Intrinsic Viscosity Measurements of Polystyrene in 4 Minutes Per Sample:

Automated, High-Throughput and Precise

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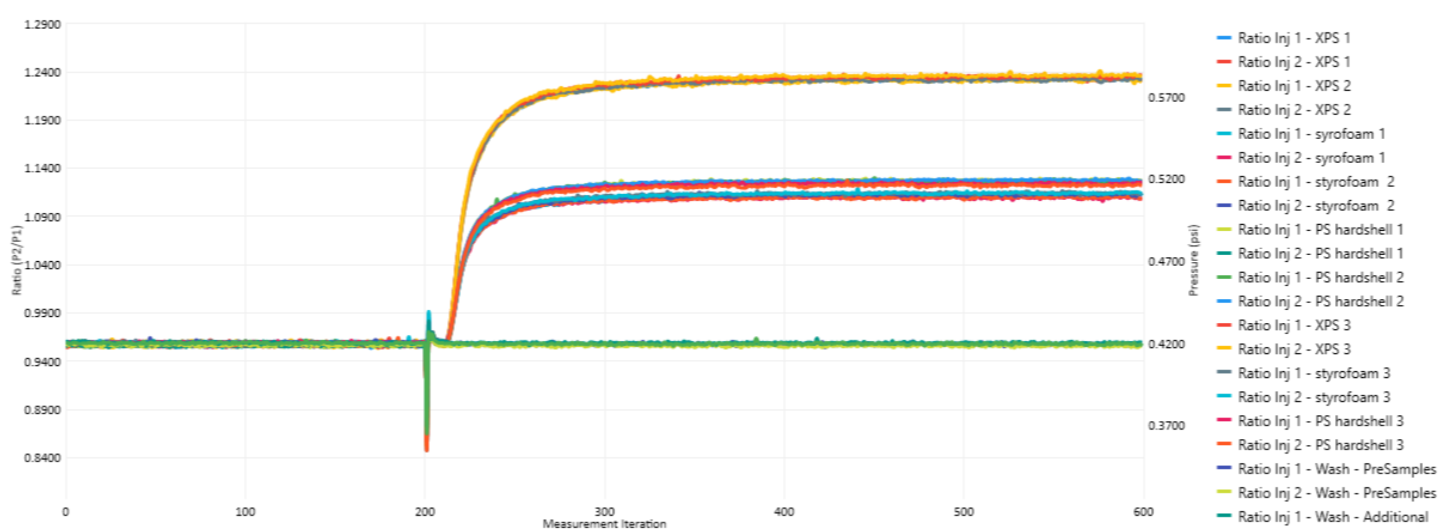
Polymer Insights: Polystyrene applications include its use in medical devices, such as Petri dishes and test tubes, due to its clarity and ease of sterilization. In electronics, high-impact polystyrene (HIPS) is used for casings and insulation components. In construction, polystyrene foam provides effective thermal insulation and lightweight building materials. It's also utilized in 3D printing filaments for prototyping and complex designs. Moreover, polystyrene is employed in advanced packaging solutions, including protective packaging for delicate electronics and food-grade containers, owing to its rigidity, lightweight, and cost-effectiveness.

Experiment Protocol

Overview: Three types of polystyrene (bead, clamshell and high-impact PS) were dissolved in THF at 30°C for 30 minutes. Each sample was prepared in triplicate, and after dissolution each sample IV was measured twice.

Sample Preparation workflow: Sample mass was recorded in the HaikuFlow software using a connected XS64 balance. Vials were placed in the sample preparation block with individually stirred positions after a PTFE stir bar and cap were added. No further user intervention was required. Dissolution solvent volume was calculated by the software and added to samples by the integrated syringe dosing pump. After the dissolution timer expired, samples were loaded and analyzed automatically.

Figure 1: P2/P1 Ratio Overlay 3 PS Samples, 3 replicates per sample. IVs range from 0.768 to 1.32 dL/g



Experiment Results

As expected, these PS samples from different applications had distinct Intrinsic Viscosity profiles. The extreme precision of the instrument for within-vial measurements allows us to identify sample inhomogeneity between preparations. Note the clamshell sample, which showed significantly higher variability between preparations versus variability between two injections of the same preparation. This is not surprising, given the wide resin specification range for thermoforming sheet versus resins used for applications with more demanding processing conditions.

