Angle Seat Valve / Air Operated Type

Low pressure loss due to angle seat structure! Reduced leakage with rubber seal!

Long service life
- 3 million cycles (Steam)  \(^*1\)
- 5 million cycles (Air)  \(^*1\)

Low leakage
- 10 cm\(^3\)/min \(^*2\) or less

Space saving
- Height 100 mm \(^*3\)

Body material
- Bronze (CAC)
- Stainless steel 316L equivalent

\(^*1\) Based on SMC’s test conditions

\(^*2\) With air

\(^*3\) Port size: 3/8

VXB Series

RoHS

CAT.ES70-54B
Angle Seat Valve / Air Operated Type  VXB Series

Long service life

Steam 3 million cycles\(^{+1}\)
Air 5 million cycles\(^{+1}\)

\(^{+1}\) Based on SMC's test conditions

1. Squeeze seal with scraper function
   A scraper function has been added to the seal to shut off fluid leakage.

2. Resin scraper
   Scraper function used during the main valve stroke

3. Protective seal
   Prevents foreign matter from entering the squeeze seal when the valve is open

4. Guide bushing
   Prevents misalignment and lengthens the squeeze seal life

Pilot pressure

<table>
<thead>
<tr>
<th>Type</th>
<th>Standard</th>
<th>High pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>[MPa]</td>
<td>0.3 to 1</td>
<td>0.5 to 1</td>
</tr>
</tbody>
</table>

Fluid temperature

183°C (steam) or less

Low leakage

Internal leakage 10 \(\text{cm}^3/\text{min}\)\(^{+2}\) or less

\(^{+2}\) With air

1. Rubber seal
   Special FKM with high sealing performance

Low pressure loss

Angle seat structure

Pressure loss Small
Pressure loss Large

Variations

<table>
<thead>
<tr>
<th>Model</th>
<th>Orifice diameter [mm]</th>
<th>Cv</th>
<th>Port size</th>
<th>Max. operating pressure [MPa]</th>
<th>Body material</th>
<th>Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>VXB215A(_D)</td>
<td>11</td>
<td>3.5</td>
<td>3/8 (10A)</td>
<td>1</td>
<td>Stainless steel 316L equivalent, Bronze (CAC)</td>
<td>Steam</td>
</tr>
<tr>
<td>VXB215B(_E)</td>
<td>14</td>
<td>5.4</td>
<td>1/2 (15A)</td>
<td>0.6</td>
<td>Stainless steel 316L equivalent, Bronze (CAC)</td>
<td>Air or water</td>
</tr>
<tr>
<td>VXB215C(_F)</td>
<td>18</td>
<td>7.6</td>
<td>3/4 (20A)</td>
<td>0.4</td>
<td>Stainless steel 316L equivalent, Bronze (CAC)</td>
<td>Air or water</td>
</tr>
</tbody>
</table>

Indicator

Visual confirmation of valve open/close status
Valve opened
Valve closed

Body material

Stainless steel 316L equivalent / Bronze (CAC)
### Series

#### VX Series

<table>
<thead>
<tr>
<th>Fluid / Orifice Diameter</th>
<th>Fluid / Orifice Diameter</th>
<th>Fluid / Orifice Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Unit</td>
<td>Manifold (Air)</td>
<td>Compact VDW Series</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valve type</th>
<th>Port size</th>
<th>Orifice diameter [mmø]</th>
<th>Valve type</th>
<th>Port size</th>
<th>Orifice diameter [mmø]</th>
<th>Valve type</th>
<th>Port size</th>
<th>Orifice diameter [mmø]</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.C./N.O.</td>
<td>1/8 to 1/2</td>
<td>ø6 to ø12</td>
<td>N.C./N.O.</td>
<td>1/4 to 1</td>
<td>ø10 to ø12</td>
<td>N.C.</td>
<td>M5, 1/8,</td>
<td>ø3.2 to ø6</td>
</tr>
<tr>
<td></td>
<td>2, 3, 4, 5</td>
<td>7, 8, 10</td>
<td></td>
<td>10, 15, 20</td>
<td>25, 35, 40, 50</td>
<td></td>
<td>1, 1.6,</td>
<td>2.3, 3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### VXD Series

