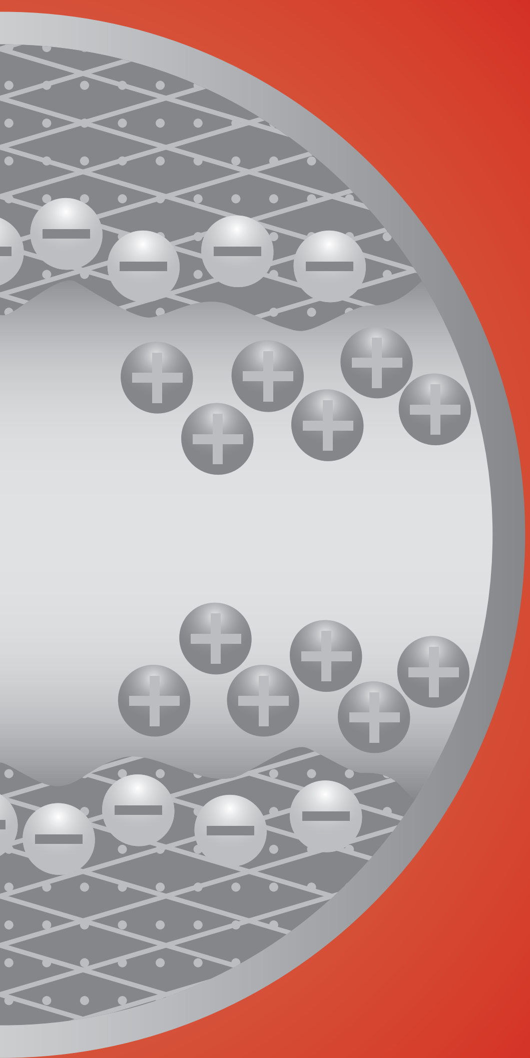
Membrane Performance Forecast



Interested in Membranes?

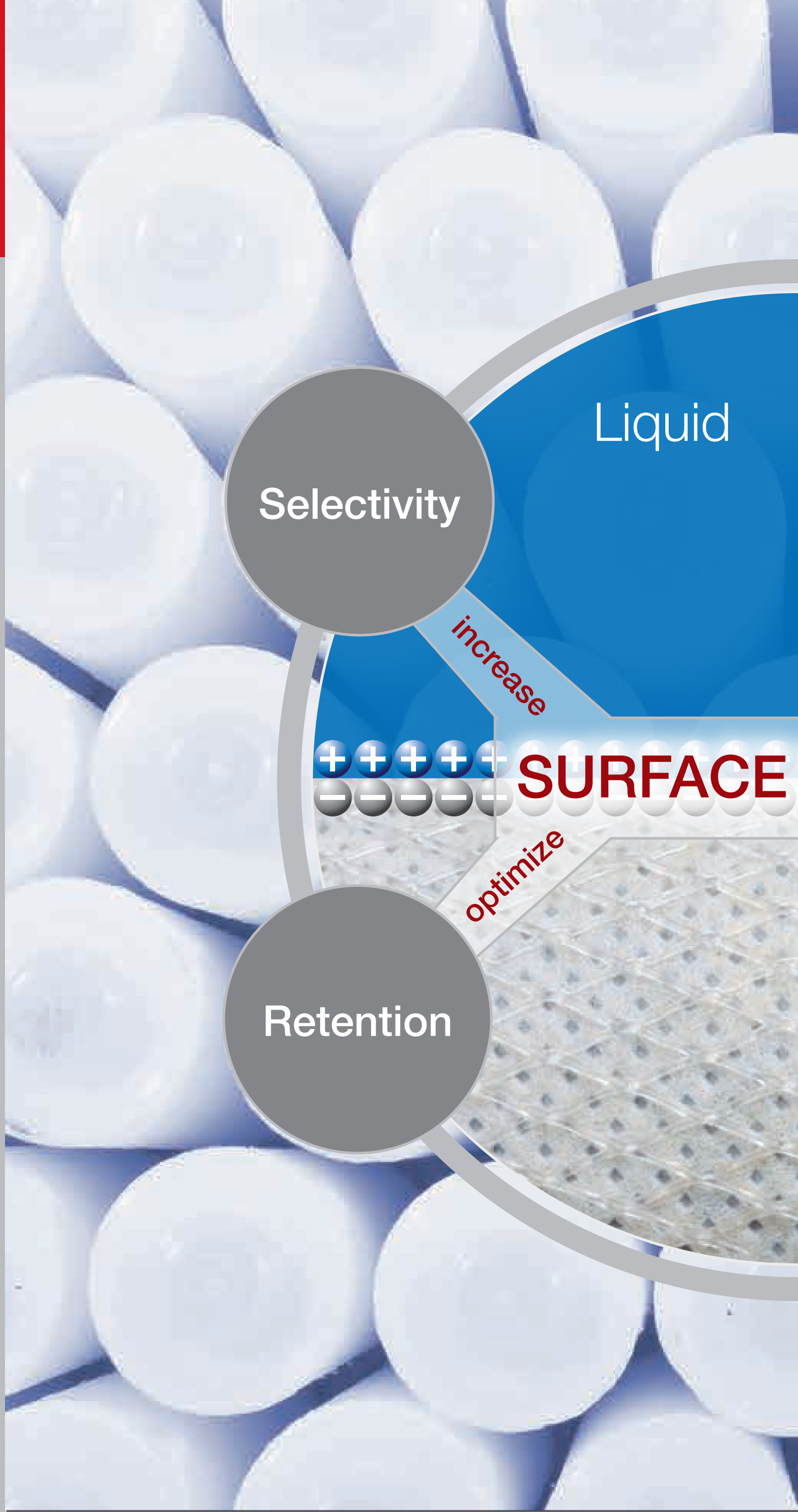
Zeta potential analysis with SurPASS™ 3 from Anton Paar opens up new possibilities in the characterization of membranes used for complex industrial or scientific applications. It gives insights into the membrane surface chemistry and elucidates the membrane's interaction with charged species in the feed solution. The benefit of the SurPASS™ 3 method is that membranes can be studied under environmental conditions, thus visualizing their behavior in the technical process.

