Application Note

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Molecular Weight Cut-Off Determination for Polysulfone Membranes

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Abstract

This application note describes the determination of the molecular weight cut-off for polysulfone membranes using GPC/SEC.

Introduction

Polysulfone enables easy manufacturing of membranes with reproducible properties and controllable pore sizes. These membranes are used for applications such as haemodialysis, but also for wastewater recovery or food and beverage processing. Cartridges made from polysulfone membranes offer extremely high flow rates at very low differential pressures.

Polysulfone membranes have several characteristics:

- Average pore size and pore size distribution
- Molecular weight cut-off (MWCO)
- Size selectivity
- Filtration behavior
- Sieve curve and retention efficiency
- Binding or non-binding efficiency
- Pore accessibility
- Chemical, physical, and biological stability
- Hydrophobic properties
- Fouling

Except for the last two, all the listed properties can be determined easily with just one single filtration experiment followed by GPC/SEC characterization, saving time and minimizing cost.[1] GPC/SEC is a robust and fast method that can also be easily established in regulated laboratories that must comply with GxP or FDA 21CFR11.

Experimental

Table 1. Instrument and sample conditions.

	Conditions
Pump	Isocratic pump Flow rate: 1 mL/min Mobile phase: H_2O, 0.1 M NaCl
Injection System	Autosampler Injection volume: 100 µL
Columns	Agilent SUPREMA medium MW combination: Agilent SUPREMA 5 µm precolumn, 8 × 50 mm (p/n SUA080505) Agilent SUPREMA 5 µm 30 Å, 8 × 300 mm (p/n SUA0830053e1) 2 × Agilent SUPREMA 5 µm 1,000 Å, 8 × 300 mm (p/n SUA0830051e3)
Temperature	23 °C
Sample Concentration	2 to 3 mg/mL
Calibration	Agilent ReadyCal-Kit Dextran (p/n PSS-DXTKITR1)
Filtration Sample	Stock solution: Dextran, broad molar mass distribution
Detectors	Refractive index (RI) detector
Software	Agilent WinGPC

Results and discussion

Filtration experiment

The membrane is characterized by filtration of a stock solution covering the complete pore size range of the membrane.[2] Dextran samples with a broad molecular weight distribution are used.

GPC/SEC experiment

A conventional GPC/SEC system with RI detection is used to measure the stock solution, the filtrate, and (optionally) the retentate.

GPC/SEC conditions are shown in Table 1. For accurate results, a pump with high precision, columns with high resolution, and internal standard correction are recommended.

Data evaluation

The GPC/SEC traces of the filtrates and the stock solution were overlaid. Figure 1 shows the overlay of the RI signals for the stock solution and the filtrates of two polysulfone membranes, A and B. Figure 2 shows the overlay of the filtrate of membrane C with the stock solution.

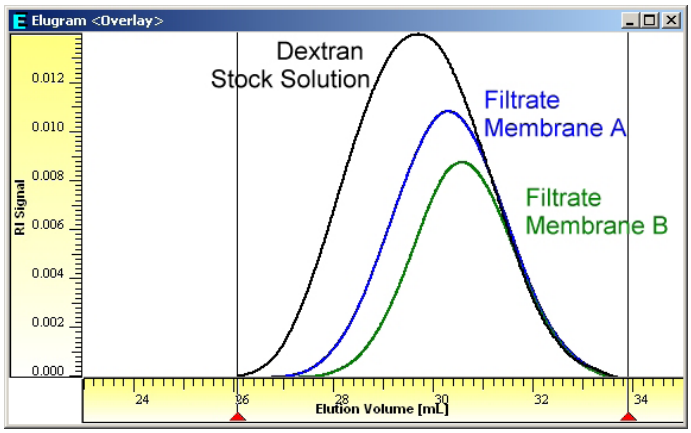

Figure 1. Overlay RI signals of membranes A and B.

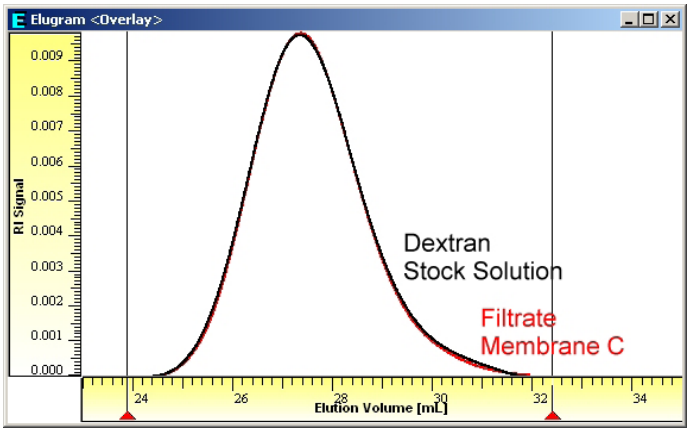

Figure 2. Overlay RI signal of defective membrane C.

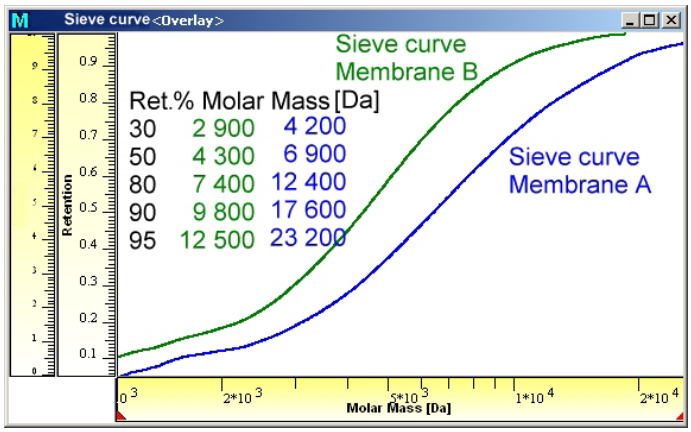

Figure 3 . Sieve curves and MWCO for membranes A and B.

These pictures show that membranes A and B are different in terms of their filtration behavior. As expected, the higher molar masses or larger molecules (eluting at low elution volumes) are not able to pass through the membrane and are missing in both filtrates.

Membrane C, however, must be defective, since the measured RI signals for the stock solution and the filtrate do not differ in shape and area. This means that all molar masses completely passed through the membrane.

The sieve curves were determined using the equation:

$$\text{SieveCure} = 1 - \left(\frac{\text{Filtrate}}{\text{StockSolution}}\right)$$

Figure 3 shows the resulting sieve curves for membranes A and B, as well as the corresponding molar masses. The molar masses were obtained using the dextran calibration curve. In addition, the molecular weight cut-off values (MWCO) for five different % limits are displayed. Other results that can be obtained are, for example, the average pore size and the membrane selectivity.

Conclusion

Robust and reliable GPC/SEC is a powerful tool for the analysis of the molecular weight cut-off for polysulfone membranes. As an example, a broad molar mass-distributed dextran is used as a stock solution, and a set of Agilent SUPREMA columns are used as the stationary phase with aqueous sodium chloride solution as the mobile phase. In addition, Agilent WinGPC software allows the depiction of sieve curves and molecular weight cut-off values.

References

1. P. Kilz, P.; Viktorin, M. Quality Control and Advanced Characterization of Membranes. *LC/GC Europe* **2007**, *20(4)*, 224–230.
2. Kilz, P. Characterization of Membranes by SEC. *Polym. Sci. Mat. Eng.* **1997**, *77*, 56.

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RA44964.6081481481

Printed in the USA, March 2, 2023
5994-5764EN

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