<table>
<thead>
<tr>
<th>Fluid / Orifice Diameter</th>
<th>Fluid / Orifice Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot Operated</td>
<td>VXD Series</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valve type</th>
<th>Port size</th>
<th>Orifice diameter [mmø]</th>
<th>Valve type</th>
<th>Port size</th>
<th>Orifice diameter [mmø]</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.C./N.O.</td>
<td>1/4 to 50A</td>
<td>ø10 to ø12</td>
<td>N.C./N.O.</td>
<td>1/4 to 1</td>
<td>ø10 to ø12</td>
</tr>
<tr>
<td></td>
<td>10, 15, 20</td>
<td>25, 35, 40, 50</td>
<td></td>
<td>10, 15, 20</td>
<td>20, 25</td>
</tr>
</tbody>
</table>

### Fluid / Orifice Diameter

#### Series

<table>
<thead>
<tr>
<th>Series</th>
<th>Applicable fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>VX Series</td>
<td>Air, Medium vacuum, Water, Oil</td>
</tr>
<tr>
<td>VXD Series</td>
<td>Air, Water, Oil, Heated water, High-temperature oil</td>
</tr>
<tr>
<td>VXS Series</td>
<td>Air, Water, Oil, Heated water, High-temperature oil</td>
</tr>
<tr>
<td>VXS Series</td>
<td>Air, Water, Oil, Heated water, High-temperature oil</td>
</tr>
</tbody>
</table>

#### Orifice Diameter [mmø]

<table>
<thead>
<tr>
<th>Orifice diameter [mmø]</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Operated</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Pilot Operated</td>
<td>3.2</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>
Standard Specifications

<table>
<thead>
<tr>
<th>Valve specifications</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve construction</td>
<td></td>
<td>Air operated piston type</td>
</tr>
<tr>
<td>Withstand pressure</td>
<td></td>
<td>2.4 MPa</td>
</tr>
<tr>
<td>Body material</td>
<td></td>
<td>Stainless steel 316L equivalent, Bronze (CAC)</td>
</tr>
<tr>
<td>Seal material</td>
<td></td>
<td>FKM</td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td>Location without corrosive or explosive gases</td>
</tr>
</tbody>
</table>

**Selection Steps**

**Step 1** Select “Body material,” “Port size,” and “Orifice diameter.”

- **Item**
  - Body material
  - Port size
  - Orifice diameter

- **Selected item**
  - Body material: Bronze
  - Port size: 3/8
  - Orifice diameter: 12

- **Symbol**
  - A

VXB215A H B L

**Step 2** Select “Pressure type.”

- **Item**
  - Pressure type

- **Selected item**
  - High pressure

- **Symbol**
  - H

VXB215A H B L

**Step 3** Select “Thread type.”

- **Item**
  - Thread type

- **Selected item**
  - NPT

- **Symbol**
  - B

VXB215A H B L

**Step 4** Select “Indicator.”

- **Item**
  - Indicator

- **Selected item**
  - Yes

- **Symbol**
  - L

VXB215A H B L

**Step 5** For special options, refer to page 5.
Flow Rate Characteristics

<table>
<thead>
<tr>
<th>Size</th>
<th>Port size</th>
<th>Orifice diameter [mm]</th>
<th>Pressure type</th>
<th>Model</th>
<th>Air</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/8</td>
<td>11</td>
<td>Standard</td>
<td>VXB215A</td>
<td>3.5</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>high pressure</td>
<td>VXB215AH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1/2</td>
<td>14</td>
<td>Standard</td>
<td>VXB215B</td>
<td>5.4</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>high pressure</td>
<td>VXB215BH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3/4</td>
<td>18</td>
<td>Standard</td>
<td>VXB215C</td>
<td>7.6</td>
<td>23.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>high pressure</td>
<td>VXB215CH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* When using steam as the fluid, refer to page 16 for pilot piping selection.
*1 The value in ( ) shows the pressure when air or water is used as the fluid.

Fluid and Ambient Temperatures

<table>
<thead>
<tr>
<th>Fluid temperature [°C]</th>
<th>Ambient temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam: 183 or less</td>
<td>~20 to 60</td>
</tr>
<tr>
<td>Water, Air: 99 or less</td>
<td></td>
</tr>
</tbody>
</table>

* No freezing

Valve Leakage Rate

<table>
<thead>
<tr>
<th>Internal Leakage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid</td>
</tr>
<tr>
<td>Steam, Air</td>
</tr>
<tr>
<td>Water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>External Leakage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid</td>
</tr>
<tr>
<td>Steam, Air</td>
</tr>
<tr>
<td>Water</td>
</tr>
</tbody>
</table>

*1 Leakage is the value at an ambient temperature of 20°C.
*2 With air
How to Order

VXB215 A B C

Valve type
1 N.C.

