfur Dioxide	2.93	0.632	0.513	0.36	0.78	0.95	1.05	0.53	0.245	0.82	0.65
Nitric Oxide	1.34	0.93	0.76	0.53	1.15	1.41	1.55	0.79	0.36	1.22	0.96
Nitrous Oxide	1.98	0.77	0.624	0.435	0.948	1.16	1.27	0.65	0.3	1.0	0.79
Nitrogen	1.25	0.967	0.785	0.547	1.19	1.46	1.6	0.82	0.38	1.26	1.0
Hydrogen	0.089	3.36	2.94	2.05	4.47	5.48	6.01	3.05	1.41	4.72	3.75

Tbl. 1-1: Normal Density Correction Table

Gas												
Krypton	Air	Methane	Neon	Propane	Propylene	Oxygen	Sulfur Dioxide	Nitric Oxide	Nitrous Oxide	Nitrogen	Hydrogen	existing actual
1.79	1.05	0.78	0.88	1.32	1.28	1.11	1.58	1.07	1.3	1.04	0.28	Acetylene
2.2	1.3	0.96	1.08	1.62	1.58	1.36	1.95	1.32	1.6	1.27	0.34	Ammonia
3.16	1.86	1.38	1.55	2.32	2.26	1.96	2.8	1.89	2.3	1.83	0.49	Ammonia diss.
1.45	0.85	0.63	0.71	1.06	1.04	0.9	1.28	0.87	1.05	0.84	0.22	Argon
1.18	0.57	0.52	0.58	0.87	0.85	0.73	1.05	0.71	0.86	0.68	0.18	Butane
1.08	0.63	0.47	0.53	0.79	0.77	0.67	0.95	0.65	0.78	0.62	0.17	Chlorine
2.12	1.25	0.93	1.04	1.56	1.52	1.31	1.88	1.27	1.54	1.23	0.33	Natural Gas
4.6	2.7	2.0	2.24	3.37	3.28	2.83	4.06	2.74	3.34	2.65	0.71	Helium
1.37	0.8	0.6	0.67	1.01	0.98	0.85	1.22	0.82	1.0	0.79	0.21	Carbon Dioxide
1.73	1.02	0.76	0.85	1.27	1.24	1.07	1.53	1.04	1.26	1.0	0.27	Carb. Monoxide
1	0.6	0.44	0.49	0.73	0.72	0.62	0.89	0.6	0.73	0.58	0.15	Krypton
1.7	1	0.75	0.83	1.25	1.22	1.05	1.5	1.02	1.24	0.98	0.26	Air
2.3	1.34	1	1.12	1.68	1.63	1.41	2.02	1.37	1.66	1.32	0.35	Methane
2.04	1.2	0.8	1	1.5	1.46	1.26	1.8	1.22	1.48	1.18	0.31	Neon
1.36	0.8	0.6	0.66	1	0.97	0.84	1.2	0.81	0.99	0.79	0.20	Propane
1.4	0.82	0.61	0.69	1.03	1	0.86	1.24	0.84	1.02	0.81	0.22	Propylene
1.62	0.95	0.71	0.79	1.19	1.16	1	1.43	0.97	01.18	0.93	0.21	Oxygen
1.13	0.66	0.5	0.55	0.83	0.81	0.7	1	0.68	0.82	0.65	0.25	Sulfur Dioxide
1.67	0.98	0.73	0.82	1.23	1.2	1.03	1.48	1	1.22	0.96	0.174	Nitric Oxide
1.37	0.8	0.6	0.67	1.01	0.98	0.85	1.22	0.82	1	0.79	0.25	Nitrous Oxide
1.73	1.02	0.76	0.85	1.27	1.24	1.07	1.53	1.04	1.26	1	0.27	Nitrogen
6.5	3.81	2.84	3.18	4.76	4.64	4.01	5.74	3.88	4.72	3.75	1	Hydrogen

1.6 Defining the Operating Pressure in a Variable Area Flowmeter

The term “Operating Pressure“ means that pressure which exists in the meter tube of the flowmeter. This pressure is usually identical to the pressure immediately downstream of the flowmeter. The pressure drop in the flowmeter is negligible.

1.6.1 Needle Valve Location

For liquids it is immaterial whether the needle valve is installed at the inlet or outlet of the flowmeter. For gas measurements it is recommended that the needle valve be installed at the outlet of the flowmeter because of compressibility effects. In this arrangement the pressure in the flowmeter will always be constant and independent of downstream pressure variations. For constant downstream pressure conditions, the needle valve can be installed at the inlet. If the gas measurements are made at atmospheric conditions, then the needle valve **must** be installed at the inlet of the flowmeter.

In addition for gas measurements, the location of the valve (at inlet or outlet) must always be considered in conjunction with the calibration pressure. As a result of the density changes due to compression changes in the gas, the upward forces on the float vary and therefore the float height. In order for the operating pressure in the meter tube to remain constant, the flow control valve should be installed as shown in the following (see Fig. 1-3).

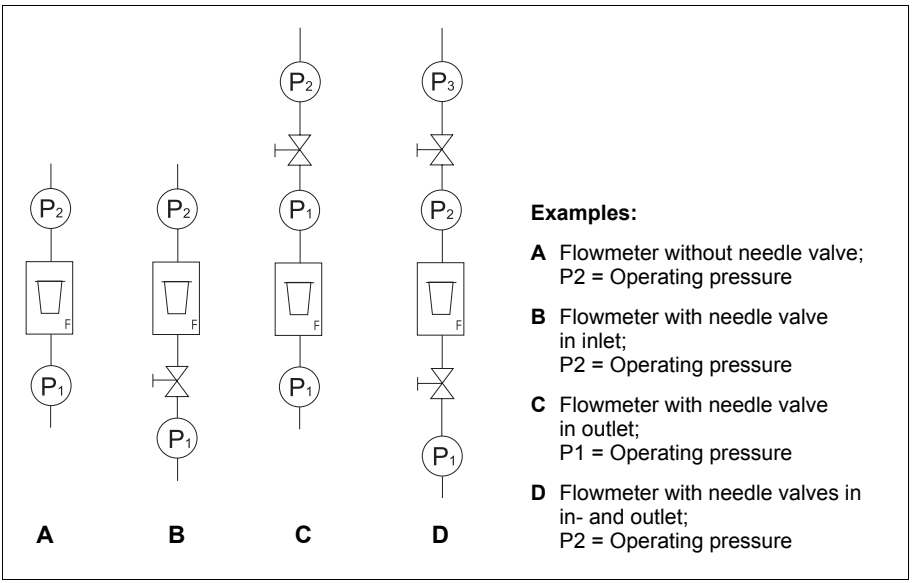


Fig. 1-3: Needle Valve Locations

1.7 Installation Recommendations

See also VDI/VDE-Directive 3513 Sheet 3, Selection and Installation Recommendations for Variable Area Flowmeters.

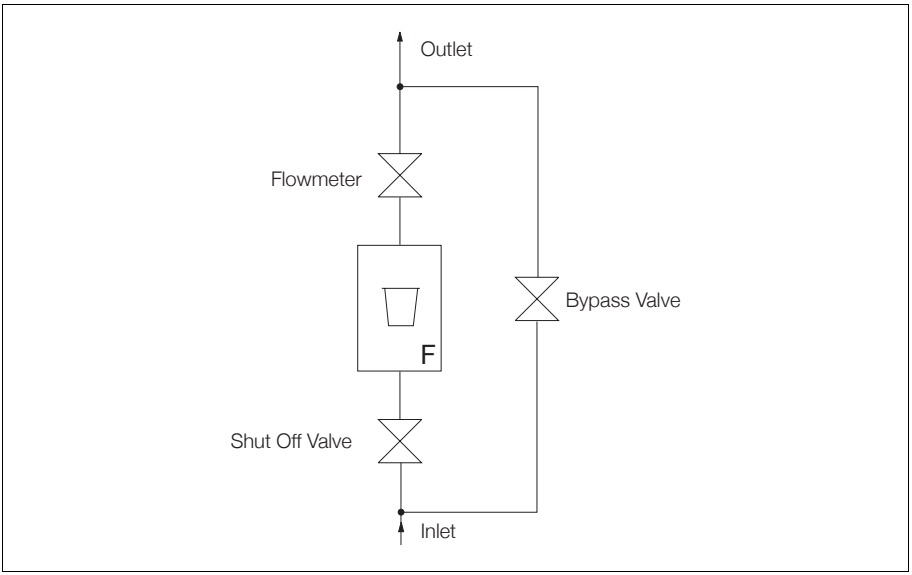


Fig. 1-4: Flowmeter Installation

Variable Area flowmeters are installed in the pipeline vertically. Pipeline vibrations and strong magnetic fields must be kept distant from the flowmeter. The size of the pipeline should correspond the flowmeter connection sizes. Straight in- and outlet sections are no required.

Accuracy and Operating Conditions

The float design is selected for defined fluid operating conditions. For liquids and gases they are the pressure and temperature dependent density and viscosity values at the operating conditions. Especially for gases, this means a defined operating pressure and a defined operating temperature. The specified accuracy of the instrument is always based on the actual fluid operating conditions.

Pressure Drop

The pressure available at the meter location must always be greater than the pressure drop through the flowmeter listed in the Specifications. The pressure drops in the pipeline, fittings and other devices installed downstream from the flowmeter must be taken into account.

Damping and Compression Oscillations in Gas Measurements

When a critical volume between the throttling points up- and downstream of the flowmeter is exceeded, it may be possible, at low operating pressures with gases, that float bounce (compression oscillations) may occur.

To prevent the occurrence of the self-generated float bounce the following information should be noted:

- Select a flowmeter with as low a pressure drop as possible.
- Keep the pipeline lengths between the closest up- and downstream throttling points as short as possible.
- Increase the operating pressure taking into account the changes in the flowrate indication due to the density changes in the gas at the new operating conditions.

Pressure Shocks

Especially when metering gases or liquids with gas bubbles, pressure shocks or excessive float travel may occur if fast opening solenoid valves together with unrestricted pipeline cross sections are employed. As a result of the sudden expansion of the gas that the float may be driven against the upper float stop with considerable force. Under certain conditions the instrument may be damaged or even destroyed.

Solids in the Fluid

Variable Area flowmeters are only suitable for metering fluids containing solids to a limited degree. As a function of the concentration, particle size and type of solids, accelerated wear due to mechanical friction may result. It may also cause weight and shape changes if solids deposit on the float. These effects can result in erroneous flowrate measurements. Generally the installation of an appropriate filter is recommended.