High performance membranes used in many industrial separation technologies require high performance analytical characterization techniques.

Parameters affecting a membrane's performance can be divided into membrane structure parameters, such as roughness and porosity, and parameters describing the interaction of membranes with solutes in feed water such as wettability and surface charge. The membrane surface charge is one of the most relevant influencing factors in aqueous filtration processes and is related to the zeta potential.

Membrane characteristics	Measuring technique
Roughness	Atomic Force Microscopy
Wettability	Contact Angle
Pore structure	Scanning Electron Microscopy
Surface charge	**Zeta Potential**

➤ The surface charge is a key parameter for membrane performance forecast!

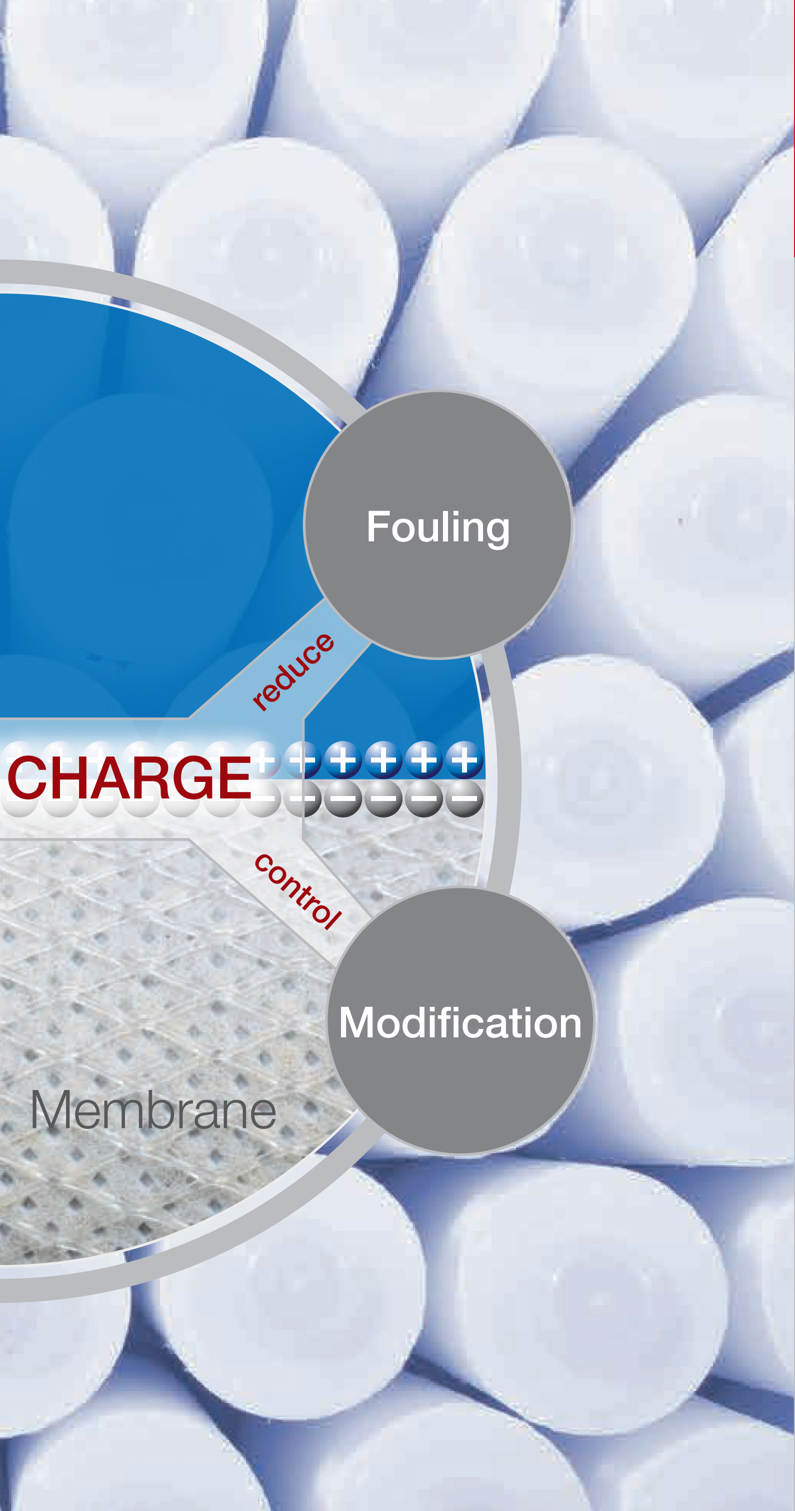


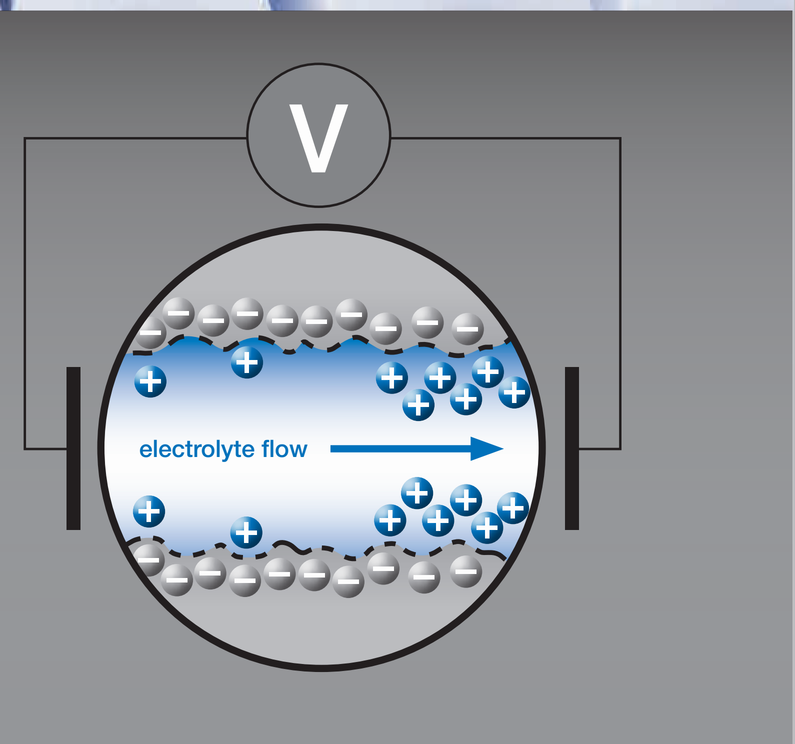
Enhanced SurPASS principle

The surface charge at the solid/liquid interface determines the electrostatic interaction between the solid surface and dissolved components in the liquid phase.

The surface charge is related to the zeta potential at the solid/liquid interface. The surface zeta potential is derived from streaming potential, which arises from the motion of the liquid phase relative to the solid surface.

SurPASS™ 3 realizes the motion of the liquid phase in a vibration-free and pulsation-free manner, guaranteeing a continuous laminar flow of the liquid. This results in an improved measuring data quality with minimized noise.





Tailored to Your Needs

SurPASS™ 3 determines the zeta potential at the membrane surface at different compositions of the surrounding aqueous solution simulating the feed solution in the separation process.

