## Application Note

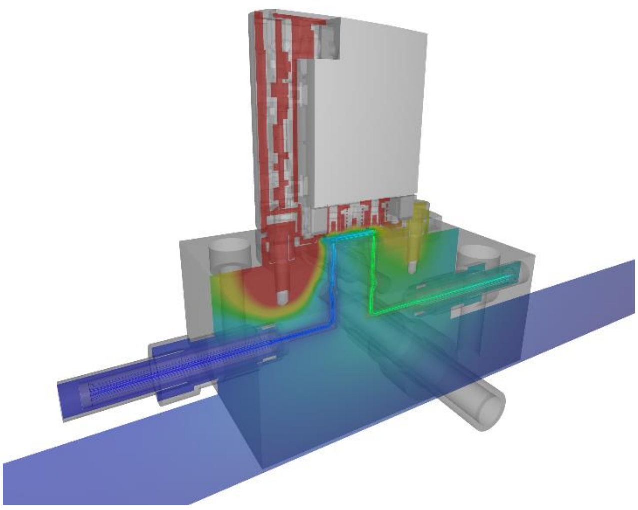
# Reduction of the heat input of media-separated valves into the flowing fluid

VYKA
VYKC

The heating of a media-separated valve can affect the fluid flowing through it in various ways. It is important to note that the exact effect of heating on the flowing fluid depends on various factors, including the specific design of the valve, the fluid used and the operating conditions.

This application note covers the following topics:

- Why is it important in laboratory automation to minimize the heat input into fluids through valves?
- What factors in the design of a valve unit influence the heat input?
- How high is the heat input of valves from different manufacturers at different flow rates and how do Festo valves compare?
- What measures can be taken to effectively reduce the heat input of valves in fluids?



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# 1 The challenge of heat input in laboratory automation

For reliable results in laboratory automation, liquid handling systems should have as little influence as possible on the fluid flowing through them. One possible disruptive factor is the introduction of heat into the medium through the valve, which is usually actuated electromagnetically. In medical diagnostics, there are many liquids that react sensitively to heating:

- Denaturation of proteins in blood can occur, which impairs the quality of blood samples and the reliability of diagnostic tests.
- With many reagents, an increase in temperature leads to reduced stability and effectiveness, which can result in incorrect test results.
- Enzymes are denatured by excessive heating, which reduces or completely deactivates their catalytic activity.
- In addition, temperature-sensitive solutions and buffers are often used, which can change their chemical composition or pH value - with negative effects on the accuracy of the tests.

It is therefore important to design and operate valve units in such a way that the heat input into the fluid is reduced to a minimum. Simulations were first used to investigate which factors in the design of a valve unit influence heating.

In the second step, these simulation results were verified using practical tests and a comparison with market competitors was made..

## 2 Simulation with the media-separated solenoid valve VYKA

The simulation was carried out with the VYKA solenoid valve in conjunction with a directly mounted VAVE control electronics unit, screwed onto a manifold block.