Table 2: 3 Polystyrene Samples, 3 Replicates Each, 2 Injections Per Replicate

Sample Details			IV Results			Repeatability	
Sample ID	**Conc. (g/dL)**	**Analysis Time**	IV1	IV2	**Average IV**	Within Vial % RSD	**Vial-to-Vial % RSD**
styrofoam 1	0.2000	13:10:55	0.7645	0.7668	**0.7656**	0.1476	
styrofoam 2	0.2000	13:14:57	0.7635	0.7747	**0.7691**	0.7284	**0.226**
styrofoam 3	0.2000	13:18:59	0.7758	0.7632	**0.7695**	0.8192	
clamshell 1	0.2000	13:23:01	0.8144	0.8124	**0.8134**	0.1220	
clamshell 2	0.2000	13:27:03	0.8318	0.8349	**0.8333**	0.1858	**1.468**
clamshell 3	0.2000	13:31:05	0.8470	0.8382	**0.8426**	0.5201	
HIPS 1	0.2000	13:35:07	1.3183	1.3206	**1.3195**	0.0866	
HIPS 2	0.2000	13:39:09	1.3182	1.3221	**1.3202**	0.1466	**0.153**
HIPS 3	0.2000	13:43:11	1.3244	1.3237	**1.3241**	0.0300	

Discussion

Each replicate finished in 2 minutes, giving a total analysis time of 4 minutes for each sample.

From start to finish, only 10 minutes of user time was required for sample weighing. All other steps were carried out automatically by the system, from dispensing solvent to stirring and heating the samples to loading and analyzing.

The viscosity measurement method used is in full compliance with internationally recognized standards including ASTM D5225 and ISO 1628-1 and represents the most advanced iteration of this technology available on the market.

Intrinsic viscosity (IV) is important in polystyrene production as it reflects the polymer's molecular weight, impacting its mechanical properties and processability. High IV indicates higher molecular weight, leading to greater strength, toughness, and thermal stability, essential for demanding applications. Low IV (low molecular weight) results in reduced mechanical properties and performance. IV also influences melt flow behavior during processing, ensuring consistent product quality and efficient manufacturing. Monitoring IV helps optimize both material properties and production processes.

The Model 575 Intrinsic Viscometer
Generation 2

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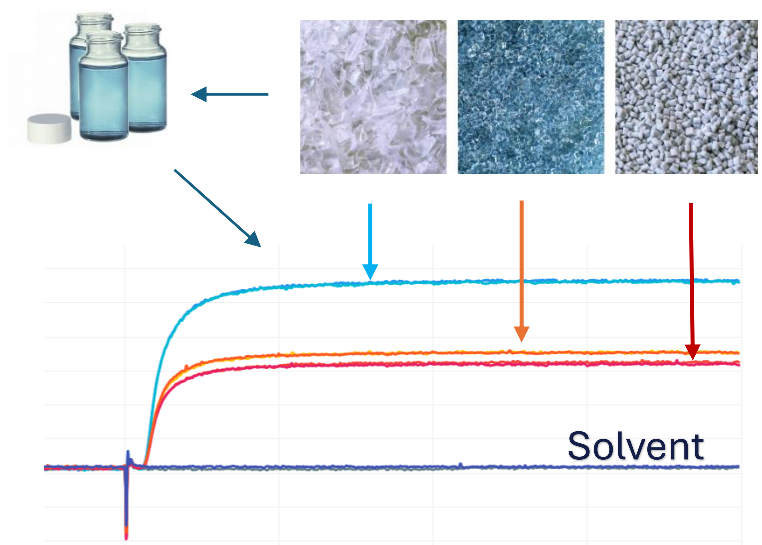
The Most Rapid and Reliable Measurement of Molecular Weight and Intrinsic Viscosity

Fully Automated Sample Preparation and IV Analysis According to ISO 1628 and ASTM D5225



Workflow Step	**Critical Advantages**
Sample Mass Determination	Guided Workflow with connected Analytical Balance
Solvent Dispensing	Fully Automated; no user interaction with solvents
Dissolution	24 Individually Stirred Autosampler Positions
Sample Analysis	Begins automatically after dissolution
Criterion	**Specification**
Viscosity Measurement Type	Dual Differential, Relative Viscosity, Forced Flow
IV Measurement Resolution	0.005 dL/g
Measurement Precision	Better than 0.2% RSD RV @ 0.800 dL/g
Shear rates	200-500 s^{-1} (typical, depending on application)
Sample Analysis Time	4-6 minutes per sample, includes duplicate injection
Solvent Compatibility	Organic, Aqueous, Acids, Halogenated
Temperature Range (Dissolution)	30°C to 160°C
Temperature Range (Analysis)	10°C to 160°C
Total Solvent Per Sample (prep + analysis + wash)	25mL
Integration, Compliance, Connection	LIMS/ERP, 21CFR part11, USB 2.0 / Windows 10

Viscometers for Plastics and Polymers
Designed and Manufactured in Houston, Texas
713-724-2890 | **admin@haikuinstruments.com**
www.linkedin.com/company/haiku-instruments