Fluid
5 Steam

Body material/Port size/Orifice diameter

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Body material</th>
<th>Port size</th>
<th>Orifice diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Bronze (CAC)</td>
<td>3/8</td>
<td>11</td>
</tr>
<tr>
<td>B</td>
<td>1/2</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>3/4</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Stainless steel</td>
<td>3/8</td>
<td>11</td>
</tr>
<tr>
<td>E</td>
<td>1/2</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>3/4</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

Indicator

• Thread type*1
  - Nil
  - Rc
  - A G2
  - B NPT

*1 The thread type for the main piping and pilot piping is the same.

• Pressure type
  - Nil Standard
  - H High pressure

Other Special Options

• Special Entry for Pilot Port/ Insulating Adapter Type

VXB215 XCA

Enter the standard product number.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Rotation angle</th>
<th>Insulated adapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>IN OUT</td>
<td>Pilot port</td>
</tr>
<tr>
<td>90°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XCA</td>
<td>OUT IN</td>
<td>No</td>
</tr>
<tr>
<td>270°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XCC</td>
<td>IN OUT</td>
<td>Pilot port</td>
</tr>
<tr>
<td>270°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XA</td>
<td>IN OUT</td>
<td>Pilot port</td>
</tr>
<tr>
<td>90°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XAA</td>
<td>OUT IN</td>
<td>Yes</td>
</tr>
<tr>
<td>270°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XAC</td>
<td>IN OUT</td>
<td>Pilot port</td>
</tr>
<tr>
<td>270°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For details about the insulated adapter, refer to page 7.
Construction

Component Parts

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cover</td>
<td>Stainless steel 316L equivalent</td>
</tr>
<tr>
<td>2</td>
<td>Spring</td>
<td>Stainless steel 304</td>
</tr>
<tr>
<td>3</td>
<td>Piston assembly</td>
<td>Al, FKM, PTFE, Stainless steel 304</td>
</tr>
<tr>
<td>4</td>
<td>Housing</td>
<td>Al</td>
</tr>
<tr>
<td>5</td>
<td>Guide bushing</td>
<td>PPS</td>
</tr>
<tr>
<td>6</td>
<td>Squeeze seal with scraper function</td>
<td>FKM</td>
</tr>
<tr>
<td>7</td>
<td>Resin scraper</td>
<td>PEEK</td>
</tr>
<tr>
<td>8</td>
<td>Main valve assembly</td>
<td>FKM, Stainless steel 316L</td>
</tr>
<tr>
<td>9</td>
<td>Bushing assembly</td>
<td>Al, FKM</td>
</tr>
<tr>
<td>10</td>
<td>Inverted internal retaining ring</td>
<td>Fe</td>
</tr>
<tr>
<td>11</td>
<td>Body</td>
<td>CAC or Stainless steel 316L equivalent</td>
</tr>
</tbody>
</table>

Dimensions

Insulated adapter (PPS, FKM, Fe)  
(Other special options)  
M5 (Tightening torque: 0.4 to 0.6 N·m)  
Pilot port  
* 10-32UNF can be connected.

Dimensions

<table>
<thead>
<tr>
<th>Model</th>
<th>Port size P</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>VXB215A</td>
<td>3/8</td>
<td>23</td>
<td>55</td>
<td>99.8</td>
<td>88.3</td>
<td>11.5</td>
</tr>
<tr>
<td>VXB215B</td>
<td>1/2</td>
<td>27</td>
<td>65</td>
<td>106.8</td>
<td>90.8</td>
<td>13.5</td>
</tr>
<tr>
<td>VXB215C</td>
<td>3/4</td>
<td>32</td>
<td>75</td>
<td>111.5</td>
<td>93.2</td>
<td>16</td>
</tr>
</tbody>
</table>
**Replacement Parts**

- **Maintenance Kit**
  How to order the maintenance kit

  VXB215 – KT

- **Component Parts**
  - (Symbol) Housing assembly 1 pc.
  - (Symbol) Mounting screw: M5 hexagon socket head cap screw 2 pcs.