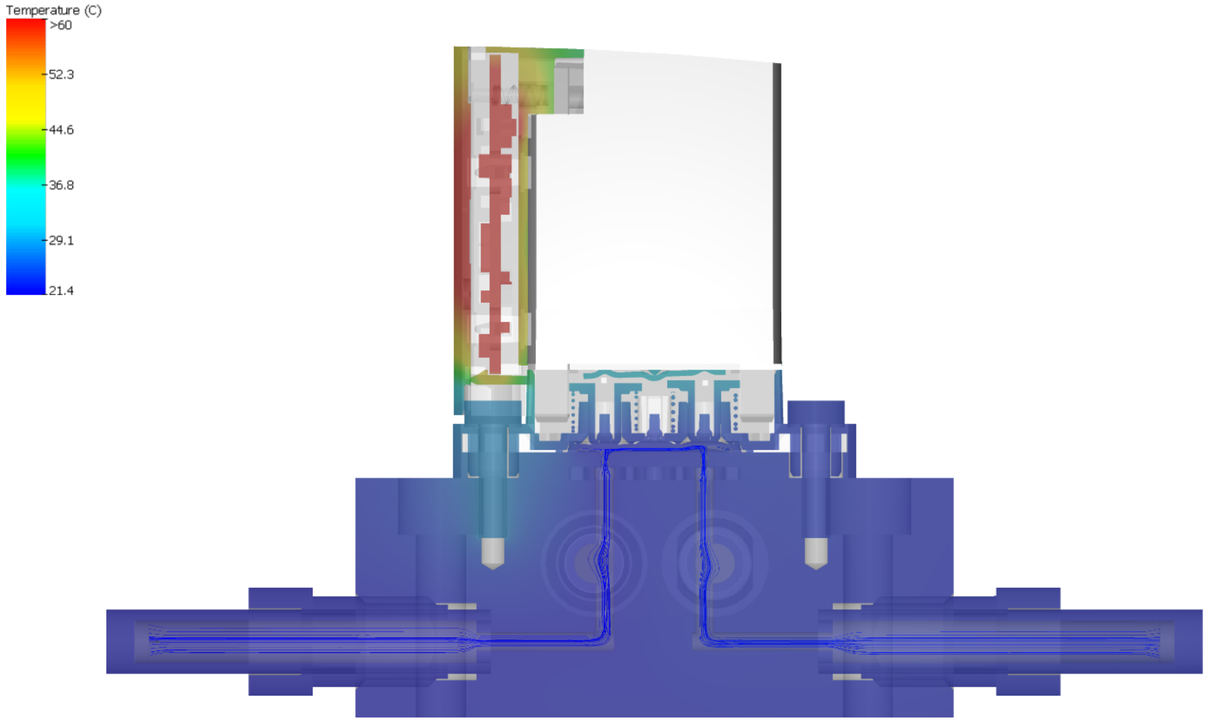



Illustration 1: Heat input through the control electronics into the system

These are the most important findings of the simulation:

- The heat input into the fluid strongly depends on the flow rate.
- The design of the valve and the manifold block have a decisive influence on the heat input - from the arrangement of the components to the choice of materials and the design of the fluid channels.
- A large proportion of the heat is generated in the control electronics and reaches the manifold block, and therefore the fluid flowing through it, primarily via the screw connection.
- The heat input of the valve into the flowing medium is extremely low. In the example shown, the permanent energization of the valve VYKA (100% ED) at a flow rate of only 1 ml/min leads to a temporary increase in the medium temperature of only 0.5 °C.

With the following measures it is possible to optimize the heat input:

- Decentralized placement of the control electronics could significantly reduce heat generation. The VYKA solenoid valve offers this option via a simple NEBV connection line in combination with a VAEM valve control module.
- The heat input into the manifold block and the fluid could be further reduced if thermal coupling via the screw joint can be prevented.

More information on heating the valve with the different control alternatives at different switching frequencies can be found in the Festo Support Portal in the Expert knowledge section.

➔ **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.

