Reliable and fast vacuum handling

Five steps to the optimum suction gripper:

Step 1:

Calculating the weight of the workpiece

m = L x B x H x ρ

Example:
m = 20 cm x 10 cm x 0,2 cm x 7,85 g/cm³
= 314 g
= 0,314 kg

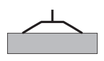
m= weight (kg), L = length (cm), W = width (cm), H = height (cm), ρ = density (g/cm3)

Step 2:

Selecting the suction gripper

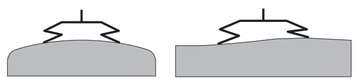
Different vacuum gripper shapes are recommended depending on the surface finish of the workpiece:

Standard suction cups
For flat and slightly undulating and domed surfaces, such as sheet metal or cardboard.

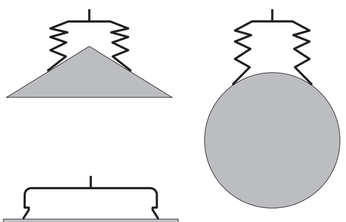


Extra deep suction cups
For round and domed workpieces.

Bellows suction cup with 1.5 convolutions
For bevelled surfaces, depending on suction cup diameter between 5° and 30°. For domed, round, large surface and pliable workpieces.



Bellows suction cup with 3.5 convolutions
For delicate workpieces such as glass bottles or light bulbs. Inexpensive height compensator.



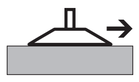
Oval suction cup
For slim, oblong workpieces such as profiles, pipes.

Step 3:

Calculating the retention and breakaway forces

The weight of the workpiece and acceleration are required to calculate the retention forces.

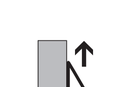
Case 1
Horizontal suction gripper position, vertical direction of movement (favourable case)



Calculation formula:
$F_H = m \times (g + a) \times S$

Example:
F_H = 0.314 kg x (9.81 m/s² + 30 m/s²) x 1.5
= 19 N

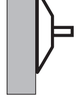
Case 2
Horizontal suction gripper position, horizontal direction of movement



Calculation formula:
$F_H = m \times (g + a/\mu) \times S$

Example:
F_H = 0.314 kg x (9.81 m/s² + 30 m/s²/0.1) x 1.5
= 146 N

Case 3
Vertical suction gripper position, vertical direction of movement (less favourable case)



Calculation formula:
$F_H = (m/\mu) \times (g + a) \times S$

Example:
F_H = (0.314 kg/0.1) x (9.81 m/s² + 30 m/s²) x 2
= 251 N

F_H = Theoretical retention force of suction gripper (N)
m = Weight (kg)
g = Acceleration due to gravity (9.81 m/s²)
a = Acceleration of system (m/s²)
Observe Emergency-Stop acceleration!

S = Safety factor
= 1.5 with vertical and horizontal movement
= 2 with rotation

μ = Friction value*

Friction (surface)*

Oily	μ = 0.1
Wet	μ = 0.2 ... 0.3
Rough	μ = 0.6
Wood, metal, glass, stone ...	μ = 0.5

Empirical values of acceleration

Electrical spindle:	6 m/s²
Electrical toothed belt:	20 m/s²
Servo-pneumatic:	25 m/s²
Pneumatic:	30 m/s²
Pneumatic rotary or semi-rotary drive: Comparable linear acceleration:	40 m/s²

* The specified friction values represent average values and must be checked for each workpiece used!

Step 4:

Determination of suction cup diameter and shape

Breakaway and retention force FA dependent on suction cup diameter and shape.

Suction cup round	F_A at –0.7 bar					Suction cup oval	F_A at –0,7 bar
Suction cup-Ø [mm]	Standard	Extra deep	1.5 convolution bellows	3.5 convolution bellows	Suction cup, bell-shaped	Suction cup size [mm]	oval
2	0.10 N					4 x 10	2.0 N
4	0.46 N					4 x 20	3.4 N
6	1.10 N					6 x 10	2.9 N
8	2.30 N					6 x 20	5.9 N
10	3.90 N		4.7 N	3.9 N		8 x 20	8.0 N
15	8.50 N	9.8 N				8 x 30	10.9 N
20	16.30 N	17.0 N	12.9 N	8.2 N		10 x 30	15.2 N
30	40.80 N	37.2 N	26.2 N	20.8 N	36 N	15 x 45	32.0 N
40	69.60 N	67.6 N	52.3 N	42.4 N	64 N	20 x 60	62.8 N
50	105.80 N	103.6 N	72.6 N	63.4 N	97 N	25 x 75	92.5 N
60	166.10 N	162.5 N			134 N	30 x 90	134.4 N
80	309.70 N	275.0 N	213.6 N		245 N		
100	503.60 N	440.8 N			375 N		
150	900.00 N						
200	1610.00 N						