1.8 Accuracy Classes

For Variable Area flowmeters the accuracy is defined in VDE/VDI-Directive 3513, Sheet 2 by various classifications, where each Accuracy Class corresponds to a specific range of errors. The maximum allowable error is the sum of the following partial errors:

1. Partial error: 3/4 of the value of the specified Accuracy Class value is the error in percent of rate
2. Partial error: 1/4 of the value of the specified Accuracy Class value is the error in percent of full scale

For each measurement value the total error in % of rate is calculated as follows:

$$F = (3/4M + 1/4E) \cdot C/M$$

M = Measured value in flowrate units
E = Scale end (full scale) value in flowrate units
C = Accuracy Class values per VDI/VDE 3513/2
F = Total error in % of rate

Flowrate in %	Accuracy Class				
	1	1.6	2.5	4	6
	Total Error in % of Rate				
100	1.000	1.600	2.500	4.000	6.000
90	1.028	1.644	2.569	4.111	6.167
80	1.063	1.700	2.656	4.250	6.375
70	1.107	1.771	2.768	4.429	6.643
60	1.167	1.807	2.917	4.667	7.000
50	1.250	2.000	3.125	5.000	7.500
40	1.375	2.200	3.438	5.500	8.250
30	1.583	2.533	3.958	6.333	9.500
20	2.000	3.200	5.000	8.000	12.000
10	3.250	5.200	8.125	13.000	19.500

Tbl. 1-2: Flowrate Accuracy for the Accuracy Classes

1.9 Frequently Asked Questions (FAQ)

- **Why should a solenoid valve not be installed?**
  The VDI/VDE-3513 does not recommend the installation of solenoid valves because of the moving parts in the Variable Area flowmeter, however good operating experiences have been reported using a so called Starting Valve.

- **Where on the float is the flowrate read?**
  For a ball float, at its center. For all other float shapes see the description in the instrument Specifications.

- **Why is information about so many parameters required?**
  For an optimal instrument selection it is essential to consider the actual operating conditions. Because the Variable Area principle depends considerably on the density, the pressure and temperature for gases are the critical values.

- **Why is my flow range different than the air flow range listed in the Specifications?**
  The values in the instrument Specifications are based 1.013 bar (a) and 0 °C. If your operating conditions differ from these base values (e.g. 2.5 bar (g) and 20 °C), then the density of your gas is different and your flow range will also be different.

- **Can one calculate a conversion factor from Air to Helium?**
  Yes, see the values in Table 1-1 in Chapter 1.5.1. The values in the table only apply for identical pressure and temperature conditions.

- **Can one calculate a conversion factor for an instrument sized for Air at 1 bar (a) 0 °C to 2.5 bar (g) and 20 °C (T)?**
  Yes, the conversion formulas in Chapter 1.5 can be used, or we can provide a software program which can be used to calculate the conversion factors and also print direct reading scales for any operating condition. For %-scales it is necessary to calculate the individual scale values starting at 100 %.

- **What are the advantages of using a conversion calculation?**
  You can use an existing instrument with a % or direct reading scale for a new application under different operating conditions. If you take into account the minimal cost for making the corrections, you avoid additional costs. Also the Variable Area principle itself is extremely economical.

1.10 Questionnaire Variable Area Flowmeter

Customer Address:

Company:		Contact:	
Street:		Administrator::	
City/(State):		Date:	
Country		Phone:	
Postal Code:		Fax:	
Customer No.:		Email:	

Operating Data:

Fluid (for gas applications)		*Fluid (for fluid applications)*	
Name:		Name:	
Normal density (kg/m^3)		Operating density (kg/l)	
Inlet pressure (bar (g))		Viscosity (mPas)	
Outlet pressure (bar (g))		Pressure rating (bar (g))	
Operating temp. (°C)		Operating temp. (°C)	

Flowrate max.: _____

	Normal[1)]	*Actual Volume*	*Mass*
Flow Units:	❑ cm^3/min (Qn)	❑ cm^3/min	❑ g/min
	❑ l/h (Qn)	❑ l/h	❑ kg/h
	❑ l/min (Qn)	❑ l/min	❑ kg/min
	❑ m^3/h (Qn)	❑ m^3/h	
	Others _____	Others _____	Others _____

Required Instrument Design:

❑ Glass tube meter
❑ Metal tube meter

Flowrate Indication:

❑ Direct reading scale
❑ Scale in %
❑ 4...20 mA with display

Connection Type:

❑ Threaded
❑ Flanged
❑ DIN 11851
Others _____

Required Options:

❑ 4...20 mA
❑ Ex design
❑ 3.1B certificate

Alarm contacts ❑ ← Quantity (max. 2 pcs.)
Needle valve ❑

Others _____

Comments: _____

1.11 Overview Metal Cone Instrument Designs

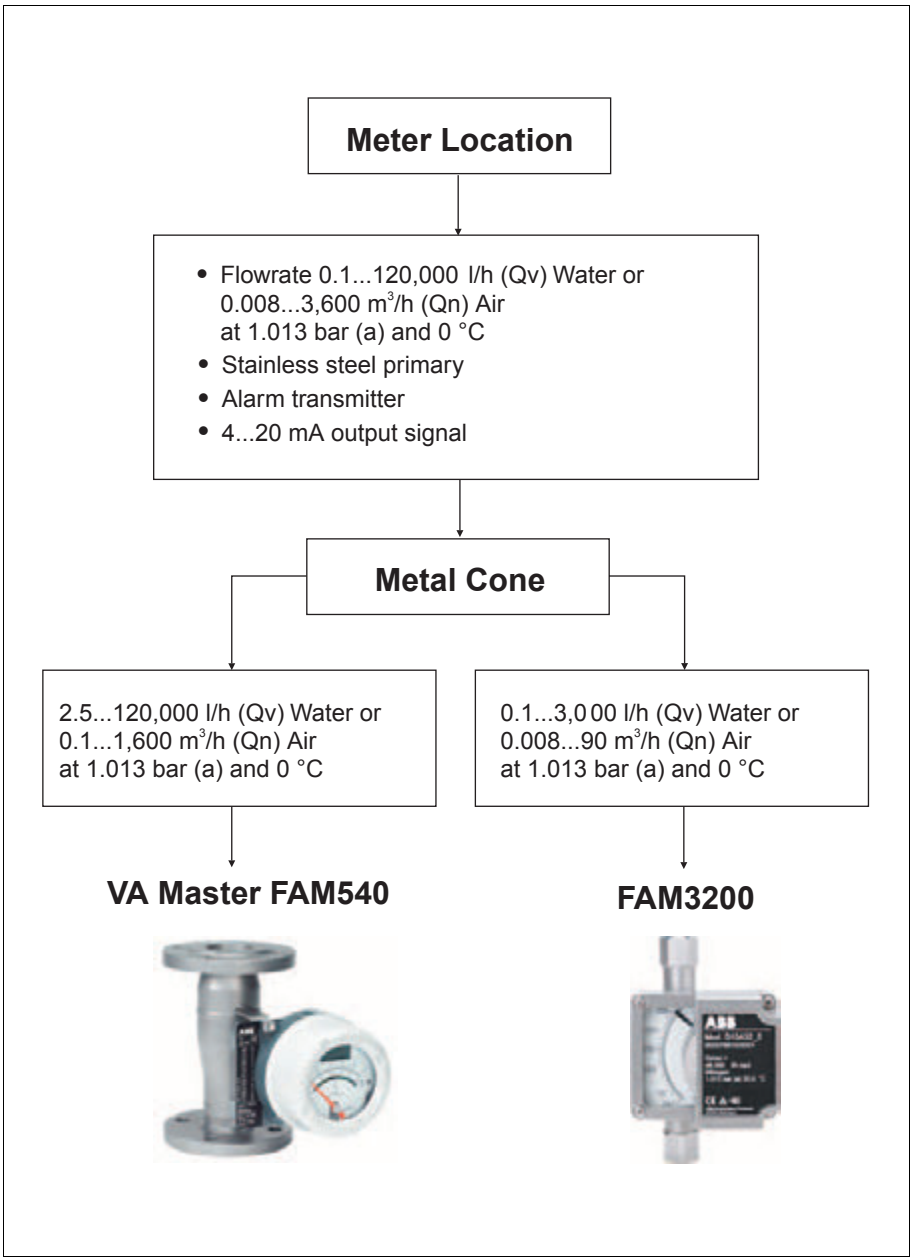


Fig. 1-5: Selection help for Metal Cone Variable Area Flowmeter

1.12 Overview Glass Tube Instrument Designs

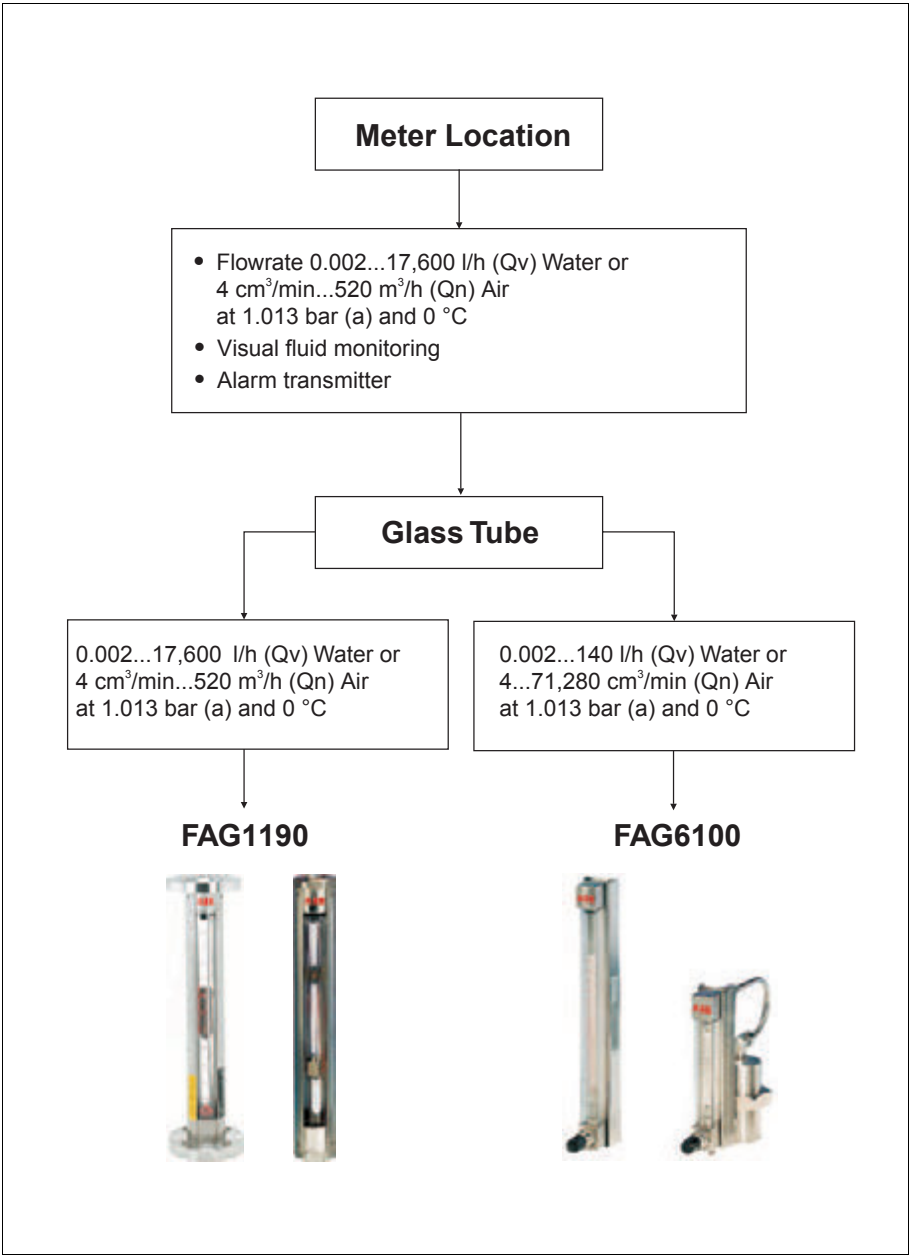


Fig. 1-6: Selection help for Glass Tube Variable Area Flowmeter

2 Variable Area Flowmeters

2.1 Metal Cone Flowmeter

Application Range

The proven, rugged metal cone flowmeter is well suited to numerous applications. It can be used to meter the flowrate of gases, liquids and steam, in process technology, the chemical, pharmaceutical and food industries. It is especially well suited for aggressive or opaque fluids or wherever for safety reasons a glass tube flowmeter cannot be utilized. For higher pressures and temperatures it is essential. The instrument operates according to the Variable Area principle. The primary section consists of a metal cone and a float. A magnet embedded in the float transmits the instantaneous height of the float, the measure for the flowrate, over a decouple proof magnet follower system. The flowrate value is indicated by a rotating pointer on a scale in the secondary section (indicator section).

