DS-VA-8503-eng
January, 2017

Data Sheet

NRS™ Needle Control Valves Models 8503 and 8504

Variable Area

Model 8504
Straight Pattern Needle Valve

Low Flow Gas and Liquid Flow Control Valves

Description

The Brooks® NRS™ (non-rising stem) control valves are designed specifically for extremely low flow gas and liquid applications. Straight and 90° angle pattern models in stainless steel are available. They feature a means of adjusting a sliding tapered needle which prevents sticking due to foreign matter in the fluid. These valves are particularly suitable for precise control requirements and possess a high turns to lift ratio. The flow is constant for any given stem position.

Six needles with different tapers provide a wide choice of flow ranges. Needles and orifices can be changed without removing the valve body from the line (two different orifices are used, one for needle sizes 1-3, another for sizes 4-6).

Features

- Smooth non-reversing flow characteristics
- Constant flow at any given stem position
- Fifteen turns full open to full close provides high turn to lift ratio for excellent resolution
- Six interchangeable needle tapers, each increases capacity by an approximate factor of three
- O-ring seal cannot be damaged by overtightening
- Panel mounting nuts included - standard
- 1/8" NPT connections integrally machined into body

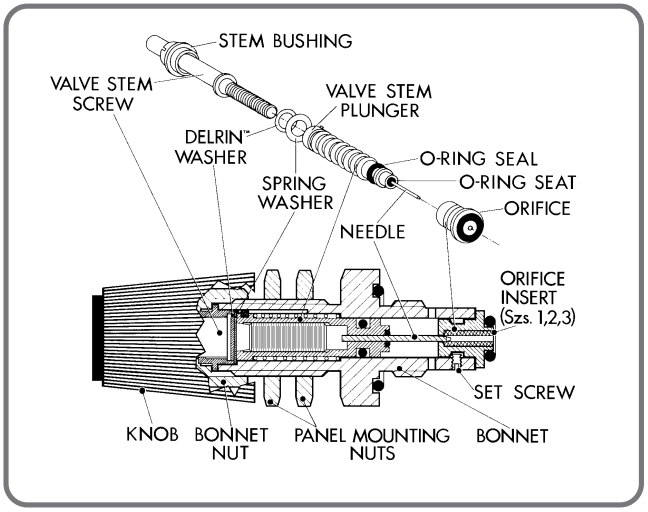
Product Specifications

Capacities and Pressure Drops	See Capacities and Pressure Drops Table
Max. Operating Pressure	Stainless Steel Model: 1000 psig
Max. Operating Temperature	Stainless Steel Model: 250°F
Connections	Standard: 1/8" Female NPT - integral
	Optional: 1/8", 1/4" compression fitting; 1/4" female NPT; 1/4" ID hose type adaptors
Dimensions	See Dimensions Figure
Materials of Construction Stainless Steel Model	
Body	316 stainless steel
Orifice	Size 1-3: Stainless steel and Teflon®; Sizes 4-6: Stainless Steel
Valve Needle	316 stainless steel
Plunger	Stainless steel
O-rings	Viton® fluoroelastomers

Capacities and Pressure Drops Table

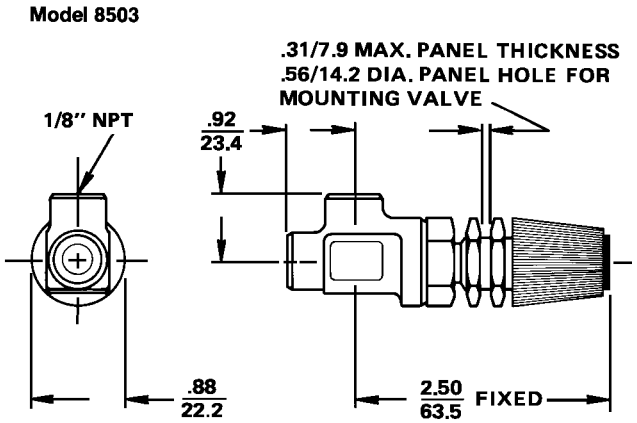
Needle Taper No.	Orifice Type	Maximum Capacity (Std. cc/min.) Helium	Air	Water
1		300	150	4
2	Small	700	350	10
3	(0.041")	1,400	600	20
4		6,000	2,400	80
5	Larger	18,000	6,800	200
6	(0.093")	55,000	22,000	650