- **Disassembly/Assembly Procedures**

  **Disassembly**

  1) Loosen the 2 M5 hexagon socket head cap screws.
  2) Remove the housing assembly from the body.

  **Assembly**

  1) Insert the housing assembly into the body.
  2) Tighten the 2 M5 hexagon socket head cap screws.

  - Tighten the screws diagonally in the order of ①→②→① (Fig.1).
  - Tightening torque for M5 hexagon socket head cap screw: 3 N·m

- **Insulated Adapter (for Individual Parts)**

  **VXB021-20-1A (1 set)**

  - Valve body is not included.

  - For connection, prepare a fitting compliant with ISO 16030 and JIS B 8674.

  - This is the same for all thread types (Rc, G, NPT).

  - Guideline for the tightening torque of the M3 round head combination screw is 0.5 N·m.

**Caution**

1. Before disassembling, be sure to shut off the pressure supply, and then release the residual pressure.
2. After assembly, confirm that there is no fluid leakage.
   Additionally, when restarting the valve, make sure that the valve operates correctly after checking the safety.
1. Indication of flow rate characteristics

The flow rate characteristics of equipment, such as a solenoid valve, etc., are indicated in their specifications as shown in Table (1).

### Table (1) Indication of Flow Rate Characteristics

<table>
<thead>
<tr>
<th>Corresponding equipment</th>
<th>Indication by international standard</th>
<th>Other indications</th>
<th>Compliant standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic equipment</td>
<td>C, b</td>
<td>—</td>
<td>ISO 6358: 1989</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>JIS B 8390: 2000</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>S</td>
<td>JIS B 8390: 2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Equipment: JIS B 8373, 8374, 8375, 8379, 8381</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cv</td>
<td>ANSI/(NFPA)T3.21.3: 1990</td>
</tr>
<tr>
<td>equipment</td>
<td></td>
<td></td>
<td>JIS B 2005: 1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Equipment: JIS B 8471, 8472, 8473</td>
</tr>
</tbody>
</table>

2. Pneumatic equipment

2.1 Indication according to the international standards

(1) Compliant standards

ISO 6358: 1989 : Pneumatic fluid power—Components using compressible fluids—Determination of flow rate characteristics
JIS B 8390: 2000 : Pneumatic fluid power—Components using compressible fluids—How to test flow rate characteristics

(2) Definition of flow rate characteristics

The flow rate characteristics are indicated as a result of a comparison between the sonic conductance $C$ and the critical pressure ratio $b$.

- **Sonic conductance $C$**: Value which divides the passing mass flow rate of a piece of equipment in a choked flow condition by the product of the upstream absolute pressure and the density in a standard condition.

- **Critical pressure ratio $b$**: Pressure ratio (downstream pressure/upstream pressure) which will turn to a choked flow when the value is smaller than this ratio.

- **Choked flow**: Flow in which the upstream pressure is higher than the downstream pressure and where sonic speed in a certain part of a piece of equipment is reached.

  - Gaseous mass flow rate is in proportion to the upstream pressure and not dependent on the downstream pressure.

- **Subsonic flow**: Flow greater than the critical pressure ratio.

- **Standard condition**: Air in a temperature state of 20°C, absolute pressure 0.1 MPa (= 100 kPa = 1 bar), relative humidity 65%.

  It is stipulated by adding the “(ANR)” after the unit depicting air volume.

  (Standard reference atmosphere)


(3) Formula for flow rate

It is described by the practical units as following.

When $\frac{P_2 + 0.1}{P_1 + 0.1} \leq b$, choked flow

$$Q = 600 \times C \left( P_1 + 0.1 \right) \frac{293}{273 + t}$$

----------(1)

When $\frac{P_2 + 0.1}{P_1 + 0.1} > b$, subsonic flow

$$Q = 600 \times C \left( P_1 + 0.1 \right) \left( 1 - \left( \frac{P_2 + 0.1}{P_1 + 0.1} - b \right)^2 \right) \frac{293}{273 + t}$$

----------(2)

$Q$: Air flow rate [dm$^3$/min (ANR)], dm$^3$ (Cubic decimeter) of SI units are also allowed to be described by L (liter). 1 dm$^3$ = 1 L
\( C \): Sonic conductance \([\text{dm}^3/(\text{s} \cdot \text{bar})]\)

\( b \): Critical pressure ratio \([-\] \)

\( P_1 \): Upstream pressure \([\text{MPa}]\)

\( P_2 \): Downstream pressure \([\text{MPa}]\)

\( t \): Temperature \([\text{°C}]\)

Note) Formula of subsonic flow is the elliptic analogous curve.

