Flow Control Valves

*Model 8504
Straight Pattern
CART III Needle Valve*

*Model 8503
Angle 90° Pattern
CART III Needle Valve*

NRS™ Series

Low Flow Gas & Liquid
Needle Control Valves

Model 8503 (angle, or 90° pattern) and Model 8504 (straight, or "in-line" pattern) needle control valves incorporate either the Brooks Cartridge III series of standard resolution, or the Brooks NRS™ series of precision resolution control valves. Both of these Brooks valve series are combined with cast 316 stainless steel bodies to provide a full range of control for low flow gas and liquid applications.

The Brooks Cartridge III ("CART III") valve is a multi-purpose valve, designed for integral use in the Brooks Sho-Rate™ 1350G/1355G series of "Purgemeters", as well as for use as a stand-alone needle valve, when incorporated in the 8503/8504 bodies. These valves are available in three different sizes - Low, Medium and High. The needle valve stem of this design features a conical taper, which, when combined with various ceramic orifices, ensures a wide range of flow capacities for common gas and liquid purge-type applications.

The Brooks NRS™ (non-rising stem) valve is designed specifically for extremely low flow gas and liquid applications. These valves feature a unique means of precisely adjusting an orifice along a tapered needle, and are particularly suited for critical flow control requirements. Due to its non-rising stem design, this valve is significantly less susceptible to changes in ambient temperature and mechanical effects than a conventional needle control valve.

Features

CART III
- Large, easy to set knob
- Rugged design, with stable flow adjustment and repeatability
- Eight turns open-to-close
- Wide flow rangeability provided by three, overlapping valve sizes

NRS™
- Smooth, non-reversing flow characteristics
- Constant flow at any given knob position
- Excellent resolution with fifteen turns open-to-close
- Seven needle tapers (Sizes 1-7) provide overlapping ranges, each size increasing maximum capacity by approximately three times
- O-ring seal design provides tight shut-off, and incorporates a mechanical stop to eliminate overtightening damage
- Panel mounting nuts are standard

Common
- 1/8" FNPT integral connections or 1/4" FNPT connections via included adapters

BROOKS®
INSTRUMENT

Beyond Measure

Capacities and Pressure Drops	See Capacity Table
Max. Operating Pressure	1000 psig
Max. Operating Temperature	250°F
Connections	Standard: 1/8" Female NPT - integral
	1/4" female NPT
Dimensions	See Dimensions Figure
Materials of Construction Stainless Steel Model	
Body & Stern	316 stainless steel
Orifice	NRS Size 1-3: Stainless steel and Teflon®; NRS Sizes 4-6: Stainless Steel; CART III all sizes: PEEK® (ceramic)
Valve Needle	316 stainless steel
Plunger (NRS only)	Stainless steel
O-rings	Viton® fluoroelastomers; Buna-N

Capacity Table

NRS Needle Taper	Air		He		Water		Cv	Kv
Units	SLPM*	(N)M3/HR**	SLPM	(N)M3/HR	LPM	L/HR		
1	0.15	0.01	0.3	0.02	0.004	0.292	0.00038	0.00038
2	0.35	0.02	0.7	0.04	0.01	0.73	0.00089	0.00075
3	0.6	0.04	1.4	0.08	0.02	1.46	0.00153	0.00151
4	2.4	0.14	6	0.36	0.08	5.84	0.00613	0.00528
5	6.8	0.41	18	1.07	0.2	14.6	0.01737	0.01545
6	22	1.31	55	3.28	0.65	47.45	0.05620	0.04938
7	43.8	2.61	109.5	6.53	1.35	98.55	0.11189	0.09830
CART III Size								
Low	5.7	0.34	14.9	0.89	0.176	13	0.015	0.012
Medium	19.7	1.17	50	2.98	0.712	51	0.05	0.044
High	75.6	4.51	94	5.60	2.04	147	0.193	0.167

*U.S. Customary Units capacities measured with 10 PSIG supply and atmospheric exhaust. Standard Temperature is 70°F and Standard Pressure is 14.7 PSIA.
**Standard International (SI) Units measured with 1 BarG supply and atmospheric exhaust. Normal Temperature is 21.1°C and Normal Pressure is 1.013 Bar. Flow capacities will vary for different gases, liquids and valve pressure drop (ΔP).

Product Dimensions

Model 8503F

A (OPEN)	
NRS VALVE	2.50 [63.5]
CARTRIDGE III VALVE	2.65 [67.3]

NOTES:
1. VALVE BODY IS 1/8"NPT INTEGRAL CONNECTION, NO ADAPTER NEEDED.