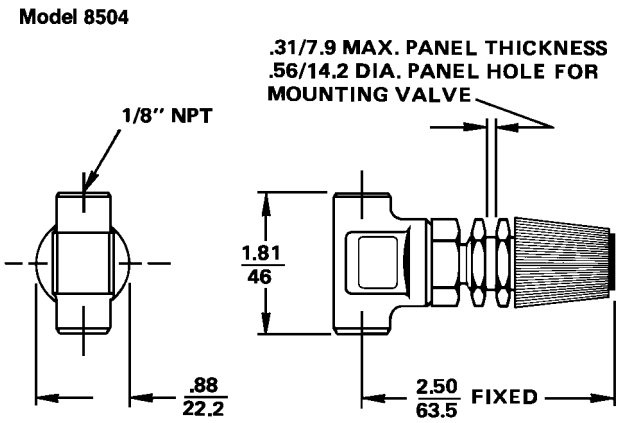
Capacities measured with 10 psig supply and an atmospheric pressure exhaust.
Flow capacities will vary for different gases, liquids and pressures.
Consult factory for further information.



Exploded-View NRS™ Valve

Product Dimensions





Needle Valve Determination

The correct needle 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.

Where:

C_V = Valve flow coefficient
Q = Gas flow in slpm
SG = Gas specific gravity (Air at 14.7 psia and 70°F = 1.0)
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)

Table 1 C_V versus Size for NRS Valves

Valve Size	C_V
1	0.00029
2	0.00066
3	0.0013
4	0.0057
5	0.017
6	0.052

Table 2 Specific Gravity Table for Gases

Gas	Specific Gravity Referred to Air at 70°F (SG)
Acetylene	0.907
Air	1.0
Ammonia	0.587
Argon	1.38
Butane	2.07
Carbon Dioxide	1.529
Helium	0.138
Hydrogen	0.0695
Methane	0.554
Nitrogen	0.967
Oxygen	1.105
Propane	1.562
Sulfur Dioxide	2.264

Example 1
Select a valve size to pass 25 slpm of helium at 70°F with an upstream pressure of 600 psig and a downstream pressure of 500 psig.

Q = 25 slpm
SG = 0.138 (from Table 2)
T = 70°F + 460° = 530°R
P_1 = 600 psig + 14.7 psi = 614.7 psia
P_2 = 500 psig + 14.7 psi = 514.7 psia
P_C = 0.5 x P_1 = 0.5 x 614.7 = 307.3 psia

Since P_2 is greater than P_C, substitute the values of the above variables in Formula 1.

$$C_V = \frac{25}{454}\sqrt{\frac{0.138 \times 530}{(614.7^2 - 514.7^2)}} = 0.0014$$

Refer to Table 1 and select the valve having the next largest C_V. Therefore, a Size 4 valve would be specified for helium at the above conditions.

Example 2
Select a valve size to pass 25 slpm of helium at 70°F with an upstream pressure of 600 psig and a downstream pressure of 200 psig.

Q = 25 slpm
SG = 0.138 (from Table 2)
T = 70°F + 460° = 530°R
P_1 = 600 psig + 14.7 = 614.7 psia
P_2 = 200 psig + 14.7 = 214.7 psia
P_C = 0.5 x P_1 = 0.5 x 614.7 = 107.3 psia

Since P_2 is less than P_C, substitute the values of the above variables in Formula 2.

$$C_V = \frac{25\sqrt{0.138 \times 530}}{385 \times 614.7} = 0.0009$$

Refer to Table 1 and select the valve having the next largest C_V. Therefore, a Size 3 valve would be specified for helium at the above conditions.

Model Code

Code Description	Code Option	Option Description
I. Base Model Number	**8503D**	NRS Angle pattern
	8504D	NRS In-line pattern
II. Material of Construction	**2**	316 Stainless Steel
III. Needle and Orifice Size	**A**	Size 1
	B	Size 2
	C	Size 3
	D	Size 4
	E	Size 5
	F	Size 6
IV. Operating Pressure	**4**	Standard 600 PSI Brass; 1000 PSI Stainless Steel
V. O-ring Material	**A**	Buna N
	B	Viton
VI. Inlet/Outlet Connections, Size & Type	**1A**	1/8" NPT integral
	2B	1/8" compression
	3C	1/4" NPT
	4D	1/4" compression
	5E	1/4" ID hose

Sample Standard Model Code

I	II	III	IV	V	VI
8504D	2	C	4	A	1A

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