



Lapol® Processing Guide for PLA Blends and Concentrates

This information is intended to serve as a guide to processing Lapol viscous resin. Compounding and extrusion requires a complex set of parameters and an experimental approach may be needed to achieve maximum results.

1.0 Description

Lapol resin is a patent pending bioplasticizer for PLA and other polymers. It is a soft solid resin with a yellow to slightly amber color and a slight surface tackiness. Lapol is designed to act as an internal plasticizing agent to “soften” polylactic acid (PLA). It is supplied in 5 or 55-gallon open lid drums as a solid viscous resin. The following guide can be used for compounding Lapol directly into PLA, making Lapol concentrates in PLA or other polymers.

Lapol® Attributes:

- Biodegradability/Compostability (screening studies indicate ASTM D6400 compliance)
- Renewability/Sustainability (predominantly plant derived raw materials sources)
- Compatibility and miscibility (no need for additional compatibilizers or additives)
- Flexibility without sacrificing modulus
- Good clarity (relatively low haze in PLA)
- Processability (Lapol is fully miscible with PLA, hence no die swell out of the compounder)

2.0 Applications

Lapol resin is used to enable PLA to perform in applications requiring flexibility and increased elongation. Lapol resin plasticizes PLA resin for applications including: injection molding, thermoforming, extrusion coating, blow molding, and cast and blown films.

3.0 Processing information

Lapol resin can be added to PLA in line as a molten resin by heating it to 140 °C (284 °F) and then pumping it into a compounding extruder. This can be accomplished using a drum melter/pump, such as a [Nordson VersaDrum™ bulk melter](#) unit. After flow calibration, the drum melter’s heated hose (140 °C or 284 °F) can be fed directly into the compounding extruder in a zone after the feed throat or into a side feeder downstream from the PLA feed section. The PLA should be melted prior to adding Lapol, usually in zone two depending on the size of the extruder.

It is imperative that there be good mixing of the Lapol and PLA to achieve a homogeneous compound.

ATTENTION: It is recommended that the heated portion of the Lapol resin be utilized when it is melted. Re-melting Lapol resin more than three times may result in gelling and compromise properties.

4.0 Safety and handling precautions

All safety precautions normally followed when handling and processing molten thermoplastics should be followed when handling Lapol resin. Consult the MSDS before processing.

Lapol resin is a true thermoplastic resin and is therefore, sensitive to processing temperature. Melt processing and the variability of those conditions may result in minor degradation. Lactide, a non-hazardous gaseous irritant, is a minor byproduct of Lapol melt processing. Normal polymer resin air handling systems should be in place and will handle this minor out-gassing during processing. In addition, Lapol should be processed below its decomposition temperature, which will occur at 210° C (410° F) and above. Avoid temperatures above 200° C (392° F).

5.0 Typical Resin Properties

Lapol® Resin Properties	Nominal Value
Melt viscosity (Brookfield spindle 6, 100°C / 50 rpm) poise	200–265
Flow temperature	130°–150° C
Glass transition temperature	-5° C to 10° C
Degradation temperature	210° C
Density	1.06/gcc
Molecular weight range	(Mn) 30,000– 40,000 (Mw) 80,000-112,000
Color (Gardner)	<6

6.0 Drying

Lapol resin is shipped in 5 and 55-gallon steel drums as a solid in a glassy state, much like a hot melt adhesive. It does not require drying prior to use, but care must be taken to ensure that the lid remains firmly fastened during storage. Repeated opening and closing of the drums is not recommended as it could allow moisture into the drum that can cause undesired degradation of the material.

PLA must be dried prior to use. PLA should be dried according to the manufacturer's processing recommendations. PLA should be dried to a maximum of 250 ppm moisture as measured by a Karl Fischer method. Processes that have unusually long residence time or result in a melt temperature greater than 200°C should dry PLA to less than 50 ppm moisture.

7.0 Extrusion

Lapol resin will process on conventional compounding extrusion equipment. A twin screw extruder is preferred with a mixing section is generally recommended along with static mixers in the process line prior to the die to ensure optimal product homogeneity and uniform temperatures of the melt. Addition ports are needed toward the front of the extruder in order to feed the Lapol resin into the extruder.

Processing Parameters	Settings (° C)
Feed Throat	15-25
Zone 1	165-175
Zone 2	165-180
Zone 3	165-180
Melt temperature	165-180
Die	165-180
Lapol Melt temperature	130-150
Screw speed (rpm)	50-100

Note 1: Temperatures are provided a guideline and may need to be adjusted. Temperatures above 200°C (392°F) should be avoided.