Flow rate characteristics are shown in Graph (1). For details, please make use of SMC’s “Energy Saving Program.”

Example)

Obtain the air flow rate for \( P_1 = 0.4\) [MPa], \( P_2 = 0.3\) [MPa], \( t = 20\) [°C] when a solenoid valve is performed in \( C = 2\) [dm\(^3\)/(s·bar)] and \( b = 0.3\).

According to formula 1, the maximum flow rate = \( 600 \times 2 \times (0.4 + 0.1) \times \sqrt{\frac{293}{273 + 20}} = 600\) [dm\(^3\)/min (ANR)]

Pressure ratio = \( \frac{0.3 + 0.1}{0.4 + 0.1} = 0.8 \)

Based on Graph (1), it will be 0.7 if the pressure ratio is 0.8 and the flow rate ratio is \( b = 0.3\).

Hence, the flow rate = Max. flow x flow ratio = \( 600 \times 0.7 = 420\) [dm\(^3\)/min (ANR)]

(4) Test method

Connect the piece of test equipment to the test circuit as shown in Fig. (1). While maintaining the upstream pressure at a fixed value above 0.3 MPa, measure the maximum flow to be saturated initially. Next, measure this flow rate at 80%, 60%, 40%, and 20%, as well as the upstream and downstream pressure. The sonic conductance \( C \) can be calculated based on this maximum flow rate. Substitute the data of the others into the subsonic flow formula to find \( b \), and calculate the critical pressure ratio \( b \) from that average.

![Fig. (1) Test circuit based on ISO 6358, JIS B 8390](image-url)
2.2 Effective area $S$

(1) Compliant standards

- **JIS B 8390: 2000: Pneumatic fluid power—Components using compressible fluids—Determination of flow rate characteristics**
- **Equipment standards:**
  - JIS B 8373: 2-port solenoid valve for pneumatics
  - JIS B 8374: 3-port solenoid valve for pneumatics
  - JIS B 8375: 4-port, 5-port solenoid valve for pneumatics
  - JIS B 8379: Silencer for pneumatics
  - JIS B 8381: Fittings of flexible joint for pneumatics

(2) Definition of flow rate characteristics

Effective area $S$: Cross-sectional area that has an ideal throttle without friction or reduced flow. The value is derived by calculating pressure changes inside of an air tank when the compressed air is discharged from a piece of equipment mounted on the tank in a choked flow. The value of the effective area $S$, like that of sonic conductance $C$, expresses the “ease of flow.”

(3) Formula for flow rate

When $\frac{P_2 + 0.1}{P_1 + 0.1} \leq 0.5$, **choked flow**

$$Q = 120 \times S \left( \frac{P_1 + 0.1}{273 + t} \right)^{293}$$

When $\frac{P_2 + 0.1}{P_1 + 0.1} > 0.5$, **subsonic flow**

$$Q = 240 \times S \left( \sqrt{\frac{P_2 + 0.1}{P_1 + 0.1} \left( P_1 - P_2 \right)} \right)^{293}$$

Conversion with sonic conductance $C$: 

$$S = 5.0 \times C$$

$Q$: Air flow rate [dm$^3$/min (ANR)], dm$^3$ (Cubic decimeter) of SI units are also allowed to be described by L (liter). 1 dm$^3 = 1$ L

$S$: Effective area [mm$^2$]

$P_1$: Upstream pressure [MPa]

$P_2$: Downstream pressure [MPa]

$t$: Temperature [$^\circ$C]

Note) The formula for subsonic flow (4) is only applicable when the critical pressure ratio $b$ is the unknown piece of equipment. In the sonic conductance $C$ formula (2), it is the same formula as when $b = 0.5$.

