Application Note

VYKA extended application information

Description of application test results and technical features of the VYKA valve that are not included in the regular datasheet values.

VYKA

100488

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1 About this document

In addition to the information on the datasheet of VYKA there is other relevant information about typical use cases and applications. This Application Note offers an overview of different topics, test results and further information that may help users and machine builders to have a better basis for decision-making.

The datasheet, the manuals and other official documents can be downloaded from the Festo Support Portal (link).

Note: All the test results hereafter were obtained with specific laboratory test setups. The results aren't guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

2 Dispensing with different media

In the following sub-chapters an example setup is described that was built for dispensing different kinds of liquid. The dispensing results are illustrated in the tables with the key performance values “Overall CV” and “Mean”.

For a comprehensive description of the meaning of these key performance values as well as a better understanding of different liquid handling terms, please refer to the Application Note “Interpretation and analysis of liquid handling results” (link).

Note: The test results shown below were generated with a specific laboratory test setup. The results aren’t guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

2.1 Description of test setup

The test was done in the Festo Experience Center Poland. An image as well as a schematic diagram of the test setup can be found in **Figure 1** and **Figure 2**. The components used are listed in **Table 1** and the parameters as well as the environmental conditions are listed in **Table 2**. The documentation template is shown in **Figure 3**.

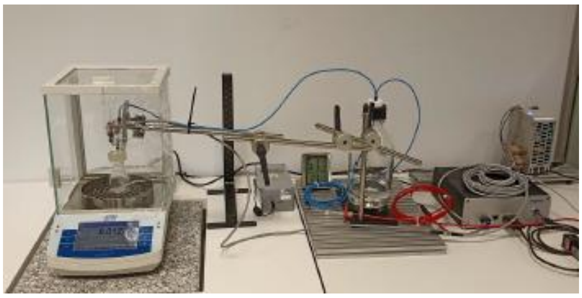

Figure 1: Test setup of dispensing tests

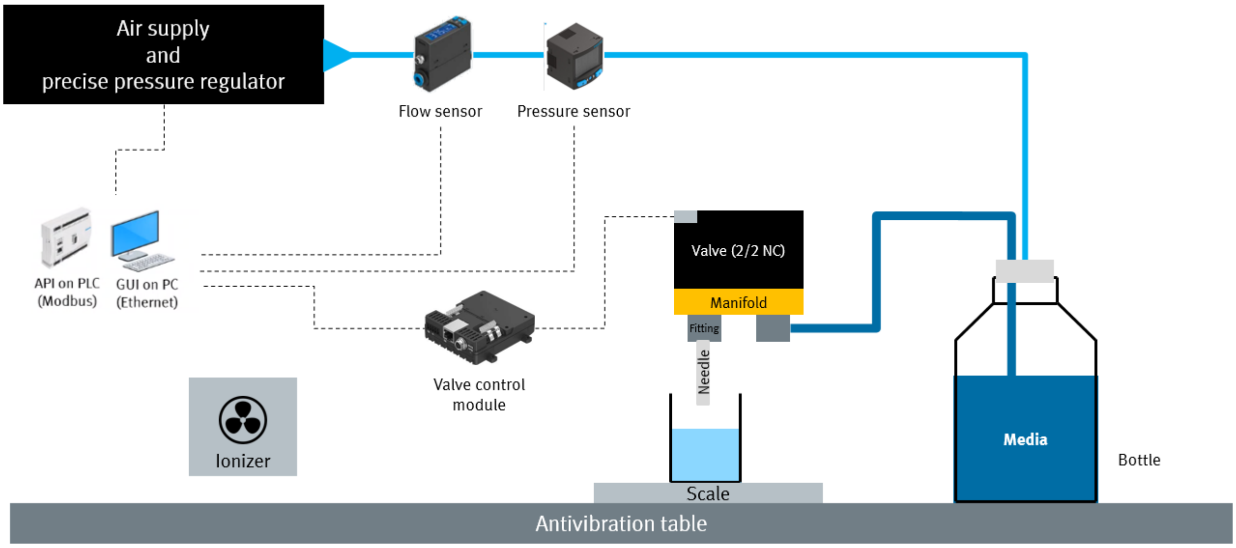

Figure 2: Test setup schematic

Components	Information
Scale	Radwag WL-104-0183 → Link
Anti-vibration table	Radwag WX-001-0076 → Link
Ionizer	Radwag WX-001-0097 → Link
Fluids	DI water, silicon oil 1 cSt,20 cSt and 100 cSt → Link
Glass bottle 1 liter pressure from -1 to 1.5bar	Duran H995.1 → Link
Stainless steel bottle 1.5 liter for high pressure	Duran AAC4.1 → Link

Cap 2 outputs ID ¼-28 UNF, OD 3.2 mm	NX25.1 → Link
Proportional pressure regulator (0.005 bar to 1 bar)	8046303, VEAB-L-26-D7-Q4-V1-1R1
Proportional pressure regulator (-1 bar to -0.005 bar)	8046307, VEAB-L-26-D14-Q4-V1-1R1
Proportional pressure regulator (0.03 bar to 6 bar)	8046299, VEAB-L-26-D9-Q4-V1-1R1
Pressure sensor	8035540, SPAN-B2R-M5F-PNLK-PNVBA-L1
Flow sensor	8035300, SFAH-1B-Q4S-PNLK-PNBVA-M8
Service unit combination	531029, MSB4-1/4:C4:H3:I1:I3:L1:G3:N2-WP
Pressure vacuum generator	8146318, PGVA-CS
Media separated valve	**8170087, VYKA-F7-M22C-12-PV-5YQ7**
Sub-base	8047063, VABS-K1-7B-12-U14-P
Fitting	8104285, NLFA-D-U14-K1.6-PP-P10
Fitting	8104286, NLFA-D-U14-K3-PP-P10
Connecting cable	8115099, NEBV-Q7G2-PD-0.5-N-LE2
Dosing needle (ID: 0.6 mm, length: 30 mm)	8104290, VAVN-N-A1.6-06-30-V1-P10
Dosing needle (ID: 1.2 mm, length: 30 mm)	8104291, VAVN-N-A1.6-12-30-V1-P10
Dosing needle (ID: 0.3 mm, tapered, length: 30 mm)	8104294, VAVN-N-A1.6-03-30-V-V1-P10
Valve control module	8088772, VAEM-V-S8EPRS2
Tubing	197375, PUN-H-3X0,5-NT

Table 1: Dispensing test components

Parameters / Environment	**Value**
Test location	Festo Experience Center Poland
Height, temperature and humidity in the room	100 m a.s.l, 22-27 °C, 28-66%
Number of valves tested	1 every type
Pressures [mbar]	50, 250, 500, 1000, 2000
Opening times [ms]	50, 150, 300
Pressure supply	Tests with water: PGVA (for 50, 250 and 500 mbar) Building pressure MSB4 and VEAB D9 (for 1000 and 2000 mbar) Tests with silicon oil: Building pressure MSB4 and VEAB D7 (for 50, 250 and 500 mbar) Building pressure MSB4 and VEAB D9 (for 1000 and 2000 mbar)
Pre-shots	3 fast pre-shots, ~10 second break, 1 pre-shot, ~10 second break, start of series
Number of shots for each parameter; frequency	30; 1 Hz
Tube length from valve to bottle bottom	0.7 m from the valve to the cap, 0.2 m from the cap to the bottle bottom
Bottle filling	With water: 500 ml of liquid in a 1000 ml bottle (for 50, 250 and 500 mbar)

	800 ml of liquid in a 1500 ml bottle (for 1000 and 2000 mbar) With silicon oil: 800 ml of liquid in a 1500 ml bottle (for all pressures)
Vertical height difference between needle and water level in bottle	4 cm
Flushing of system	Every morning

