Reliable and fast vacuum handling

Five steps to the optimum suction gripper:

Step 1:

Calculating the weight of the workpiece

 $m = L x B x H x \rho$

Example:

- $m = 20 \text{ cm x } 10 \text{ cm x } 0,2 \text{ cm x } 7,85 \text{ g/cm}^3$
- = 314 g= 0,314 kg
- m= weight (kg), L = length (cm), W = width (cm), H = height (cm), ρ = density (g/cm3)

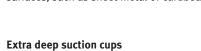
Step 2:

Selecting the suction gripper

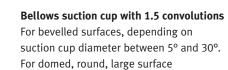
Different vacuum gripper shapes are recommended depending on the surface finish of the workpiece:

Standard suction cups

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



For round and domed workpieces.

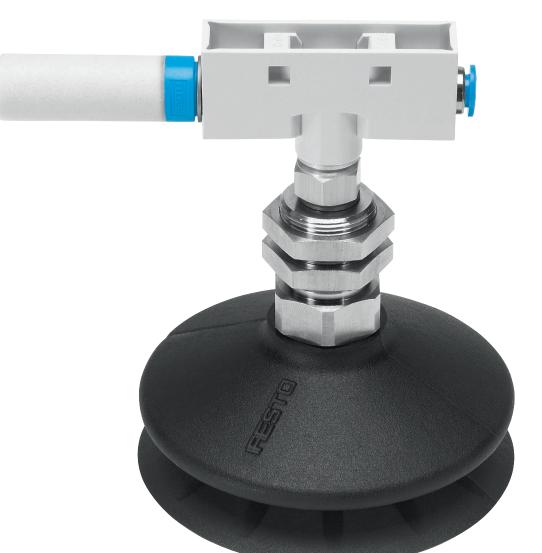


Bellows suction cup with 3.5 convolutions For delicate workpieces such as glass bottles or light bulbs. Inexpensive height compensator.

and pliable workpieces.







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 ba	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	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						

FESTO

2000 options, 1 principle, zero selection problems

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

Step 5:

Observing of environmental conditions

Material	Nitrile rubber	Polyurethane	Vulkollan®	Silicone	Fluor rubber	Nitrile rubber (anti-static)
Charakteristic in °C	-10 +70	-20 +60	-10 +80	−30 +180	-10 +200	-10 +70
operating temperatures 200						
150						
100						
50						
0						
-50						
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	Rough	Automobile	Food	Glass	Electronics
Typical application areas	application	surface	industry	industry	industry	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 ® Vulkollan® is a registered trademark of Bayer

Step 3:

Case 2

Case 3

Calculating the retention and breakaway forces

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

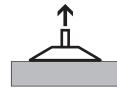
Case 1 Horizontal suction gripper position, vertical direction of movement (favourable case)

Horizontal suction gripper position,

horizontal direction of movement

Vertical suction gripper position,

vertical direction of movement (less favourable case)



 $F_H = m x (g + a) x S$

Calculation formula:

 $F_H = 0.314 \text{ kg x } (9.81 \text{ m/s}^2 + 30 \text{ m/s}^2) \text{ x } 1.5$

Example:

Example:

Calculation formula:

 $F_H = m x (g + a/\mu) x S$

 $F_H = 0.314 \text{ kg x } (9.81 \text{ m/s}^2 + 30 \text{ m/s}^2/0.1) \text{ x } 1.5$

Calculation formula:

Example:

= 146 N

 $F_{H} = (m/\mu) x (g + a) x S$

Friction (surface)*

Rough

Wood, metal,

glass, stone ... $\mu = 0.5$

 $\mu = 0.1$

 $\mu = 0.6$

 $\mu = 0.2 \dots 0.3$

 $F_{H} = (0.314 \text{ kg}/0.1) \times (9.81 \text{ m/s}^2 + 30 \text{ m/s}^2) \times 2$

 6 m/s^2

 20 m/s^2

 25 m/s^2

 30 m/s^2

40 m/s²

Empirical values of acceleration

Electrical spindle:

Servo-pneumatic:

linear acceleration:

Pneumatic:

Electrical toothed belt:

Pneumatic rotary or semirotary drive: Comparable

 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

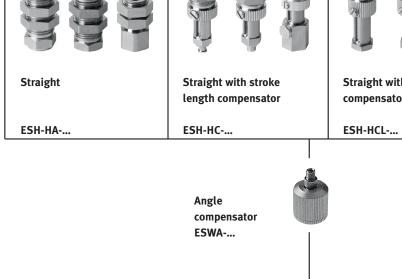
 μ = Friction value*

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

Modular vacuum suction gripper range from Festo

Suction cup holder

ESH-...



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



ESH-HF-...







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

I myrosper
Hillysch (M., Crack (M., Cremon (M., Prejich heryt), USPuglich (m.), Special (m.), Forest (M., Cracker (M.,
Hurgelen (M., Haller (M.), Appendix (M.), Hornes (M.), Hornes (M.), Talakh (M.), Domenian (M.), Liparese (M.), Hornes (M.), Hornison (M.), Talakh (M.), Domenian (M.), Cracker (M.), Skonsi (M.),
Skonsin (M.), Chiema (M.), Liparese (M.)

Vacuum range

from Festo

selection software

Angle compensator (optional)

Filter (optional)





ESV-...-...S...

Suction cup, standard, without attachment parts with attachment

partsESS-...-S...

(not for oval suction cups)



without attachment parts



Suction cup, extra-deep

with attachment parts

ESV-...-E...

ESH-HB-...



ESS-...-E...



parts ESV-...-B...

Angular, with stroke length

compensator

ESH-HD-...



compensator, long

ESH-HDL-...



parts ESS-...-B...







parts ESS-...-C...





service_international@festo.com