Step 5:

Observing of environmental conditions

Material		Nitrile rubber	Polyurethane	Vulkollan®	Silicone	Fluor rubber	Nitrile rubber (anti-static)
Charakteristic operating temperatures	in °C	–10 ... +70	–20 ... +60	–10 ... +80	–30 ... +180	–10 ... +200	–10 ... +70
	200						
	150						
	100						
	50						
	0						
	–50						
Material characteristics							
Material Code		N	U	T	S	F	NA
Colour		Black	Blue	Red-brown	Transparent	Grey	Black with white dot
Wear resistance Abrasion resistance		••	•••	•••	•	••	••
Shore hardness A		50 ±5	60 ±5	72 ±5	50 ±5	60 ±5	50 ±5
Typical application areas		Conventional application	Rough surface	Automobile industry	Food industry	Glass industry	Electronics industry
Very demanding conditions		–	•	•	•	–	–
Food		–	–	–	•	–	–
Oily workpieces		•	•	•••	–	•	•
High ambient temperatures	–	–	–	•	•	–	
Low ambient temperatures	–	•	•	•	–	–	
Smooth surfaces (glass)		•	•	•	–	•	–
Rough surfaces (wood, stone)		–	•	••	–	–	–
Anti-static		–	–	–	–	–	•
Fragile surfaces		–	•	•	•	–	–
Resistance							
Atmospheric conditions		•	••	••	•••	•••	••
Tensile strength		••	•••	•••	•	••	••
Permanent deformation		••	•	••	••	•••	••
Hydraulic oil, mineral		•••	•••	•••	–	•••	–
Hydraulic oil, synthetic ester		•	–	–	–	•	–
Non-polar solvents (e.g. petroleum spirit)		•••	••	••	–	•••	–
Polar solvents (e.g. acetone)		–	–	–	–	–	–
Ethyl alcohol		•••	–	–	•••	•	–
Isopropanol		••	–	–	•••	•••	–
Water		•••	–	–	••	••	–
Acids (10%)		–	–	–	•	•••	–
Alkaline solutions (10%)		••	•	•	•••	••	–

••• Highly suitable •• very suitable • suitable – unsuitable ® Vulkollan® is a registered trademark of Bayer

FESTO

2000 options, 1 principle, zero selection problems

The ideal “pneumatic hand” with over 2,000 gripper type variants, sizes and materials.

Modular vacuum suction gripper range from Festo

Suction cup holder ESH-...

Straight	Straight with stroke length compensator	Straight with stroke length compensator, long	Angular	Angular, with stroke length compensator	Angular, with stroke length compensator, long	Straight, with screw-in threadh	Adaption
ESH-HA-...	ESH-HC-...	ESH-HCL-...	ESH-HB-...	ESH-HD-...	ESH-HDL-...	ESH-HF-...	ESH-HE-...

Angle compensator (optional)

Angle compensator ESWA-...

Filter (optional)

Filter (not for oval suction cups) ESF-...

Suction cups

Illustrations of one example each from the product range

Suction cup, standard, without attachment parts ESV-...-...S...	Suction cup, standard, with attachment partsESS-...-S...	Suction cup, extra deep without attachment parts ESS-...-GT...	Suction cup, extra-deep with attachment parts ESV-...-E...	Suction cup, extra-deep with attachment parts ESS-...-E...	Suction cup, 1.5 convolution bellows, without attachment parts ESV-...-B...	Suction cup, 1.5 convolution bellows, with attachment parts ESS-...-B...	Suction cup, 3.5 convolution bellows, without attachment parts ESV-...-C...	Suction cup, 1.5 convolution bellows, with attachment parts ESS-...-C...	Suction cup, oval, with attachment parts ESS-...-O...

Vacuum range selection software from Festo

For the convenient and safe selection of suction cups, tubing and vacuum generators.

Available on the Internet via:
www.festo.com/vacuumselection

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