Table 2: Dispensing test parameters and environment

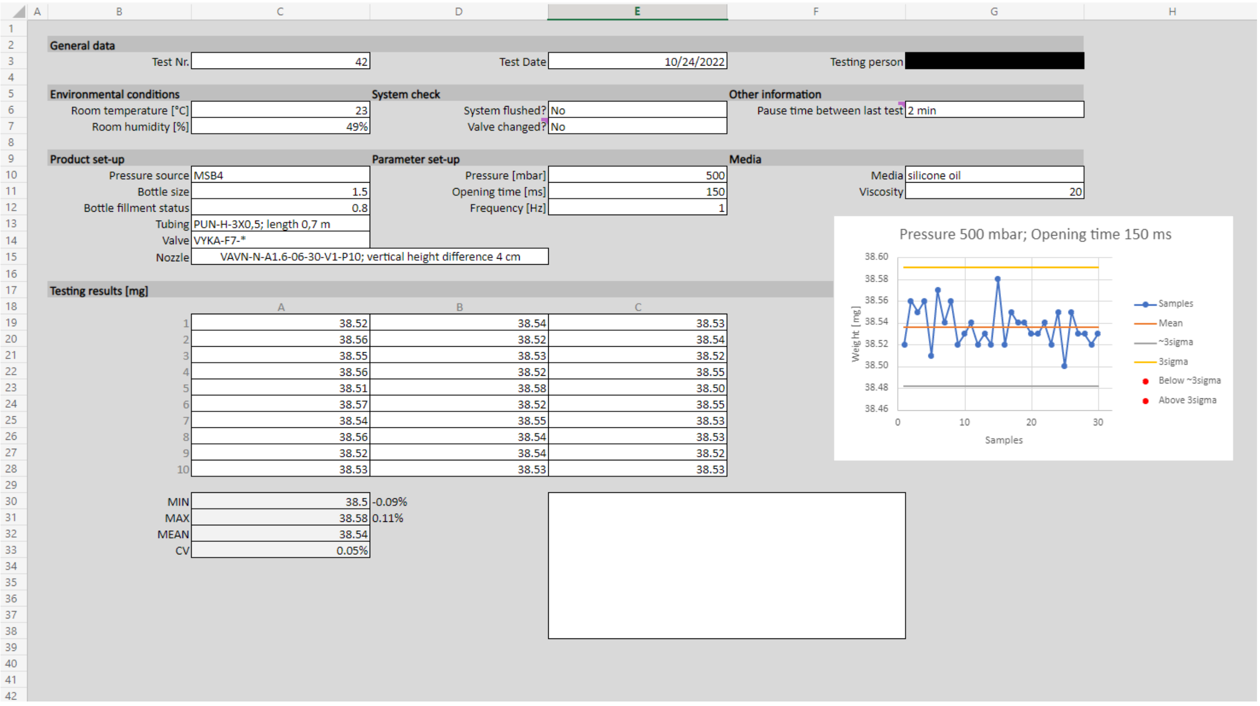

Figure 3: Screenshot of Excel template to document the results

2.2 Test results

2.2.1 Media: Water (0,893 cSt)

2.2.1.1 Key findings

- All CV values are below 1.2%. That means the repeatability and reproducibility of VYKA is great with water!
- Even small volumes of water can be dispensed precisely -> by reducing the opening time, even lower target volumes are possible.
- The lower the target volume and the simultaneous requirement to work with very low pressures, the better it is to select a needle with a smaller inner diameter. This increases the total dispensing time and improves precision.
- Linear behavior of increasing opening times with keeping other parameters constant (pressure, needle ID, etc.).
- **Note:** These results were generated with a specific laboratory test setup. The results aren't guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

2.2.1.2 Results in detail

Table 3 shows the results with water as a medium (0.893 cSt) at a pressure level of 50 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV	0.64%	0.29%	0.20%	1.11%	0.80%	0.67%	1.15%	0.70%	0.40%
Mean [µl]	4.86	16.83	35.11	8.59	40.75	92.05	12.40	70.00	175.69

Table 3: Medium: Water (0.893 cSt) – Pressure: **50 mbar**

Table 4 shows the results with water as a medium (0.893 cSt) at a pressure level of 250 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.43%	0.18%	0.13%	0.43%	0.19%	0.10%	0.64%	0.28%	0.20%
Mean [µl]	16.66	53.24	108.36	38.16	145.14	305.33	58.95	247.12	529.16

Table 4: Medium: Water (0.893 cSt) – Pressure: **250 mbar**

Table 5 shows the results with water as a medium (0.893 cSt) at a pressure level of 500 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.44%	0.19%	0.16%	0.33%	0.28%	0.13%	0.59%	0.35%	0.26%
Mean [µl]	26.11	80.91	162.92	64.22	217.98	447.31	103.09	381.45	796.90

Table 5: Medium: Water (0.893 cSt) – Pressure: **500 mbar**

Table 6 shows the results with water as a medium (0.893 cSt) at a pressure level of 1000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.11%	0.20%	0.14%	0.27%	0.47%	0.22%	0.90%	0.50%	0.43%

Mean [µl]	41.05	121.50	241.38	105.66	330.56	667.58	178.35	602.33	1248.25

Table 6: Media: Water (0.893 cSt) – Pressure: **1000 mbar**

Table 7 shows the results with water as a medium (0.893 cSt) at a pressure level of 2000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.13%	0.07%	0.04%	0.36%	0.41%	0.52%	1.12%	0.62%	0.40%
Mean [µl]	63.21	181.39	359.54	165.49	494.33	988.86	298.02	957.25	1945.28

Table 7: Medium: Water (0.893 cSt) – Pressure: **2000 mbar**

2.2.2 Media: Silicon oil 1 cSt

2.2.2.1 Key findings

- When fluid viscosities are similar (water 0.893 cSt vs. silicon oil 1 cSt), fluid density is becoming more important.
- All CV values are below 3.3%. That means the repeatability and reproducibility of VYKA is great with silicon oil 1 cSt!
- Even small volumes of silicon oil 1 cSt can be dispensed precisely -> by reducing the opening times, even lower target volumes are possible.
- The lower the target volume and the simultaneous requirement to work with very low pressures, the better it is to select a needle with a smaller inner diameter. This increases the total dispensing time and improves precision.
- Linear behavior of increasing opening times while keeping other parameters constant (pressure, needle ID, etc.).
- **Note:** These results were generated with a specific laboratory test setup. The results aren't guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

2.2.2.2 Results in detail

Table 8 shows the results with silicon oil (1 cSt) at a pressure level of 50 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	1.13%	0.60%	1.10%	2.05%	0.22%	0.17%	3.26%	0.67%	0.42%
Mean [µl]	5.98	17.89	36.65	10.15	43.23	99.92	14.18	75.46	179.38

Table 8: Medium: Silicon oil 1 cSt – Pressure: **50 mbar**

Table 9 shows the results with silicon oil (1 cSt) at a pressure level of 250 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.14%	0.09%	0.09%	3.26%	0.05%	1.02%	0.44%	0.66%	1.35%
Mean [µl]	19.00	58.58	121.27	42.11	159.20	330.94	64.86	261.44	558.18

Table 9: Medium: Silicon oil 1 cSt – Pressure: **250 mbar**

Table 10 shows the results with silicon oil (1 cSt) at a pressure level of 500 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.07%	0.07%	0.02%	0.62%	0.54%	0.43%	0.45%	0.81%	0.35%
Mean [µl]	30.07	92.47	183.47	73.24	244.65	505.02	117.82	421.00	883.67

Table 10: Medium: Silicon oil 1 cSt – Pressure: **500 mbar**

Table 11 shows the results with silicon oil (1 cSt) at a pressure level of 1000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.08%	0.04%	0.25%	0.35%	0.12%	0.29%	0.65%	0.54%	0.20%
Mean [µl]	46.64	140.51	278.14	117.46	367.38	744.55	203.72	679.41	1401.63

Table 11: Medium: Silicon oil 1 cSt – Pressure: **1000 mbar**

Table 12 shows the results with silicon oil (1 cSt) at a pressure level of 2000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.07%	0.08%	0.05%	0.45%	0.46%	0.55%	1.36%	0.53%	0.31%

Mean [µl]	70.85	205.47	413.07	181.87	545.08	1101.50	335.62	1068.29	2165.53

Table 12: Medium: Silicon oil 1 cSt – Pressure: **2000 mbar**

2.2.3 Media: Silicon oil 20 cSt

2.2.3.1 Key findings

- All CV values are below 2.74%. That means the repeatability and reproducibility of VYKA is great with silicon oil 20 cSt!
- A certain pressure in combination with the inner diameter of the needle is needed to get dispensing results (see also sub-chapter “Threshold”).
- Even small volumes of silicon oil 20 cSt can be dispensed precisely -› by reducing the opening times, even lower target volumes are possible.
- Linear behavior of increasing opening times with keeping other parameters constant (pressure, needle ID, etc.).
- When using small needle inner diameters with low pressure, no or unsatisfactory results were obtained. These are marked with “x” in the following table.
- **Note:** These results were generated with a specific laboratory test setup. The results aren’t guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

2.2.3.2 Results in detail

Table 13 shows the results with silicon oil (20 cSt) at a pressure level of 50 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	x	x	x	x	x	x	2.63%	0.28%	0.26%
Mean [µl]	x	x	x	x	x	x	11.99	37.00	74.77

Table 13: Medium: Silicon oil 20 cSt – Pressure: **50 mbar**

Table 14 shows the results with silicon oil (20 cSt) at a pressure level of 250 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	x	x	x	x	x	x	2.74%	0.08%	0.40%
Mean [µl]	x	x	x	x	x	x	15.95	49.41	99.60

Table 14: Medium: Silicon oil 20 cSt – Pressure: **250 mbar**

Table 15 shows the results with silicon oil (20 cSt) at a pressure level of 500 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.22%	0.13%	0.05%	0.13%	0.05%	0.03%	0.13%	0.06%	0.35%
Mean [µl]	6.01	17.55	34.99	13.43	40.35	81.02	32.62	102.07	205.71

Table 15: Medium: Silicon oil 20 cSt – Pressure: **500 mbar**

Table 16 shows the results with silicon oil (20 cSt) at a pressure level of 1000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.21%	0.12%	0.22%	0.15%	0.11%	0.22%	0.15%	0.03%	0.07%
Mean [µl]	11.85	34.17	67.68	27.04	79.82	159.70	64.70	204.33	418.58

Table 16: Medium: Silicon oil 20 cSt – Pressure: **1000 mbar**

Table 17 shows the results with silicon oil (20 cSt) at a pressure level of 2000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	0.06%	0.08%	0.02%	0.02%	0.09%	0.12%	0.48%	0.09%	0.03%
Mean [µl]	23.37	65.92	130.16	54.22	159.42	317.29	126.05	396.42	805.83

Table 17: Medium: Silicon oil 20 cSt – Pressure: **2000 mbar**

2.2.4 Medium: Silicon oil 100 cSt

2.2.4.1 Key findings

- All CV values are below 3.19%. That means the repeatability and reproducibility of VYKA is great with silicon oil 100 cSt!
- A certain pressure in combination with the inner diameter of the needle is needed in order to get dispensing results (see also sub-chapter “Threshold”).
- Even small volumes of silicon oil 100 cSt can be dispensed precisely -> by reducing the opening times, even lower target volumes are possible. However, the pressure level needed is much higher than with lower viscosities.

