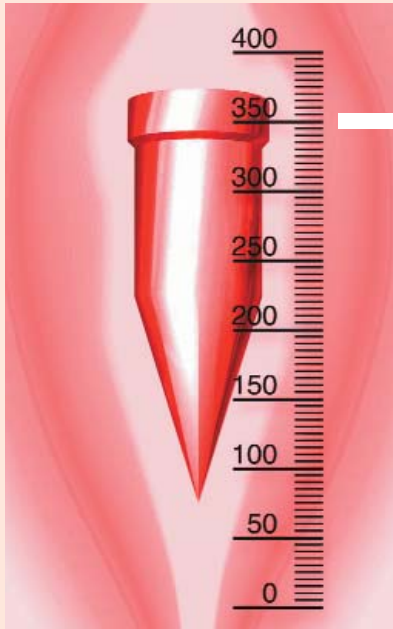


Variable area flowmeters



Variable area flowmeters

- Vortex flowmeters
- Flow controllers
- Electromagnetic flowmeters
- Ultrasonic flowmeters
- Mass flowmeters
- Level measuring instruments
- Communications technology
- Engineering systems & solutions
- Switches, counters, displays and recorders
- Heat metering
- Pressure and temperature



Variable area flowmeters

There's no alternative to reliability

That's why variable area flowmeters from KROHNE offer not only the maximum possible accuracy but also maximum reliability.

A wealth of experience and an intelligent quality assurance system enables us to place our VA meters in applications inaccessible to other manufacturers such as nuclear power stations where safety is critical.

So play it safe - Flowmeters from KROHNE

The KROHNE strategy

KROHNE is at home in almost all plants and processes, as well as in all corners of the world. Being a global player, we are able to react at any time to the widest variety of requests by our customers.

We are in the most important committees and industry groups, which enables us to recognize - and often help set - industry trends.

Our strategy aims at making it easy for the customer to do business with KROHNE by offering the best products at the best overall conditions and coupled with the best consultation, service and support that the industry has to offer.

KROHNE - easy to work with.

Technical features

Flowmeters operating on the float principle are suitable for both liquids and gases. This method is inexpensive yet highly accurate and reliable.

Benefits of variable area flowmeters:

- Accurate measurement even at very low flow rates
- Standard rangeability of 10 : 1 (ratio of full-scale to lower limit value)
- Suitable for low operating pressures
- Minimal pressure losses
- Local indication without the need for auxiliary power
- Can be used even with short or no straight inlet/outlet runs
- Essential components easily replaced
- Exact calculations to VDI codes.



Choosing the right flowmeter

Variable-area flowmeters are fitted with measuring cones made of glass or metal.

- **The glass measuring cone** allows direct viewing of the process liquid and direct reading of the flow.
- **The metal measuring cone** is used for difficult operating conditions
 - pressure
 - temperature
 - corrosion resistance

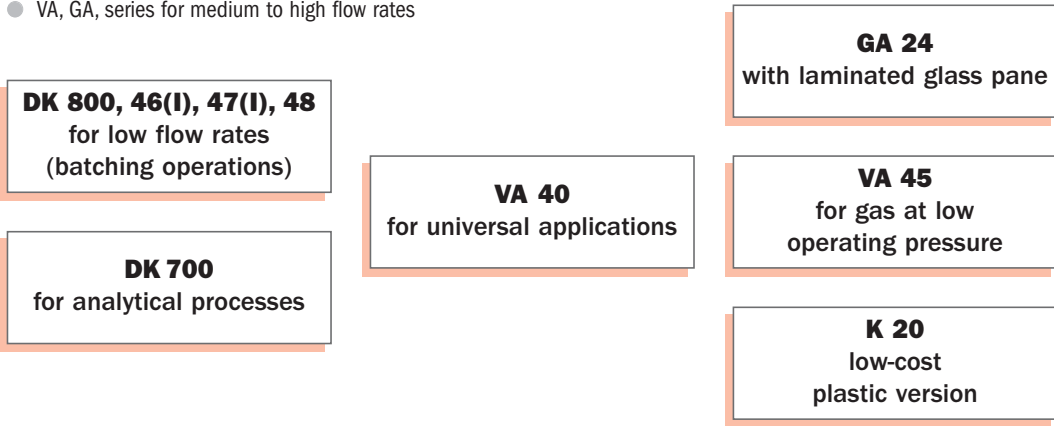
As direct readings are not possible, these are equipped with a mechanical, electromechanical or electronic display.

