

# CASE STUDY

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**Bartels** <sup>m</sup>ikrotechnik

*with passion for microfluidics*

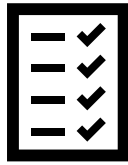
Perfusion systems for  
microfluidic cell  
culturing

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High throughput



Reagent saving



Lab automation

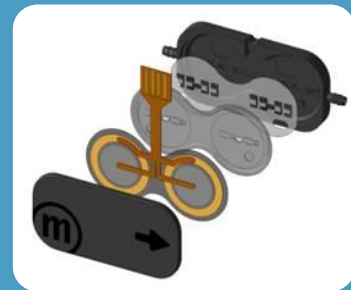
## What is microfluidics?

Microfluidics is the fine art of creation and manipulation of small portions of fluids, often realized by flow within small, sub-millimetre-scale channels. These small dimensions allow the fluid flow to be controlled with exquisite precision (Seifert, Thiele; 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. The alternating displacement of the piezo acutators lead to the following typical fluidic values of the pump:

- Liquids ( $\eta = 1 \text{ mPas}$ ):  $q = 5\text{--}8000 \text{ }\mu\text{l}/\text{min}$  in free flow and  $p > 600 \text{ mbar}$
- Gas:  $q > 25 \text{ ml}/\text{min}$  in free flow and  $p > 150 \text{ mbar}$



Cell culturing is an important tool in pharmaceutical development, cosmetics and food & beverage while also being a highly sensitive process. Besides chemical and biological parameters, i.e. pH value, temperature, feed concentration etc., the physiological parameters and therefore the fluidic parameters play an important role in mimicking real body behaviour. The combination of biotechnology and microfluidics is a game changer in these fields. While biotechnology is the base for these research fields, microfluidics offers an added value by getting closer to the body's physiological environment.

Standard procedures for culturing cells, especially in high throughput applications, are based on static principles. Cells usually sense fluid dynamics, such as flow speed and shear stress. Active microfluidics can still offer high throughput options due to its micro footprint. Additionally, it allows for dynamic perfusion as expected in the human body. Also, it is possible to mimick the blood flow and therefore a dynamic exchange of nutrients and waste products.

Another important aspect of active microfluidics for cell culturing is the option of digitization. Manual handling, such as pipetting, can be eliminated. This boosts laboratory automation, saves time and resources while gathering even more information as with manual handling procedures. Documentation process can be automated and the potential for human errors is minimized.

The objective of this case study is to share the variety of setup possibilities utilizing components by Bartels Mikrotechnik and its partners. These components are implemented into the read-to-start Cell Culture kit. Additionally, the case study discusses results of a cell transporting experiment pumping cells through the piezo actuated micropump determining the viability before and after the pumping process.

## Perfusion systems for microfluidic cell culturing

In general, the Cell Culture Kit consists of a micropump and a flow sensor controlling a very stable flow rate and a microfluidic chip with reaction chambers for cell culturing. The simple plug-and-play setup realizes constant flow rates down to one digit  $\mu\text{l}/\text{min}$  and is digitally accessible via a microcontroller and a user interface.

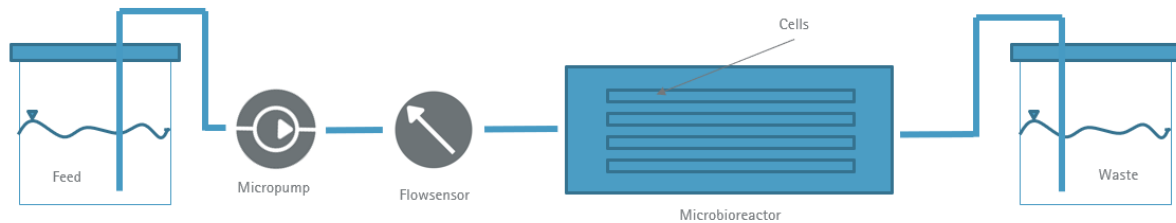


Figure 1 Microfluidic on-way perfusion system

The setup above shows a one-way arrangement in which the flow controlling system perfuses the bioreactors. This completely exchanges the chambers with fresh medium ending up in a waste or harvest reservoir.