(4) Test method

Connect the piece of test equipment to the test circuit as shown in Fig. (2). Discharge the air from the air tank filled with compressed air at a fixed value above 0.6 MPa (0.5 MPa) into the atmosphere until the pressure inside the tank falls to 0.25 MPa (0.2 MPa). Measure the discharge time and the residual pressure inside the tank after discharging until it has returned to the normal value. Then, calculate the effective area $S$ using the following formula. Select an air tank with a volume within the specified range of the test equipment’s effective area. For JIS B 8373, 8374, 8375, 8379, and 8381, the pressure values are in parentheses and the coefficient of the formula is 12.9.

$$S = 12.1 \left( \frac{V}{t} \right) \log_{10} \left( \frac{P_s + 0.1}{P + 0.1} \right) \frac{293}{T}$$

$S$: Effective area [mm$^2$]

$V$: Air tank capacity [dm$^3$]

$t$: Discharging time [s]

$P_s$: Pressure inside air tank before discharging [MPa]

$P$: Residual pressure inside air tank after discharging [MPa]

$T$: Temperature inside air tank before discharging [K]

- **Fig. (2) Test circuit based on JIS B 8390**
2.3 Flow coefficient $C_V$ factor

The United States Standard ANSI/(NFPA)T3.21.3: 1990: Pneumatic fluid power—Flow rating test procedure and reporting method for fixed orifice components

This standard defines the $C_V$ factor of the flow coefficient by the following formula that is based on the test conducted by the test circuit analogous to ISO 6358.

$$
C_V = \frac{Q}{114.5 \sqrt{\frac{\Delta P (P_2 + P_a)}{T_1}}} \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots 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Conversion of flow coefficient:

\[ Av = 28 \times 10^{-6} \quad Kv = 24 \times 10^{-6} \quad Cv \]  

(11)

Here,

- \( Kv \) factor: Value of the clean water flow rate (represented by m³/h) which runs through a valve at 5 to 40°C when the pressure difference is 1 bar.
- \( Cv \) factor (Reference values): Value of the clean water flow rate (represented by US gal/min) which runs through a valve at 60°F when the pressure difference is 1 lbf/in² (psi).

The values of \( Kv \) and \( Cv \) factors for pneumatic purposes are different due to different test methods.

Example 1)

Obtain the pressure difference when 15 [L/min] of water runs through a solenoid valve with an \( Av = 45 \times 10^{-6} [m^2] \).

Since \( Q_0 = 15/45 = 0.33 [L/min] \), according to Graph (2), if reading \( \Delta P \) when \( Q_0 \) is 0.33, it will be 0.031 [MPa].

Example 2)

Obtain the saturated steam flow rate when \( P_1 = 0.8 \) [MPa], \( \Delta P = 0.008 \) [MPa] with a solenoid valve with an \( Av =1.5 \times 10^{-6} [m^2] \).

According to Graph (2), if reading \( Q_0 \) when \( P_1 \) is 0.8 and \( \Delta P \) is 0.008, it is 0.7 [kg/h]. Hence, the flow rate is \( Q = 0.7 \times 1.5 = 1.05 \) [kg/h].

(4) Test method

Connect the piece of test equipment to the test circuit as shown in Fig. (3). Pour in 5 to 40°C water and measure the flow rate with a pressure difference of 0.075 MPa. There are cases in which the pressure difference may need to be set higher in order to keep the Reynolds number in the range above \( 4 \times 10^4 \).

Substitute the measurement results into the formula (8) to calculate \( Av \).
**VXB Series**

**Flow Rate Characteristics**

Note) Use this graph as a guide. If an accurate flow rate is required, refer to pages 8 to 12.

### For Air

The sonic range pressure to generate a flow rate of 4000 L/min (ANR) is $P_1 \approx 0.4$ MPa for the VXB215A (H).

### For Water

When a water flow of 50 L/min is generated, $\Delta P \approx 0.1$ MPa for the VXB215F (H).
For Saturated Steam

The sonic range pressure to generate a flow rate of 300 kg/h is $P_1 = 0.3$ MPa for the VXB215C (H).

The holding heat is approximately 196 Mcal/h at 300 kg/h.
**Warning**

1. For usage of reverse pressure, please consult SMC.
2. Cannot be used as an emergency shutoff valve, etc.
   
   The valves presented in this catalog are not designed for safety applications such as an emergency shutoff valve. If the valves are used in this type of system, other reliable safety assurance measures should also be adopted.

3. Liquid rings
   
   In cases where a flowing liquid is used, provide a bypass valve in the system to prevent the liquid from entering the liquid seal circuit.

4. Pressure holding
   
   It cannot be used for an application such as holding the pressure inside of a pressure vessel because air leakage is entailed in a valve.