You're sure to find a measuring device in this product range to suit your specific requirements.

Measuring devices are available for low operating pressures, high flow rates, for batching operations, for the food industry, and for analytical processes.

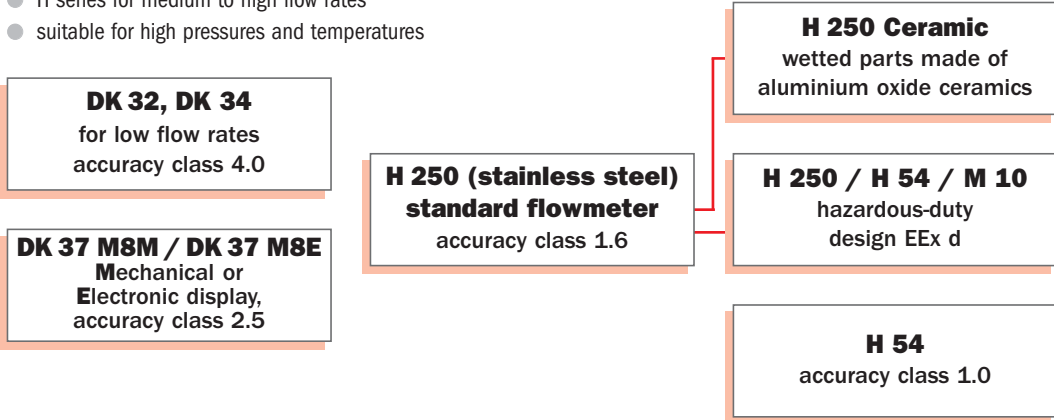
Glass measuring cones

- The DK Glass series for low to medium flow rates
- VA, GA, series for medium to high flow rates



Metal measuring cones

- DK Metal series for low to medium flow rates
- H series for medium to high flow rates
- suitable for high pressures and temperatures



Measuring principle

Variable area flowmeters feature an upright tapered tube, wider end up, in which a specially shaped float moves freely up and down.

The fluid flows upwards through the tube, causing the float to lift a certain distance and form a gap between tube wall and float, so that the forces acting on the float are in equilibrium.

Three forces act on the float:

- Constant force of gravity **G**
- Buoyancy **A**, which according to Archimedes' principle is constant if fluid density is constant
- Force **S**, the upward force of the fluid flowing past the float, which depends on the flow rate

Flowmeters which operate on the float principle have an upright conical measuring tube of glass, metal or plastics in which a specially shaped float is allowed to move freely up and down. With flow from bottom to top, the float adjusts so that buoyancy **A** and resistance **W** are in equilibrium with mass **M**. The flow values are read off from the scale at the level of the float reading line.

Every measured value thus corresponds to a defined annular gap, resulting from the conical form of the measuring tube and the specific position of the float.

With glass cones, the flow value can be read directly from a scale at the level of the float reading line.

With metal cones, the float position is transmitted to an indicator by magnetic means.

VDI/VDE Code 3513 describes the method used to calculate scales for variable area flowmeters to include all material and flow parameters, such as density, viscosity, pressure and temperature.

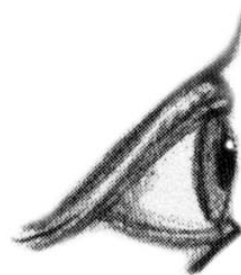
This method can also be used for scale conversions to accommodate changed operating conditions.

KROHNE software is available for this purpose:
KROHNE Variable Area Calculation (KroVaCal)
KROHNE Variable Area Selection (KroValSel)

