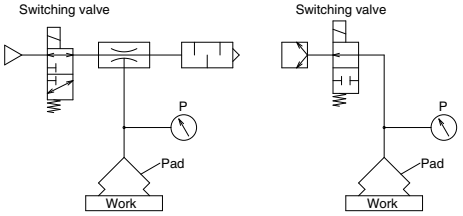
5 Adsorption Response Time

When a vacuum pad is used for the adsorption transfer of a workpiece, the approximate adsorption response time can be obtained (the length of time it takes for the pad's internal vacuum pressure to reach the pressure that is required for adsorption after the supply valve {vacuum switching valve} has been operated). An approximate adsorption response time can be obtained through formulas and selection graphs.

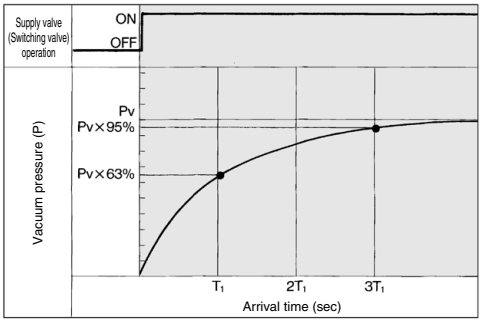
● Relationship between Vacuum Pressure and Response Time after Supply Valve (Switching Valve) is Operated

The relationship between vacuum pressure and response time after the supply valve (switching valve) is operated as shown below.

Vacuum System Circuit



Vacuum Pressure and Response Time after Supply Valve (Switching Valve) is Operated



Pv: Final vacuum pressure
T1 : Arrival time to 63% of final vacuum pressure **Pv**
T2 : Arrival time to 95% of final vacuum pressure **Pv**

● Calculating Adsorption Response Time with the Formula

Adsorption response times **T1** and **T2** can be obtained through the formulas given below.

Adsorption response time $T_1 = \frac{V \times 60}{Q}$

Adsorption response time $T_2 = 3 \times T_1$

Piping capacity

$V = \frac{3.14}{4} D^2 \times L \times \frac{1}{1000}$ (L)

T1 : Arrival time to 63% of final vacuum pressure **Pv** (sec)
T2 : Arrival time to 95% of final vacuum pressure **Pv** (sec)
Q1: Average suction flow rate L/min [ANR]
Calculation of average suction flow rate
- Ejector
  Q1 = (1/2 to 1/3) x Ejector max. suction flow rate L/min [ANR]
- Vacuum pump
  Q1 = (1/2 to 1/3) x 55.5 x Conductance of vacuum pump [dm³/(s·bar)]

D : Piping diameter (mm)
L : Length from ejector and switch valve to pad (m)
V : Piping capacity from ejector and switching valve to pad (L)
Q2: Max. flow from ejector and switching valve to pad by piping system
Q2 = C x 55.5 L/min [ANR]
Q : Smaller one between the **Q1** and **Q2** L/min [ANR]
C : Conductance of piping [dm³/(s·bar)]

For the conductance, the equivalent conductance can be found in "8. Data: Conductance by Tube I.D. (Selection Graph (3))."

● Adsorption Response Time from the Selection Graph

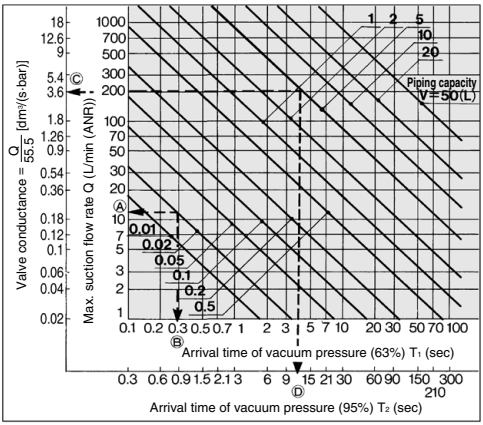
1. Tube Piping Capacity

Piping capacity from the ejector and switching valve at vacuum pump to the pad can be found in “8. Data: Piping Capacity by Tube I.D. (Selection Graph (2)).”

2. Obtain the adsorption response times.

By operating the supply valve (switching valve) that controls the ejector (vacuum pump), the adsorption response times **T_1** and **T_2** that elapsed before the prescribed vacuum pressure is reached can be obtained from the Selection Graph (1).

Selection Graph (1) Adsorption Response Time



∗ Conversely, the size of the ejector or the size of the switching valve of the vacuum pump system can be obtained from the adsorption response time.

How to read the graph

Example 1: For obtaining the adsorption response time until the pressure in the piping system with a piping capacity of 0.02 L is discharged to 63% (**T_1**) of the final vacuum pressure through the use of the vacuum ejector ZH07□S with a maximum suction flow rate of 12 L/min (ANR).

<Selection Procedure>

From the point at which the vacuum ejector’s maximum vacuum suction flow rate of 12 L/min (ANR) and the piping capacity of 0.02 L intersect, the adsorption response time **T_1** that elapses until 63% of the maximum vacuum pressure is reached can be obtained. (Sequence in Selection Graph (1), Ⓐ→Ⓑ) **$T_1 \approx$ 0.3 seconds.**

Example 2: For obtaining the discharge response time until the internal pressure in the 5 L tank is discharged to 95% (**T_2**) of the final vacuum pressure through the use of a valve with a conductance of 3.6 [dm³/(s·bar)].

<Selection Procedure>

From the point at which the valve’s conductance of 3.6 [dm³/(s·bar)] and the piping capacity of 5 L intersect, the discharge response time (**T_2**) that elapses until 95% of the final vacuum pressure is reached can be obtained. (Sequence in Selection Graph (1), Ⓒ→Ⓓ) **$T_2 \approx$ 12 seconds.**