8.0 Startup and shutdown

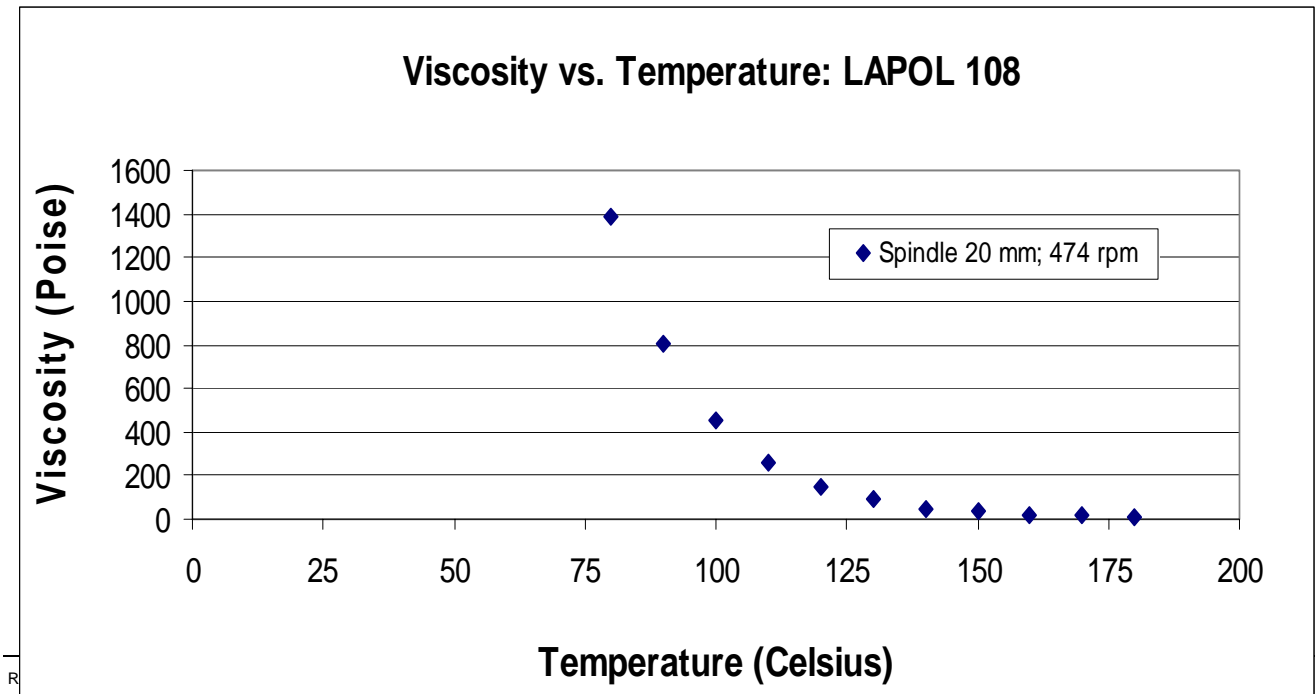
In running Lapol resins startup and shutdown procedures are the same as with any other polylactic

acid compound. The PLA manufacturer's procedures should be followed to ensure a quality product. Polylactic acid polymers are incompatible with most polyolefin resins and special purging sequences should be followed.

1. Purge extruder using a linear polypropylene or a purging compound and run at the manufacturer's recommended temperatures. Purge for at least 7x average residence time (~30 minutes).
2. If following PET, PA, HDPE in the system, start with a linear low viscosity polypropylene (MFI <1) for 30 minutes, then add a high viscosity polypropylene for an additional 30 minutes.
3. Reset temperatures to normal PLA temperature profile.
4. Transition to PLA and purge with PLA for a minimum of 7x average residence time.
5. Once it is apparent that PLA is running through the system, attach the Lapol melt line to the downstream port.
6. At the completion of the run, stop the heat pump, disconnect the Lapol melt line and allow PLA to purge the system.

9.0 Disposal

Lapol is not a RCRA hazardous waste. Disposal of this material is not regulated under RCRA. Consult federal, state and local regulations to ensure that this material and its containers, if discarded, is disposed of in compliance with all local regulatory requirements.



10.0 Typical Properties of Compounded PLA

Typical Physical Properties of Compounded Lapol® 108 in PLA

Lapol 108 viscous resin compounded into NatureWorks®, LLC 4042D (biaxially oriented film – general purpose grade) polylactic acid at 0.5 mm thick films.

Physical Property	ASTM Test	5% Lapol in PLA	10% Lapol in PLA
Elongation @ Break	D 638	160%-200%	180%-210%
Tensile Stress @ Yield MPa	D 638	77-84	57-59
Tensile Modulus MPa	D 638	2160-2313	1700-1786
Specific Gravity	D 1505	1.23 g/cc	1.22/g/cc
Melt Flow Index @ 190°C – 2.16kg	D 1238	3-4 g/10 min.	9-11 g/10 min.

Disclaimer: the aforementioned technical data and applications in this processing guide are believed to be reliable. The user may process the materials differently or use it in an otherwise modified way in which Lapol has no control; therefore, Lapol does not offer a guarantee, either expressed or implied, that similar results will be achieved as explained in this processing guide. The user should make its own evaluation of the material to determine the suitability of the material for its own intended use.