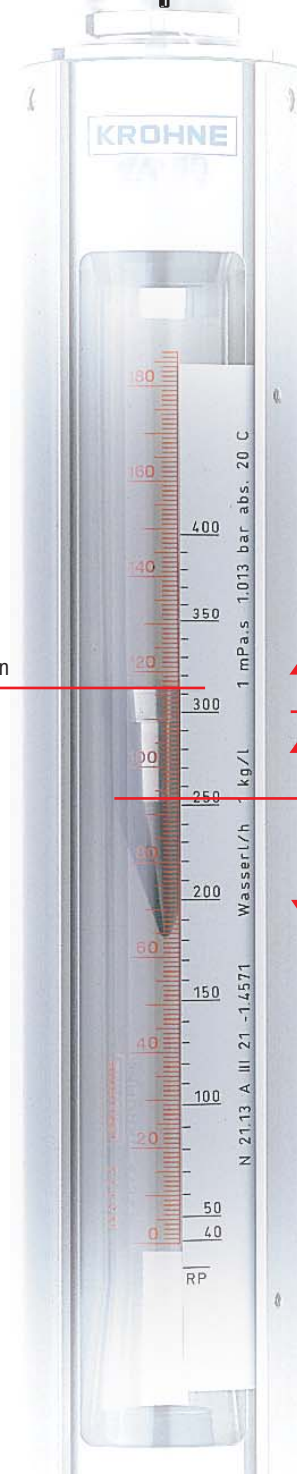
Reading lines of various float shapes:

Shape	A III	A III	Ball
		guided	

Reading line



float position



S upward force on float **S (W)**
A buoyancy **A**
G mass **M** (gravity **G**)

Accuracy

In conformity with VDI/VDE 3513, Sh. 2, accuracy for variable area flowmeters is defined by various accuracy classes. The following total errors are permitted as a factor of the flow rate, measured as % of measured value or % of full-scale range.

For accuracy classes 1 to 4, our instruments are calibrated with water or air followed by conversion to customer-specified operating data and instrument scaling. Accuracy class 0.4 requires calibration at actual flowing conditions.

Accuracy class	0.4		1.0		1.6		2.5		4.0	
	Total error %	Flow rate %	Measured	Full-scale	Measured	Full-scale	Measured	Full-scale	Measured	Full-scale
100	0.400	0.400	1.000	1.000	1.600	1.600	2.500	2.500	4.000	4.000
90	0.411	0.370	1.028	0.925	1.644	1.480	2.569	2.313	4.111	3.700
80	0.425	0.340	1.063	0.850	1.700	1.360	2.656	2.125	4.250	3.400
70	0.443	0.310	1.107	0.775	1.771	1.240	2.768	1.938	4.429	3.100
60	0.467	0.280	1.167	0.700	1.867	1.120	2.917	1.750	4.667	2.800
50	0.500	0.250	1.250	0.625	2.000	1.000	3.125	1.563	5.000	2.500
40	0.550	0.220	1.375	0.550	2.200	0.880	3.438	1.375	5.500	2.200
30	0.633	0.190	1.583	0.475	2.533	0.760	3.958	1.188	6.333	1.900
20	0.800	0.160	2.000	0.400	3.200	0.640	5.000	1.000	8.000	1.600
10	1.300	0.130	3.250	0.325	5.200	0.520	8.125	0.813	13.000	1.300

Extract from VDI/VDE Code 3513 Sheet 2

Each accuracy class is related to an error range which may not be exceeded at any point in the measuring range.

This permissible maximum error range is the sum of the following two partial errors:

1st partial error: $\frac{3}{4}$ of the figure specified as the accuracy class equals the error as a percentage of the measured value

2nd partial error: $\frac{1}{4}$ of the figure specified as the accuracy class equals the error as a percentage of the full-scale range

For a specific measured value, the total error F in flow units can be calculated according to the following formula:

$$F = \left(\frac{3}{4} M + \frac{1}{4} E \right) \frac{K}{100}$$

M measured value in flow units

E full-scale value in flow units

K figure specified as the accuracy class

Accessories

Apart from the various instrument types and materials offered, additional options are also available to equip the instruments for special applications.

The available accessories, e.g. limit switches, remote data transmission system or panel mounting sets, are described in the individual flowmeter data sheets.