- Linear behavior of increasing opening times with keeping other parameters constant (pressure, needle ID, etc.).
- When using needles with smaller inner diameters and low to medium pressure, no or unsatisfactory results were obtained. These are marked with “x” in the tables below.
- **Note:** These results were generated with a specific laboratory test setup. The results aren’t guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

2.2.4.2 Results in detail

Table 18 shows the results with silicon oil (100 cSt) at a pressure level of 50 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	x	x	x	x	x	x	x	x	x
Mean [µl]	x	x	x	x	x	x	x	x	x

Table 18: Medium: Silicon oil 100 cSt – Pressure: **50 mbar**

Table 19 shows the results with silicon oil (100 cSt) at a pressure level of 250 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	x	x	x	x	x	x	x	x	x
Mean [µl]	x	x	x	x	x	x	x	x	x

Table 19: Medium: Silicon oil 100 cSt – Pressure: **250 mbar**

Table 20 shows the results with silicon oil (100 cSt) at a pressure level of 500 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	x	x	x	x	x	x	3.19%	0.57%	0.24%
Mean [µl]	x	x	x	x	x	x	7.62	20.11	39.23

Table 20: Medium: Silicon oil 100 cSt – Pressure: **500 mbar**

Table 21 shows the results with silicon oil (100 cSt) at a pressure level of 1000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	x	x	x	x	x	x	0.41%	0.12%	0.25%
Mean [µl]	x	x	x	x	x	x	15.10	41.35	80.90

Table 21: Medium: Silicon oil 100 cSt – Pressure: **1000 mbar**

Table 22 shows the results with silicon oil (100 cSt) at a pressure level of 2000 mbar.

Needle ID [mm]	0.3			0.6			1.2		
Opening time [ms]	50	150	300	50	150	300	50	150	300
Overall CV [%]	x	0.98%	0.26%	1.02%	0.21%	0.17%	0.72%	0.11%	0.04%

Table 22: Medium: Silicon oil 100 cSt – Pressure: **2000 mbar**

2.2.5 Threshold

Depending on the pressure, there are different ways in which the liquid flows out of the system. Especially with higher viscosities, the effects are visible and lead to unsatisfactory dispensing results. The time of each flow depends on the selected needle, viscosity of the liquid, opening time of the valve, environmental conditions etc.

As part of the test results for silicon oil 20 cSt and 100 cSt (see above) it was mentioned that with lower pressures (in combination with small inner diameter of the needle) no (acceptable) results were possible (marked with "x"). This is exactly due to this effect. **Figure 4** illustrates these different flows.

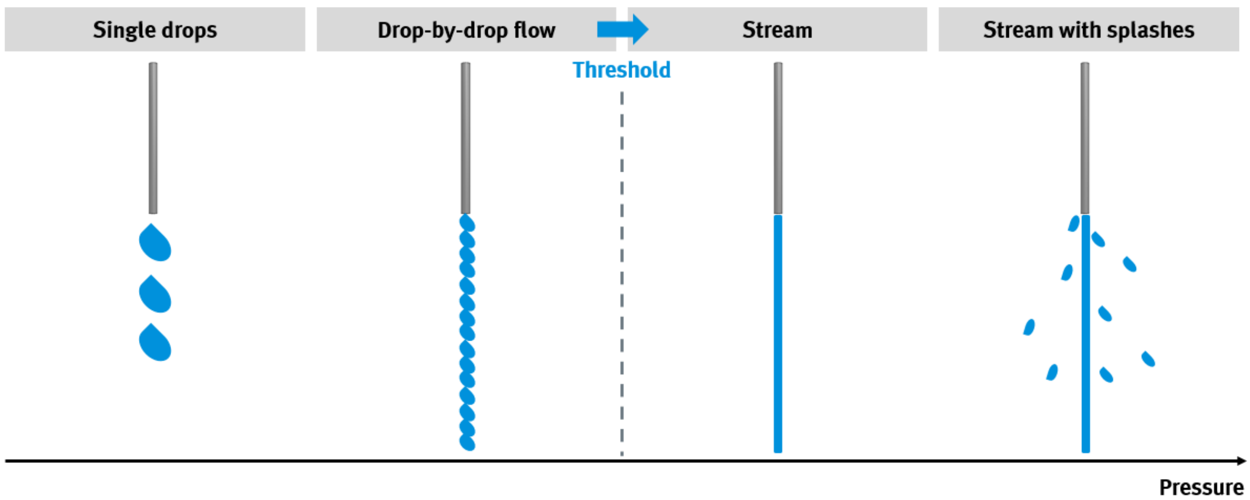

Figure 4: Different ways in which the liquid flows out of the system

Analyses were carried out to determine at which pressure level the fluid flow changes from a drop-by-drop flow to a constant stream. This was done for silicon oil 20 cSt and 100 cSt in both directions: by increasing and decreasing the pressure, as you can see in **Figure 5** for 20 cSt. However, additional tests showed that this threshold is no fixed value – it's in a range of roughly +/- 25 mbar. In addition, another effect is visible: by giving the system more time, e.g. by increasing the opening time, a lower pressure threshold can also be reached. This effect can be seen for the needle with ID 1.2 mm.

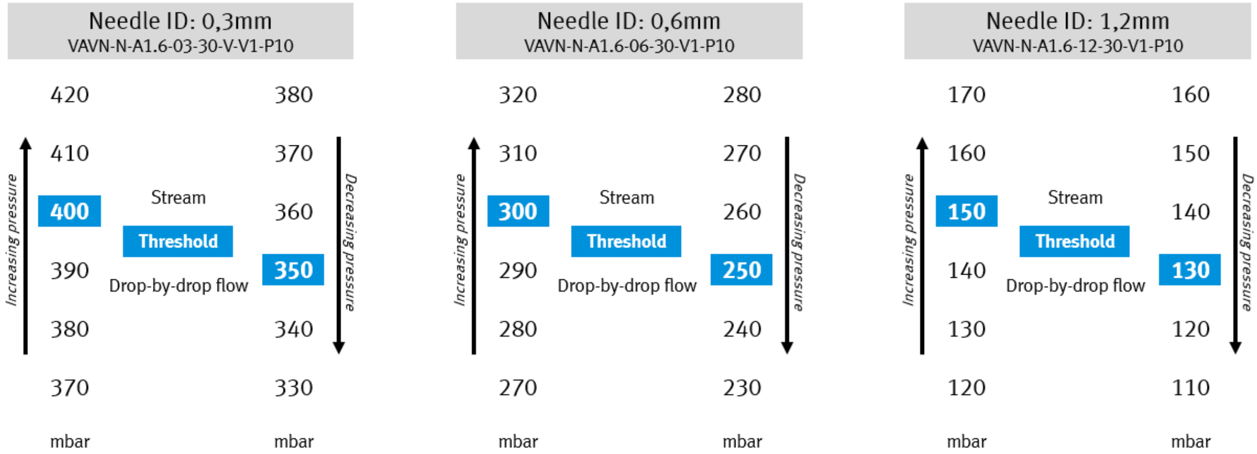

Figure 5: Threshold with silicon oil 20 cSt

Note: These results were generated with a specific laboratory test setup. The results aren't guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

2.3 Other dispensing tests with different medias

Several other media (such as ink, oil, cell suspensions, cell gel suspensions, hydrogel, solvents, cleaning agents, magnetic beads and many more) had already been tested in the Festo Application Center. For further information please contact Festo.

3 Valve surface heating-up effect and maximum switching frequencies

The datasheet for VYKA states (see also **Table 23**) that the maximum switching frequency is 6 Hz, with the note: “At a 100% duty cycle depending on ambient temperature and installation conditions. Higher switching frequencies possible with duty cycle ‹ 100%.” The catalog pages as well as the user manual have a table with the maximum switching frequencies for individual valve and manifold assemblies at different ambient temperatures. Those values are based on the most critical situations with a 100% duty cycle, operating infinitely without exceeding the valve surface temperature of 85 °C (to fulfill IEC 61010).

Environmental temperature	Max. switching frequency at 100% duty cycle [Hz]	
	Single mounting	Manifold mounting
‹20 °C	6	2
20 … 30 °C	5	1,5
30 … 40 °C	4	1
40 … 50 °C	3	0,5

Table 23: Datasheet data for VYKA with maximum switching frequency

Beyond the IEC 61010 standard, it is not advisable to heat the valve above 85 °C, as otherwise the internal mechanics may be affected and the service life or the functionality of the valve will be restricted.