5. When an impact, such as steam hammer, etc., caused by rapid pressure fluctuation is applied, the valve may be damaged. Please use with caution.

**Selection**

**Warning**

1. Fluid
   
   Corrosive gases cannot be used since cracks caused by stress corrosion or other incidents may result.

2. Air quality
   
   **<Steam, Water>**
   
   The use of a fluid that contains foreign matter can cause problems, such as malfunction and seal failure, by promoting the wear of the valve seat and seal. Install a suitable filter (strainer) immediately upstream from the valve. As per standard, the mesh count for the strainer should be 100 mesh. However, the size and shape of the foreign matter that occur depends on the operating environment. Check the fluid status and choose an appropriate mesh count.
   
   The supply water to a boiler includes materials that create a hard sediment or sludge, such as calcium and magnesium.
   
   Sediment and sludge from steam can cause the valve to not operate properly. Install a water softening device which removes these materials. Do not use operation steam which contains chemicals, synthetic oils that contain organic solvents, salts, corrosive gases, etc., as these can cause damage or deterioration.
   
   The seal material (special FKM) used for wetted parts of the product can withstand steam in standard conditions. However, the resistance of the sealing material can deteriorate depending on the types of additives such as boiler compounds and water conditioners within the boiler steam. Please only utilize the product after determining the sealing material resistance within the actual usage conditions.

3. Ambient environment
   
   Use within the operable ambient temperature range. Check the compatibility between the product’s composition materials and the ambient atmosphere. Be certain that the fluid used does not touch the external surface of the product.

4. Low-temperature operation
   
   1) The valve can be used in an ambient temperature of –20°C. However, take measures to prevent the freezing or solidification of impurities, etc.
   
   2) When using valves for water applications in cold climates, take appropriate countermeasures to prevent the water from freezing in the tubing after cutting the water supply from the pump, by draining the water, etc. The installation of a dryer and heat retaining of the body is recommended to prevent a freezing condition in which the dew point temperature is high and the ambient temperature is low, and the high flow runs.

For 2 Port Solenoid Valves for Fluid Control Precautions, refer to the “Handling Precautions for SMC Products” and the “Operation Manual” on the SMC website: http://www.smcworld.com
**Warning**

1. If air leakage increases or equipment does not operate properly, stop operation.
   After mounting is completed, confirm that it has been done correctly by performing a suitable function test.

2. Do not apply external force to the operating section.
   When tightening is performed, apply a wrench or other tool to the outside of the piping connection parts.

3. Mount a valve with its operating section upward, not downward.
   If the operating section is installed downward, foreign matter in the fluid may stick to the seal, causing a malfunction.

4. Avoid sources of vibration, or adjust the arm from the body to the minimum length so that resonance will not occur.

5. Painting and coating
   Warnings or specifications printed or labeled on the product should not be erased, removed, or covered up.

**Caution**

1. Preparation before piping
   Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove chips, cutting oil, and other debris from inside the pipe. Avoid pulling, compressing, or bending the valve body when piping.

2. Avoid connecting ground lines to piping, as this may cause electric corrosion of the system.

3. Always tighten threads with the proper tightening torque.
   Refer to the tightening torque in the table below for connecting steel piping. Insufficient tightening torque will lead to fluid leakage. For mounting the fittings, refer to the specified torque.

   **Tightening Torque for Piping**
<table>
<thead>
<tr>
<th>Connection thread</th>
<th>Proper tightening torque [N·m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS (Insulated adapter)</td>
<td>0.4 to 0.6</td>
</tr>
<tr>
<td>Rc1/8</td>
<td>7 to 9</td>
</tr>
<tr>
<td>Rc3/8</td>
<td>22 to 24</td>
</tr>
<tr>
<td>Rc1/2</td>
<td>28 to 30</td>
</tr>
<tr>
<td>Rc3/4</td>
<td></td>
</tr>
</tbody>
</table>

4. When connecting piping to a product, avoid mistakes regarding the connecting direction of the product.

**Caution**

5. Winding of sealant tape
   When connecting pipes, fittings, etc., be sure that chips from the pipe threads and sealing material do not enter the valve. Furthermore, when sealant tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.

6. If an excessive amount of thread sealant, such as sealant tape or liquid thread sealant, is used during piping, it will get inside the product and lead to a malfunction.