Upon adding various components to the aqueous solution, the change in surface charge and tendency to membrane fouling can be analyzed in real time. Automated pH adjustment enables the pH dependent analysis of zeta potential and the determination of the isoelectric point, i.e. the pH value, where virtually no charge is present at the surface. This information is relevant for optimizing the membrane's performance and monitoring the efficiency of surface modification.

Tailored measuring cells can accommodate membranes of different shape and geometry. The surface charge of flat sheet membranes can be investigated on the outer surface (tangential measurement mode) as well as inside the pores (transmembrane measurement mode). Hollow fiber membranes used for inside-out or outside-in filtration can also be characterized, independently of pore size and diameter. Membranes used in microfiltration, ultrafiltration, nanofiltration and reverse osmosis can be analyzed with the same reliability.

The zeta potential enables you to

- understand surface chemistry
- optimize surface modification
- control membrane fouling

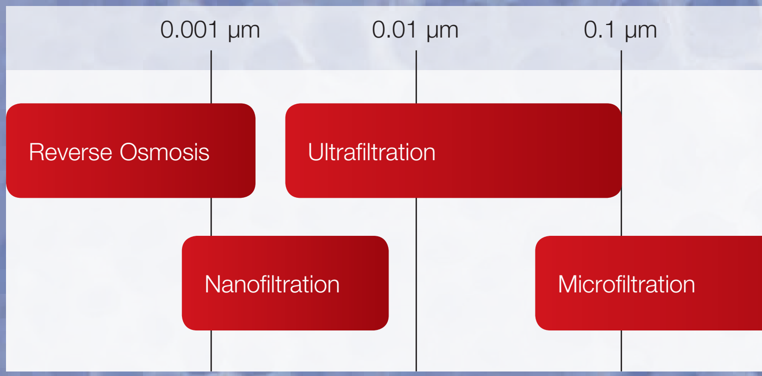
From Membrane Development …

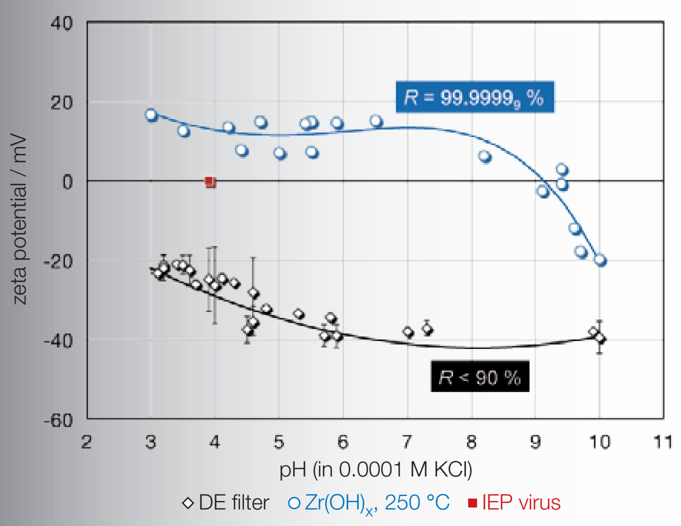
Independent of the membrane material ranging from polymers to ceramics, the zeta potential describes the surface chemistry before and after surface modification. It enables efficiency monitoring of surface modification processes and the optimization of membrane performance for a given application.

Surface modifications

- to optimize retention
- to increase selectivity
- to reduce fouling

Separation Processes

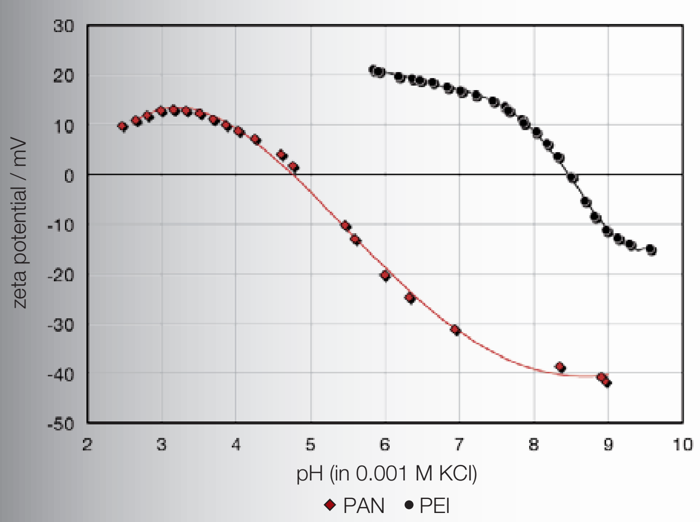




Virus removal by depth filtration

Diatomaceous earth filters and many common viruses possess a negative charge in the typical pH range of surface water. Due to the resulting electrostatic repulsion viruses can easily pass through the microporous filter. Modification of the diatomaceous earth filter with a heavy metal oxide like ZrO_2 shifts the isoelectric point of the filter surface to higher pH.