As mentioned above, these frequency values aren’t the real limit for VYKA. Under certain conditions the frequency could be set to 83.33 Hz (mechanical limit – 6 ms impulse time, 6 ms pause time). And even this limit has a certain safety buffer. In addition to the mechanical limitation, the surface temperature of the valve is the key to calculating the maximum frequency. According to IEC 61010, the surface temperature must be below 85 °C.

To gain a better understanding several tests using different test setups were carried out; these are shown in the following sub-chapters.

3.1 Key findings

- The maximum switching frequency depends on several variables like duty cycle, impulse and pause time, environmental conditions, electronics, etc.
- By considering application-specific data, much higher frequencies than those mentioned in the datasheet can be achieved.
- Greater pause times are not considered in the tests below. It is possible to achieve very high frequencies, which are running only for a short time, as long as the valve has enough time to cool down again.
- With the VAEM the electrical values can be parametrized and optimized. E.g. the inrush time can be decreased, which leads to a lower heating-up effect and higher possible frequencies with high duty cycles.
- The heating-up effect while the valve is constantly switched on is very low due to the low power consumption when using a current reduction like VAEM or VAVE.
- It is advisable to use current reduction (like VAEM or VAVE) to switch VYKA valve. However, under certain circumstances it is possible to switch the VYKA with 12 V and standard NEBV cable.

3.2 Measurement setups

Three VYKA valves were mounted on a manifold at a distance of 9 mm from each other. Three temperature sensors were installed on three different sides of the valve placed in the middle (see also **Figure 6**) . All three values were documented. However, the results below will also show you the mean values.

Figure 6: Temperature sensors on VYKA valve

In order to simulate different application setups, three different environmental conditions were analyzed (see also **Figure 7**):

1. Covered VYKA valve manifold in switched-off climatic chamber, door open, no convection, environment warms up. Simulates a Lab-device without internal active ventilating and/or cooling system inside, environment/installed area is not actively cooled.
2. Covered VYKA valve manifold in active climatic chamber (20 °C), minimal convection, environment is kept constant. Simulates a Lab-device without internal active ventilating and/or cooling system inside, environment/installed area is actively cooled.
3. Uncovered VYKA valve manifold in active climatic chamber (20 °C), maximum convection, VYKA valve manifold and environment are cooled. Simulates a Lab-device with active ventilating and cooling system, providing constant environmental conditions.

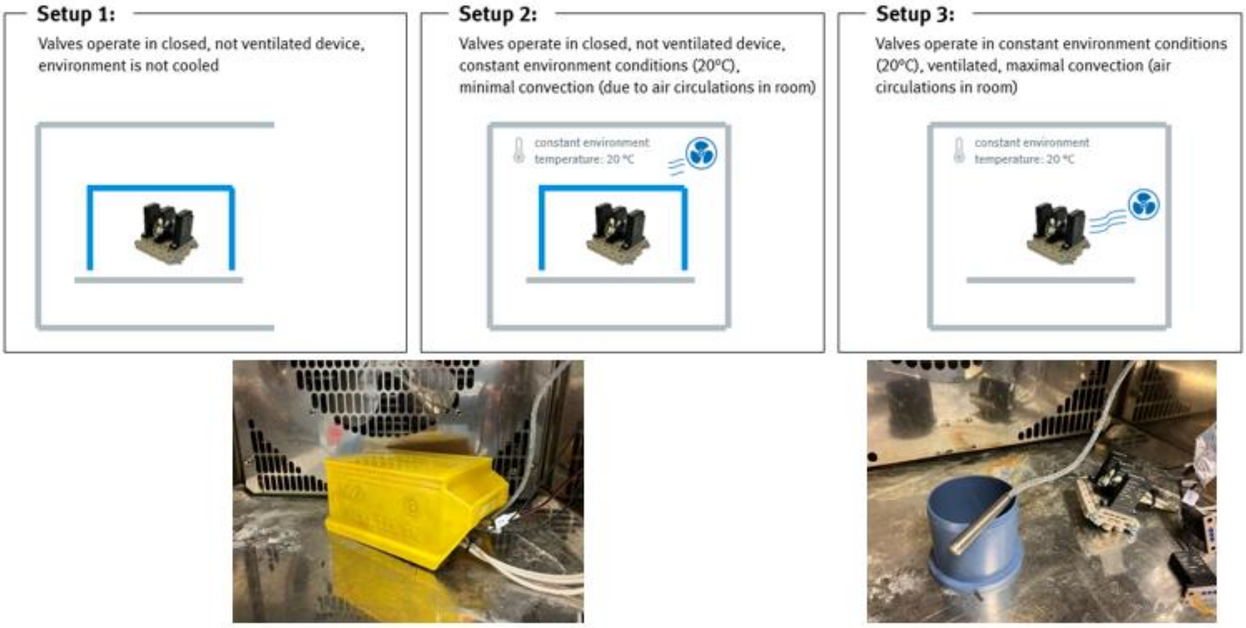

Figure 7: Different measurement setups

3.3 Using VYKA with current reduction

3.3.1 Operating procedures

Five different operating procedures were considered as part of this test to show different use cases. However, as mentioned above, any parameter setup should be analyzed with respect to the given conditions, to check if the valves are getting too hot or not.

In general, an impulse time as well as a pause time were defined. Based on this the frequency and the duty cycle can be calculated. The temperature rises against a limit value after a certain time. The measurement of the final temperature was therefore carried out after a total time, when a steady state was reached. An example of one of the operating procedures is illustrated in **Figure 8**.

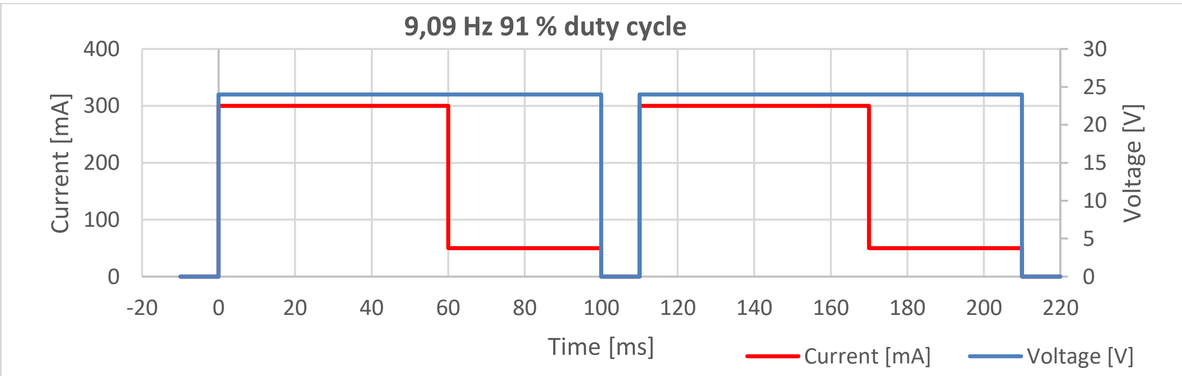

Figure 8: Description of an operating procedure

All tests were done with three different electronic connection types:

1. With the electrical connection box VAVE-K1-7-5YL1-LR (PN: 8115100)
2. With the valve control module VAEM-V-S8EPRS2 (PN: 8088772) and connecting cable NEBV-Q7G2-PD-0.5-N-LE2 (PN: 8115099)
3. With the valve control module VAEM-V-S8EPRS2 (PN: 8088772) and connecting cable NEBV-Q7G2-PD-0.5-N-LE2 (PN: 8115099). But: With the smallest possible inrush time, at which the valve still switches. This temperature shows the minimum value of the temperature which can theoretically be reached with maximum optimization. However, this inrush time value does not contain any buffer and is therefore not recommended to be used. Here marked as "X".

The default parameters of VAVE as well as for VAEM are:

Inrush current: 300 mA

Inrush time: 60 ms

Holding current: 50 mA

Note: All test results were obtained with specific laboratory test setups. The results aren't guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

3.3.2 Results with measurement setup 1

Table 24 shows the results for the five different operating procedures with measurement setup 1.

Parameters					Temperature		
Frequency	**Duty cycle**	**Impulse time**	**Pause time**	**Total time**	**With VAEM[1]**	**With VAVE[2]**	**With X[3]**
6,02 Hz	96%	160 ms	6 ms	30 min	69.5 °C	68.5 °C	35.6 °C
9,09 Hz	91%	100 ms	10 ms	30 min	99.7 °C* 66.4 °C**	80.2 °C*	40.4 °C
10 Hz	60%	60 ms	40 ms	30 min	98.3 °C	85.8 °C	42.8 °C
25 Hz	50%	20 ms	20 ms	30 min	98.2 °C	104 °C	56.6 °C
25 Hz	25%	10 ms	30 ms	25 min	59.9 °C	68.9 °C	46.6 °C

Table 24: Results with measurement setup 1 (housed, not cooled)

*As described in footnote 1 and 2, the default values for the inrush time are 60 ms. But when the VAVE is getting warm, the inrush time is decreased to around 30 ms over the time.

