Data Sheet
DS-VA-8503-eng
March, 2008

NRS™ Needle Control Valves Models 8503 and 8504

- 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
- Bubble tight O-ring seal cannot be damaged by overtightening
- Panel mounting nuts included - standard
- The NRS valve cartridge is available on the Brooks Sho-Rate® "50" flowmeters (see DS-VA-1350E-eng, DS-VA-K1350-55-eng)
- 1/8" NPT connections integrally machined into body
- Optional numerical handle available for precise valve positioning

Model 8504
Straight Pattern
Needle Valve

Model 8513 Angle Pattern
Needle Valve with
Numerical Handle

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 brass or 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). An optional numerical handle provides precise valve settings of this high resolution valve.

SPECIFICATIONS

Capacities and Pressure Drops

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.

Maximum Operating Pressure
Brass Model: 600 psig
Stainless Steel Model: 1000 psig

Maximum Operating Temperature
Brass Model: 180°F
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
Refer to Figure 3

Needle Valve Determination
Refer to Page 3

Ordering Information and Model Code
Refer to Table 3

Materials of Construction
Brass Model: Nickel plated brass body. Size 1-3: Brass and Delrin® orifice; sizes 4-6: Brass orifice; 316 steel valve needle, brass plunger, Buna-N O-rings.

Stainless Steel Model: 316 Stainless steel body and valve needle. Size 1-3: Stn. Stl. and Teflon® orifice; Sizes 4-6: Stn. Stl. orifice; Stn. Stl. plunger, Viton® fluoroelastomers O-rings

COMPATIBLE BROOKS EQUIPMENT

Numerical Handle: Model 8513: Right angle, Model 8514: Straight pattern
3 digit direct read numerical handle: 10 digits per turn (15 turns to full open) readable to 1/20 turn. Handle can be rotated 360° to facilitate reading of indicator.

ORDERING INFORMATION

To order, please specify:
1. Model number
2. Brass or Stainless Steel
3. Needle valve size
4. Connection type and size
5. Options, if desired