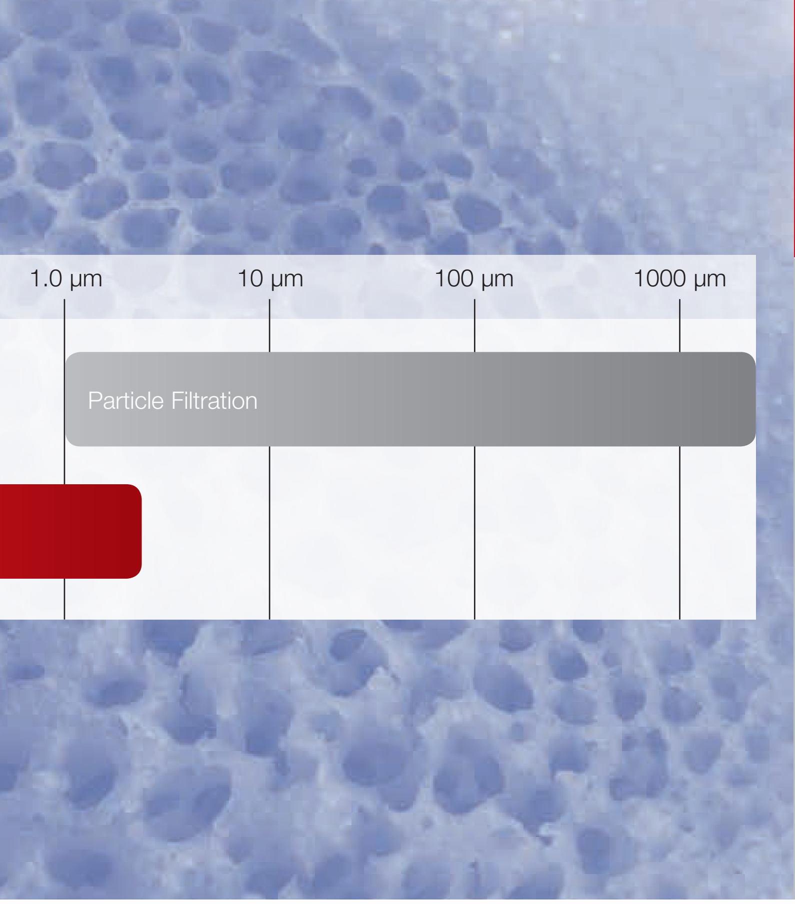
The surface of the filter and the contaminants become oppositely charged and efficient virus removal takes place.



Increasing the performance of ultrafiltration membranes

The deposition of a single layer of poly(ethylene imine), PEI, on a poly(acrylonitrile), PAN, ultrafiltration membrane improves the separation of ethanol-water mixtures. The shift of the isoelectric point from pH 4.6 for the PAN surface to pH 8.4 for the PEI layer confirms the presence of the cationic polyelectrolyte on the surface.

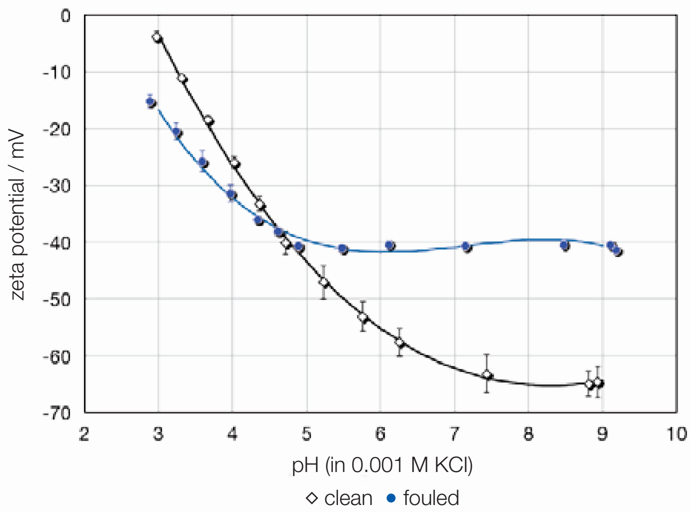
The zeta potential is sensitive to a decay in the PEI surface concentration upon wear during the cross-flow filtration process.



