

Analysis of polypropylene random copolymer samples using the EcoSEC® High Temperature GPC System

EcoSEC GPC System APPLICATION NOTE

Introduction

The polypropylene market is one of the largest and most versatile polymer markets today with over 50 million tons produced annually and sold into a wide variety of household and industrial applications. In the home, polypropylene can be found in everything from audio speakers to carpets and automotive components. Industrially, polypropylene is essential in living hinges, RF capacitors, medical devices, and contact lens molding.

The variety of products in which polypropylene is present require versatility in mechanical, thermal and chemical properties. For this reason, depending upon the application, three major categories of polypropylene exist; homopolymer, block copolymer, and random copolymer. While homopolymer is the general purpose grade of polypropylene, block copolymer usually contains 5-15% ethylene and exhibits enhanced impact resistance. Random copolymer containing 1-7% ethylene is more malleable and crystal clear. For this reason, it is often used in medical applications and contact lens production.

In this application note, the molar mass averages and polydispersity of two polypropylene random copolymer samples via refractive index (RI) detection was determined using the EcoSEC High Temperature GPC System and TSKgel® columns. The enhanced thermal, flow rate and dual flow RI detector signal stability of the EcoSEC High Temperature GPC System in combination with the excellent resolving power of the TSKgel GMH_{HR}-H (20) HT2 high temperature GPC columns produce reliable and highly reproducible data for the two samples analyzed in triplicate.

Experimental GPC Conditions

Column: TSKgel GMH_{HR}-H (20) HT2, 20 μ m, 7.8 mm ID \times 30 cm \times 2
Mobile phase: trichlorobenzene (butylated hydroxyl toluene (BHT) added, 200 ppm)
Flow rate: 1 mL/min
Detection: RI
Temperature: 140°C
Injection vol.: 300 μ L
Sample: polypropylene random copolymer

Results and Discussion

The EcoSEC High Temperature GPC System encompassing a dual flow refractive index detector was successfully used to perform gel permeation chromatography (GPC) analysis of two polymer samples using a series of TSKgel high temperature GPC columns. The number-, weight- and z-average molar mass values (M_n , M_w , and M_z) and polydispersity index, PDI , were calculated for a polypropylene equivalent via EcoSEC software by applying a Mark-Houwink constant. The obtained values are given in [Tables 1 and 2](#). Overlays of triplicate analysis in [Figure 1 and 2](#) indicate a very high level of reproducibility.

The Mark-Houwink constant for polypropylene (PP) is:

$$\alpha_{PP} = 0.750, \log K_{PP} = -3.8633$$

Figure 1. GPC elution profile of 3 consecutive injections of sample 1 (PP equivalent) as monitored by RI

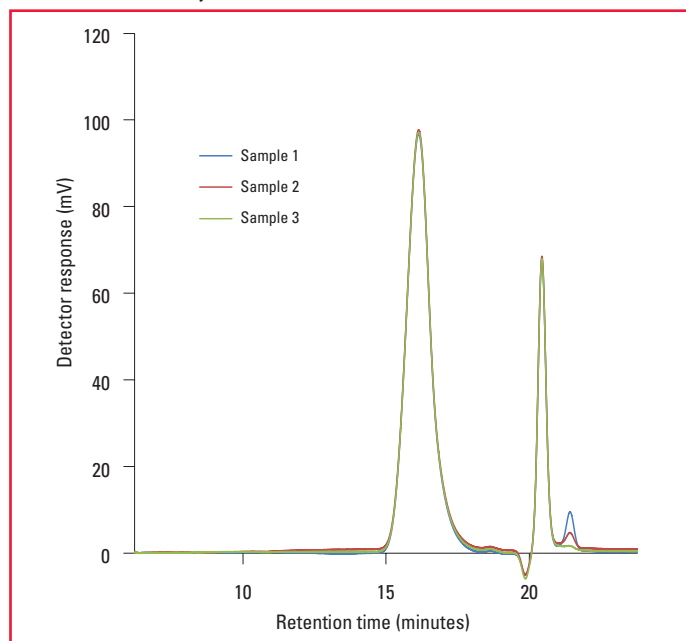


Table 1. Molar mass averages and polydispersity index of sample 1 (PP equivalent) via RI

Injection number	Retention time (minutes)	M_n (g/mol)	M_w (g/mol)	M_z (g/mol)	$PDI (M_w/M_n)$
1	16.532	54380	145630	286074	2.678
2	16.527	54153	145548	289290	2.688
3	16.548	54027	145195	286331	2.687
Average	16.537	54186.67	145457.70	287231.70	2.684
STDEV	0.011	178.89	231.14	1787.20	0.001
CV%	0.066	0.33	0.16	0.62	0.200



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Figure 2. GPC elution profile of 3 consecutive injections of sample 2 (PP equivalent) as monitored by RI

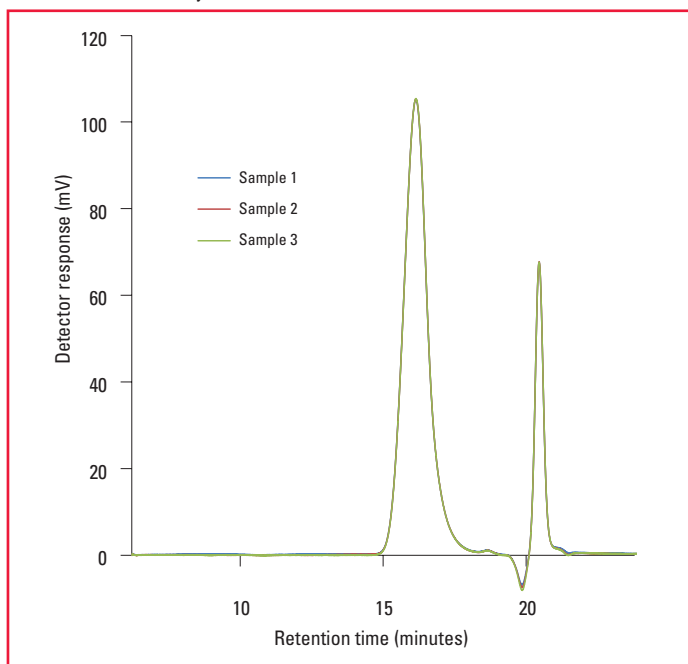


Table 2. Molar mass averages and polydispersity index of sample 2 (PP equivalent) via RI

Injection number	Retention time (minutes)	M_n (g/mol)	M_w (g/mol)	M_z (g/mol)	$PDI (M_w/M_n)$
1	16.532	52396	145040	292193	2.768
2	16.532	52519	145298	292904	2.767
3	16.533	54427	145729	291369	2.677
Average	16.532	53114	145355.70	292155.30	2.737
STDEV	0.001	1138.75	348.10	768.19	0.052
CV%	0.036	2.14	0.24	0.26	1.900

Conclusions

An EcoSEC High Temperature GPC system was used to analyze two polypropylene random copolymers. The molar mass averages, M_n , M_w , and M_z , were determined via polystyrene calibration curves. The reproducibility and reliability of the dual flow refractive index detector in the EcoSEC High Temperature GPC System were shown through both the very low variation in sample retention and superb baseline stability observed when overlaying three consecutive RI injections of each sample. The molar mass values were calculated by EcoSEC software for PP equivalents based on Mark-Houwink constants.

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