Waters Lab Highlights

An Internal Communication of Applications and Techniques

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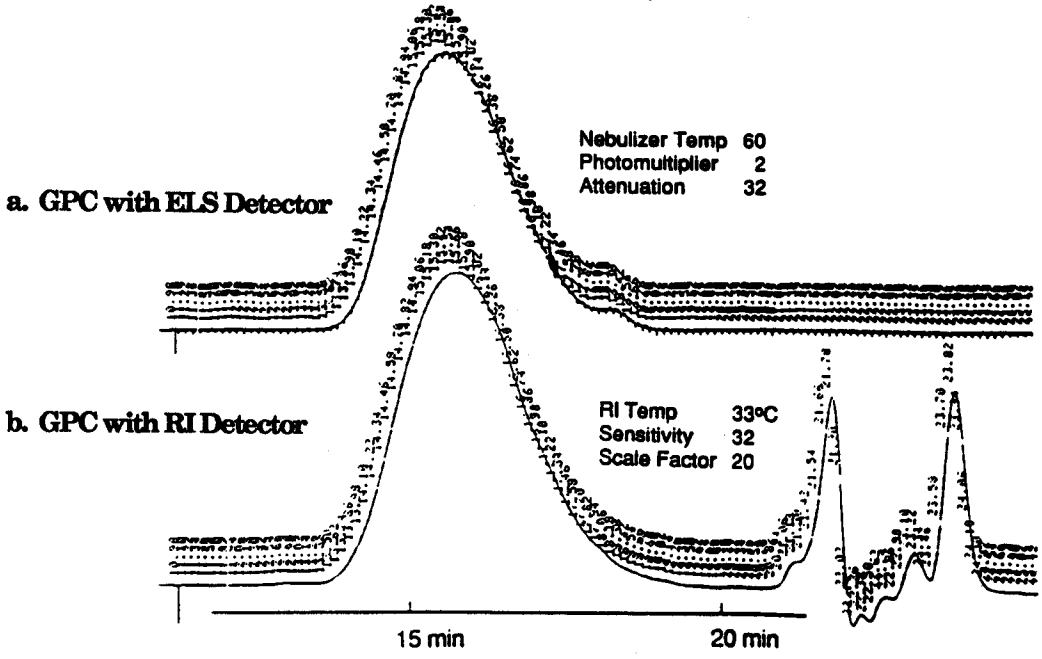
Evaporative Light Scattering Detectors III. Application to GPC

The evaporative light scattering (ELS) detector[1,2] would appear to be a natural for use with Gel Permeation Chromatography (GPC). Since most polymer samples are less volatile than typical GPC solvents, evaporation of the solvent from the column effluent and subsequent detection of the remaining sample with an ELS device is straightforward. This Lab Highlight compares the performance of an ELS detector with that of a refractive index detector in a GPC application and demonstrates that the ELS detector is not a true concentration detector and thus cannot properly be used to calculate accurate molecular weight averages from GPC data.

In Figure 1, a sample of polystyrene (75 µl, 0.1% in THF) is analyzed on a typical Waters GPC system (590 pump, U6K injector, two linear Ultrastyragel® columns at 35°C, THF at 1 ml/min) using first an ELS detector (Figure 1a) and then a 410 refractive index detector (Figure 1b). The ELS detector equilibrates quickly and is straightforward to use. Since the solvent is evaporated before the detection process, the ELS detector is not subject to the baseline drift that is sometimes experienced with RI detectors when the GPC system has not properly been equilibrated. However, since volatile sample components are also removed during the solvent evaporation process, volatile low molecular weight components (additives, etc.) are not detected with the ELS device.

Figure 1. GPC Analysis of Polystyrene



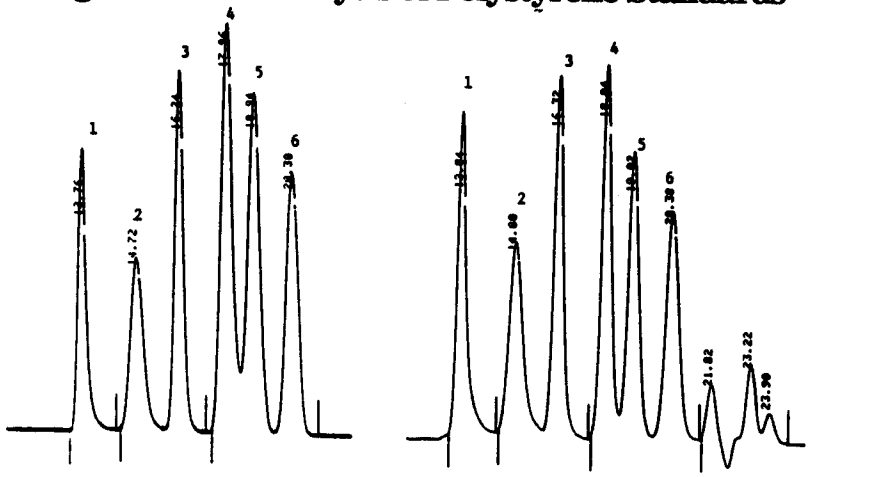
Waters
Division of MILLIPORE 34 Maple Street Milford, MA 01757 508-478-2000

Juris Ekmanis

What about the use of an evaporative light scattering detector to calculate molecular weight averages in GPC? These calculations require that the detector affords equal response for equal concentrations of the eluting fractions in each slice independent of the molecular weight of the polymer. The RI detector is the traditional concentration detector used in GPC and, for molecular weights above about 2000, its response is indeed proportional to concentration of polymer and independent of molecular weight. For GPC calculations to be accurate, alternate detectors must have the same concentration response characteristics as the RI detector.

To test this, a mixture of six narrow distribution polystyrene standards in THF was injected onto the GPC system described in Figure 1. The chromatogram in Figure 2a was obtained with an ELS detector and that in Figure 2b was generated with an RI detector (410). If the ELS detector had exhibited the same response characteristics as the RI detector, the ratio of peak heights of corresponding peaks in the ELS chromatogram and the RI chromatogram would be equal. However, the data in Table 1 indicates that this is not the case. As molecular weight increases from 890 to 2,880,000, the response of the ELS detector decreases relative to the RI detector. Since the ELS device is not a true concentration detector, it cannot be used to calculate accurate molecular weight averages in GPC.

Figure 2. GPC Analysis of Polystyrene Standards



a. PS Standards with ELS Detector **b. PS Standards with RI Detector**

Table 1: Comparison of ELS and RI Detector Responses

Peak #	Polystyrene Std.	Response ratio (ELS/RI)
1	2,880,000	0.87
2	422,000	0.88
3	107,000	1.00
4	16,700	1.10
5	6,200	1.18
6	890	1.12

References:

1. LAH 0398 4/89.
2. LAH 0399 4/89.

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