… to Fouling Control

Understanding the mechanisms of fouling is important for both, membrane manufacturers as well as membrane users. The consequences of fouling are a decline in permeate flux, a loss in selectivity and the need for frequent cleaning or replacement - all leading to high operational costs.

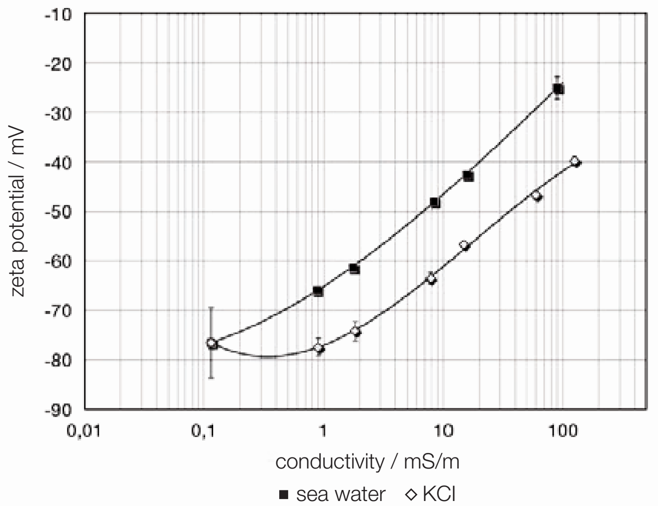
Solutes in the feed solution alter the membrane due to electrostatic, physical and chemical interactions, inevitably causing membrane fouling. A membrane´s fouling tendency is influenced by its roughness, wettability and charge. Characterizing the changes in the membrane's charge both inside the pores and across its surface helps to control and reduce the effects of membrane fouling.



Membrane fouling

The changes on the surface of a nanofiltration membrane due to fouling during a filtration process can be monitored by the zeta potential. Thin-film composite polymer membranes typically show a high negative zeta potential. The decrease in the negative zeta potential after filtration indicates the deposition of a foulant layer on the membrane surface.

The zeta potential helps to monitor fouling during filtration and to optimize the efficiency of membrane cleaning.



Seawater desalination

Reverse osmosis membranes are increasingly important for the final stage of seawater desalination. The membrane lifetime and the maintenance costs of a desalination plant are determined by the interaction of seawater components with the membrane surface.

The concentration dependence of the zeta potential elucidates this interaction.

Your Benefits

➤ Real samples

SurPASS™ 3 can characterize the zeta potential of virgin and fouled membranes.

➤ Transmembrane and tangential analysis

Membranes can be analyzed by streaming electrolyte through the membrane pores or across the membrane surface.

➤ Different geometries in one instrument

SurPASS™ 3 enables the analysis of flat-sheet and hollow fiber membranes.

➤ Easy sample mounting

The elaborate design of the SurPASS™ 3 measuring cells facilitates reproducible sample mounting.

➤ Fully automated analysis

SurPASS™ 3 enables the fully automated zeta potential analysis over a wide pH range and at different electrolyte compositions.

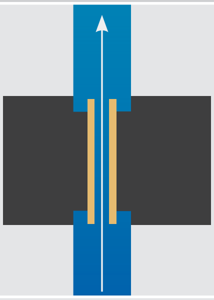
➤ Visualization of membrane behavior

SurPASS™ 3 enables clear visualization of the membrane behavior when exposed to different environmental conditions.

➤ Easy-to-use software

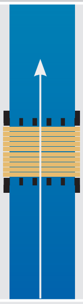
The lean structure of the SurPASS™ 3 software gives fast access to the zeta potential by the click of a button.

Application-specific Set-up



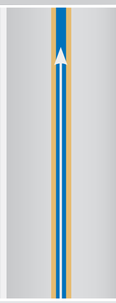
Flat sheet membranes – tangential measurement mode

Analyzing the outermost membrane surface by streaming electrolyte across a flat sheet membrane.



Flat sheet membranes – transmembrane measurement mode

Simulating operational conditions of a membrane by streaming electrolyte through the membrane pores.



Hollow fiber membranes – inner surface characterization

Set-up for the characterization of hollow fiber membranes used for inside-out filtration.

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