

## Intrinsic Viscosity Measurements of PET (Polyethylene Terephthalate): High-Throughput, Automated and Integrated



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**Polymer Insights:** Polyethylene terephthalate (PET) is a thermoplastic polymer used in bottles, packaging, textiles, and engineering applications. Known for its clarity, strength, and recyclability, PET is formed through the polymerization of terephthalic acid and ethylene glycol. Its molecular structure provides excellent barrier properties against oxygen and carbon dioxide, making it ideal for beverage bottles and food containers. PET's durability and lightweight nature contribute to its popularity in the packaging industry. Additionally, its ability to be recycled into fibers for clothing or other products supports sustainability efforts.

### Experiment Protocol

**Overview:** PET pellets from an in-house reference standard were dissolved in Phenol/Tetrachloroethane (60/40 v/v, Harrell Industries) at 110°C for 45 minutes. After dissolution each sample IV was measured twice. Details are listed in Table 1 (below).

**Sample Preparation workflow:** Sample mass was recorded in the HaikuFlow software using a connected XS104 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 a preset dissolution timer expired, samples were loaded and analyzed automatically.

**Table 1:** Sample Preparation, Dissolution and Temperature Settings Details

Application			Dissolution			Temperature (°C)		
Sample ID	Polymer	Solvent	Conc. (g/dL)	Time (minutes)	Stir Speed (RPM)	Heater Block	Inline H/X	Visc Oven
PET_0_62 (all samples)	PET	Phenol/TCE	0.500	40	300	110	28	30

## Experiment Results

PET is hygroscopic, absorbing water up to 1% w/w. Some laboratories develop extensive drying protocols. These results were obtained from a laboratory using a default 0.5% water weight factored into the automated sample preparation in the HaikuFlow software.

**Table 2:** Experimental Results for 5 Replicate PET Samples, 2 Injections Each

Sample Details			Viscosity Results				Repeatability
Sample ID	Conc. (g/dL)	Analysis Time	RV1	RV2	IV1	IV2	% RSD (IV)
PET 0_62	0.500	6:25:24	1.3484	1.3471	<b>0.6291</b>	<b>0.6270</b>	<b>0.1687</b>
PET 0_62	0.500	6:30:22	1.3409	1.3400	<b>0.6168</b>	<b>0.6153</b>	<b>0.1190</b>
PET 0_62	0.500	6:35:19	1.3431	1.3429	<b>0.6204</b>	<b>0.6201</b>	<b>0.0309</b>
PET 0_62	0.500	6:40:17	1.3448	1.3440	<b>0.6232</b>	<b>0.6220</b>	<b>0.0982</b>
PET 0_62	0.500	6:45:14	1.3438	1.3424	<b>0.6216</b>	<b>0.6193</b>	<b>0.1850</b>

## Discussion

Intrinsic Viscosity (IV) is the primary critical-to-quality criterion determining whether a resin is appropriate for **film, fiber, bottle or thermoforming**. These IV specifications and tolerance ranges are the starting point for application development and processing conditions.

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

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

Each replicate injection was completed in around 2.5 minutes, giving a total analysis time of approximately 5 minutes for each sample. Matching these ultra-fast analysis times to the interval between sample preparation time ensures that results are not influenced by the position in the sample queue.

## Insights into Integration: LIMS and ERP Connectivity

In our experience, stakeholders outside the laboratory often wait significantly longer for sample results to be reported than it takes to prepare and analyze samples. Sometimes hours, sometimes **over the weekend**.

**With HaikuFlow software, this need not be the case.** As each sample is completed, results are made available for import into your Laboratory Information Management System (LIMS) or Enterprise Resource Planning (ERP) software.

Worried about data quality? System suitability checks, threshold setpoints and trend analysis all ensure that results outside of specifications are flagged for manager review before results are released from the software.



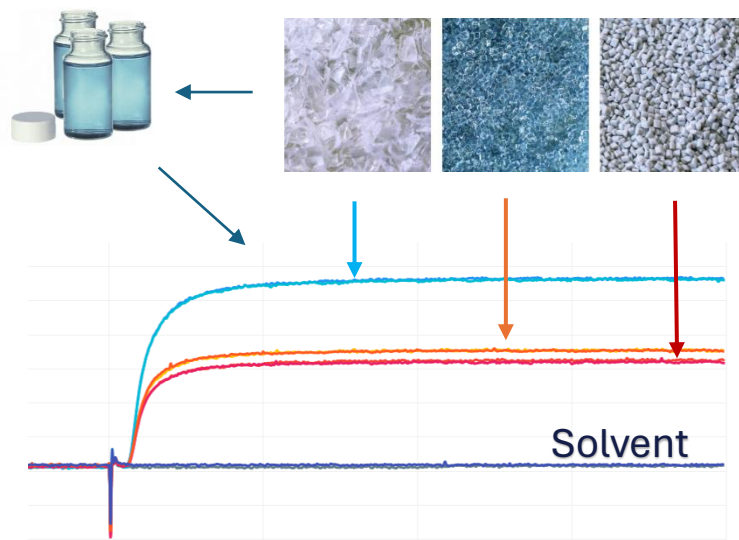
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The Model 575 Intrinsic Viscometer  
Generation 2

## 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 <sup>-1</sup> (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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