Intrinsic Viscosity Measurements of Polyphenylene Oxide:

Fully Automated, Precise and Reliable

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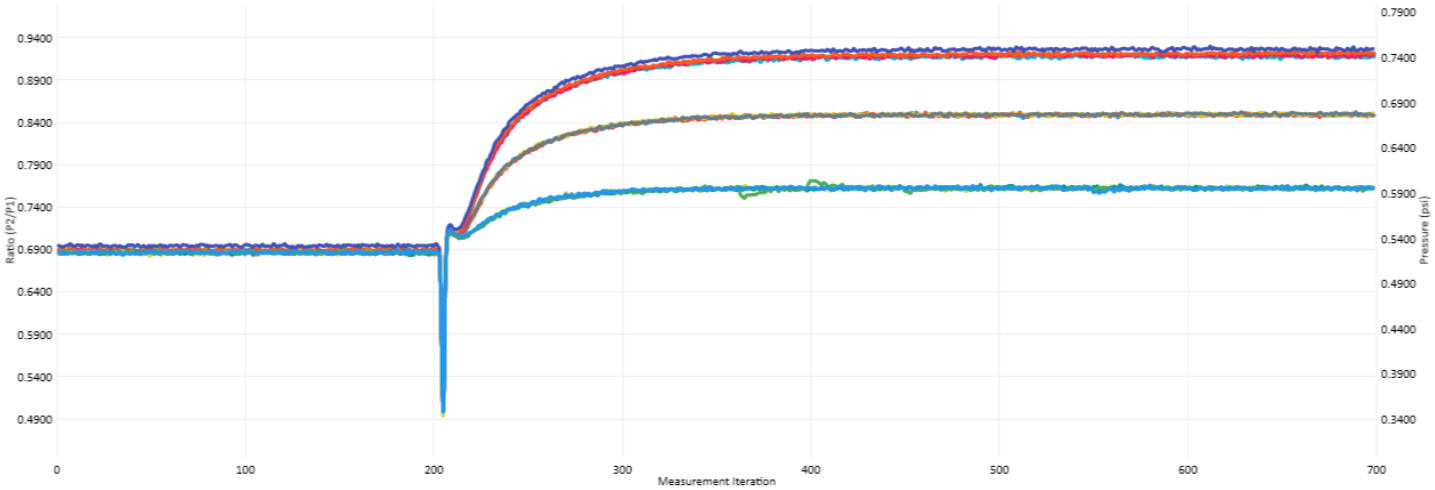
Polymer Insights: Polyphenylene oxide (PPO) is a high-performance polymer known for its excellent thermal stability, mechanical strength, and low moisture absorption. Its chemistry, featuring a phenylene ring and ether linkage, provides resistance to heat and chemicals. PPO is used in automotive fuel systems, electrical connectors, circuit boards, and water management components due to these properties. Additionally, its biocompatibility and resistance to sterilization make it suitable for medical devices and food contact applications.

Experiment Protocol

Overview: Three grades of PPO were dissolved in toluene at 60°C for 30 minutes. Samples were conditioned down to 30°C inline before measurement during loading. Historical data was available from glass capillary tubes at 30°C, so we had to match it. Each sample was prepared in duplicate, and after dissolution each sample IV was measured twice.

Sample Preparation workflow: Sample mass was recorded in the HaikuFlow software using a connected XSR105 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 PPO Samples, 2 replicates per sample. IVs range from 0.545 to 1.102 dL/g



Viscometers for Plastics and Polymers
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Experiment Results

The PPO samples appeared to dissolve in toluene within about 15 minutes of solvent addition, but we allowed a full 30 minutes for dissolution. These results aligned with a correlation factor of 0.985 with the mean historical data that this customer revealed after the test results were submitted. Using only 25mL of solvent decreased usage by 70% versus the previous measurement method, and results were available for these 6 samples within 1 hour of weighing them out.

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

Sample Details			Viscosity Results			Repeatability	
Sample ID	**Conc. (g/dL)**	**Analysis Time**	IV1	IV2	**Average IV**	Within Vial % RSD	**Vial-to-Vial % RSD**
PPO-1a	0.2000	16:26	1.1001	1.1042	**1.1021**	0.1832	**0.013**
PPO-1b	0.2000	16:31	1.1013	1.1024	**1.1019**	0.0485	
PPO-2a	0.2000	16:36	1.5112	1.5236	**1.5174**	0.4066	**0.018**
PPO-2b	0.2000	16:41	1.5201	1.5158	**1.5179**	0.1435	
PPO-3a	0.2000	16:46	0.5455	0.5450	**0.5452**	0.0476	**0.780**
PPO-3b	0.2000	16:51	0.5351	0.5385	**0.5368**	0.3157	

Discussion

Each replicate finished in 3 minutes, giving a total analysis time of 6 minutes for each sample.

The low variance between **duplicate injections** shows complete **dissolution without degradation**.

The low variance between **replicate preparations** shows the **precision of the sample preparation**.

For this customer, the major improvement was in variation. Their old method of using glass capillary tubes resulted in up to 5% variation between measurements. Many of their close grades were indistinguishable by IV. With the precision and removal of human error from the measurement, their processes could be better controlled, and QC was simplified.

From start to finish, only 6 minutes of user time was required for the whole sample set. After weighing, all steps were handled 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 PPO 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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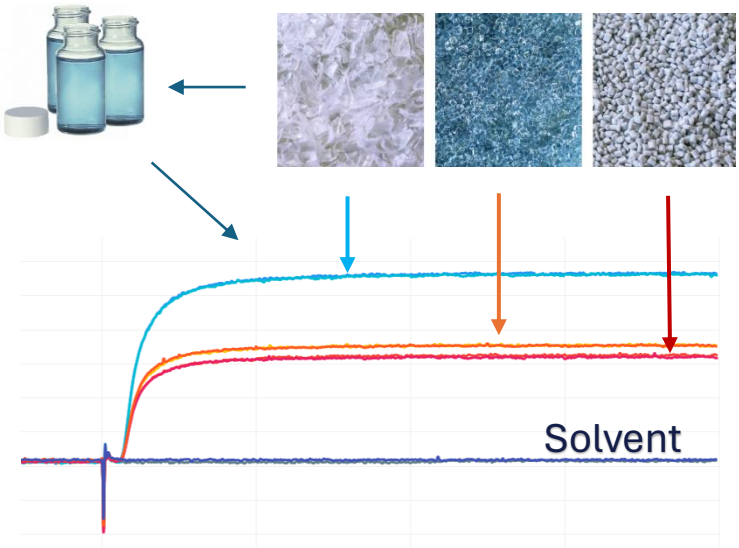
The Most Rapid and Reliable Measurement of Molecular Weight and Intrinsic Viscosity

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

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