Bartels mikrotechnik

Case Study

Active Sensor feeding with micropumps

What is microfluidics?

Microfluidics is the fine art of creation and manipulation of small portions of fluids, often realized by flow within small, sub-millimeter-scale channels. These small dimensions allow the fluid flow to be controlled with exquisite precision (Seifert, Thiele; 2020).

Microfluidic systems are used in many applications, including medical testing, drug delivery, chemical analysis, chip cooling, etc. These systems have the advantages of small volume, low cost, high throughput analysis (Gidde; 2020).

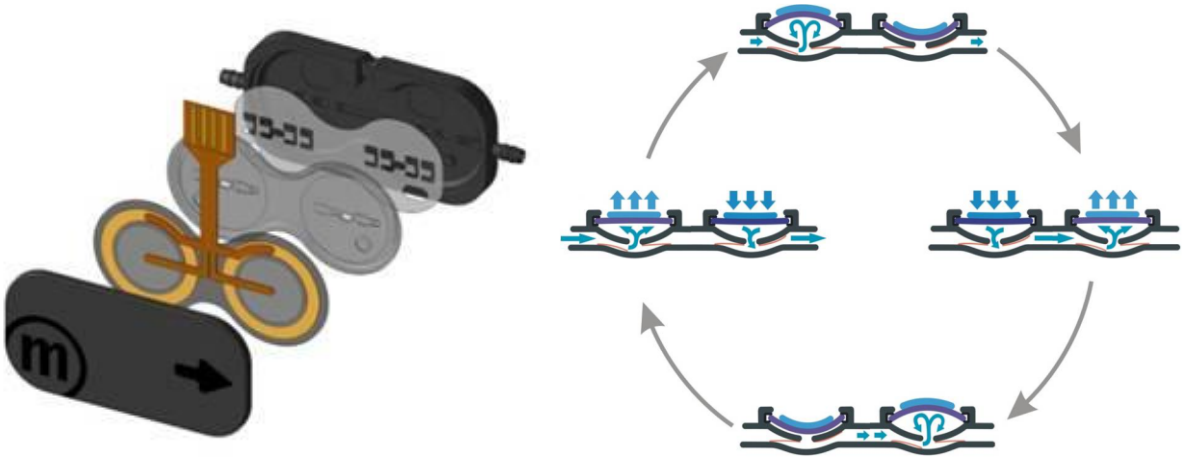
Further use of this method in the realm beyond academic research, such as that of commercial fine-chemical production, sensor development, or encapsulation of active substances, is presently being explored. Microfluidics, though, is a demanding field and working area that requires both profound theoretical understanding and experimental skills. As there is no standard in education and training on this method in many fields of study that actually can benefit most from this technique (Seifert, Thiele).

Micropumps are essential components in the microfluidic systems and are used to manipulate, transport and control the precise quantity of fluid in terms of microlitre and millilitre (Gidde; 2020). Comparing with the conventional syringe pumps, microfluidic pumps have the capability of combining with other on-chips functional units to realize portable micro total analysis systems (μTAS) (Gao; 2020). Micropumps have been developed on various principles for many different applications viz. drug delivery and biomedical assays (Gidde; 2020).

About the mp6 micropump

The available, industrialized and commercialized example is the mp6 micropump by Bartels Mikrotechnik GmbH. This micro pump is a positive displacement membrane pump utilizing piezo buzzers. With a volume of 2250 mm3 (30 mm x 15 mm x 5 mm) it is, as a micro pump, dimensionally very beneficial.

It is built up in a „sandwich" (stack) setup and combined and sealed in laser welding process.



There is absorbing and transparent plastic material that can be melted by a laser, so that the melted mass unites the parts. There is no glue in contact with the fluid, but only the material the micropump is made from. Standard materials are PPSU, PI and PP. Due to the unibody and the fact that the pump does not contain any moving parts, it is sterilizable, robust and reliable with a lifetime with more than 5000 h. The micropump possesses two membrane stages in a series setup running with a 180° shift.

These two stages behave like two micropumps in series doubling the pressure. Besides, this principle makes it much more tolerant regarding gas bubbles. The mp6 is running at high voltages which regulate the bending of the piezo membranes and the frequencies which define the number of displacements per second. The available ranges are 0-250 Vpp and 1-600 Hz. These electronic parameters applied to the piezo membranes lead to the following typical fluidic values of the pump:

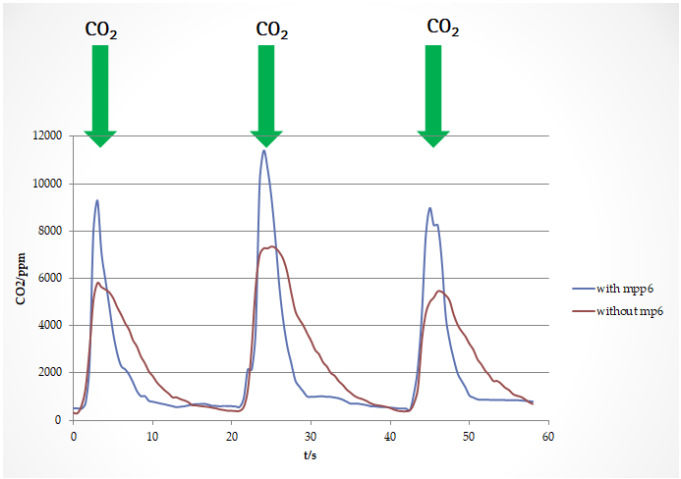
- Liquids (eta = 1 mPas): q = 5 - 8000 µl/min in free flow and p > 600 mbar
- Gas: q > 25 ml/min in free flow and p > 150 mbar

The flow rate depends on the pressure. In addition, the performance of the mp6 is dependent on the viscosity of the liquids.

The mp6 micropump is made in Germany and leaves the factory after a 100% OQC.

Active sensor feeding with micropumps

Together with the request for higher safety and efficiency in industrial processes, the use of sensors increases continuously. To generate stable and defined measurement values in these processes, the environmental conditions of the sensor need to be kept at a constant level. This especially applies to feeding the sensor with an analyte fluid. Besides a faster response to changing analyte properties, a lowered target concentration at the point of measurement can be balanced as applied for catalytic sensors for example.



As because of these reasons various sensors can not be used with completely passive feeding, micropumps from Bartels Mikrotechnik open up new fields of application. Due to their simple setup, they can be produced at a low cost level and with their particle tolerance they prove performance under real conditions.

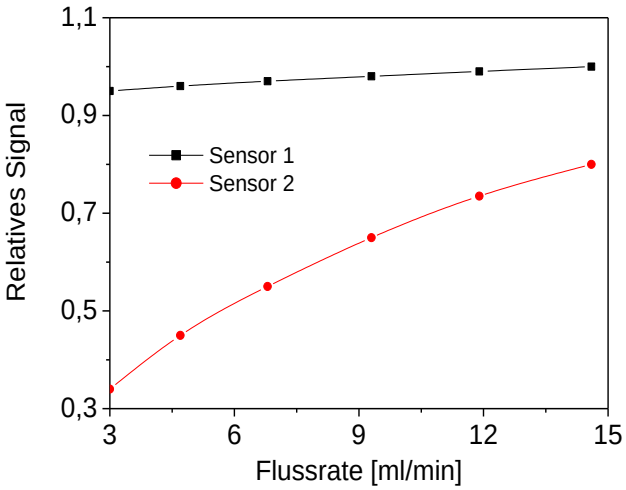
With its small dimensions, the pump can either be used as a subassembly together with the sensor or as an OEM component to be integrated into a more complex unit. Especially for portable instruments, where miniaturization plays an important role, the low energy consumption comes into play. Battery operation can be easily realized. Dependent on the customers need the driving electronics can be either integrated into the main PCB of the unit or even inside an enlarged pump housing.

The use of an inert polymer in combination with an optimized placement of the pump inside the system enables operation also under difficult conditions.

The micropump mp6 provides a minimum flow rate of 6 ml/min with liquids and 18 ml/min with gases. By using the available evaluation kit, the pump performance can be tested in the target application and the driving parameters can be defined.

In a customer application, the pump has been used to monitor a mixture of hydrogen, oxygen and nitrogen gas. Using a bypass channel, gas was extracted for analysis and fed to the sensor. During the system evaluation of the pump, characteristic flow rates in dependence on driving voltage and frequency have been determined, as shown in the first graph.

The second graph shows the dependency between the relative sensor signal and the gas flow. On the one hand this shows the signal improvement with active sensor feeding, on the other hand the need to provide a stable flow rate throughout the measurement.



In a second application, a CO2 gas sensor from the company Sensirion was directly exposed to a changing CO2 concentration, once directly and once by using of an mp6 micropump.

The direct couoling of the test gas to the test beam slope of the IR sensor shows a significant improvement in the time response.

Besides standard components, Bartels microComponents is specialized in the development of application specific pumps and system integration

Bartels Mikrotechnik is a globally active manufacturer and development service provider in the field of microfluidics. In the microEngineering division, the company supports industrial customers in the modification, adaptation and new development of high-performance and market-oriented product solutions through the innovative means of microsystems technology. The second division, microComponents, produces and distributes microfluidic products and systems, especially for miniaturized and portable applications. Our key products are micropumps that convey smallest quantities of gases or liquids and are used in a variety of ways in biotechnology, pharmaceuticals, medical technology and numerous other applications.

Bartels Mikrotechnik with passion for microfluidics!

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