**To be able to compare the tests, another test with VAEM was carried out with an inrush time of 30 ms. This time a temperature of 66.4 °C was reached – much lower than with an inrush time of 60 ms. In general, the default and recommended value for an inrush time of 60 ms has a huge buffer during which, for any application under every circumstance and environmental condition, the valve switches. However, the VYKA valve usually switches between 1-6 ms (with 24 V rated voltage, depending on the material and environmental conditions). Therefore, there is room for upgrading the system (the maximum possible optimization is shown in column "With X"). For further information please contact Festo.

[1] The electrical values can be parametrized and optimized using the VAEM. E.g. the inrush time can be decreased, which leads to a lower heating-up effect. Both the inrush and holding current can be finetuned. The following fixed values were used: inrush current: 300 mA; inrush time: 60 ms; holding current: 50 mA.

[2] The default values of VAVE are: inrush current: 300 mA; inrush time: 60 ms; holding current: 50 mA. However, if the electronics are getting warm, the inrush time is decreased to roughly 30 ms.

[3] With VAEM and the smallest possible inrush time, at which the valve still switches. Here marked as "X".

In addition, Festo developed a tool to calculate the temperature of a valve when it is operating within a setup 1 environment. For further information please contact Festo.

3.3.3 Results with measurement setup 2

Table 25 shows the results for the five different operating procedures with measurement setup 2.

Parameters					Temperature		
Frequency	**Duty cycle**	**Impulse time**	**Pause time**	**Total time**	**With VAEM[1]**	**With VAVE[2]**	**With X[3]**
6.02 Hz	96%	160 ms	6 ms	20 min	53.2 °C	56.5 °C	30.4 °C
9.09 Hz	91%	100 ms	10 ms	20 min	78.5 °C	68.2 °C	34.4 °C
10 Hz	60%	60 ms	40 ms	20 min	66.8 °C	72.2 °C	32.9 °C
25 Hz	50%	20 ms	20 ms	20 min	76.6 °C	85.6 °C	45.8 °C
25 Hz	25%	10 ms	30 ms	20 min	44.4 °C	56.2 °C	38.4 °C

Table 25: Results with measurement setup 2 (housed, cooled outside)

3.3.4 Results with measurement setup 3

Table 26 shows the results for the five different operating procedures with measurement setup 3.

Parameters					Temperature		
Frequency	**Duty cycle**	**Impulse time**	**Pause time**	**Total time**	**With VAEM[1]**	**With VAVE[2]**	**With X[3]**
6.02 Hz	96%	160 ms	6 ms	10 min	36 °C	43.5 °C	26.3 °C
9.09 Hz	91%	100 ms	10 ms	10 min	42.8 °C	50.9 °C	28.5 °C
10 Hz	60%	60 ms	40 ms	10 min	46.7 °C	55.2 °C	28.7 °C
25 Hz	50%	20 ms	20 ms	10 min	42.9 °C	56.9 °C	35.7 °C
25 Hz	25%	10 ms	30 ms	10 min	32.8 °C	39.9 °C	31.2 °C

Table 26: Results with measurement setup 3 (not housed, cooled)

3.3.5 Temperature rise while permanently switched on (100% duty cycle)

Table 27 shows the average temperature rise while the valve is permanently switched on. This value shows the maximum temperature rise when the valve is switched on once and kept switched on permanently. The temperature rise was measured at the surface of the solenoid and also calculated on the inside of the solenoid at the winding. It is a very localized rise so the temperature rise near the fluid is lower.

Please also bear in mind that a possible temperature rise of the fluid depends a lot on the time the fluid stays inside the valve.

Mounting	**Temperature rise (compared to environmental temperature)**
Single mounting	~ +6 °C
Manifold mounting[4]	~ +15 °C

Table 27: Temperature rise with 100% duty cycle

[4] Manifold mounting means the empty space between two valves is <7.5mm / grid dimension <15mm.

3.4 Using VYKA without current reduction

3.4.1 Permanent 12 V actuation

In the following example, the valves are operated directly with 12 V. The voltage is applied until the maximum temperature of 100 °C is reached at the valve surface while the environmental temperature is 20 °C. This is measured using the three known measuring setups (see above). The temperature is measured every 10 s.

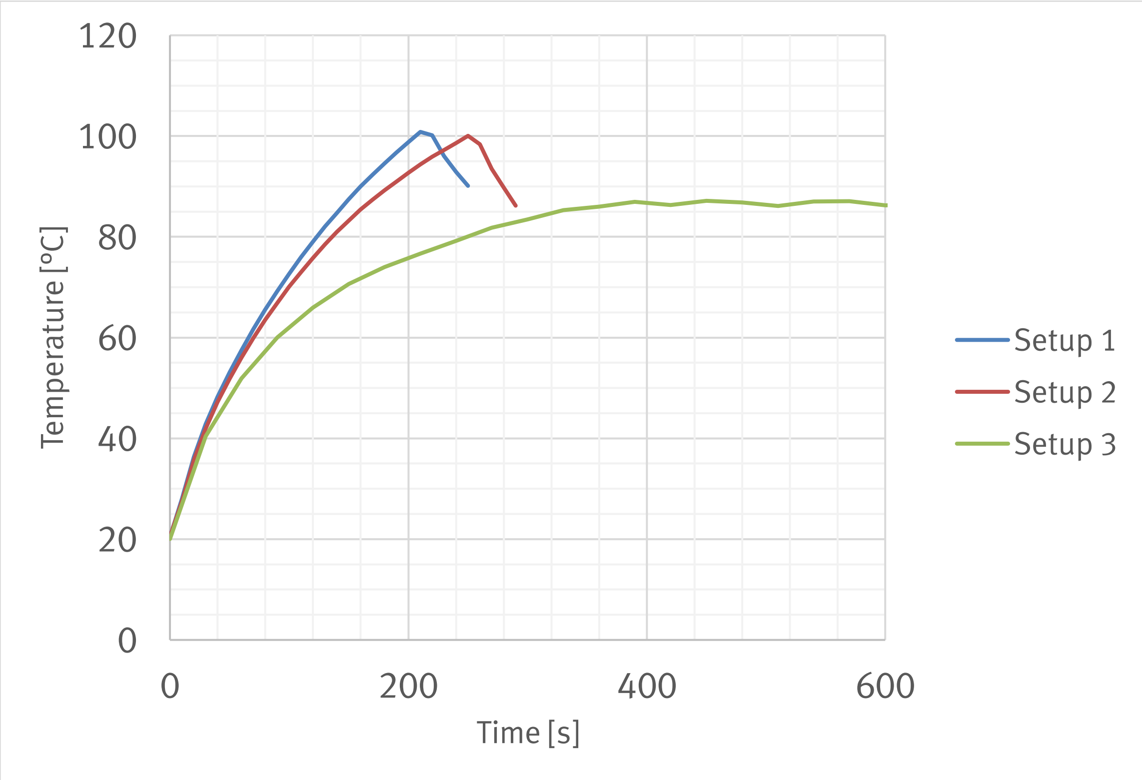

Figure 9: Temperature of the surface of VYKA with permanent 12 V actuation

The measurement with permanent 12 V actuation shows the following temperature developments (see also **Figure 9**):

- Measurement setup 1 (blue): After 3:20 min 100 °C is reached.
- Measurement setup 2(red): After 4:00 min 100 °C is reached.
- Measurement setup 3 (green): 100 °C is not reached.

In comparison to that, the measurements with permanent 24 V actuation shows these temperature developments:

- Measurement setup 1: After 0:30 min 100 °C is reached.
- Measurement setup 2: After 0:35 min 100 °C is reached.
- Measurement setup 3: After 0:40 min 100 °C is reached.

It is therefore highly recommended not to actuate VYKA valve with 24 V, because it gets too hot in just a few seconds. Other than this aspect, the lifetime factor with the valve VYKA actuated simply by a specific voltage (and without current reduction) has not been analyzed.

Nevertheless, it is possible to operate VYKA without current reduction by considering other aspects (voltage, frequency, environmental conditions, duty cycle, etc.), as you also can see from the results in the following subchapters. However, it is recommended to use VYKA with current reduction.

3.4.2 Results 12 V actuation with measurement setup 1

Table 28 shows the results of switching the valve with 12 V using measurement setup 1 (housed, not cooled).

Parameters					Temperature
Frequency	**Duty cycle**	**Impulse time**	**Pause time**	**Total time**	**With NEBV**
10 Hz	20%	20 ms	80 ms	30 min	59.8 °C
0.2 Hz	20%	1000 ms	4000 ms	30 min	59.8 °C

Table 28: 12 V actuation results with measurement setup 1 (housed, not cooled)

3.4.3 Results 12 V actuation with measurement setup 2

Table 29 shows the results of the valve being switched with a 12 V actuation using measurement setup 2 (housed, cooled outside).