FAM541
Standard

FAM544
Hygienic

FAM545
PTFE liner

FAM546
Heating jacket

Standard Designs	
FAM540-A	**Local indication**
FAM540-B/C/D	**Indicator with alarm transmitter, Min. / Max. / Min. + Max. alarm**
FAM540-E	**Indicator with electrical converter, without Display, Output 4...20 mA**
FAM540-F	**Indicator with electrical converter, with Display, Output 4...20 mA**
Specifications – Standard Design	
Flow range	See Table, others upon request
Scale format	Direct reading
Accuracy Class	1.6
Connections	Flanges DIN 2501/EN 1092; ANSI CL 150
Standard pressure rating	PN 40; ANSI CL 150
Temperature range	Fluid -20...+400 °C; ambient -40...70 °C
Meter length	See Dimensions
Materials Housing Gaskets Sight glass	1.4404 [316L] Aluminum Buna-N Safety glass
Gas damping	Integrated in standard design for gas measurements

Special Designs
• Heating jacket design, Food Industry design • PTFE liner • Higher pressure ratings • DN 100 [4”] for higher flowrates • Pressure tight design per ATEX / IECEx • Intrinsic Safety design per ATEX / IECEx • Ex-Design per FM • NACE per MR0175 • Design with GOST-R-Certificate

2.1.1 Indicator with/without Alarm Transmitter VA Master FAM540-A/B/C/D

Design Features

- Two housing designs:
  – Non-Ex and Ex designs
  – Ex housing design flameproof enclosure.
- Explosion protection according to ATEX / IECEx Ex d, Ex ia, Ex nA, dust-ignition proof
- Alarm signals can be added using a Compact-Module.
- Alarm settings visible externally.
- Alarm points can be set on the scale.
- Ball bearing, decouple proof and hysteresis free magnet follower system.
- Instrument corresponds to NAMUR-Recommendations NE21 for Electromagnetic Compatibility of Equipment in Processes and Laboratories 5/93 and EMC-Directive 89/EWG.
- Minimum difference between min. and max. alarm points 5 %.
- Secondary can be removed or mounted on the primary section without opening the indicator housing.
- Reproducibility ± 0.25 % of range end value.
- Round indicator housing.

Alarm Transmitter for FAM540

An alarm is released when the control vane enters the slot initiator (active surface becomes covered). The contact opens. The alarm setting can be monitored, – visible externally – set and changed.

Operating mode	Bi-stabile
Reproducibility	± 0.5 % of range end value
Nominal voltage	8 V DC (Ri approx. 1 kΩ)
Operating voltage	5...25 V
Switch frequency, max	3 kHz

Isolated Switch Amplifiers are required for the alarm transmitter.

Recommended Amplifiers

Amplifier	Supply power	Channels
KFD2-SR2-Ex1.W	24 V DC	1
KFA5-SR2-Ex1.W	115 V AC	1
KFA6-SR2-Ex1.W	230 V AC	1
KFD5-SR2-Ex2.W	24 V DC	2
KFA5-SR2-Ex2.W	115 V AC	2
KFA6-SR2-Ex2.W	230 V AC	2

These Isolated Switch Amplifiers from Pepperl & Fuchs are examples. Others could also be used.

2.1.2 Indicator with Electrical Converter with/without Display VA Master FAM540-E/F

Design Features

- Flowrate indication or flow totalization (FAM540-F).
- Display can be added later.
- Electronic Min./Max. instrument alarms.
- Menu controlled configuration (FAM540-F).
- Configuration using HART-Communication from Handheld Terminal or DSV401 (SMART-VISION).
- Electronic linearization of the flow curve.
- Menu controlled configuration of the instrument without opening the housing using a Magnet Stick (FAM540-F).
- User configurable display (FAM540-F).
- For connection to all designs of primaries.
- Two housing designs:
  – Non-Ex and Ex designs
  – Ex housing design flameproof enclosure
- The same instrument for intrinsically safe or non-intrinsically safe installations.
- Explosion protection according to ATEX/IECEx Ex d, Ex ia, Ex nA, dust-ignition proof
- Changing the pressure and temperature values of the fluid possible at any time.
- Supply power
  – 10...46 V DC (Standard)
  – 10...28 V DC (Ex-Design)

Output Signals

Current output for flowrate signal: 4...20 mA

Binary Output

The function assigned to the binary output can be selected in the software as:

- Flowrate alarm: Min., Max. or Min.-Max.
- System alarm
- Pulse output: fmax 50 Hz;
  pulse width: 5...256 ms
- Standard: Optocoupler U_H = 16...30 V,
  I_L = 2...15 mA
- Ex ia: Configured as a NAMUR-Contact

Display (Design FAM540-F)

High contrast LC-Display. For indication of the instantaneous flowrate or totalized flow values.

Data can be entered in the plain text dialog using the 4 keys of the display (if the cover is closed use the magnet stick) or using digital communication via the HART protocol (FDT DTM interface, handheld).

2.1.3 Ordering Information FAM541

Fluid	Flowrate Range	Connection Size	Press. Drop [mbar]	Catalog No.				
Water	2.5...28 l/h	DN15; 1/2 inch	90	FAM541	A	Y0	D	L01
Water	5.0...50 l/h	DN15; 1/2 inch	90	FAM541	A	Y0	D	L02
Water	10...100 l/h	DN15; 1/2 inch	30	FAM541	A	Y0	D	L03
Water	25...250 l/h	DN15; 1/2 inch	60	FAM541	A	Y0	D	L04
Water	50...500 l/h	DN15; 1/2 inch	70	FAM541	A	Y0	D	L05
Liquid	Special scale*	DN15; 1/2 inch		FAM541	A	Y0	D	L06
Water	0.1...1m³/h	DN25; 1 inch	50	FAM541	A	Y0	D	L07
Water	0.25...2.5 m³/h	DN25; 1 inch	50	FAM541	A	Y0	D	L08
Water	0.4...4.0 m³/h	DN25; 1 inch	80	FAM541	A	Y0	D	L09
Liquid	Special scale*	DN25; 1 inch		FAM541	A	Y0	D	L10
Water	0.5...5.0 m³/h	DN50; 2 inch	30	FAM541	A	Y0	D	L11
Water	1.0...10.0 m³/h	DN50; 2 inch	50	FAM541	A	Y0	D	L12
Water	1.5...16.0 m³/h	DN50; 2 inch	70	FAM541	A	Y0	D	L13
Water	2.0...24.5 m³/h	DN50; 2 inch	80	FAM541	A	Y0	D	L14
Liquid	Special scale*	DN50; 2 inch		FAM541	A	Y0	D	L15
Water	5.0...50.0 m³/h	DN80; 3 inch	70	FAM541	A	Y0	D	L16
Liquid	Special scale*	DN80; 3 inch		FAM541	A	Y0	D	L17
Air 1.013 bar (a) 20°C	0.1...1.0 m³/h (Qn)	DN15; 1/2 inch	90	FAM541	A	Y0	D	G01
Air 1.013 bar (a) 20°C	0.25...2.75 m³/h (Qn)	DN15; 1/2 inch	30	FAM541	A	Y0	D	G02
Air 1.013 bar (a) 20°C	0.5...5.4 m³/h (Qn)	DN15; 1/2 inch	60	FAM541	A	Y0	D	G03
Air 1.013 bar (a) 20°C	1.5...15.0 m³/h (Qn)	DN15; 1/2 inch	70	FAM541	A	Y0	D	G04
Gas	Special scale*	DN15; 1/2 inch		FAM541	A	Y0	D	G05
Air 1.013 bar (a) 20°C	2.0...20.0 m³/h (Qn)	DN25; 1 inch	30	FAM541	A	Y0	D	G06
Air 1.013 bar (a) 20°C	5.0...50.0 m³/h (Qn)	DN25; 1 inch	30	FAM541	A	Y0	D	G07
Air 1.013 bar (a) 20°C	8.0...80.0 m³/h (Qn)	DN25; 1 inch	40	FAM541	A	Y0	D	G08
Gas	Special scale*	DN25; 1 inch		FAM541	A	Y0	D	G09
Air 1.013 bar (a) 20°C	10.0...120.0 m³/h (Qn)	DN50; 2 inch	20	FAM541	A	Y0	D	G10
Air 1.013 bar (a) 20°C	20.0...200.0 m³/h (Qn)	DN50; 2 inch	40	FAM541	A	Y0	D	G11
Gas	Special scale*	DN50; 2 inch		FAM541	A	Y0	D	G12
Air 1.013 bar (a) 20°C	50.0...500.0 m³/h (Qn)	DN80; 3 inch	40	FAM541	A	Y0	D	G13
Gas	Special scale*	DN80; 3 inch		FAM541	A	Y0	D	G14

	Indicator =	**A**			
Min. alarm contact	Indicator with Min. alarm =	B			
Max. alarm contact	Indicator with Max. alarm =	C			
Min/Max. alarm contact	Indicator with Min/Max. alarm =	D			
Signal output 4...20 mA	Indicator with 4...20 mA signal output =	E			
Signal output 4...20 mA with display	Indicator with 4...20 mA signal output with display =	F			
Without explosion protection			**Y0**		
Approval ATEX / IECEx zone 2			B1		
Approval ATEX / IECEx zone 1			A4		
	DIN-Flanges =			**D**	
	ASME CL 150 =			A	

* To design "special scales" we require the information in the questionnaire Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc.

