Suction Components - Overview

■Material Properties of Suction Cups

Select an appropriate cup material according to the usage environment, conditions, atmosphere, conductivity, and material and properties of the workpiece.

<Material property list>

Pad Material		Rubber Type					Sponge Type
		Nitrile Rubber	Silicon Rubber	Conductive Silicon Rubber	Fluoro Rubber	Phlorosilicon Rubber	Chloroprene Rubber
Applications		Cardboard Plywood Metal Plates Other common materials	Semiconductors Removal of molded parts Thin materials Food-related		Chemical atmosphere High Temperature	Removal of molded parts	Uneven surface
Color		Black	White*	Black	Gray	Light Brown	Black
Max. Operating Temp.		110°C	180°C		230°C	180°C	80°C
Min. Operating Temp.		-30°C	-40°C		-10°C	-50°C	-45°C
Weather Resistance		△	◎		○	○	○
Ozone Resistance		×	◎		◎	◎	○
Oil Resistance / Solvent Resistance	Gasoline, Light Oil	◎	△		◎	△	×
	Benzene, Toluene	×~△	△		◎	△	△
	Alcohol	◎	◎		△~○	-	△
	Ether	×~△	×~△		×~△	-	×
	Ketone	×	○		×	-	×
Acid Resistance / Alkali Resistance	Water	◎	○		◎	-	○
	Organic Acid	×	○		△~○	-	×
	Alkaline	○	◎		×	◎	◎

◎: Most suitable　Hardly affected　○: Suitable　Slightly affected but can withstand use depending on the condition
△: Allowed.　If possible, do not use　×: Not suitable　Seriously affected and not suitable for use
* Some products have black, semitransparent, and sky blue variations.
(Note) The above table just shows general properties of materials, which may vary depending on usage conditions and other factors and are not guaranteed.

■Recommended methods of attaching and piping suction cups

Shock to a cup and positioning

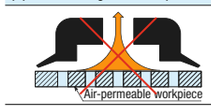
If a strong shock is given to a cup, it will be deformed, cracked, and worn more quickly.
Position the cup within the deformation range of the skirt of the cup or place it in a position where it slightly touches the workpiece.
Precisely position small cups in particular.

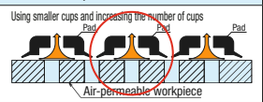
Balance of installed cups

Place suction cups on a workpiece so that it is well balanced.
Take measures such as balancing the workpiece, preventing the cups from sticking out of the workpiece, and equalizing the loads on the respective cups.

When the suction face is air-permeable or has holes

If the face is air-permeable, the amount of air leakage becomes larger and the suction force is reduced. It is necessary to take measures such as enlarging the effective sectional area of the pipeline or using smaller cups and increasing the number of cups.





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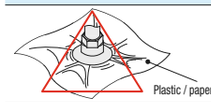
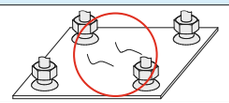
When there is a danger of falling of the workpiece, install fall prevention guards and take safety measures.

When the workpiece is wrinkled

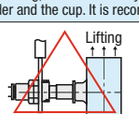
Soft workpieces such as paper, thin materials, plastic sheets, can be deformed or wrinkled by the suction force. Use smaller cups or reduce the vacuum pressure.

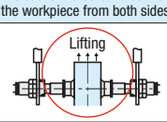




In vertical lifting

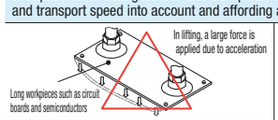
Cups are basically designed to be used for horizontal lifting.
For vertical lifting, consider not only the safety factor for the suction force but also the strength of the holder and the cup. It is recommended to suction the workpiece from both sides.

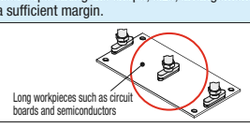




When the workpiece is flat and long

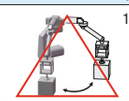
Workpieces such as circuit boards and glass boards may form ripples due to the load of the workpiece itself during suction and transport. Select cups taking the shape, size, arrangement, and transport speed into account and affording a sufficient margin.

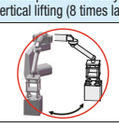




When the workpiece undergoes rotary conveyance or acceleration

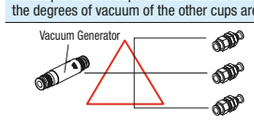
When a workpiece undergoes rotary conveyance, make sure the screws are not loosened and pay special attention if the cup is out of the center of the gravity of the workpiece. For rotary conveyance with a lateral movement, set a safety factor larger than that for vertical lifting (8 times larger).