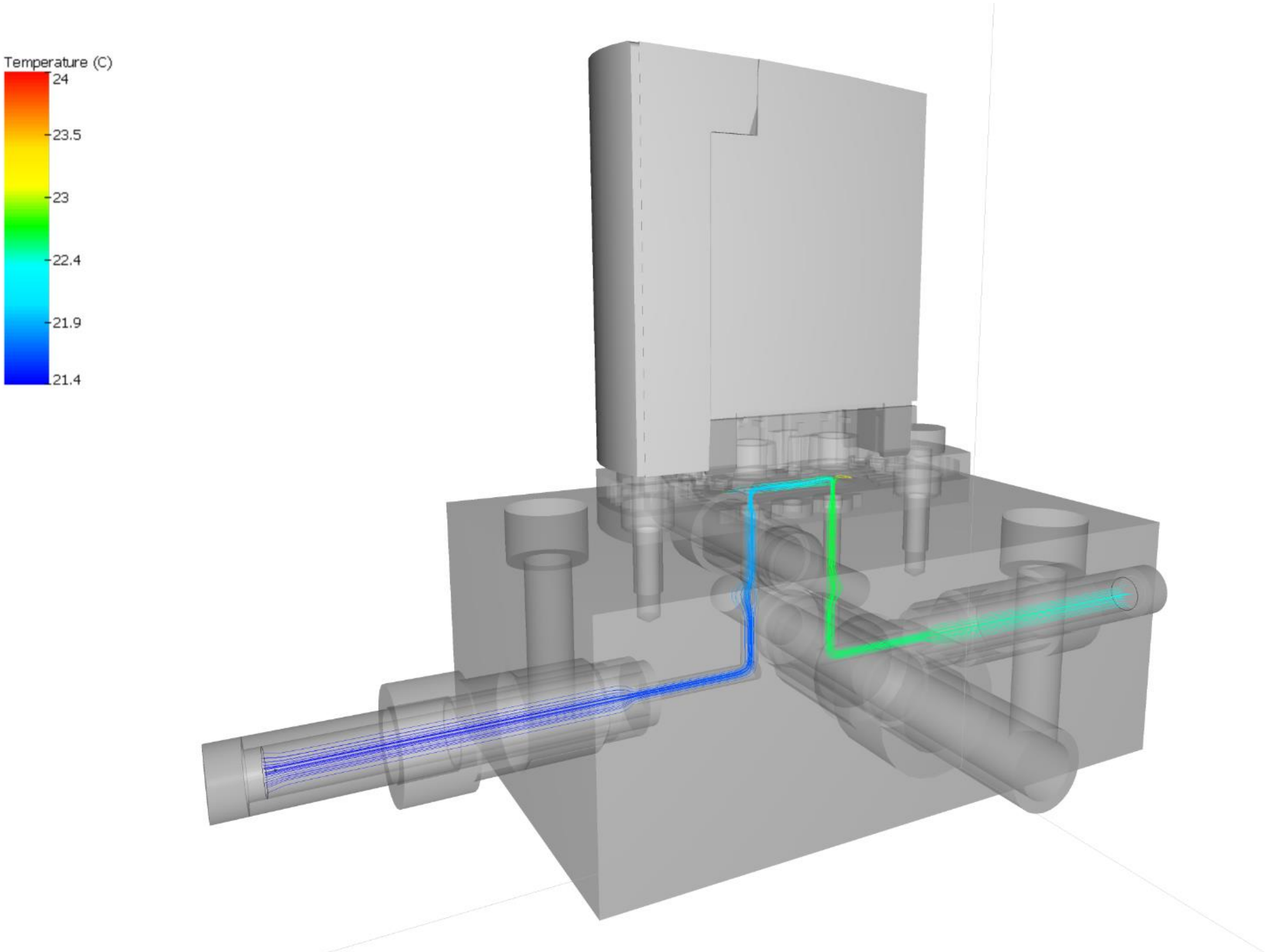


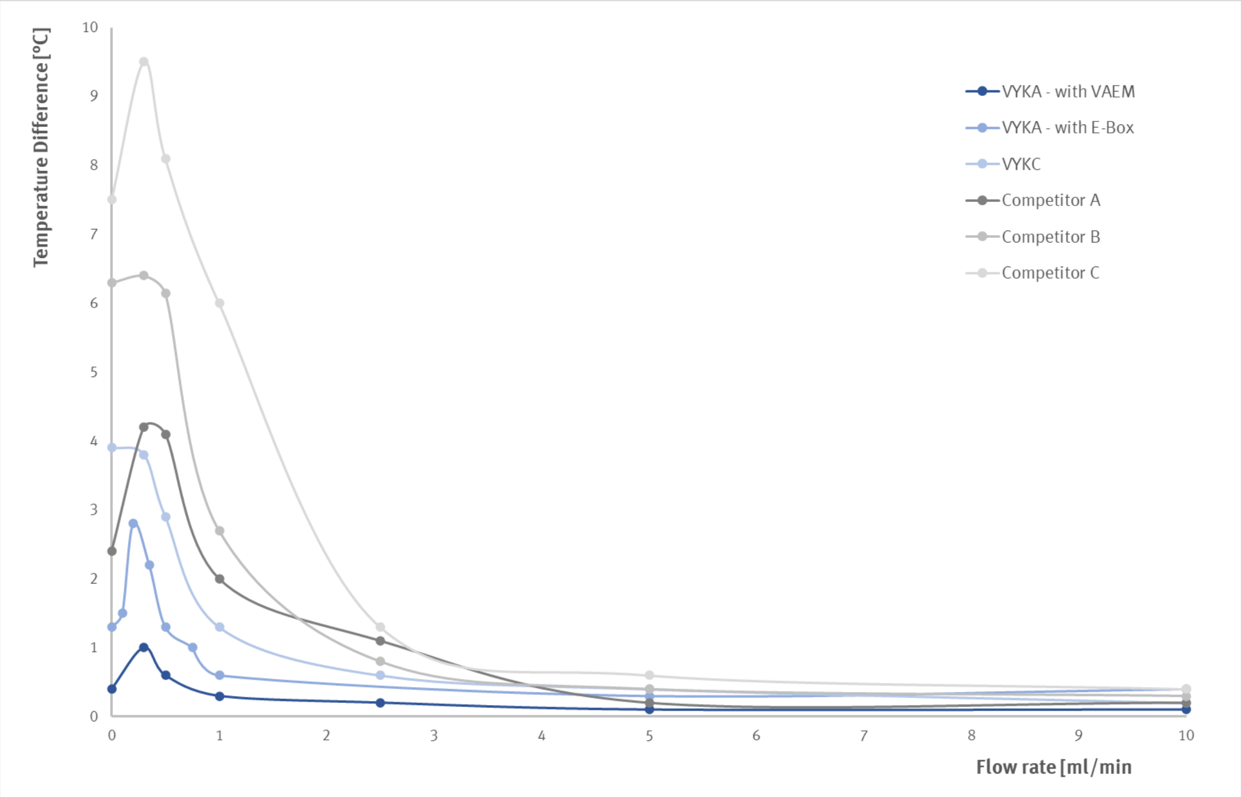

Illustration 2: Temperature gradient in the fluid at a flow rate of 0,5 ml/min.

# 3 Tests with valves from Festo and other manufacturers

The next step involved experimental tests on heat input into fluids at different flow rates with various Festo valves and comparable products from other manufacturers.

These are the most important results of the tests:

- The series of measurements carried out with various valves confirmed the simulation results.
- The heat input through the valve into the flowing medium depends on the flow rate. As a general rule, the higher the flow rate, the lower the temperature rise. The heat input is greatest when the fluid is at a standstill or at very low flow rates. It decreases exponentially with the flow rate - up to the point at which no more heat input can be measured.
- The performance of Festo valves is generally superior to that of products from other manufacturers. This applies in particular to the VYKA solenoid valve. Even at extremely low flow rates of just 1 ml/min, local temperature increases remain limited to below 1 °C.




There are specific reasons for the very low heat input of VYKA:

- The media-separated valve VYKA has been designed for very low power consumption and the best possible dissipation of thermal losses into the environment.
- The power consumption is further reduced by the holding current reduction integrated in the Electrical connection plate VAVE. After switching the valve, the system switches to a lower holding current, which is sufficient to hold the valve in the actuated position. This reduces heat generation and electrical consumption to a minimum.