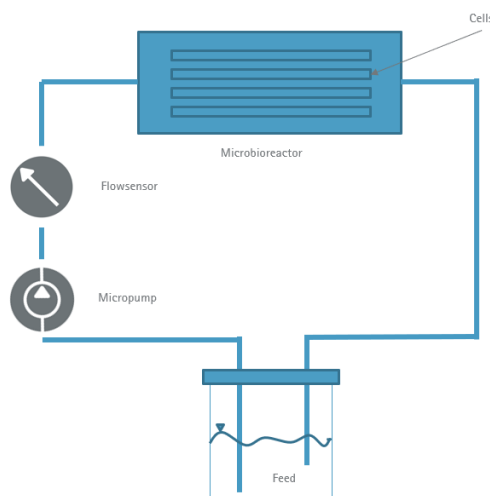


Figure 2 Microfluidic closed-loop perfusion system

Especially some stem cell culture application require an incomplete exchange of medium, also in some cases it is more efficient, i.e. reagent saving, transporting the feed in a loop. The setup above shows the closed-loop option where the feeding medium runs through the micro bioreactor and then is re-used over and over again.

## Viability experiment – paired test

For both setups it is possible to add a parallel strand to the bioreactor for an automated cell pipetting step.

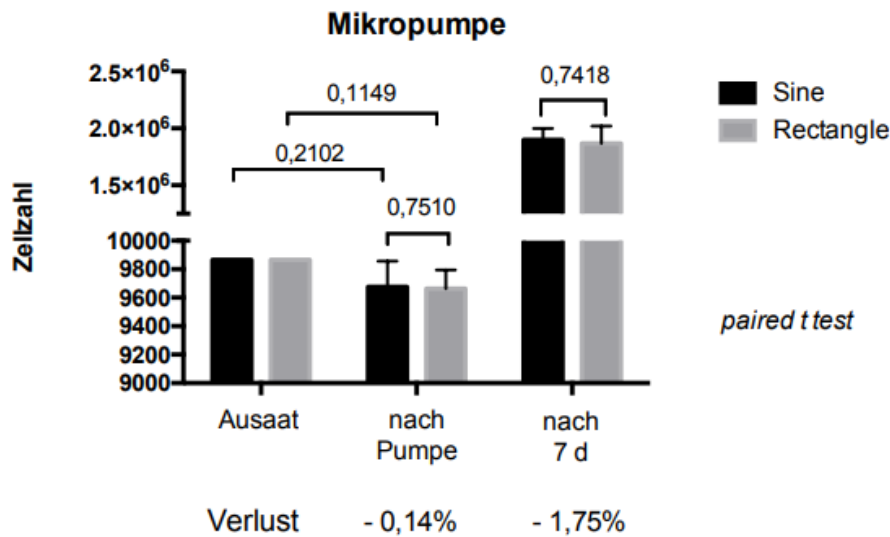


Figure 3 Paired test for cell pipetting - cell count before and after pumping process

Both setups were used as a pipetting system determining the impact on the cell viability utilizing the paired test. After the pumping process, all cells are still viable and the loss due to the pumping process is  $> 0.14\%$ .

## Components used

Cell Culture Kit by Bartels Mikrotechnik – including:

- mp6 micropumps by Bartels Mikrotechnik
- microfluidic reaction chamber chip by microfluidic Chipshop: Fluidic 131
- SLF3x liquid flow sensor by Sensirion
- mp-damper pulsation damper by Bartels Mikrotechnik

[Shop for the Cell Culture Kit in our online shop.](#)

## Acknowledgement:

Our partners *microfluidic ChipShop* and *Sensirion* were instrumental in defining our research path, whereby we were able to develop these high throughput perfusion systems for cell culture applications. For that, we are extremely grateful and we are looking forward to our close collaboration. In case you are interested in the above-described microfluidic components or if you are interested in getting in touch with either one of us, *microfluidic ChipShop*, *Sensirion* or *Bartels Mikrotechnik*, please feel free to contact us. You can find the contact details below.



**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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