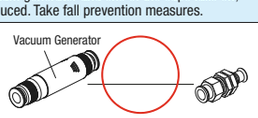




Placement of multiple suction cups

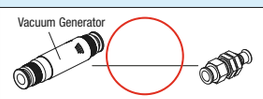
It is ideal to install a vacuum generator piping for each suction cup.
If multiple suction cups are attached to one vacuum generator and one of the cups falls off, the degrees of vacuum of the other cups are reduced. Take fall prevention measures.

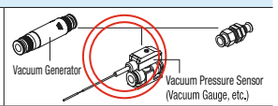




Checking the suction force (vacuum pressure)

It is recommended to install a sensor or a gauge so that the vacuum pressure can be checked. It is effective as a safety measure for detecting abnormalities and suction condition.





Selection Method of Suction Cups

■Selection Method of Vacuum Equipment

The following shows a simple selection procedure and calculation method for selecting cups.

■When selecting cups

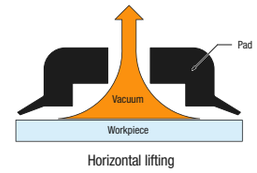
(1) Calculate the theoretical suction (lifting) force from the suction area (cup area x number of pieces) and suction pressure. Calculate the suction (lifting) force taking into account the lifting method, movement conditions, and safety factor.
A. Calculation using a formula
B. Selection using the theoretical suction force
(2) Compare the load (mass) of the workpiece and the lifting force to determine the cup area.
(3) Determine the cup shape, material, and whether to use a buffer (stroke) or not according to the usage environment and characteristics, shape, and material of the workpiece.

(1) Calculation of suction force

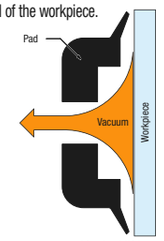
A. Calculation using a formula: Suction force of a suction cup can be calculated by substituting values in the following formula.

$$W = C \times P \times 0.1 \times f$$

W: Suction Force (N)
C: Cup area (cm^2)
P: Vacuum Pressure (-kPa)
f : Safety factor　In horizontal lifting: 1/4 or more
In vertical lifting: 1/8 or more



Horizontal lifting



Vertical lifting

*** The lifting method shall basically be horizontal lifting.**

B. Selection using the theoretical suction force: Suction force of a suction cup can be calculated by the following formula based on the tables below.

Suction Force (N) = Theoretical Suction Force (N) / f (Safety Factor)

■Theoretical suction force table (Suction force = $\frac{C \times P}{101}$ x10.13)

<For a round pad>　(Unit: N)

Pad Diameter (mm)		0.7	1	1.5	2	3	4	6	8	10	15	20	25	30	35	40
Suction Area (cm²)		0.004	0.008	0.018	0.031	0.071	0.126	0.283	0.502	0.785	1.766	3.14	4.906	7.065	9.616	12.56
Vacuum Pressure (kPa)	-85	0.034	0.068	0.153	0.264	0.604	1.07	2.41	4.27	6.67	15.01	26.7	41.7	60.05	81.74	106.8
	-80	0.032	0.064	0.144	0.248	0.568	1.01	2.26	4.016	6.28	14.13	25.1	39.25	56.52	76.93	100.5
	-75	0.03	0.06	0.135	0.233	0.533	0.945	2.12	3.765	5.89	13.25	23.6	36.8	52.99	72.12	94.2
	-70	0.028	0.056	0.126	0.217	0.497	0.882	1.98	3.514	5.5	12.36	22	34.34	49.46	67.31	87.92
	-65	0.026	0.052	0.117	0.202	0.462	0.819	1.84	3.263	5.1	11.48	20.4	31.89	45.92	62.5	81.64
	-60	0.024	0.048	0.108	0.186	0.426	0.756	1.7	3.012	4.71	10.6	18.8	29.44	42.39	57.7	75.36
	-55	0.022	0.044	0.099	0.171	0.391	0.693	1.56	2.761	4.32	9.713	17.3	26.98	38.86	52.89	69.08
	-50	0.02	0.04	0.09	0.155	0.355	0.63	1.42	2.51	3.93	8.83	15.7	24.53	35.33	48.08	62.8
	-45	0.018	0.036	0.081	0.14	0.32	0.567	1.27	2.259	3.53	7.95	14.1	22.08	31.79	43.27	56.52
	-40	0.016	0.032	0.072	0.124	0.284	0.504	1.13	2.008	3.14	7.064	12.6	19.62	28.26	38.46	50.24