Glass cone flowmeters

GA 24
Heavy-duty (rotating connections)



VA 40
Various connections for universal applications



Measurable flowrates			
Water	min.	0.04 l/h (0.011 US GPH)	0.04 l/h (0.011 US GPH)
	max.	10 000 l/h (2642 US GPH)	10 000 l/h (2642 US GPH)
Air	min.	0.0007 m ³ /h (0.00044 SCFM)	0.0007 m ³ /h (0.00044 SCFM)
	max.	310 m ³ /h (192 SCFM)	310 m ³ /h (192 SCFM)
Calibration conditions			
Water		20°C (68°F)	20°C (68°F)
Air		1.013 bar abs., 20°C (14.7 psia, 68°F)	1.013 bar abs., 20°C (14.7 psia, 68°F)
Accuracy class		1.0 (Option 0.4)	1.0
Operating data			
Max. pressure		10 bar (145 psig)	10 bar (145 psig)
Max. temperature		120°C (248°F)	100°C (212°F)
Materials			
Metering cone		glass	glass
Other wetted parts		grey cast iron/stainless steel/PTFE	PVDF/stainless steel, Hastelloy, PTFE, TFM
Gaskets		Neoprene/PTFE	Buna, Viton, EPDM
Connection		Flanges DN 15 ... 50 ANSI 1/2" ... 2"	threaded pipe connection G 3/8 ... G 2 tube nozzle 15 ... 52 mm (0.6" ... 2") Flanges DN 15 ... 50 (1/2" ... 2") Pipe connections in the food industry
Connection dimension		500 mm (19.69")	Type V screw connection 375 mm (14.76") Type S tube nozzle DN 15: 400 mm (15.8") DN 25: 450 mm (17.7") Type F flange connection 425 mm (16.7") Type A aseptic DN 15: 375 mm (14.76") DN 40, DN 50: 400 mm (1 1/2", 2": 15.8")
Limit switches		max. 2	max. 2

Product Overview

K 20 Economy version for machine monitoring



Glass cone flowmeters

5 l/h (1.32 US GPH) 24 000 l/h (6340 US GPH)	Measurable flowrates Water min. max.
20°C (68°F)	Calibration conditions Water
2.5	Accuracy class
6 bar (87 psig) -10 ... 60°C (14 ... 140°F)	Operating data Max. pressure Max. temperature
polysulphone (PSU) stainless steel, EPDM	Materials Metering cone Other wetted parts Gaskets
screw connection G 1/2 to G 2	Connection
376 mm (14.80")	Connection dimension
max. 2	Limit switches

Glass cone flowmeters

DK Glass series
DK 800, DK 46(I), DK 47(I), DK 48
Miniature flowmeter



DK 700
Miniature flowmeter
for analytical purposes



Measurable flowrates			
Water	min.	0.04 l/h (0.011 US GPH)	0.25 l/h (0.059 US GPH)
	max.	160 l/h (42 US GPH)	40 l/h (10.6 US GPH)
Air	min.	5 l/h (0.00031 SCFM)	0.5 l/h (0.00031 SCFM)
	max.	5 000 l/h (3.1 SCFM)	1000 l/h (0.62 SCFM)
Calibration conditions			
Water		20°C (68°F)	20°C (68°F)
Air		1.2 bar abs., 20°C (17.4 psia, 68°F)	1.013 bar abs., 20°C (14.7 psia, 68°F)
Accuracy class		4.0, 2.5, 1.0	6.0, 4.0, 2.5
Operating data			
Max. pressure		10 bar (145 psig)	4 bar (58 psig)
Max. temperature		80 ... 100°C (176 to 212°F)	100°C (212°F)
Materials			
Metering cone		glass	glass
Other wetted parts		brass/stainless steel/PVDF	stainless steel/PVDF
Gaskets		Viton	Viton
Connection		1/4 NPT G 1/4	G 1/8 tube nozzle 6 mm (0.24")
Connection dimension		90 ... 325 mm (3.54 ... 12.79")	75 mm (2.95")
Limit switches		max. 2	-