2.1.4 Dimensions FAM541

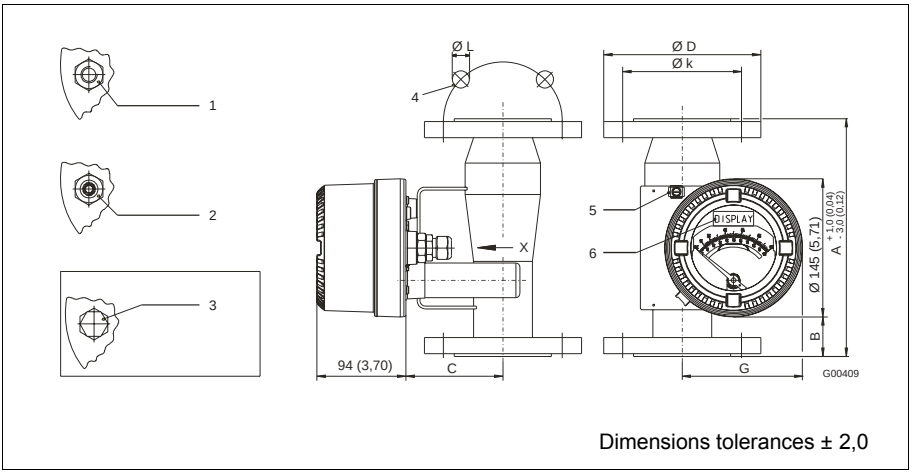


Bild 2-1: 1 Threaded socket 1/2" NPT
2 Cable entry M20 x 1.5
3 Threaded plug M25 x 1.5 (FAM541-A only)
4 N number of holes
5 Protective conductor
6 FAM541-F only

Meter size	Press. rating	Standard design							
	PN	DN	ø D	ø k	ø L	N	A	C	G
1/2”	40	15	95,0	65,0	14,0	4	250,0	87,0	118,0
	63	15	105,0	75,0	14,0	4	258,0	87,0	118,0
	100	15	105,0	75,0	14,0	4	258,0	87,0	118,0
	CL 150	1/2”	89,0	60,3	15,9	4	250,0	87,0	118,0
	CL 300	1/2”	95,2	66,7	15,9	4	250,0	87,0	118,0
	CL 600	1/2”	95,2	66,5	15,7	4	260,0	87,0	118,0
1”	40	25	115,0	85,0	14,0	4	250,0	87,0	118,0
	63	25	140,0	100,0	18,0	4	262,0	87,0	118,0
	100	25	140,0	100,0	18,0	4	262,0	87,0	118,0
	CL 150	1”	107,9	79,4	15,9	4	250,0	87,0	118,0
	CL 300	1”	123,8	88,9	19,0	4	250,0	87,0	118,0
	CL 600	1”	124,0	88,9	19,0	4	250,0	87,0	118,0
2”	40	50	165,0	125,0	18,0	4	250,0	102,0	130,0
	63	50	180,0	135,0	22,0	4	262,0	102,0	130,0
	100	50	195,0	145,0	26,0	4	266,0	102,0	130,0
	CL 150	2”	152,4	120,6	19,0	4	250,0	102,0	130,0
	CL 300	2”	165,1	127,0	19,0	8	250,0	102,0	130,0
	CL 600	2”	165,1	127,0	19,0	8	274,0	102,0	130,0

Continuation see next page

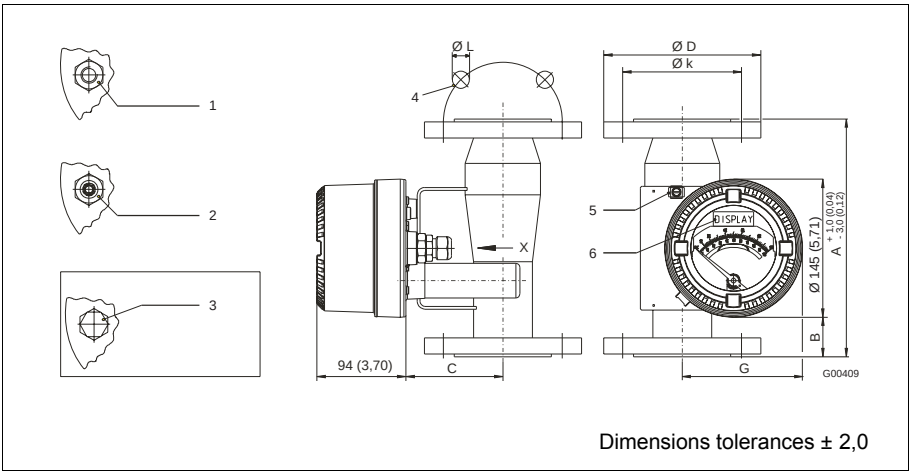


Bild 2-2: 1 Threaded socket 1/2" NPT
2 Cable entry M20 x 1.5
3 Threaded plug M25 x 1.5 (FAM541-A only)
4 N number of holes
5 Protective conductor
6 FAM541-F only

Meter size	Press. rating	Standard design							
	PN	DN	ø D	ø k	ø L	N	A	C	G
3”	40	80	200,0	160,0	18,0	8	250,0	132,0	144,0
	63	80	215,0	170,0	22,0	8	258,0	132,0	144,0
	100	80	230,0	180,0	26,0	8	272,0	132,0	144,0
	CL 150	3”	190,5	152,4	19,0	4	250,0	132,0	144,0
	CL 300	3”	209,5	168,3	22,2	8	250,0	132,0	144,0
	CL 600	3”	209,5	168,1	22,2	8	278,0	132,0	144,0
4”	16	100	220,0	180,0)	18,0	8	250,0	147,0	158,0
	40	100	235,0	190,0	22,0	8	250,0	147,0	158,0
	63	100	250,0	200,0	26,0	8	262,0	147,0	158,0
	CL 150	4”	228,6	190,5	19,0	8	250,0	147,0	158,0
	CL 300	4”	254,0	200,0	22,2	8	266,0	147,0	158,0

Alle dimensions in mm

Comments:
Installation lengths for PTFE lined flowmeters DN 25 [1”] PN 40 = 260 mm;
DN 50/80 [2”/3”]PN 40 = 375 mm. Others upon request

2.2 Armored Purgemeter

FAM3200

Application Range

With small Variable Area flowmeters in an all metal design it is possible, without difficulty, to meter under extreme conditions. Opaque liquids, often found in the chemical, petrochemical and pharmaceutical industries present no problems. But also in the laboratory, gas analysis systems and everywhere that glass tube flowmeters cannot be installed, the advantages of the small armored purgemeter come to the fore.

Standard Designs	
FAM3200-25	**Local indication**
FAM3200-25A	**Indicator with alarm transmitter, Min. alarm**
FAM3200-25B	**Indicator with alarm transmitter, Max. alarm**
FAM3200-25C	**Indicator with alarm transmitter, Min. + Max. alarm**
FAM3200-55	**Indicator with electrical converter, Output 4...20 mA**

Specifications – Standard Design	
Flow range	See Table, others upon request
Scale format	Direct reading
Accuracy Classes	6
Connections	NPTi vertical
Max. allowable pressure	100 bar
Max. allowable temperature	100 °C
Meter length	See Dimensions
Materials Fluid wetted parts Housing	 1.4571 [316Ti] /Viton-A Polycarbonate
Gas damping	For standard designs > 1/4“ integrated

Special Designs

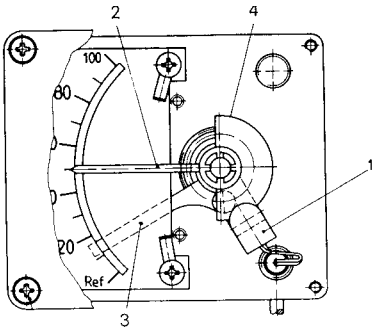
- With integrated needle valve in 1/4“
- With needle valve and differential pressure regulator
- With horizontal connections in 1/4“
- Higher flowrates in 1“
- Higher temperature limit to 150 °C

2.2.1 Specifications for Accessories

Alarm Signal Contacts for FAM3200-25A-C

Alarm signal contacts can be installed in the housing that respond for min.- and/or max. flowrates. They can be used to switch pumps, magnet valves, etc. (Fig. 2-3).

The alarm transmitter consists of a slot initiator and a switch amplifier. The switch amplifier is mounted external from the indicator housing. A control vane activates the switch when it enters the slot initiator. The slot initiator setting can be adjusted using a screwdriver.



1 Slot Initiator
2 Pointer
3 Alarm Adjustment
4 Control Vane

Fig. 2-3: Armored Purgemeter FAM3200-25;
Indicator with Single alarm

Alarm point setting	Single alarm min. 0...60 %, max. 40...100 %; Minimum double alarm settings approx. 5 %
Setting accuracy	± 2 % of rate

Electrical Converter FAM3200-55

Attention!
Model FAM3200-55 is a flowmeter with a built-in angular transducer. The transducer is mounted on the axle of the pointer and transforms the pointer position into a flowrate proportional 4...20 mA output current. The Models with angular transducers **may not be installed in Ex-Areas.**

Output signal 4...20 mA, 2-Wire	$U_{max.}$ = 30 V; $I_{max.}$ = 30 mA
Ambient temperature	-20 °C...+40 °C

2.2.2 Ordering Information FAM3200-25/-55

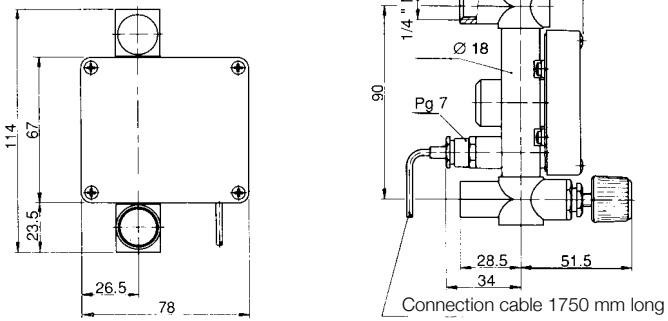
Fluid	Flow Range	Connec-tion Size	Press. Drop in [mbar]	Catalog No.			
Water	0.1...1 l/h	1/4" NPTi	10	D10A32	25	O	L01
Water	0.2...2.5 l/h	1/4" NPTi	10	D10A32	25	O	L02
Water	0.6...6 l/h	1/4" NPTi	10	D10A32	25	O	L03
Water	1...10 l/h	1/4" NPTi	10	D10A32	25	O	L04
Water	2...25 l/h	1/4" NPTi	10	D10A32	25	O	L05
Water	4...40 l/h	1/4" NPTi	15	D10A32	25	O	L06
Water	6...60 l/h	1/4" NPTi	15	D10A32	25	O	L07
Water	10...100 l/h	1/4" NPTi	20	D10A32	25	O	L08
Liquid	Special scale*	1/4" NPTi		D10A32	25	O	L09
Water	20...225 l/h	3/8" NPTi	70	D10A32	25	O	L10
Liquid	Special scale*	3/8" NPTi		D10A32	25	O	L11
Water	40...250 l/h	1/2" NPTi	100	D10A32	25	O	L12
Water	60...800 l/h	1/2" NPTi	125	D10A32	25	O	L13
Liquid	Special scale*	1/2" NPTi		D10A32	25	O	L14
Air 1.013 bar (a) 20 °C	8...44 l/h (Qn)	1/4" NPTi	10	D10A32	25	O	G01
Air 1.013 bar (a) 20 °C	16...96 l/h (Qn)	1/4" NPTi	10	D10A32	25	O	G02
Air 1.013 bar (a) 20 °C	30...125 l/h (Qn)	1/4" NPTi	10	D10A32	25	O	G03
Air 1.013 bar (a) 20 °C	80...330 l/h (Qn)	1/4" NPTi	10	D10A32	25	O	G04
Air 1.013 bar (a) 20 °C	120...250 l/h (Qn)	1/4" NPTi	10	D10A32	25	O	G05
Air 1.013 bar (a) 20 °C	180...800 l/h (Qn)	1/4" NPTi	10	D10A32	25	O	G06
Air 1.013 bar (a) 20 °C	200...1200 l/h (Qn)	1/4" NPTi	15	D10A32	25	O	G07
Air 1.013 bar (a) 20 °C	300...1800 l/h (Qn)	1/4" NPTi	15	D10A32	25	O	G08
Air 1.013 bar (a) 20 °C	250...3000 l/h (Qn)	1/4" NPTi	20	D10A32	25	O	G09
Gas	Special scale*	1/4" NPTi		D10A32	25	O	G10
Air 1.013 bar (a) 20 °C	800...4800 l/h (Qn)	3/8" NPTi	80	D10A32	25	O	G11
Air 1.013 bar (a) 20 °C	600...8800 l/h (Qn)	3/8" NPTi	170	D10A32	25	O	G12
Gas	Special scale*	3/8" NPTi		D10A32	25	O	G13
Air 1.013 bar (a) 20 °C	2000...12000 l/h (Qn)	1/2" NPTi	90	D10A32	25	O	G14
Air 1.013 bar (a) 20 °C	2000...17000 l/h (Qn)	1/2" NPTi	110	D10A32	25	O	G15
Air 1.013 bar (a) 20 °C	2000...23000 l/h (Qn)	1/2" NPTi	125	D10A32	25	O	G16
Gas	Special scale*	1/2" NPTi		D10A32	25	O	G17