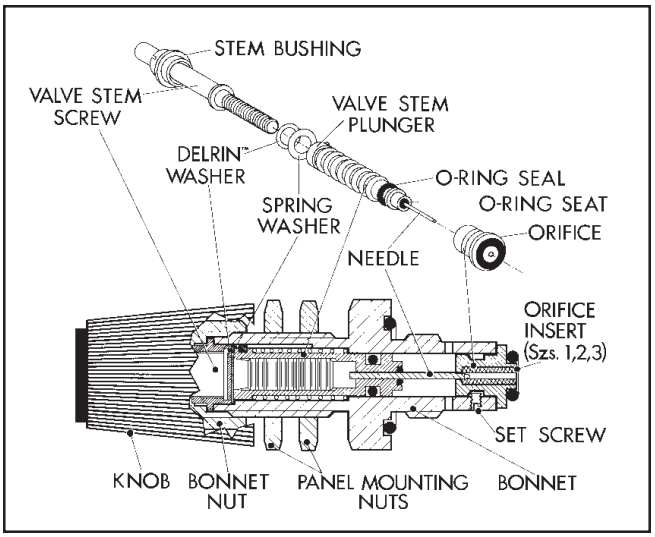

Figure 1 Exploded View NRS Valve

Figure 2 Numerical Handle and NRS Needle Valve

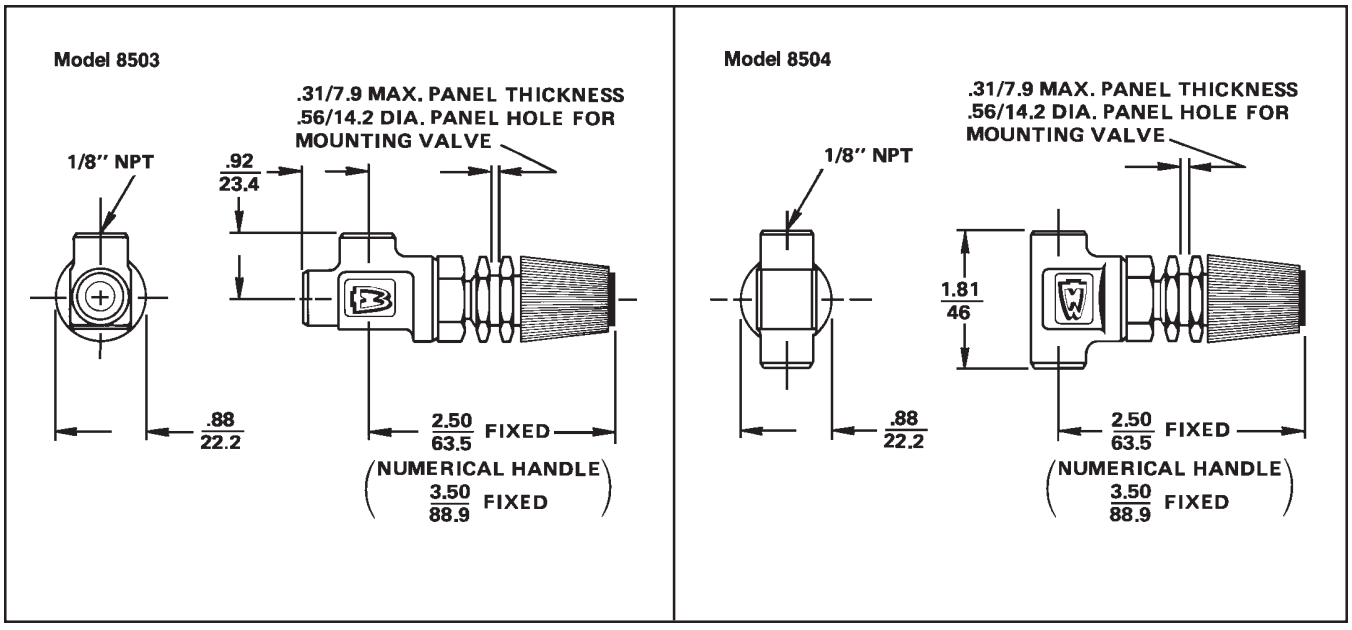

Figure 3 Dimensions, Models 8503 & 8504

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.

Table 3 Ordering Information and Model Code

MODEL	NEEDLE VALVES
8503D	NRS, ANGLE PATTERN
8504D	NRS, IN-LINE PATTERN
8513D	NRS, ANGLE PATTERN WITH DIGITAL HANDLE
8514D	NRS, IN-LINE PATTERN WITH DIGITAL HANDLE

CODE	MATERIAL OF CONSTRUCTION
1	BRASS
2	316 STAINLESS STEEL

CODE	NEEDLE AND ORIFICE SIZE
A	SIZE 1
B	SIZE 2
C	SIZE 3
D	SIZE 4
E	SIZE 5
F	SIZE 6

CODE	OPERATING PRESSURE
4	STANDARD 600 PSI BRASS / 1000 PSI STAINLESS STEEL

CODE	O-RING MATERIAL
A	BUNA-N
B	VITON

CODE	INLET AND OUTLET CONNECTIONS SIZE AND TYPE
1A	1/8" NPT INTEGRAL
2B	1/8" COMPRESSION
3C	1/4" NPT
4D	1/4" COMPRESSION
5E	1/4" I.D. HOSE

8504D	1	C	4	A	1A	TYPICAL MODEL CODE

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- Brooks Instrument provides sales and service facilities around the world.
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START-UP SERVICE AND IN-SITU CALIBRATION

- Brooks Instrument can provide start-up service prior to operation when required, if necessary under in-situ conditions, and the results will be traceable to the relevant international quality standards.

CUSTOMER SEMINARS AND TRAINING

- Brooks® can provide customer seminars and dedicated training to engineers, end users and maintenance persons.

HELP DESK

In case you need technical assistance:

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ISO 9001 QUALITY SYSTEM

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

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