Product Overview

DK 32 / DK 34
All-metal miniature flowmeter



DK 37
All-metal miniature flowmeter



Metal cone flowmeters

0.3 l/h (0.08 US GPM) 100 l/h (26.4 US GPM) (160 l/h [(42.3 US GPM) optional]) 1.6 l/h (0.42 US GPM) 3400 l/h (2.11 SCFM)	0.3 l/h (0.08 US GPM) 100 l/h (26.4 US GPM) (160 l/h [(42.3 US GPM) optional]) 1.6 l/h (0.42 US GPM) 3400 l/h (2.11 SCFM)	Measurable flowrates Water min. max. Air min. max.
20°C (68°F) 1.013 bar abs., 20°C (14.7 psia, 68°F)	20°C (68°F) 1.013 bar abs., 20°C (14.7 psia, 68°F)	Calibration conditions Water Air
4.0	2.5	Accuracy class
130 bar (1885 psig) 150°C (302°F)	130 bar (1885 psig) 180°C (356°F)	Operating data Max. pressure Max. temperature
stainless steel stainless steel PTFE/Viton	stainless steel stainless steel PTFE/Viton	Materials Metering cone Other wetted parts Gaskets
1/4 NPT DK 32 horizontal DK 34 vertical	1/4 NPT	Connection
90 mm (3.54") (DK 32) 110 mm (4.33") (DK 34)	125 mm (4.92")	Connection dimension
max. 2	max. 2 (DK 37 M8M only)	Limit switches
-	electronic, 4-20 mA (DK 37 M8E only) Ex-i current output HART®	Data transfer

Variable area flowmeters with metal cone

H 250/RR/M 9
Stainless steel
Metal cone flowmeter



H 250/C/M9
Ceramic/PTFE



Measurable flowrates			
Water	min.	2.5 l/h (0.66 US GPM)	2.5 l/h (0.66 US GPM)
	max.	100 000 l/h (26 425 US GPM)	40 000 l/h (10 570 US GPM)
Air	min.	0.07 m ³ /h (0.043 SCFM)	0.18 m ³ /h (0.11 SCFM)
	max.	600 m ³ /h (372.2 SCFM)	350 m ³ /h (217 SCFM)
Calibration conditions			
Water		20°C (68°F)	20°C (68°F)
Air		1.013 bar abs., 20°C (14.7 psia, 68°F)	1.013 bar abs., 20°C (14.7 psia, 68°F)
Accuracy class		1.6	2.5
Operating data			
Max. pressure		16 ... 100 bar (232 ... 1450 psig)	16 ... 40 bar (232 ... 580 psig)
Max. temperature		300°C (572°F)	250°C (482°F)
Materials			
Metering cone		stainless steel	stainless steel
Other wetted parts		stainless steel/Hastelloy	PTFE, ceramic Al ₂ O ₃
Gaskets		-	PTFE (flange)
Connection			
		Flanges DN 15 ... 100 ANSI 1/2" ... 4"	Flanges DN 15 ... 100 ANSI 1/2" ... 4"
Connection dimension		250 mm, 300 mm (9.84", 11.81")	250 mm (9.84")
Limit switches		max. 2	max. 2
Data transfer			
		electrical Ex-i current output HART® (4 ... 20 mA) Profibus PA	electrical Ex-i current output HART® (4 ... 20 mA) Profibus PA

Product Overview

H 250 / H 54 / M 10
Metal cone flowmeter
EEx d design



H 54
Metal cone flowmeter



Variable area flowmeters with metal cone

2.5 l/h (0.66 US GPM) 100 000 l/h (26 425 US GPM) 0.07 m ³ /h (0.043 SCFM) 600 m ³ /h (372.2 SCFM)	1.6 l/h (0.42 US GPM) 150 000 l/h (39 640 US GPM) 0.04 m ³ /h (0.025 SCFM) 3 000 m ³ /h (1861 SCFM)	Measurable flowrates Water min. max. Air min. max.
20°C (68°F) 1.013 bar abs., 20°C (14.7 psia, 68°F)	20°C (68°F) 1.013 bar abs., 20°C (14.7 psia, 68°F)	Calibration conditions Water Air
1.0 - 2.5	1.0	Accuracy class
16 ... 100 bar (232 ... 1450 psig) 300°C (572°F)	16 ... 100 bar (232 ... 1450 psig) 400°C (752°F)	Operating data Max. pressure Max. temperature
stainless steel stainless steel/Hastelloy, PTFE, ceramic	stainless steel stainless steel/Hastelloy B+C	Materials Metering cone Other wetted parts
Flanges DN 15 ... 150 ANSI 1/2" ... 6"	Flanges DN 15 ... 150 ANSI 1/2" ... 6"	Connection
250 ... 500 mm (9.84" ... 19.68")	500 ... 600 mm (19.68 ... 23.62")	Connection dimension
Binary outputs, pulse output, reset input	max. 2	Limit switches
Ex-i current output HART® (4 ... 20 mA)	electrical Ex-i current output HART® (4 ... 20 mA)	Data transfer