Options:	Local indication with/without alarm =	**25**		
4...20 mA output signal	Local ind. w/ 4...20 mA output signal =	55		
	Local indication=		**O**	
Min. alarm contact	Indicator with Min. alarm =		A	
Max. alarm contact	Indicator with Max. alarm =		B	
Min./ Max. alarm contact	Indicator with Min./Max. alarm =		C	

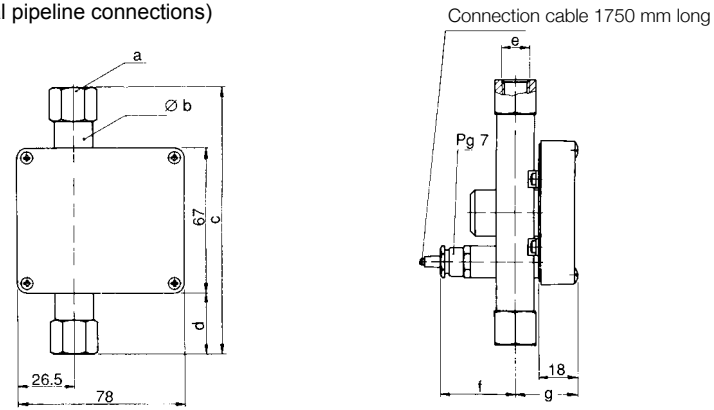
* To design "special scales" we require the information in the questionnaire (page 21)
Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc.

2.2.3 Dimensions FAM3200-20/-25

FAM3200-20 ≤ 100 l/h Water
(Horizontal pipeline connections)



FAM3200-25 ≤ 800 l/h Water
(Vertical pipeline connections)



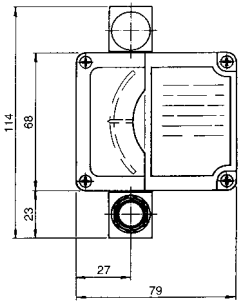
	a	Øb	c	d	e	f	g	Model
Flow range ≤ 100 l/h Water	SW19	18	125	29	1/4" NPT	34	29	FAM3200-20/-25
Flow range 100 l/h to 300 l/h Water	SW24	25	164	48.5	3/8" NPT	30.5	32.5	FAM3200-20/-25
Flow range ≤ 400 l/h to 800 l/h Water	SW27	25	164	48.5	1/2 NPT	30.5	32.5	FAM3200-20/-25
Flow range 800 l/h to 3000 l/h Water	SW50	50	230	81	1" G 1" NPT	18	45/50	FAM3200-20/-25

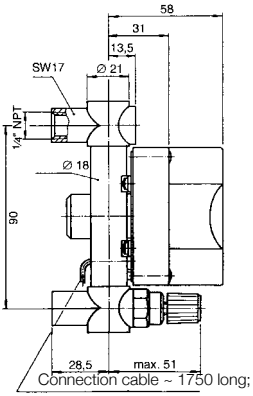
SW = Size of Wrench

Fig. 2-4: FAM3200-20/-25 to 800 l/h Water

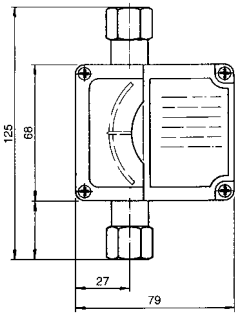
2.2.4 Dimensions FAM3200-50/-55

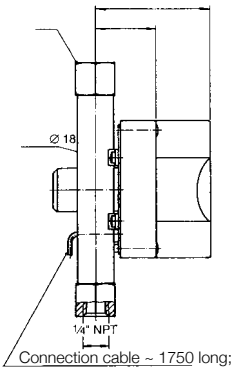
FAM3200-50 ≤ 100 l/h Water
Armored Purgemeter
with Electronic Converter





FAM3200-55 ≤ 800 l/h Water
Armored Purgemeter
with Electronic Converter





	a	∅b	c	d	e	f	g	Model
Flow range ≤ 100 l/h Water	SW19	18	125	29	1/4" NPT	31	58	FAM3200-50/-55
Flow range 100 l/h to 300 l/h Water	SW24	25	164	48.5	3/8" NPT	34.5	61.5	FAM3200-50/-55
Flow range ≤ 400 l/h to 800 l/h Water	SW27	25	164	48.5	1/2 NPT	34.5	61.5	FAM3200-50/-55
Flow range 800 l/h to 3000 l/h Water	–	–	–	–	1" G 1" NPT	–	–	FAM3200-50/-55

SW = Size of Wrench

Fig. 2-5: FAM3225 (10A3225) 800 to 3000 l/h Water

2.3 Glass Tube Flowmeter

FAG1190

Application Range

This universal, rugged measurement instrument for liquids and gases is used in many sectors of industry, e.g., system apparatus manufacture, water treatment facilities, food and beverage industries and the chemical sector. The availability of a wide range of available fluid wetted material combinations make the flowmeter suitable for metering aggressive fluids.

Standard Design	
FAG1190-97	**Local indication** **With Options:** **Add-on alarm transmitter Model 55AX1000 for** **Min. alarm** **Max. alarm or** **Min. + Max. alarm**

Specifications – Standard Design	
Flow range	See Table, others upon request
Scale format	Direct reading
Accuracy Classes	1.6
Connections	R-internal threads, vertical, see Table
Max. allowable pressure	See Table
Max. allowable temperature	Liquids 150 °C; Gases 100 °C
Meter length	See Dimensions
Materials Meter tube Fittings O-rings Floats	 Borosilicate glass 1.4571 [316Ti] Viton-A 1.4571 [316Ti]
Mounting design	Pipeline mount
Burst protection	Integrated for gas measurements

Special Designs

- Additional flow ranges
- Designs with threaded stubs per DIN 11851
- Designs with flanged connections
- Diverse materials available for other fluids
- Special float designs for minimal pressure drop and larger flowrates
- Designs for panel mounting to R 1“
- Separate needle valve

2.3.1 Ordering Information FAG1190

Fluid	Flow Range	Connection Size	Press. Drop [mbar]	Allow. Press.* [bar]	Catalog No.		
Water	0.4...6.6 l/h	R1/4"		30	D10A1197	0	L01[3]
Water	2...25 l/h	R1/4"		30	D10A1197	0	L02[3]
Water	3...49 l/h	R1/4"		30	D10A1197	0	L03[3]
Water	10...90 l/h	R1/4"		30	D10A1197	0	L04[3]
Liquid	Special scale*	R1/4"		30	D10A1197	0	L05[3]
Air 1.013 bar (a) 20 °C	20...350 cm^3/min (Qn)	R1/4"		30	D10A1197	0	G01[2)3)]
Air 1.013 bar (a) 20 °C	40...660 cm^3/min (Qn)	R1/4"		30	D10A1197	0	G02[2)3)]
Air 1.013 bar (a) 20 °C	80...1000 cm^3/min (Qn)	R1/4"		30	D10A1197	0	G03[2)3)]
Air 1.013 bar (a) 20 °C	0.2...2.7 l/min (Qn)	R1/4"		30	D10A1197	0	G04[2)3)]
Air 1.013 bar (a) 20 °C	0.4...5 l/min (Qn)	R1/4"		30	D10A1197	0	G05[2)3)]
Air 1.013 bar (a) 20 °C	1...13 l/min (Qn)	R1/4"		30	D10A1197	0	G06[2)3)]
Air 1.013 bar (a) 20 °C	1.5...22 l/min (Qn)	R1/4"		30	D10A1197	0	G07[2)3)]
Air 1.013 bar (a) 20 °C	6...46 l/min (Qn)	R1/4"		30	D10A1197	0	G08[2)3)]
Air 1.013 bar (a) 20 °C	10...65 l/min (Qn)	R1/4"		30	D10A1197	0	G09[2)3)]
Gas	Special scale*	R1/4"		30	D10A1197	0	G10[2)3)]
Water	4...53 l/h	R1/2"	5	21	D10A1197	0	L05[3]
Water	12...110 l/h	R1/2"	10	21	D10A1197	0	L06[3]
Water	12...158 l/h	R1/2"	20	21	D10A1197	0	L07
Water	20...255 l/h	R1/2"	20	21	D10A1197	0	L08
Liquid	Special scale*	R1/2"		21	D10A1197	0	L09
Water	35...445 l/h	R3/4"	15	17	D10A1197	0	L10
Water	50...610 l/h	R3/4"	20	17	D10A1197	0	L11
Water	60...810 l/h	R3/4"	30	17	D10A1197	0	L12
Liquid	Special scale*	R3/4"		17	D10A1197	0	L13
Water	80...1060 l/h	R1"	30	14	D10A1197	0	L14
Water	140...1700 l/h	R1"	50	14	D10A1197	0	L15
Water	200...2500 l/h	R1"	90	14	D10A1197	0	L16
Liquid	Special scale*	R1"		14	D10A1197	0	L17
Water	250...3050 l/h	R1-1/2"	40	9	D10A1197	0	L18
Water	300...4000 l/h	R1-1/2"	40	9	D10A1197	0	L19
Water	400...4800 l/h	R1-1/2"	50	9	D10A1197	0	L20
Liquid	Special scale*	R1-1/2"		9	D10A1197	0	L21
Water	500...6000 l/h	R2"	50	7	D10A1197	0	L22
Water	600...7900 l/h	R2"	60	7	D10A1197	0	L23
Water	1800...9600 l/h	R2"	80	7	D10A1197	0	L24
Liquid	Special scale*	R2"		7	D10A1197	0	L25
Air 1.013 bar (a) 20 °C	0.18...1.7 m3/h (Qn)	R1/2"	5	17	D10A1197	0	G10[2)3)]
Air 1.013 bar (a) 20 °C	0.2...2.75 m3/h (Qn)	R1/2"	5	17	D10A1197	0	G11[2)3)]
Air 1.013 bar (a) 20 °C	0.3...3.9 m3/h (Qn)	R1/2"	10	17	D10A1197	0	G12[2)3)]
Air 1.013 bar (a) 20 °C	0.4...5.3 m3/h (Qn)	R1/2"	15	17	D10A1197	0	G13[2)3)]
Gas	Special scale*	R1/2"		17	D10A1197	0	G14[2)3)]
Air 1.013 bar (a) 20 °C	0.6...7.5 m3/h (Qn)	R3/4"	5	13	D10A1197	0	G15[2)3)]
Air 1.013 bar (a) 20 °C	1...12.8 m3/h (Qn)	R3/4"	20	13	D10A1197	0	G16[2)]
Air 1.013 bar (a) 20 °C	1.4...17.6 m3/h (Qn)	R3/4"	20	13	D10A1197	0	G17[2)]

