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A Brief Note on Gel Permeation Chromatography

Dinkar Sahal*

Department of Pharmaceutical Analysis, Jamia Hamdard University, New Delhi, India

Perspective

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***For Correspondence:**
Dinkar Sahal, Department of Pharmaceutical Analysis, Jamia Hamdard University, New Delhi, India

E-mail: Sahald97@gmail.in

ABOUT THE STUDY

Gel Permeation Chromatography (GPC) is a type of size-exclusion chromatography (SEC) that separates analytes on the basis of size, typically in organic solvents. The technique is often used for the analysis of polymers. As a technique, SEC was first developed in 1955 by Lathe and Ruthven. The term gel permeation chromatography can be traced back to J.C. Moore of the Dow Chemical Company who investigated the technique in 1964. The proprietary column technology was licensed to Waters Corporation, who subsequently commercialized this technology in 1964. GPC systems and consumables are now also available from a number of manufacturers. It is often necessary to separate polymers, both to analyze them as well as to purify the desired product.

GPC separates based on the size or hydrodynamic volume (radius of gyration) of the analytes. This differs from other separation techniques which depend upon chemical or physical interactions to separate analytes. Separation occurs via the use of porous beads packed in a column.

The smaller analytes can enter the pores more easily and therefore spend more time in these pores, increasing their retention time. These smaller molecules spend more time in the column and therefore will elute last. Conversely, larger analytes spend little if any time in the pores and are eluted quickly. All columns have a range of molecular weights that can be separated.

If an analyte is too large, it will not be retained; conversely, if the analyte is too small, it may be retained completely. Analytes that are not retained are eluted with the free volume outside of the particles (V_o), while analytes that are completely retained are eluted with volume of solvent held in the pores (V_i).

Applications

- GPC is often used to determine the relative molecular weight of polymer samples as well as the distribution of

molecular weights.

- GPC truly measures the molecular volume and shape function as defined by the intrinsic viscosity. If comparable standards are used, this relative data can be used to determine molecular weights within ± 5% accuracy.
- Polystyrene standards with dispersities of less than 1.2 are typically used to calibrate the GPC. Unfortunately, polystyrene tends to be a very linear polymer and therefore as a standard it is only useful to compare it to other polymers that are known to be linear and of relatively the same size.

Advantages

As a separation technique, GPC has many advantages. First of all, it has a well-defined separation time due to the fact that there is a final elution volume for all unretained analytes. Additionally, GPC can provide narrow bands, although this aspect of GPC is more difficult for polymer samples that have broad ranges of molecular weights present. Finally, since the analytes do not interact chemically or physically with the column, there is a lower chance for analyte loss to occur.

Disadvantages

There is a limited number of peaks that can be resolved within the short time scale of the GPC run. Also, as a technique GPC requires around at least a 10% difference in molecular weight for a reasonable resolution of peaks to occur. In regards to polymers, the molecular masses of most of the chains will be too close for the GPC separation to show anything more than broad peaks. Another disadvantage of GPC for polymers is that filtrations must be performed before using the instrument to prevent dust and other particulates from ruining the columns and interfering with the detectors.