<For an oval pad>　(Unit: N)

Pad Diameter (mm)		4x10	4x20	4x30	5x10	5x20	5x30	6x10	6x20	6x30
Suction Area (cm²)		0.365	0.765	1.165	0.446	0.946	1.446	0.522	1.122	1.722
Vacuum Pressure (kPa)	-85	3.103	6.503	9.903	3.791	8.041	12.29	4.437	9.537	14.64
	-80	2.92	6.12	9.32	3.568	7.568	11.57	4.176	8.976	13.78
	-75	2.738	5.738	8.738	3.345	7.095	10.85	3.915	8.415	12.92
	-70	2.555	5.355	8.155	3.122	6.622	10.12	3.654	7.854	12.05
	-65	2.373	4.973	7.573	2.899	6.149	9.399	3.393	7.293	11.19
	-60	2.19	4.59	6.99	2.676	5.676	8.676	3.132	6.732	10.33
	-55	2.008	4.208	6.408	2.453	5.203	7.953	2.871	6.171	9.471
	-50	1.825	3.825	5.825	2.23	4.73	7.23	2.61	5.61	8.61
	-45	1.643	3.443	5.243	2.007	4.257	6.507	2.349	5.049	7.749
	-40	1.46	3.06	4.66	1.784	3.784	5.784	2.088	4.488	6.888

* The table does not take safety factors into account. Be sure to take the safety factor into account in calculating the suction force before selecting a part.

(2) Compare the load (mass) of the workpiece and the lifting force to calculate the cup diameter (area).

<Calculation using a formula>

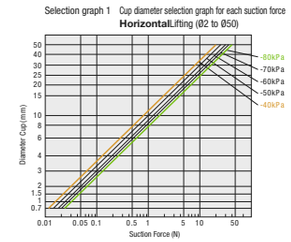
Calculate the diameter of the suction cup from the suction force actually needed.

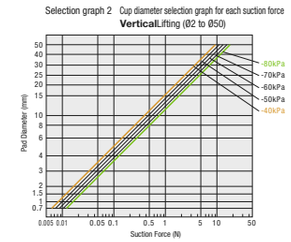
$$D = \sqrt{\frac{4}{3.14} \times \frac{1}{P} \times \frac{W}{n} \times \frac{1}{f} \times 1000}$$

D: Cup diameter (mm)　n: Number of cups to a workpiece
W: Suction Force (N)　P: Vacuum Level (-kPa)　f: Safety Factor

<Selection using the selection graph>

Find a cup diameter from the suction force of 1 suction cup on the table on the right.

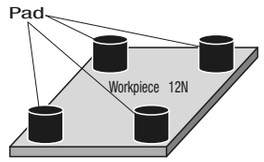




Example of calculation/selection: Selection of cup area

<Conditions>
・Mass of Workpiece: 12N (Approx. 1.2kg)
・Vacuum Pressure: -60kPa
・Lifting method: Horizontal lifting
* Assume that no acceleration is gained during conveyance.

[Image]



Place one cup at each of the four corners so that it is well balanced.

<Calculation using a formula> Assign values of the conditions into red circles.

$$D = \sqrt{\frac{4}{3.14} \times \frac{1}{P} \times \frac{W}{n} \times \frac{1}{f} \times 1000}$$

Convert the weight of the workpiece into Newtons and assign the value.
Assign the safety factor
Assign 4 because this is horizontal lifting.

$$\sqrt{\frac{4}{3.14} \times \frac{1}{60} \times \frac{12}{4} \times 4 \times 1000} = 15.96$$

Assign the value of vacuum pressure
Remove the minus sign
and then enter the value.
Assign the number of cups to be used
Assign 4 because 4 cups are used this time.

According to the formula and the selection graph, it is recommended to use a cup of at least 20 mm in diameter. However, since the recommended diameter varies depending on the acceleration during conveyance, the condition and material of the workpiece, and the usage environment; thus, setting a larger value as a safety factor is recommended.

<Calculation using the selection graph>

To lift a workpiece which requires a force of 12N with 4 cups, 1 cup needs to have a suction force of 12/4=3N.
<From the selection graph below>①Start from the position of 3N on the horizontal axis "Suction force (N)" and find the point of intersection with the line of -60 kPa.②Move horizontally from the point. The point of intersection with the vertical axis for cup diameter shows the necessary cup diameter. Thus, according this graph, the cup diameter needs to be a little larger than 15 mm.