

## Intrinsic Viscosity Measurements of Biopolymers – PBS, PHA, PLA, PBAT: Precise, High-Throughput and Fully Automated



**Haiku Instruments**  
Precision | Compliance | Quality

### Polymer Insights:

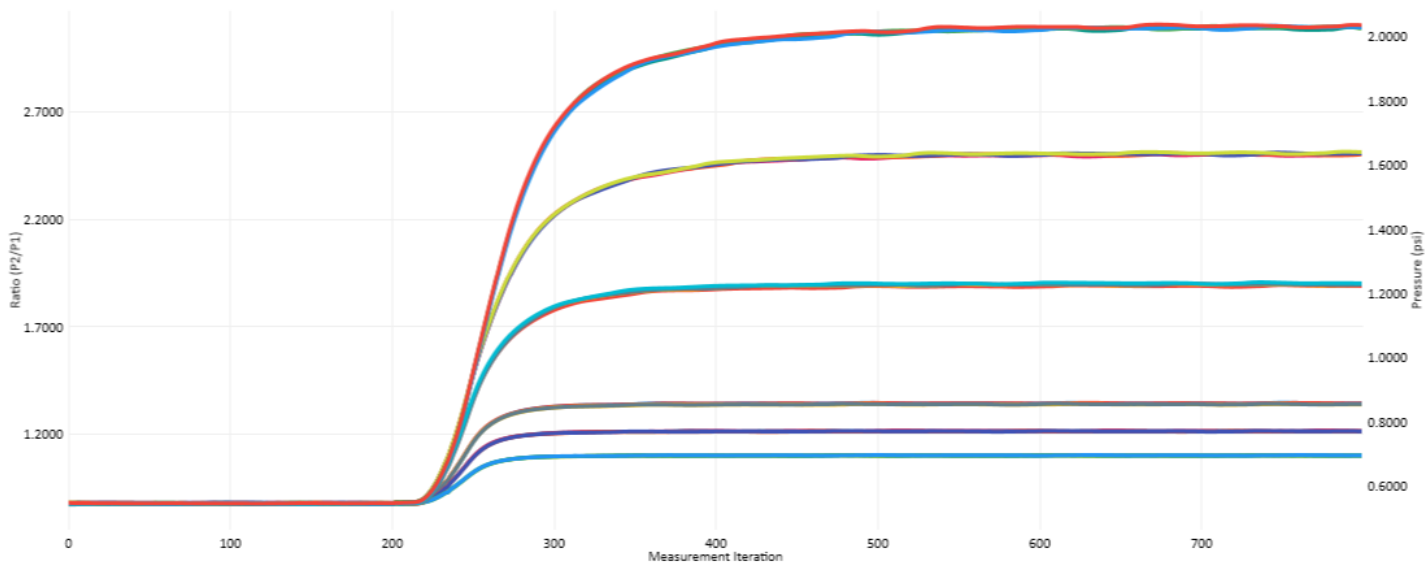
Compostable biopolymers like **PHA** (polyhydroxyalkanoates), **PBAT** (polybutylene adipate terephthalate), **PLA** (polylactic acid), and **PBS** (polybutylene succinate) are eco-friendly alternatives to traditional plastics. PHA is biodegradable and used in medical and packaging applications. PBAT, known for its flexibility and biodegradability, is often blended with other biopolymers to enhance properties. PLA, derived from corn starch or sugarcane, is used in packaging and disposable items due to its compostability. PBS, made from succinic acid and butanediol, is used in agricultural films and packaging.

### Experiment Protocol

**Overview:** Six biopolymer samples from various suppliers were dissolved in chloroform at 50°C for 45 minutes. 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 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 a preset dissolution timer expired, samples were loaded and analyzed automatically.