7. Steam generated in a boiler contains a large amount of drainage. Be sure to operate it with a drain trap installed.

8. Arrange piping so that condensate will not accumulate in the valve.
   Install the piping to the valve higher than the peripheral piping. Be sure to avoid installing the piping to the valve at the lowest part of the piping layout. If condensate accumulates in the valve or peripheral piping, the steam entering the piping will cause steam hammer. This will lead to the destruction and malfunction of the valve and piping. If steam hammer causes problems, install bypass piping to thoroughly discharge condensate from the piping. Apply steam to the device afterward to start operation.

9. For the convenience of maintenance and repair, install a bypass circuit and use a union for piping.

10. To control the fluid in the tank, connect the piping slightly higher than the bottom of the tank.

11. Pilot piping
   When using steam as the fluid, use heat resistant fittings and tubing. (Metal One-touch fittings, self-align fittings, fluoropolymer tubing, copper tubing, etc.)
   When an insulated adapter (other special option) is used, nylon tubes can be used. However, nylon tubes may not be used according to the operating pressure. Measure the temperature of the operating environment with the actual machine to select usable tubes and fittings.

   **[Reference temperature]**
   * The temperature of the pilot port becomes approx. 70°C as the insulated adapter is mounted.
   Measurement conditions: Fluid temperature 183°C, Ambient temperature 60°C
   Temperature of the fitting port of the insulated adapter:
   - Mounted 70°C
   - Not mounted 130°C
**Warning**

1. **Removing the product**
   
   The valve will reach a high temperature when used with high-temperature fluids. Confirm that the valve temperature has dropped sufficiently before performing work. If touched inadvertently, there is a danger of being burned.

   1) Shut off the fluid supply and release the fluid pressure in the system.
   2) Shut off the power supply.
   3) Dismount the product.

2. **Low-frequency operation**
   
   Switch valves at least once every 30 days to prevent a malfunction. Also, in order to use them under the optimum state, conduct a regular inspection biannually.

**Caution**

1. **Strainers**
   
   1) Be careful regarding the clogging of strainers.
   2) Clean strainers when the pressure drop reaches 0.1 MPa.

2. **Lubrication**
   
   When using after lubricating, be sure to lubricate continuously.

3. **Storage**
   
   In case of long term storage after use, thoroughly remove all moisture to prevent rust and the deterioration of rubber materials, etc.

4. **Exhaust the drainage from the piping periodically.**

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**Adiabatic Space**

There is a space between the body and housing (\*: approximately 1 mm) for adiabatic effect.

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**Operating Precautions**

**Warning**

1. The valve will reach a high temperature when used with high-temperature fluids. Use caution, as there is a danger of being burned if a valve is touched directly.

2. When problems are caused by steam hammer, install a steam hammer relief device, such as an accumulator.

3. When the valve is closed and pressure exceeding the maximum operating pressure is applied suddenly, due to the starting of a fluid supply source such as a boiler, the valve may open momentarily and fluid may leak.
Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of “Caution,” “Warning” or “Danger.” They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)*1, and other safety regulations.

Caution: Caution indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.

Warning: Warning indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.

Danger: Danger indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.
   Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results. The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product. This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

2. Only personnel with appropriate training should operate machinery and equipment.
The product specified here may become unsafe if handled incorrectly. The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.
   1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.
   2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.
   3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.
   1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.
   2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.
   3. An application which could have negative effects on people, property, or animals requiring special safety analysis.
   4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.

1. The product is provided for use in manufacturing industries.
The product herein described is basically provided for peaceful use in manufacturing industries. If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.

If anything is unclear, contact your nearest sales branch.

Limited warranty and Disclaimer
The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”. Read and accept them before using the product.

Compliance Requirements
1. The use of SMC products with production equipment for the manufacture of weapons of mass destruction (WMD) or any other weapon is strictly prohibited.
2. The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulations of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.

SMC products are not intended for use as instruments for legal metrology.
Measurement instruments that SMC manufactures or sells have not been qualified by type approval tests relevant to the metrology (measurement) laws of each country. Therefore, SMC products cannot be used for business or certification ordained by the metrology (measurement) laws of each country.

Revision History
1. Indicator have been added.
   • Component parts of the maintenance kit have been changed.
   • Notations about pilot piping have been revised.

Safety Instructions
Be sure to read the “Handling Precautions for SMC Products” (M-E03-3) and “Operation Manual” before use.