Parameters					Temperature
Frequency	**Duty cycle**	**Impulse time**	**Pause time**	**Total time**	**With NEBV**
10 Hz	20.%	20 ms	80 ms	20 min	39.0 °C
0.2 Hz	20.%	1000 ms	4000 ms	20 min	47.7 °C

Table 29: 12 V actuation results with measurement setup 2 (housed, cooled outside)

3.4.4 Results 12 V actuation with measurement setup 3

Table 30 shows the results of the valve being switched with a 12 V actuation using measurement setup 3 (not housed, cooled).

Parameters					Temperature
Frequency	**Duty cycle**	**Impulse time**	**Pause time**	**Total time**	**With NEBV**
10 Hz	20%	20 ms	80 ms	10 min	35.7 °C
0.2 Hz	20.%	1000 ms	4000 ms	10 min	35.9 °C

Table 30: 12 V actuation results with measurement setup 3 (not housed, cooled)

4 Heating-up effect related to the medium

There are two ways of considering the heating-up effect. Firstly, the temperature on the surface of the valve (see Chapter 3), and secondly the heating-up effect of the medium itself.

For this purpose, the VYKA valve was analyzed with VAEM and VAVE for a customer project. A temperature sensor was installed in the fluid chamber (see **Figure 10**). In addition, a VYKB valve was analyzed.

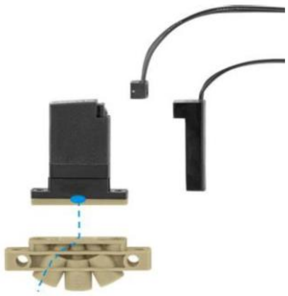

Figure 10: Placement of temperature sensor

The test procedure:

- The valves are permanently energized (100% ED) and the temperature of the medium is monitored.
- The pressure and vacuum generator generates a constant pressure of 50 mbar to ensure that the entire system is pressurized without a flow rate.
- The temperature probe is inserted via the output port of the sub-base.
- The temperature of the medium will be measured directly between the diaphragm of the valve and the fluid module.
- The valve is alternately 1h on/off. The valve is controlled by the VAVE E-Box or by the VAEM.

Figure 11 shows the results. When the VYKA is actuated by the VAEM, this has a negligible effect on the temperature of the medium. However, when the VYKA is actuated by the VAVE E-box, this shows still a very low heating-up effect (smaller than 4 °C). Take into consideration that the valve gets hotter if it is switched with a higher frequency or the environmental conditions are different (compare to **Chapter 3**). Nevertheless, the results show that VYKA only has a minimal heating-up effect regarding to the medium itself heating up.

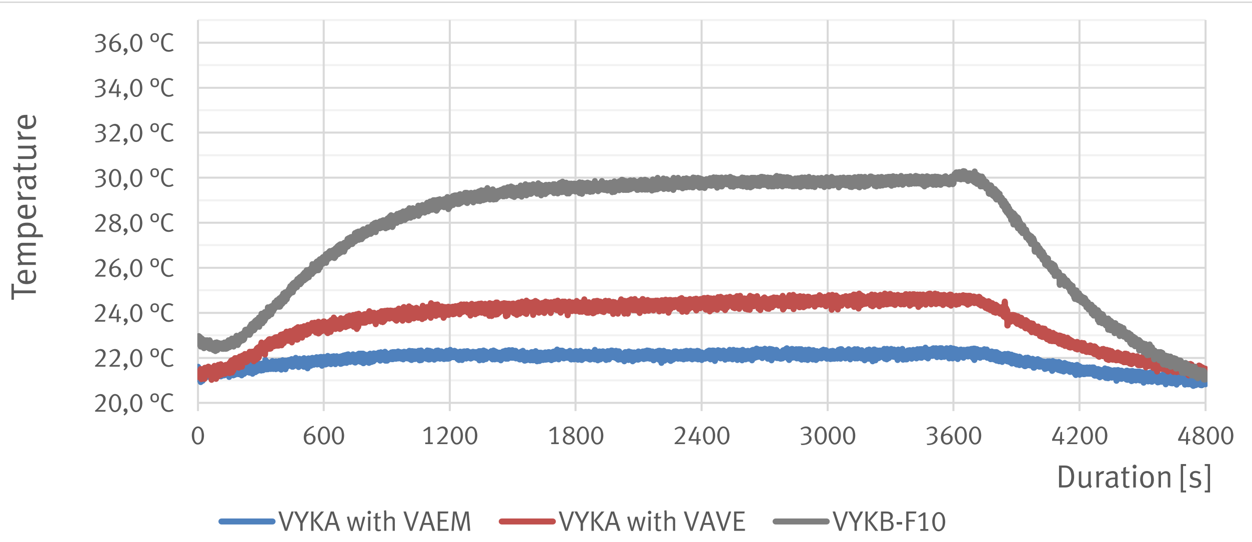

Figure 11: Heating-up effect related to the medium

Note: These results were generated with a specific laboratory test-setup. The results aren't guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups.

5 Switching time

The switching time of a valve depends on different aspects, like pressure level, flow direction, diaphragm material, valve function and many more. The different switching times are listed in the datasheet, which can also be found in **Table 31**.

		2/2-way valve			3/2-way valve		
		FFKM	FKM	EPDM	FFKM	FKM	EPDM
Switching time for gaseous media	On [ms]	9	5	5	9	5	5
	Off [ms]	9	-	-	9	5	5
Switching time for liquid media	On [ms]	9	5	5	9	5	5
	Off [ms]	9	-	-	9	5	5

Table 31: VYKA switching time catalog data

However, the catalog values are worst case values that take into consideration all possible flow directions measured with 2 bar. If necessary, Festo can get application-specific values.

Table 32 shows the results from an application-specific test with a VYKA 3/2-way valve with EPDM diaphragm. It is obvious that the switching time of the valve is much below the 5 ms as per the datasheet.

In the test, the switching time for three test specimens is determined using pressure, according to ISO 12238. The switching time via pressure is the time required by the valve to reach 10% of the set pressure (set pressure = 2 bar, 10%= 0.2 bar). For this purpose, an input pressure of 1 bar or 2 bar is applied and the valve is switched via MDS.

Test object	Pressure [bar]	COM -› NC [ms]	COM -› NO [ms]
1	1	2	2.7
1	1	2.1	2.7
1	1	2.2	2.7
2	1	2.1	2.8
2	1	2.2	2.8
2	1	2.2	2.8
3	1	2.1	2.9
3	1	2.1	3.0
3	1	2.1	2.9
3	2	2.2	3.2
3	2	2.3	3.2
3	2	2.2	3.1

Table 32: Switching time test results VYKA EPDM 3/2 valve with air

Note: These results were generated with a specific laboratory test-setup. The results aren’t guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups. If you are interested in application-specific values, please contact Festo.

6 Service life

The most important parameters for the valve's service life are the specific environmental conditions, the diaphragm as well as the seal material, the medium and the pressure level used. **Table 33** shows the valve parameters that are in the datasheet.

Parameter	Material	Value
Temperature[5]	EPDM and FKM	0 … 50 °C
	FFKM	15 … 50 °C
Pressure of medium	EPDM and FKM	-0.25 … 2 bar -0.5 … 1 bar (reversible)
	FFKM	-0.25 … 2 bar -0.5 … 0,5 bar (reversible)

Table 33: VYKA catalog parameters

A VYKA valve has to pass **at least 10 million switching cycles** without violating the parameters mentioned above. This means, for example, that a valve with EPDM material had to pass several tests at three different temperatures (0 °C, room temperature, 50 °C) with different pressure setups (e.g. maximum pressure of 2 bar and maximum vacuum of -0,5 bar). To confirm the service life in terms of functionality, the leakage was measured after 0, 2.5, 5, 7.5 and 10 million switching cycles using a dynamic functional test (so called "bubbles test") on the one hand and using a static functional test with helium on the other hand, according to the general leakage requirement (see **Chapter 7**). In addition, the switching time as well as the flow rate with air was measured. The test was stopped after 10 million switching cycles and no further measurements were carried out.

This means that there are no restrictions with regard to the target value of 10 million switching cycles in relation to the various valve parameters, as is common in the market.

For VYKA with 3/2 way function and FFKM sealing material, **extended vacuum range up to -0,8 bar** can be achieved in flow direction from COM to NC and COM to NO. In case of high vacuum, slight flow reduction of less than 10% can remain.

Higher pressures and vacuum ranges are possible for further valve variants on request.

For further information please contact Festo.

[5] This value is equal for the temperature of gaseous media, the temperature of liquid media or ambient temperature.

7 Leakage test in production

After production, every VYKA valve is tested using the max. allowed pressure at a max. leakage value of 2.8e-4 mbar*l/s (0.0168 ml/min = 1.008 ml/h). The test is done with helium.

It is therefore highly suitable for applications with strict requirements regarding leakage test devices, emission monitoring systems or gas chromatography.

As a reference, other valves from Festo are listed in **Table 34**:

Valve	Max. allowed leakage according to datasheet
VYKA	**< 0,001008 l/h**
VYKB	< 0.033 l/h
VYKC	< 0.004 l/h
VUVS	< 1.0 l/h
VUVG	< 2.0 l/h
VEMP	< 0.012 l/h

Table 34: Reference leakage values from Festo valves

For further information please contact Festo.