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1. VALVE BODY IS 1/8"NPT INTEGRAL CONNECTION, NO ADAPTER NEEDED.

GAS - United States Customary Units
The correct cartridge valve can be determined for any gas by using one of the formulas below:

1. Subcritical Flow Formula (when downstream pressure, P_2, is greater than the critical pressure P_C, or $P_1 < 2P_2$)

$$C_V = \frac{Q}{454} \sqrt{\frac{(SG) \times (T)}{P_1^2 - P_2^2}}$$

2. Critical Flow Formula (when downstream pressure, P_2, is less than the critical pressure P_C, or $P_1 > 2P_2$)

$$C_V = \frac{Q \sqrt{(SG) \times (T)}}{385 \times P_1}$$

Note: Critical pressure is equal to approximately 1/2 of the upstream absolute pressure. ($P_C = 1/2 \ P_1$)

Where:
C_V = Valve flow coefficient
Q = Gas flow in slpm
SG = Gas specific gravity (See Specific Gravity Table)
T = Absolute temp. of flowing gas in °R (°F + 460)
P_1 = Upstream pressure (psia)
P_2 = Downstream pressure (psia)
P_C = Critical pressure (psia)

LIQUID - United States Customary Units
The correct needle valve can be determined for any liquid by using the formula below:

$$C_V = 0.264 \ (Q) \sqrt{\frac{(SG)}{\Delta P}}$$

Where:
C_V = Valve flow coefficient
Q = Liquid flow (slpm)
ΔP = Pressure drop (psi)
SG = Liquid specific gravity

GAS - Standard International Units
The correct cartridge valve can be determined for any gas by using one of the formulas below:

1. Subcritical Flow Formula (when downstream pressure, P_2, is greater than the critical pressure P_C, or $P_1 < 2P_2$)

$$K_V = \frac{Q_{max}}{514} \sqrt{\frac{\text{density} \ (T)}{\Delta P \ (P_2)}}$$

2. Critical Flow Formula (when downstream pressure, P_2, is less than the critical pressure P_C, or $P_1 > 2P_2$)

$$K_V = \frac{Q_{max}}{257(P_1)} \sqrt{\text{density} \ (T)}$$

Where:
K_V = Valve flow coefficient
Q_{max} = Gas flow (m^3_n/h)
Density = Gas density (kg/m^3_n) (See Specific Gravity Table)
T = Absolute actual operating temp. °K (°C + 273)
P_1 = Upstream pressure (bar abs)
P_2 = Downstream pressure (bar abs)
ΔP = Pressure drop (bar)

LIQUID - Standard International Units
The correct cartridge valve can be determined for any liquid by using the formula below:

$$K_V = (Q_{max}) \sqrt{\frac{\text{(density)}}{\Delta P(1000)}}$$

Where:
K_V = Valve flow coefficient
Q_{max} = Liquid flow (m^3/h)
D = Fluid density (kg/m^3)
ΔP = Pressure drop (bar)

Specific Gravity and Density Table for Gases

Gas	Specific Gravity Referred to Air at 70°F (SG)	Density (kg/m^3_n)
Acetylene	0.907	1.173
Air	1.0	1.293
Ammonia	0.587	0.771
Argon	1.38	1.784
Butane	2.07	2.593
Carbon Dioxide	1.529	1.977
Helium	0.138	0.178
Hydrogen	0.0695	0.090
Methane	0.554	0.717
Nitrogen	0.967	1.251
Oxygen	1.105	1.429
Propane	1.562	2.008
Sulfur Dioxide	2.264	2.858

Code Description	Code Option	Option Description
I. Base Model Numbers	8503F	Angle pattern
	8504F	In-line pattern
II. Material of Construction	2	316 Stainless Steel
III. Needle and Orifice Size	A	NRS Size 1
	B	NRS Size 2
	C	NRS Size 3
	D	NRS Size 4
	E	NRS Size 5
	F	NRS Size 6
	G	NRS Size 7
	1	CART III Low
	2	CART III Medium
	3	CART III High
IV. O-ring Material	A	Buna N
	B	Viton® fluoroelastomers
V. Inlet/Outlet Connections, Size & Type	1A	1/8" NPT (integral)
	3C	1/4" NPT (adapters supplied)

Sample Standard Model Code

I	II	III	IV	V
8504F	2	1	B	1A

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.BrooksInstrument.com to locate the service location nearest to you.

START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required. For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

SEMINARS AND TRAINING

Brooks Instrument can provide seminars and dedicated training to engineers, end users, and maintenance persons.

Please contact your nearest sales representative for more details.

Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

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