**Figure 1: P2/P1 Ratio Overlay of 6 Biopolymer Samples, 2 replicates per sample. IVs range from 0.496 to 3.39 dL/g**



Viscometers for Plastics and Polymers  
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## Experiment Results

These six grades ranged in Intrinsic Viscosity from 0.496 dL/g to 3.39 dL/g. All samples dissolved easily in chloroform, showing no signs of degradation over the course of the measurement. From vial to vial, less than 0.25% variability was seen indicating both a consistent preparation as well as uniformity in the polymer pellets and powders.

**Table 2: Experimental Results for 6 Replicate Samples, 2 Injections Each**

Sample Details			IV Results			Repeatability	
Sample ID	Conc. (g/dL)	Analysis Time	IV1	IV2	Average IV	Within Vial % RSD	Vial-to-Vial % RSD
PLA-1	0.4000	0.5091	0.4954	0.4978	<b>0.4966</b>	0.2100	<b>0.122</b>
PLA-1a	0.4000	0.5129	0.4976	0.4981	<b>0.4978</b>	0.0462	
PBAT-1	0.4000	0.5168	0.7276	0.7282	<b>0.7279</b>	0.0370	<b>0.124</b>
PBAT-1a	0.4000	0.5206	0.7292	0.7301	<b>0.7297</b>	0.0540	
PHA-1	0.4000	0.5245	0.9651	0.9669	<b>0.9660</b>	0.0786	<b>0.052</b>
PHA-1a	0.4000	0.5283	0.9656	0.9684	<b>0.9670</b>	0.1231	
PHA-2	0.4000	0.5322	1.8806	1.8872	<b>1.8839</b>	0.1489	<b>0.218</b>
PHA-2a	0.4000	0.5360	1.8876	1.8968	<b>1.8922</b>	0.2076	
PLA-2	0.4000	0.5398	2.6914	2.6928	<b>2.6921</b>	0.0213	<b>0.119</b>
PLA-2a	0.4000	0.5437	2.6961	2.7009	<b>2.6985</b>	0.0752	
PBS-1	0.4000	0.5475	3.3768	3.3807	<b>3.3788</b>	0.0484	<b>0.122</b>
PBS-1a	0.4000	0.5514	3.3840	3.3901	<b>3.3870</b>	0.0771	

## Discussion

For biodegradable polymers, Intrinsic Viscosity (IV) is the most relevant critical-to-quality parameter for process control. Operators see high variance on Melt Flow Index because these polymers are easily subject to hydrolysis. This is a core aspect of the biodegradability and/or compostability of these polymers. Using Intrinsic Viscosity remove the influence of water, preventing degradation impacts during measurement.

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

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

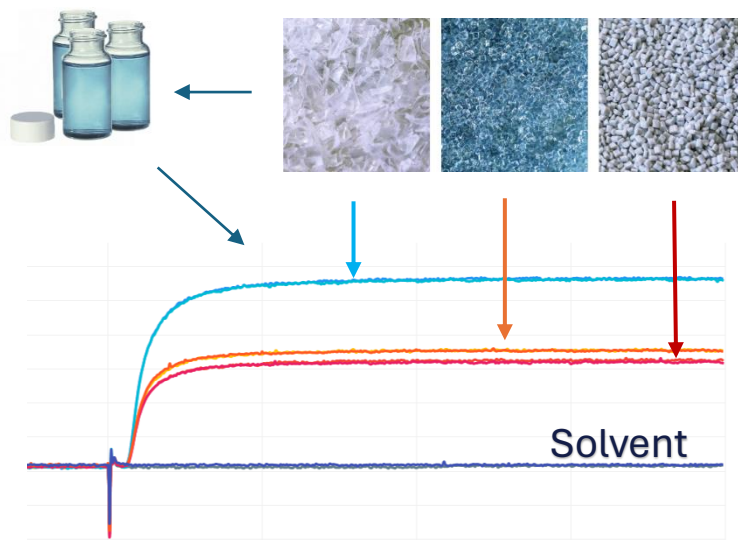
Each replicate injection was completed in around 2.75 minutes, giving a total analysis time of approximately 5.5 minutes for each sample. Pairing these analysis times to the interval between sample preparation time ensures that results are not influenced by the position in the sample queue.



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