8 Dynamic cleanliness test according SEMI F70.1

Particle testing has been defined and included in national and international standards for several situations, but they are executed in a variety of ways. Airborne particles in the range of 0.1 µm to 5 µm can be measured using a Laser Particle Counter (LPC). Festo uses the Lasair III unit from PMS (Particle Measurement Systems), the same brand and type as used by many of our customers.

Festo measures the number of particles per (valve) switch, added to a certain gas flow, for several semiconductor applications. To do this, Festo has developed a test method that has also been adopted by SEMI.org and is described in detail in SEMI F70.1-0320.

As applications for clamping and releasing wafers use pulsed compressed air systems, the contamination requirements are indicated as the maximum amount of particles of a certain size per switch.

With the information from this test, the particle contribution for any given application can be calculated.

The major test results are presented below. For further information and a detailed test report please contact Festo.

Conclusion

- The VYKA valve is a very clean valve.
- As the test shows, no particles at 8 million switches, the valve does not generate particles as a result of switching, indicating very low wear. The particles detected at the start of the test are likely to originate from the assembly of unclean parts.
- VYKA fulfils the requirements for **ISO class 1.**

The representative result for the valve is taken from the values at 520,000 cycles (see also **Table 35**):

Particles per switch cycle

	›0.10 µm	›0.15 µm	›0.20 µm	›0.25 µm	›0.30 µm	›0.50 µm	›1.0 µm	›5.0 µm
Average last 36 minutes	0.065	0.016	0.004	0.001	0.000	0.000	0.000	0.000
Peak value last 36 minutes	0.125	0.058	0.017	0.008	0.000	0.000	0.000	0.000

Table 35: Particles in VYKA valve after 520.000 switching cycles

Remarks:

The cleanliness of the valve in a new state is not yet suitable for immediate use in cleanroom applications. Cleaning the interior of the valve with a cleaning agent (like IPA/water solution) will make the unit suitable for use in cleanroom applications.

The suitability for ISO 14644-1 cleanroom classes can be calculated using the number of particles per switch and multiplying that with the frequency of use in the actual application and then dividing this by the refresh rate of the volume that is looked at.

Example:

Frequency (F)	:	300 switches per hour
Downflow speed	:	0.01 m/sec = 36 m/hour
Area	:	0.09 m^2
Refresh rate (RR)	:	0.09 x 36 = 3.24 m^3/hour

Concentration = PPS x F / RR

The results are listed in **Table 36**.

Particle size	›0.10 µm	›0.15 µm	›0.20 µm	›0.25 µm	›0.30 µm	›0.50 µm	›1.0 µm	›5.0 µm
Average last 36 minutes	0.065	0.016	0.004	0.001	0.000	0.000	0.000	0.000
Concentration #/m³	6.010	1.523	0.365	0.102	0.000	0.000	0.000	0.000

Table 36: Particles in VYKA valve with frequency example

➔ This fulfils the requirements for ISO class 1:
No particles › 0.3 µm, less than 2 particles › 0.2 µm and less than 10 › 0.1 µm

9 Cell handling

The effect that dispensing components from Festo have on cell viability and proliferation was evaluated using various applied parameters. Based on the results of a live-dead assay, **an average cell viability of over 90% was confirmed**, which is comparable to the viability of the cells examined using hand pipettes.

The measurements of the applied assay confirmed that the processed cells subsequently grew at a rate comparable to that of the control group of hand-pipetted cells. These results confirm the applicability of Festo's pressure over liquid dispensing system for dispensing live cells as well as the suitability of the VYKA valve for such a process.

Looking at the results for each incubation time individually, it is noticeable that there is no significant difference in cell viability between the needles at an incubation time of 30 minutes. The tendency that the needle with ID 0.6 mm had a gentler effect on the cells was only evident after 24 hours.

However, it should be noted that only the HEK293 cell line was studied. The extent to which the results can be transferred to other cell lines must be examined on a case-by-case basis. Both the robustness of the cell line and its size play a role.

It should also be noted that a calibration must be carried out for each cell line and each cell concentration, since the viscosity of the cell suspension changes depending on the cell size and concentration. Different valve opening times must therefore be set for each target volume.

Note: These results were generated with a specific laboratory test-setup. The results aren’t guaranteed product specifications from a datasheet. Every system is different and generates different results. These results provide a benchmark for other, similar setups. For further information and detailed test report please contact Festo.

If you are interested in a white paper about applications for **sorting and dispensing spheroids**, please also contact Festo.

10 Flushability and cleanability

In many applications (such as cell handling) the system must be cleaned regularly. Cleaning cycles with cleaning liquids are therefore often carried out in practice. In order to obtain a satisfactory cleaning result, however, a number of things must be taken into account in advance. On the one hand, the materials selected must be suitable for contact with the (cleaning) media. Secondly, the internal geometry must be designed in such a way that they are easy to flush. This is achieved by a suitable design with few dead spaces that has been tested in flow simulations. However, to be absolutely sure that the design and the cleaning agent used have the desired result, the cleaning process must finally be verified and validated. These four steps are shown in **Figure 12**.

What exactly does this mean? Good flushability is often verified on the shop floor/in the field with so-called color rinsing tests. Here, the system is flushed with a colored substance, then the system is rinsed with DI water and the time or volume is measured until the color concentration is below a desired threshold. However, this method has a major disadvantage: it does not provide any information on whether something has settled inside the system that cannot be rinsed out. This is precisely the difference between good flushability and cleanability of a system or, in this case, a valve.

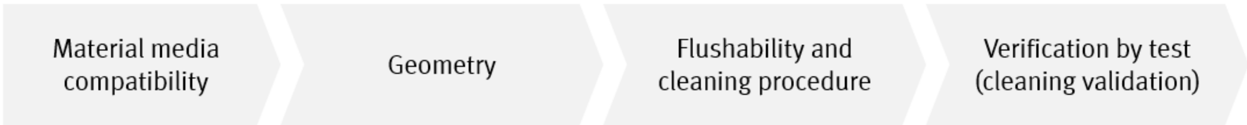

Figure 12: The four steps of cleanability

10.1 Material compatibility

The wetted materials of VYKA valve are PEEK for the fluidic plate and EPDM, FKM or FFKM for the seal and diaphragm. A comprehensive overview of media compatibility is listed in **Chapter 11.1**.

10.2 Geometry and internal design

The idea that a small internal volume equates to good flushability and cleanability is a common one. Of course, a small internal volume is advantageous because you need less volume to flush the system. However, design is just as important. **Figure 13** shows how these two variables interact. Fluid chamber A has a smaller internal volume than fluid chamber B. However, the flushability and cleanability of fluid chamber B will be much better thanks to the elimination of all (dead) corners.

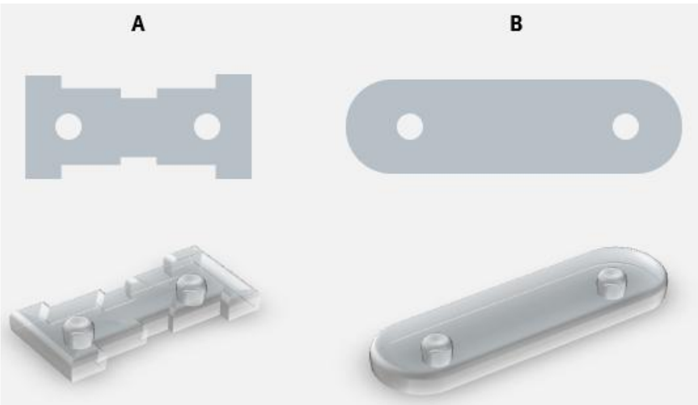

Figure 13: Example of low internal volume vs. cleanability

Attention was therefore paid during the development of the VYKA valve to a small internal volume as well as to a suitable design. With regard to the internal volume, it should be noted at this point that the various manufacturers on the market provide different information. **Figure 14** shows the different views of the internal volume and the information provided by Festo in its catalog.

**Our catalog value **How competition measures. We have added this information in our catalog, too.*

Figure 14: Different views of internal volume of VYKA

In addition to the flow-optimized design of the fluid chamber, the seal and diaphragm design of the VYKA valve is also unusual. As shown in **Figure 15**, instead of standard O-rings a curved shape was chosen to minimize the area "under the seal".

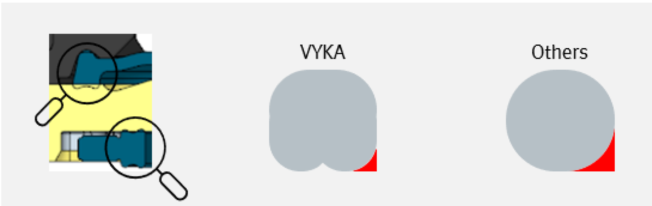

Figure 15: Special sealing technology with low internal volume

Finally, flow simulations were used to determine whether all areas of the valve can be flushed and cleaned. In addition, the flow velocity was determined, which also plays a major role in cell handling. An exemplary flow simulation of a 2/2 NC VYKA valve is shown in **Figure 16**.