Continued on next page

Continuation Ordering Information FAG1190

Fluid	Flowrate Range	Connection Size	Press. Drop [mbar]	Allow. Press. *	Catalog No.		
Gas	Special scale*	R3/4"					
Air 1.013 bar (a) 20 °C	1.6...20.8 m3/h (Qn)	R1"	15	10	D10A1197	0	G18[2)3)]
Air 1.013 bar (a) 20 °C	2.5...30.5 m3/h (Qn)	R1"	30	10	D10A1197	0	G19[2)]
Air 1.013 bar (a) 20 °C	3.5...43 m3/h (Qn)	R1"	40	10	D10A1197	0	G20[2)]
Air 1.013 bar (a) 20 °C	5...57 m^3/h (Qn)	R1"	50	10	D10A1197	0	G21[2)]
Gas	Special scale*	R1"		10	D10A1197	0	G22[2)]
Air 1.013 bar (a) 20 °C	2.5...28.5 m3/h (Qn)	R1-1/2"	10	4	D10A1197	0	G23[2)3)]
Air 1.013 bar (a) 20 °C	6...56 m^3/h (Qn)	R1-1/2"	20	4	D10A1197	0	G24[2)3)]
Gas	Special scale*	R1-1/2"		4	D10A1197	0	G25[2)3)]
Air 1.013 bar (a) 20 °C	8...102 m^3/h (Qn)	R2"	30	2	D10A1197	0	G23[2)3)]
Gas	Special scale*	R2"		2	D10A1197	0	G26[2)3)]

Options:	no alarm contact =	**0**
Min. alarm contact	with Min. alarm contact =	1
Max. alarm contact	with Max. alarm contact =	2
Min./ Max. alarm contact	with Min./ Max. alarm contact =	3

Accessories: Switch Amplifier
Model
Single alarm 230V AC, 50/60 Hz
Single alarm 115V AC, 50/60 Hz
Single alarm 24V DC

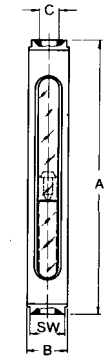
Double alarm 230V AC, 50/60 Hz
Double alarm 115V AC, 50/60 Hz
Double alarm 24V DC

* To design special scales we require the parameters listed in the Questionnaire. Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc..
2) with Polycarbonate protection tube for gas applications
3) not available with alarms, we will be glad to suggest alternative solutions

Reductions to the max. allow. pressure
For meter pipe sizes 1"...2" the max. allow. pressure is reduced by 1 % for every 2 °C at operating temperatures above 95 °C.
The reduced pressures for gas applications result from safety considerations.
The strength of the Polycarbonate protection tube is reduced as the temperature increases.
Therefore further restrictions must be observed when metering gases:

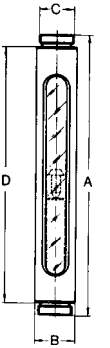
- Listed max. allow. operating pressure is for 30 °C fluid temperature and 30 °C ambient temperature
- Max. ambient temperature 40 °C
- Max. fluid temperature 100 °C
- For fluid or ambient temperatures over 30 °C the max. allow. operating pressure is reduced by 1.05 % / 1 °C.

2.3.2 Dimensions FAG1190



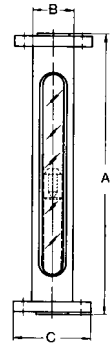
FAG1190-97 (P)

Meter Tube Size	Threaded Connections			Size of Wrench SW	Weight ca. kg
	C	A ±1	∅ B		
1/16"/1/8"/1/4"	G 1/4	260	29	27	0.5
1/2"	G 1/2	405	40	36	1.7
3/4"	G 3/4	405	53	50	2.3
1"	G1	405	58.5	55	2.7
1 1/2"	G1 1/2	420	78	65	4.4
2"	G2	420	97	85	6.5



FAG1190-97 (V)

Meter Tube Size	Threaded Stubs per DIN 11851 DIN 405 Part 1					
	∅ B	C	Threaded Stubs	A	D	Weight ca. kg
1/2"	40	Rd 34 x 1/8"	SC 15	423	383	1.7
3/4"	53	Rd 44 x 1/6"	SC 20	423	379	2.3
1"	58.5	Rd 52 x 1/6"	SC 25	423	379	2.7
1 1/2"	78	Rd 65 x 1/6"	SC 40	441	393	4.4
2"	97	Rd 78 x 1/6"	SC 50	437	390	6.5



FAG1190-98 (P)

Meter Tube Size	Flanged Connections per DIN 2501						ANSI - Drilled for CL 300							
	DN	PN	C	k	No. of Holes	d2	DN	C	k	No. of Holes	d2	A±1	∅ B	Wgt.. ca. kg
1/16"/1/8"/1/4"	10	40	90	60	4	14	1/2"	95.2	66.7	4	15.9	270	29	1.4
1/2"	15	40	95	65	4	14	1/2"	95.2	66.7	4	15.9	415	40	2.4
3/4"	20	40	105	75	4	14	3/4"	117.5	82.6	4	19.0	415	53	3.5
1"	25	40	115	85	4	14	1"	123.8	88.9	4	19.0	415	58.5	4.7
1 1/2"	40	16	150	110	4	18	11/2"	156.6	114.3	4	22.5	425	78	7.5
2"	50	16	165	125	4	18	2"	165.1	127.0	8	19.0	425	97	10.0

Fig. 2-6: Dimensions

2.4 Glass Tube Purgemeter

FAG6100

Application Range

This universally applicable Variable Area flowmeter is especially suitable for metering and injecting small flowrates of liquids and gases.
The application range includes, among others, the gas analysis sector, biotechnology, medical technology, system apparatus manufacture and the laboratory.

Standard Design	
FAG6100-41	**Local indication, 70 mm scale length**
FAG6100-42	**Local indication, 130 mm scale length**
	Each with options: **Add-on alarm transmitter Model 55AN3000 for** **Min. alarm** **Max. alarm or** **Min. + Max. alarm**
Specifications – Standard Design	
Flow range	See Table, others upon request
Scale format	Direct reading
Accuracy Classes	6 (70 mm-scale); 2.5 (130 mm-scale)
Connections	R 1/4"-internal threads, horizontal
Max. allowable pressure	18 bar
Max. allowable temperature	0...150 °C
Meter length	See Dimensions
Materials Meter tube Fittings O-rings Floats	 Borosilicate glass 1.4401 [316] Viton-A 1.4401[316] (SS); Carboloy (CA); Glass (BG, CD)
Mounting design	Pipeline mount/panel mount M5 x 20
Burst protection	Polycarbonate
Needle valve	Integrated in inlet
Special Designs	
• Diverse materials available for other fluids • Without needle valve or with valve in outlet • Panel or laboratory stand mounting • Design with add-on differential pressure regulator for constant flowrate	

2.4.1 Ordering Information FAG6100-41

Fluid	Flow Range	Float	Catalog No.		
Water	0.8...5.4 l/h	SS-18	10A6141	0	L01
Water	2...23 l/h	SS-14	10A6141	0	L02
Water	10...75 l/h	SS-14	10A6141	0	L03
Water	15...105 l/h	CA-14	10A6141	0	L04
Liquid	Special scale*		10A6141	0	L05
Air 1.013 bar (a) 20 °C2)	40...340 cm^3/min (Qn)	BG-18	10A6141	0	G01
Air 1.013 bar (a) 20 °C	100...850 cm^3/min (Qn)	SS-18	10A6141	0	G02
Air 1.013 bar (a) 20 °C2)	150...1500 cm^3/min (Qn)	BG-18	10A6141	0	G03
Air 1.013 bar (a) 20 °C	0.2...3 l/min (Qn)	SS-18	10A6141	0	G04
Air 1.013 bar (a) 20 °C2)	0.8...6 l/min (Qn)	CD-14	10A6141	0	G05
Air 1.013 bar (a) 20 °C	1.5...12 l/min (Qn)	SS-14	10A6141	0	G06
Air 1.013 bar (a) 20 °C	2...24 l/min (Qn)	CA-14	10A6141	0	G07
Air 1.013 bar (a) 20 °C	4...38 l/min (Qn)	SS-14	10A6141	0	G08
Gas	Special scale*		10A6141	0	G09

Options:	Without alarm contact =	**0**
Min. alarm contact	Min. alarm contact =	1
Max. alarm contact	Max. alarm contact =	2
Min./Max. alarm contact	Min/Max. alarm contact =	3

Accessories: Switch amplifier
Model
Single alarm 230 V AC, 50/60 Hz
Single alarm 115 V AC, 50/60 Hz
Single alarm 24 V DC

Double alarm 230 V AC, 50/60 Hz
Double alarm 115 V AC, 50/60 Hz
Double alarm 24 V DC

* To design "special scales" we require the information in the questionnaire (page 21)
Our Expert Team will gladly answer any questions you may have regarding your
2) not available with alarms, we will be glad to suggest alternative solutions

Ordering Information FAG6100-42

Fluid	Flow Range	Float	Catalog No.		
Water	0.4...6.6 l/h	SS-18	10A6142	0	L01
Water	2...25 l/h	SS-14	10A6142	0	L02
Water	3...49 l/h	CA-14	10A6142	0	L03
Water	10...90 l/h	SS-14	10A6142	0	L04
Liquid	Special scale*		10A6142	0	L05
Air 1.013 bar (a) 20 °C	8...125 cm^3/min (Qn)	SS-16	10A6142	0	G01
Air 1.013 bar (a) 20 °C2)	20...350 cm^3/min (Qn)	BG-18	10A6142	0	G02
Air 1.013 bar (a) 20 °C2)	40...660 cm^3/min (Qn)	BG-18	10A6142	0	G03
Air 1.013 bar (a) 20 °C2)	80...1000 cm^3/min (Qn)	BG-18	10A6142	0	G04
Air 1.013 bar (a) 20 °C	0.2...2.7 l/min (Qn)	SS-18	10A6142	0	G05
Air 1.013 bar (a) 20 °C	0.4...5 l/min (Qn)	CA-18	10A6142	0	G06
Air 1.013 bar (a) 20 °C	1...13 l/min (Qn)	SS-14	10A6142	0	G07
Air 1.013 bar (a) 20 °C	1.5...22 l/min (Qn)	SS-14	10A6142	0	G08
Air 1.013 bar (a) 20 °C	6...46 l/min (Qn)	SS-14	10A6142	0	G09
Air 1.013 bar (a) 20 °C	10...65 l/min (Qn)	CA-14	10A6142	0	G10
Gas	Special scale*		10A6142	0	G11