- In addition, the heat input into the medium can be further reduced if the control electronics are positioned decentrally. Thanks to the modular valve design, this is possible via a connecting cable NEBV in combination with the valve control module VAEM. In this way, a large part of the power loss associated with the electrical control is generated away from the fluid flow.

# 4 Recommendations for a heat-optimized valve design

Clear recommendations for the heat-optimized design of a valve unit can be derived from the results of the simulation and the tests:

1. Pay attention to the following points when selecting the valve:
   a. a valve design that requires low energy consumption for actuation and is optimized for the dissipation of thermal energy into the environment
   b. a holding current reduction to minimize the power consumption after switching the valve
   c. the option of decentralizing the control electronics

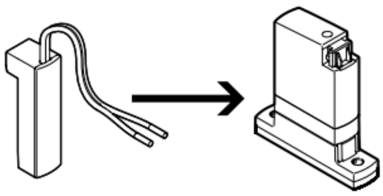
2. Select a material with good thermal conductivity for the manifold block and design the fluid channels to optimize temperature equalization with the environment.

3. Ideally, assemble the valves to the sub-base using thermal insulators.

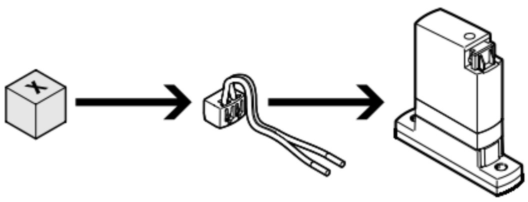
# A Technical Appendix

## A.1 Control options VYKA

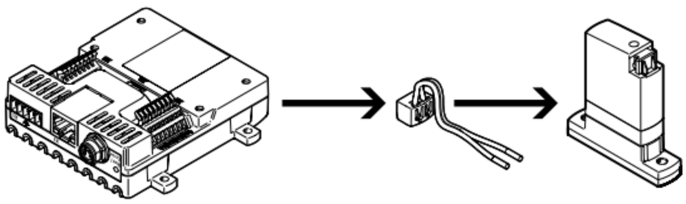
> **Note**
> The solenoid valve VYKA is controlled by means of a constant current source. It is essential to reduce the holding current, otherwise the valve will heat up considerably. A holding current reduction can be achieved as follows:



When using the Electrical connection plate VAVE, holding current reduction is integrated (recommended).



When using the connecting cable NEBV, a separate holding current reduction must be provided by the customer.



The valve control module VAEM with the connecting cable NEBV (recommended) offers the option of actuation with holding current reduction.