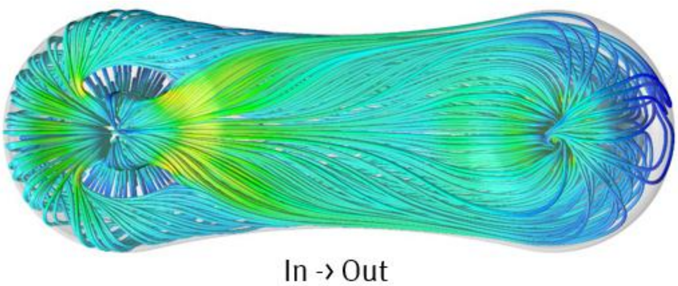

Figure 16: Simulation of flushability of VYKA

For further information please contact Festo.

10.3 Flushability and cleanability

For a recommended cleaning procedure as well as a verification report, please contact Festo.

11 Media compatibility, FDA listed material and oxygen

11.1 General media compatibility

The different variants of the VYKA (seal and diaphragm EPDM, FKM or FFKM – all with PEEK fluidic plate) have different chemical resistances when getting in contact with various media. The table below (**Table 37**) provides an overview of several compounds and an assessment of the chemical resistance of the VYKA variants.

For further information go to Material resistance or contact Festo.

Legend	+	Resistant
	o	Conditionally resistant
	-	Not resistant

Compound	Chem. formula	Conc. %	Temp. °C	VYKA-EPDM	VYKA-FKM	VYKA-FFKM
Acetone	CH3COCH3	100	20	+	-	+
Aluminum oxide	Al2O3	100	20	+	+	+
Formic acid	HCOOH	10	20	+	-	+
Formic acid	HCOOH	10	100	+	-	+
Formic acid	HCOOH	100	20	-	-	o
Ammonia	NH3	10	20	+	-	+
Aniline	C6H5NH2		20	+	-	+
Benzaldehyde	C6H5CHO		20	+	-	+
Gasoline, petrol			20	-	+	+
Benzene	C6H6		20	-	o	+
Benzophenone	C6H5COC6H5		20	o	+	+
Beer			20	+	+	+
Boric acid	B(OH)3	10	20	+	+	+
Boric acid	B(OH)3	4	20	+	+	+
Brake fluid (DOT4)			20	+	-	+
Butyric acid	CH3CH2CH2COOH		20	o	+	+
Butyl acetate	CH3COOC4H9		20	+	-	+
Calcium chloride	CaCl2		20	+	+	+
Calcium hydroxide	Ca(OH)2		20	+	+	+
Calcium sulfate	CaSO4		20	+	+	+
Chloroacetic acid	ClCH2COOH		20	+	-	+
Chlorine gas, dry	Cl2		20	+	+	+
Chloroform	CHCl3		20	-	+	+
Hydrogen chloride, gaseous	HCl		20	+	+	+
Chromic acid	H2CrO4	10	20	+	+	+
Chromic acid	H2CrO4	20	20	+	+	+
Cyclohexane	C6H12		20	-	+	+

Diesel oil			20	-	+	+
Diethylene glycol	(HOCH2CH2)2O		20	+	+	+
Diisooctyl sebacate	C10H16O4(C8H17)2		20	-	+	+
Dioxane	C4H8O2		20	+	-	+
Iron(III)chloride	FeCl3		20	+	+	+
Glacial acetic acid	CH3COOH	100	20	+	-	+
Epoxy resins			20	+	+	+
Acetic acid	CH3COOH	10	20	+	-	+
Acetic acid	CH3COOH	100	20	+	-	+
Acetic acid	CH3COOH	25	40	+	-	+
Acetic acid	CH3COOH	80	40	+	-	+
Ethanol	C2H5OH	96	20	+	o	+
Ethyl acetate	CH3COOC2H5		20	+	-	+
Ethylbenzene	C6H5C2H5		20	-	o	+
Ethylene chloride	Cl-CH2-CH2-Cl		20	-	+	+
Fatty acid			20	o	+	+
Hydrofluoric acid	HF	5	20	-	-	-
Formaldehyde	HCHO	40	20	+	o	+
Glycol	HO-CH2-CH2-OH	commer-cial	20	+	+	+
Glycerol	(CH2OH)2CHOH		20	+	+	+
Glycerol	(CH2OH)2CHOH		100	+	+	+
Urea	(NH2)2CO	up to 33	20	+	+	+
Heptane	CH3(CH2)5CH3		20	-	+	+
Hexane	CH3(CH2)4CH3		20	-	+	+
Hydraulic oil, mineral oil			20	-	+	+
Hydraulic oil, synthetic ester			20	-	+	+
Isooctane	CH3C(CH3)2CH2CH(CH3)CH3		20	-	+	+
Isopropanol	C3H7OH		20	+	+	+
Coffee extract			20	+	+	+
Potassium acetate	CH3COOK		20	+	+	+
Potassium carbonate	K2CO3	any	20	+	+	+
Potassium chlorate	KClO3	any	20	+	+	+
Potassium dichromate	K2Cr2O7	satu-rated	20	+	+	+
Potassium hydrogen tar-trate	C4H5KO6		20	+	+	+
Potassium hydroxide	KOH	10	20	+	-	+
Potassium hydroxide	KOH	10	90	+	-	+
Potassium hydroxide	KOH	conc.	20	+	-	+

Potassium hydroxide	KOH	conc.	90	+	-	+
Potassium nitrate	KNO3		20	+	+	+
Potassium permanganate	KMnO4		20	+	+	+
Whitewash	Ca(OH)2		20	+	-	+
Cresol	C7H8O	100	20	-	-	-
Copper sulfate, aqueous	CuSO4	any	20	+	+	+
Air, dry			20	+	+	+
Magnesium sulfate	MgSO4		20	+	+	+
Sea water			20	+	+	+
Methanol	CH3OH		20	+	-	+
Methylene chloride	CH2Cl2		20	-	-	+
Ethyl methyl ketone	CH3COC2H5		20	+	-	+
Ethyl methyl ketone	CH3COC2H5		60	+	-	+
Sodium acetate	CH3COONa		20	+	+	+
Sodium carbonate	Na2CO3	10	20	+	o	+
Sodium hydroxide	NaOH	10	90	+	-	+
Sodium hydroxide	NaOH	conc.	20	+	-	+
Sodium hydroxide	NaOH	conc.	90	+	-	+
Sodium hypochlorite	NaOCl	13	20	+	-	+
Sodium sulfate	Na2SO4		20	+	+	+
Oil, ASTM Oil Nr.1			20	-	+	+
Oil, ASTM Oil Nr.2			20	-	+	+
Oil, ASTM Oil Nr.3			20	-	+	+
Oil, ASTM Oil Nr.4			20	-	+	+
Oil, Ester			20	o	+	+
Oil, Glycol			20	+	+	+
Oil, Mineral			20	-	+	+
Oil, Perfluorinated			20	+	+	+
Oil, Silicone			20	+	+	+
Oil, synthetic			20	-	+	+
Oleic aid			20	+	+	+
Oxalic acid	(COOH)2	10	20	+	+	+
Ozone	O3	20 ppm	20	+	+	+
Pentane	CH3(CH2)3CH3		20	+	+	+
Kerosene			20	-	+	+
Phenol	C6H5OH		20	-	o	o
Phosphoric acid	H3PO4	10	20	+	+	+
Phosphoric acid	H3PO4	80	20	+	+	+
Salicylic acid	HOC6H4COOH		20	+	+	+
Nitric acid	HNO3	10	20	+	+	+
Nitric acid	HNO3	conc.	20	-	-	-

Hydrochloric acid	HCl	10	20	+	+	+
Hydrochloric acid	HCl	conc.	20	+	+	+
Sulfur dioxide, gaseous	SO2		20	+	-	+
Sulfuric acid	H2SO4	10	20	+	+	+
Sulfuric acid	H2SO4	conc.	20	-	-	-
Hydrogen sulfide, gase-ous, dry	H2S		60	+	-	+
Hydrogen sulfide, gase-ous, humid	H2S		60	+	-	+
Soap solution		any	20	+	+	+
Starch solution		0.01	20	+	+	+
Stearic acid	C17H35COOH		20	o	+	+
Turpentine oil			20	-	+	+
Carbon tetrachloride	CCl4		20	-	+	+
Tetrahydrofuran (THF)	C4H8O		20	-	-	+
Toluene	C6H5CH3		20	-	o	+
Vaseline			20	-	+	+
Water	H2O		20	+	+	+
Wasser, demineralized	H2O		20	+	+	+
Hydrogen peroxide	H2O2	30	20	+	+	+
Tartaric acid	HOOCCH(OH)CH(OH) COOH	10	20	+	+	+
Xylene, isomeric mixture	C6H4(CH3)2		20	-	+	+
Citric acid	(HOOCCH2) 2C(OH)COOH	10	20	+	+	+

Table 37: Media resistance of wetted materials of VYKA valve

11.2 FDA listed material

All wetted materials are FDA listed. You can find more information here.

11.3 Medium oxygen

The PEEK sub-base VABS-K1 as well as the PEEK fluidic plate are tested by BAM for their oxygen compatibility.
The diaphragm FKM was tested by BAM, too.
It was a safety-related investigation for gaseous oxygen operation at temperatures up to 60 °C.
For further information please contact Festo.