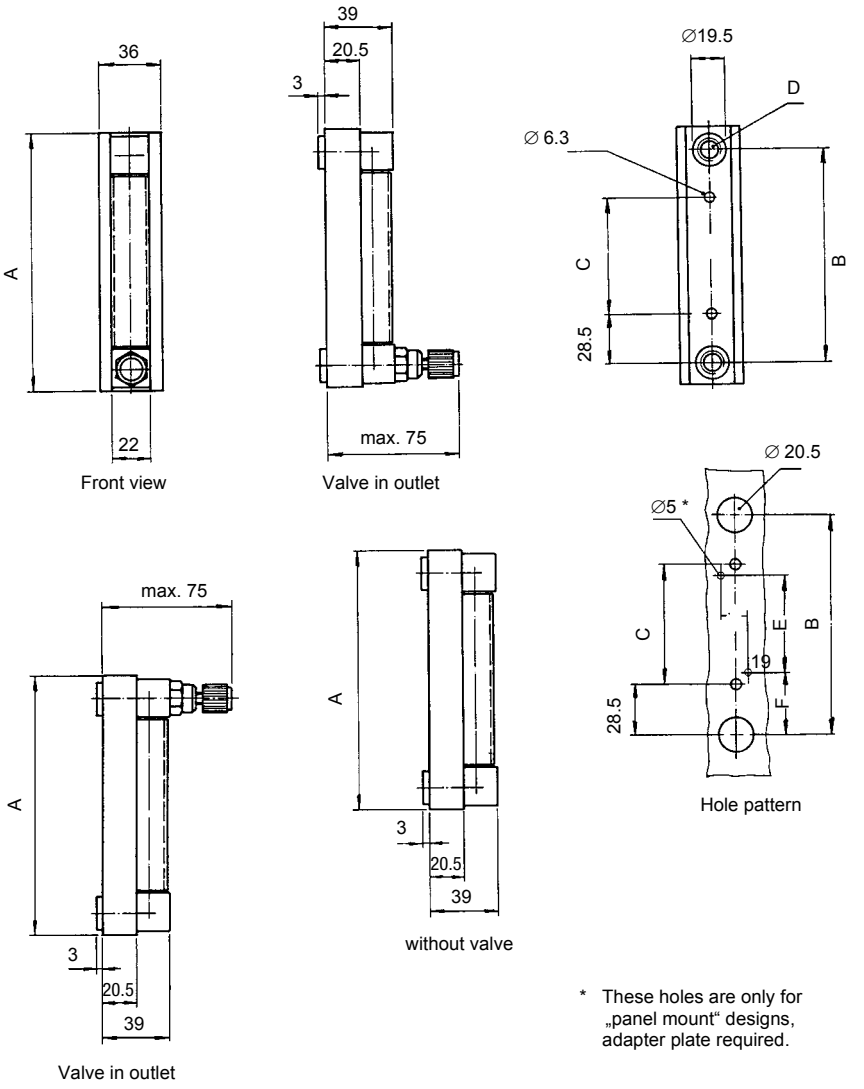
Options:	Without alarm contact =	**0**	
Min. alarm contact	Min. alarm contact =	1	
Max. alarm contact	Max. alarm contact =	2	
Min./Max. alarm contact	Min/Max. alarm contact =	3	

Accessories: Switch amplifier
Model
Single alarm 230 V AC, 50/60 Hz
Single alarm 115 V AC, 50/60 Hz
Single alarm 24 V DC

Double alarm 230 V AC, 50/60 Hz
Double alarm 115 V AC, 50/60 Hz
Double alarm 24 V DC

* To design "special scales" we require the information in the questionnaire (page 21)
Our Expert Team will gladly answer any questions you may have regarding your operating conditions, pressure drop etc..
2) not available with alarms, we will be glad to suggest alternative solutions

2.4.2 Dimensions FAG6100



Dimensions:

D		F	E	C	B	A	Scale Length	Model No.
G 1/4	1/4” NPT	36.5	165	181	238	264	5”	FAG6100-42
G 1/4	1/4” NPT	27.2	71	68	125	151	3”	FAG6100-41

Fig. 2-7: Pipeline and Panel Mounting

3 Material Selections for Variable Area Flowmeters

This selection does not claim to be complete, however it does offer ease when selecting materials. At the present time these recommendations are based on laboratory tests by the material manufacturers or upon repetitve applications in practice. When in doubt the material recommendations should be obtained from the manufacturer since he has the most expreience. Not included are the ball floats sizes 1/16" to 1/4". If a glass meter tube is sutiable for the application, then the assumption that a ball float made of glass or sapphire should also be suitable can be made.

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flowmeters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Acetaldehyde						×				×									×	×	×		
Acetic Acid	60	20				x				x									x	x	x		
Acetic Acid	98.5 99.9	25				x				x									x	x	x		
Acetic Anhydride						x				x									x	x	x		
Acetone			×		×					×		×							×	×	×		
Acetylene			×		×					×		×					×			×	×		
Acrid salt, see Mangnesium Sulfate																							
Acrolein						×				×								a.A.		×	×		
Air			x		x	x				x	x	x					x			x	x		
Alaun, see Kalialaun																							
Alcohol			×			×				×		×					×			×	×		
Aluminium Sulfate						×	×			×	×						×			×	×		
Ammonia gas					×	×	×			×	×	×					×			×	×		
Ammonia liquid						×				×							×			×	×		
Ammonia solution	1	25			×	×	×			×	×	×					×			×	×		
Ammonium Carbonate					×	×				×		×							×	×	×		
Ammonium Chloride							×				×					×	×			×			
Ammonium Hydroxide					×	×				×		×							×	×	×		
Ammonium Nitrate						x				x							x			x	x		
Ammonium Phosphate						x				x							x			x	x		
Ammonium Sulfate						x				x							x			x	x		
Amyl Acetate						x				x									x	x	x		
Amyl Alcohol			x		x	x				x		x							x	x	x		
Amyl Chloride			x		x					x		x							x		x	x	
Aniline					x	x				x		x							x	x	x		
Antichlor, see Sodium Thiosulfate																							

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Argon			x		x					x	x	x					x			x	x		
Asphalt										x											x		
ATE-Brake Fluid			x							x		x					x			x	x		
Äthancarbonsäure						×				×							×			×	×		
Äthanolamin					×	×				×		×					×			×	×		
Barium Chloride									x							x	x			x			x
Barium Hydroxide					x	x				x		x					x			x	x		
Barium Nitrate						x				x							x			x	x		
Barium Sulfide						x				x							x			x	x		
Benzaldehyde					x					x		x							x	x	x		
Benzine			x		x					x		x					x			x	x		
Benzoic Acid						x				x								x		x	x		
Benzol			x		x					x		x						x		x	x		
Blood						x				x							x			x	x		
Boiler water										x											x		
Borax					x					x		x							x	x	x		
Boric Acid						x				x							x			x	x		
Boron Chloride					x					x		x						x		x	x		
Botyl Alcohol			x							x		x					x			x	x		
Brine	50-65								x				x			x	x			x			x
Bromine gas									x							x		x		x			x
Bromwasserstoffsäure									x							x		x		x			x
Bunker C Oil										x											x		
Butadiene			x		x					x		x							x	x	x		
Butane			x		x					x		x					x			x	x		
Butane, Iliquid			x		x					x		x					x			x	x		
Butyl Acetate			x		x					x		x							x	x	x		
Butylene			x							x		x					x			x	x		
Butyric acid						x				x									x	x	x		
Calcium Bisulfite							x		x		x		x				x			x			x
Calcium Chloride		40					x		x		x		x			x	x			x			x
Calcium Chloride		>40							x				x			x	x			x			x
Calcium Hydroxide					x	x				x			x				x			x	x		
Calcium Hypochloride								x	x							x		x		x			x
Carbolic Acid (Phenol)						x							x			x		x		x			x
Carbon Bisulfide					x	x				x		x						x		x	x		
Carbon Dioxide			x		x	x				x		x					x			x	x		

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Carbon Monoxide			x		x	x				x		x					x			x	x		
Carbonic Acid						x				x									x	x	x		
Carbonic Acid			x			x				x		x					x			x	x		
Caustic potash, see Calcium Hydroxide																							
Caustic Soda	> 20	20			x	x				x		x							x	x	x		
Caustic Soda	> 20	> 20								x											x		
Caustic Soda, see Sodium Hydroxide																							
Cellulose Acetate						x				x		x					x				x		
Chlorine (dry gas)					x								x					x		x	x		
Chlorine (wet gas)								x	x				x			x		x		x			x
Chlorine Dioxide (dry gas)					x				x				x		x	x		x		x			x
Chlorine line	3	30					x						x			x		x		x			x
Chlorine Water		20					x		x		x		x			x		x		x			x
Chloroform			x		x	x				x		x						x		x	x		
Chromic Acid	50	40					x		x		x		x → @ 20 %			x		x		x			x
Chromic Acid, pure, SO3-free	10-50					x				x								x		x	x		
Citric Acid						x				x							x			x	x		
Chlorine (liquid)					x			x	x				x			x		x		x			x
Condopal			x							x		x						x		x	x		
Condorid-S						x	x			x	x						x			x	x		
Copper Chloride		20					x		x		x		x			x	x			x			x
Copper Sulfate						x				x							x			x	x		
Creosote					x	x				x		x					x			x	x		
Crude Oil										x											x		
Cyclohexane					x	x				x		x						x		x	x		
Cyclohexanol					x	x				x		x					x			x	x		
Cyclohexanole					x	x				x		x							x	x	x		
Cyclopropane			x		x	x				x		x					x			x	x		
Diacetone			x		x	x				x		x							x	x	x		
Diacetone Alcohol			x		x	x				x		x							x	x	x		
Diboran						x				x								x		x	x		
Dibutylphtalate						x				x									x	x	x		
Dichlormethane						x				x								x		x	x		
Diesel Oil, light					x					x		x					x			x	x		
Diethylene Glycol					x	x				x		x					x			x	x		

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Diisopropylekton						x				x									x	x	x		
Dimethylether, see Ether, Methyl																							
Diphenyl					x					x		x						x		x	x		
Dye, color not transparent										x											x		
Dye, color transparent					x	x				x		x							x	x	x		
Electrolyte Solution		40					x		x		x					x		x		x			x
Electrolyte Solution	>40	100							x							x		x		x			x
Ethane			×		×					×		×					×			×	×		
Ether, Methyl, Ethyl			×		×					×		×					×			×	×		
Ethyl Acetate					×	×				×		×						×		×	×		
Ethyl Acrylate					×	×				×		×							×	×	×		
Ethyl Alcohol			×		×					×		×					×			×	×		
Ethyl Cellulose					×	×				×		×					×			×	×		
Ethyl Ether			×		×					×		×					×			×	×		
Ethylene Chloride					×	×				×		×					×			×	×		
Ethylene			×		×					×		×					×			×	×		
Ethylene Chlorohydrin					×	×				×		×						×		×	×		
Ethylene Diamine						×				×							×		×	×	×		
Ethylene Dichloride						×				×								×		×	×		
Ethylene Glycol					×	×				×		×							×	×	×		
Ethylene Oxide					×	×				×		×							×	×	×		
Fatty Acid						☐				☐								☐		☐	☐		
Ferric-II-Chloride							x		x		x		x			x	x			x			x
Ferric-III-Chloride							x		x		x		x			x	x			x			x
Ferric-III-Chloride (high conc.& temp.)							x		x							x							x
Ferric-III-Sulfate						x				x							x			x	x		
Ferric-II-Sulfate						x				x							x			x	x		
Flour													x			x							x
Formaldehyde (Formalin)						x				x							x			x	x		
Formic Acid	0-100	80				×							×				×			×	×		
Frigen (note type)			x		x	x				x		x					m			x	x		
Gelantin						x				x							x			x	x		
Glucose					x	x				x		x					x			x	x		
Glycerine					x	x				x	x						x			x	x		
Glysantin			x		x	x				x		x					x			x	x		

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Heating Oil			x		x	x				x		x					x			x	x		
Helium			x		x	x				x		x					x			x	x		
Heptane					x	x				x		x						x		x	x		
Hexane					x	x				x		x						x		x	x		
Hydraulic Oil			x		x	x				x		x					x			x	x		
Hydrochloric Acid							x		x		x					x		x			x		x
Hydrochloric Acid, all concentrations		max. 25														x							x
Hydrochloric Gas (HCL-Gas)						x	x		x		x		x			x	x			x			x
Hydrogen			x		x	x				x		x					x			x	x		
Hydrogen Peroxide						x				x								x		x	x		
Hydrogen Sulfide, dry					x	x	x			x	x								x	x	x		
Hydrogen Sulfide, wet						x				x									x	x	x		
Illuminating gas					x	x				x		x					x			x	x		
Iodine solution	10	65							x				x			x			x				x
Isobutylacetate			x		x	x				x		x							x	x	x		
Isobutylene						x				x							x			x	x		
Isocyanate						x				x									x	x	x		
Jet Fuel JP 1 & 4			x		x	x				x		x						x		x	x		
Kalialaun	105	20				x				x							x			x	x		
Kaliumjodid					x	x				x		x					x			x	x		
Kerosene			x		x	x				x		x						x		x	x		
Krypton			x		x	x				x		x					x			x	x		
Lactid acid						x				x							x			x	x		
Latex										x											x		
Laughing gas (Nitrous Oxide)			x		x	x				x		x					x			x	x		
Linseed Oil					x	x				x		x					x			x	x		
Lithium Chloride							x		x		x					x	x			x			x
Machine Oil - not transparent										x											x		
Machine Oil - transparent			x		x	x				x		x					x			x	x		
Mahic acid						x				x							x			x	x		
Mahic acid						x				x									x	x	x		
Mahic acid		<40 >40				x			x	x						x	x	x		x x	x		x
Manganese Sulfate						x				x							x			x	x		

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Magnesium Chloride							x		x		x		x			x	x			x			x
Magnesium Hydroxide					x	x				x		x					x			x	x		
Magnesium Nitrate					x	x				x		x					x			x	x		
Magnesium Sulfate = Acrid salt					x	x				x		x					x			x	x		
Mercaptan					x	x				x		x							x	x	x		
Methane			x		x	x				x		x					x			x	x		
Methanol, see Methyl Alcohol																							
Methyl Ethyl Ketone						x				x									x	x	x		
MethylAlcohol, Methanol			x		x	x				x		x					x			x	x		
Methylbenzol seeToluene																							
Methylene Chloride (gas)				x		x				x		x						x		x	x		
Methylene Chloride (liquid)						x				x								x		x	x		
Methylisobutylketone						x				x									x	x	x		
Methylmethacrylate						x				x							x			x	x		
Milk										x											x		
Mine Water, acidic						x				x							x			x	x		
Miscella (Acetone + soj bean oil)						x				x								x		x	x		
Molasses solution					x	x				x		x					x			x	x		
Naphtalin					x	x				x		x						x		x	x		
Naphtha					x	x				x		x						x		x	x		
Natridithionit, see Hydrosulfit																							
Natural Gas			x		x	x				x		x					x			x	x		
Neon			x		x	x				x		x					x			x	x		
Nickel Chloride							x		x		x					x	x			x			x
Nickel Sulfate						x				x							x			x	x		
Nitric Acid	<50					x	x		x	x	x					x		x		x	x		x
Nitric Acid, concentrated.						x				x								x		x	x		
Nitric Acid, fuming		20			AL/95.5%				x		AL/95.5%				x	x					x		x
Nitrobenzol						x				x		x						x		x	x		
Nitrogen			x		x	x				x	x	x					x			x	x		
Nitrogen Dioxide						x				x							x			x	x		

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Nitrogen Monoxide			x			x				x		x					x			x	x		
Oleum, see Sulfuric Acid																				x	x		
Olive Oil			x			x				x		x					x			x	x		
Ölsäure						x				x							x						
Oxalic Acid, cold						x				x								x		x	x		
Oxygen			x		x	x				x		x						x		x	x		
Ozone						x	x			x		x						x	x	x	x		
Palmin acid					x	x				x		x					x			x	x		
Paraffine			x		x	x				x		x					x			x	x		
Pectin						x				x							x			x	x		
Pentane			x		x					x		x					x			x	x		
Perchlorethylene			x		x	x				x		x						x		x	x		
Petroleum			x		x	x				x		x					x			x	x		
Phenol, see Carbolic Acid						x							x			x				x			x
Phenylamine						x				x							x			x	x		
Phosgene										x											x		
Phosphinic acid						x				x								x		x	x		
Phosphoric Acid						x		x		x			x					x		x	x		
Phosphorous, liquid										x											x		
Photographic solutions						x	x			x	x						x			x	x		
Pikin acid						x				x								x		x	x		
Potassium Chlorate					x	x				x		x					x			x	x		
Potassium Chloride							x		x		x		x			x	x			x			x
Potassium Cyanide					x	x				x		x					x			x	x		
Potassium Hydroxide = Potassium iodide	20-50									x											x		
Potassium Permanganate					x	x				x		x					x			x	x		
Potassium Phosphate						x				x							x			x	x		
Potassium Sulfate					x	x				x		x					x			x	x		
Prissic Acid						x				x							x			x	x		
Propane (gas)			x		x	x				x		x						x		x	x		
Propane, liquid					x	x				x		x						x		x	x		
Propylene			x		x	x				x		x						x		x	x		
Propylene Oxide						x				x									x	x	x		
Pyrid					x	x				x		x							x	x	x		
Salicic Acid						x				x									x	x	x		x

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Salt solutions				x			x		x		x		x			x	x			x			x
Salt, see Sodium Chloride																							
Sea Water				x			x		x		x					x	x			x			x
Seasoning						x				x							x			x	x		
Silicone Oil						x				x								x		x	x		
Skydrol 500 B & C/7000			x		x	x				x		x							x	x	x		
Soda, see Sodium Carbonate																							
Sodium Acetate						x				x									x	x	x		
Sodium Aluminate					x	x				x		x					x			x	x		
Sodium Bicarbonate						x				x							x			x	x		
Sodium Bisulfate									x							x	x			x			x
Sodium Bisulfite						x				x							x			x	x		
Sodium Carbonate (Soda)					x	x				x		x					x			x	x		
Sodium Chloride (salt)				x			x		x		x					x	x			x			x
Sodium Chlorite									x		x		x			x	x			x			x
Sodium Cyanide					x	x				x		x					x			x	x		
Sodium di/triphosphate					x	x				x		x					x			x	x		
Sodium Dichromate					x					x		x					x			x	x		
Sodium Glutamate					x	x				x		x					x			x	x		
Sodium Hydoxide	0-20	20			x	x				x		x							x	x	x		
Sodium Hypochlorite							x		x		x		x			x		x		x			x
Sodium Nitrate (saltpeter)					x	x				x		x							x	x	x		
Sodium or Trisodium Phosphate					x	x				x		x					x			x	x		
Sodium Perborate						x				x							x			x	x		
Sodium Peroxide						x				x									x	x	x		
Sodium Phosphate						x				x							x			x	x		
Sodium Silicate (water glass)					x	x				x		x					x			x	x		
Sodium Sulfate					x	x				x		x					x			x	x		
Sodium Sulfide					x	x				x		x					x			x	x		
Sodium Sulfite				x		x				x		x					x			x	x		
Sodium Sulphate																							
Sodiumthiosulfat						x				x							x			x	x		
Soy Oil						x				x		x					x			x	x		
Spaltglas					x	x				x		x					x			x	x		
Spinning Bath Solution									x				x			x		x					x

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
			304[1.4301]/ Brass	Bronze	1,4301/ Steel	316Ti [1.4571]	PVC/40 °C	Hastelloy C	PVDF/PTFE	316Ti [1.4571]	PVC/40 °C	1.4301	Hastelloy C	Hastelloy B	Titanium	PVDF/PTFE	Buna-N	Viton-A	Ethylene Propylene	Glass	316Ti [1.4571]	Hastelloy C	PTFE max. 125 °C
Starch						x				x		x					x			x	x		
Steam										x											x		
Stearic Acid						x				x		x					x			x	x		
Stickstoffoxydul, see Laughing Gas																							
Styrene			x		x					x		x						x					
Sugar Liquor						x				x		x					x			x	x		
Sulfitbase						x												x		x	x		
Sulfur Chloride, dry						x				x								x		x	x		
Sulfur Dioxide, dry					x	x	x			x	x	x							x	x	x		
Sulfur Dioxide, liquid					x	x				x		x							x	x	x		
Sulfur Dioxide, wet							x		x		x		x			x				x			x
Sulfur Hexafluoride gas			x			x	x			x	x	x							x	x	x		
Sulfur, molten										x													
Sulfuric Acid	90-95						x	x	x		x		x			x		x		x			x
Sulfuric Acid	96	20					x		x		x		x			x		x		x			x
Sulfuric Acid	≤ 90						x		x		x		x			x		x		x			x
Sulfuric Acid	98 conc.	20			x	x	x		x	x	x	x	x			x		x		x	x		x
Sulfurous Acid	20-30					x	x		x	x	x		x			x		x		x	x		
Sulphurate Oil						x				x							x			x	x		
Tannin						x				x							x			x	x		
Tar										x											x		
Tartar acid						x				x							x			x	x		
Tetrachlorine					x	x				x		x						x		x	x		
TID						x				x								x		x	x		
Toluene (methyl benzene)					x	x				x		x						x		x	x		
Träthanolarmin					x	x				x		x							x	x	x		
Trichlorethane					x	x				x		x						x		x	x		
Trichlorethylene					x	x				x		x						x		x	x		
Trisodium Phosphate					x	x				x		x					x			x	x		
Turbineöl			x		x	x				x		x					x			x	x		
Turpentine					x	x				x		x						x		x	x		
Urea		20				x	x			x	x						x			x	x		
Urea		135				x				x								x		x	x		
Vegetable Oil				x	x	x				x		x					x			x	x		
Vinegar						x				x							x			x	x		
Vinyl Acetate			x			x				x		x							x	x	x		

Fluid	Concentration in %	Temperature in °C	Fittings							Floats							O-Rings			Meter Tube	Meter Tube for All Metal Flow-meters		
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Vinyl Chloride					x	x				x		x						x		x	x		
Water			x		x	x				x		x					x			x	x		
Water Glass, see Sodium Silicate																							
Water, demineralized						x	x			x	x						x			x	x		
Water, desalinated						x	x			x	x						x			x	x		
Water, distilled						x				x							x			x	x		
Wine						x				x							x			x	x		
Wood Alcohol, see Methyl Alcohol																							
Xenon			x		x	x				x		x					x			x	x		
Xylene, Xylol					x	x				x		x						x		x	x		
Zinc Chloride							x		x		x					x	x			x			x
Zinc Sulfate						x				x							x			x	x		

☐ Materials are to be specified by the user, because in some cases 316Ti/316 [1.4571/1.4401] are unsatisfactory, alternate 1.4439

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The most important variable area flow metering practices and their principles are described.

A large number of practical details provide the user with comprehensive and valuable information about the topic variable area flowmetering in an industrial environment.

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