
PLA Filament Processing Recommendations for Producing Flat Yarn Products

This information is intended to be used only as a guide for the Manufacture of PLA flat yarns starting with POY feedstock. Because production of fibers is a complex process, an experimental approach may be required to achieve desired results.

Flat yarn production is best completed on a machine that allows string-up of rotating godets. Optimum processing conditions can not be obtained on drawing machines that require the machine to be stopped during string-up. This results in excessive crystallization of PLA at the optimum godet temperatures and the inability to draw at required draw ratios.

Processing Parameters

1.1 Pre-draw Godet Temperature

The pre-draw godet temperature has a significant effect on product tensile properties; the recommended range of operation is from 70 to 90° C to obtain maximum tensile properties.

1.2 Draw ratio

To provide optimal PLA texturing performance, POY can typically be drawn at draw ratios ranging from 1.5 to 2.0 depending on the characteristics of the POY and the final target product properties. Tenacity and elongation response to draw ratio is significantly less for PLA as compared to PET.

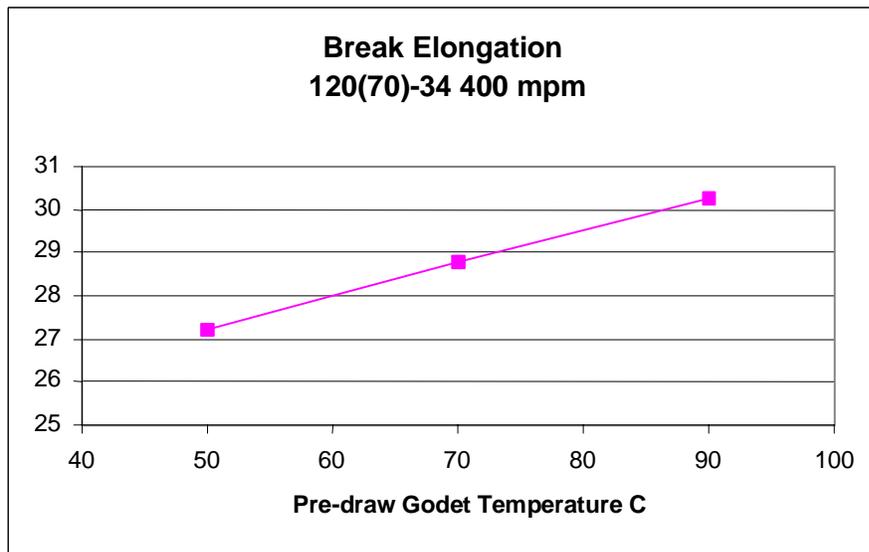
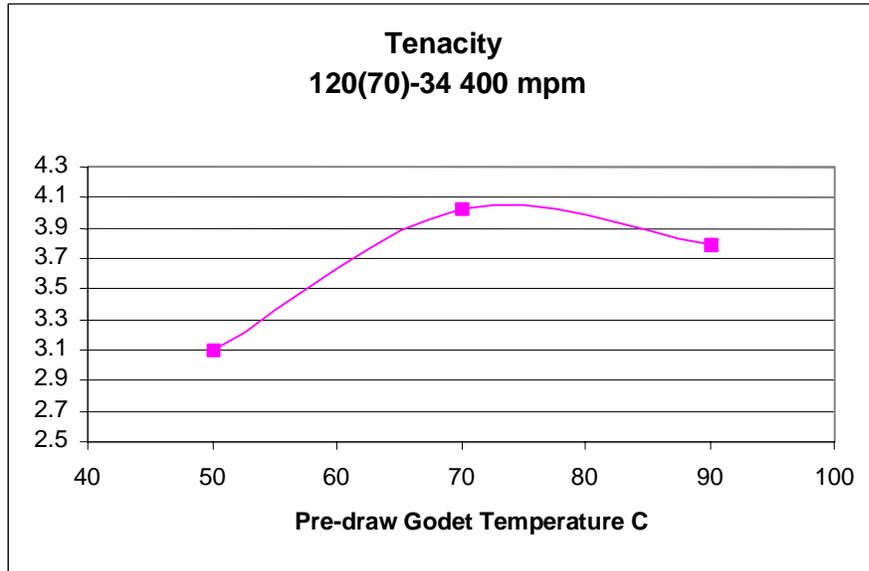
1.3 Speed

For initial evaluations, a starting point for draw winder line speeds of approximately 400 - 500 meters/min is recommended. Depending on equipment design, speed capabilities and yarn contact time, speeds can be optimized as appropriate. Speeds up to 800 mpm have been demonstrated with PLA flat yarn production.

1.4 Post Draw Godet Temperature

The use of post draw heating is a requirement to minimize product shrinkage. The recommended temperature range for a 1.5 to 2 second contact time is 100 – 120°C.

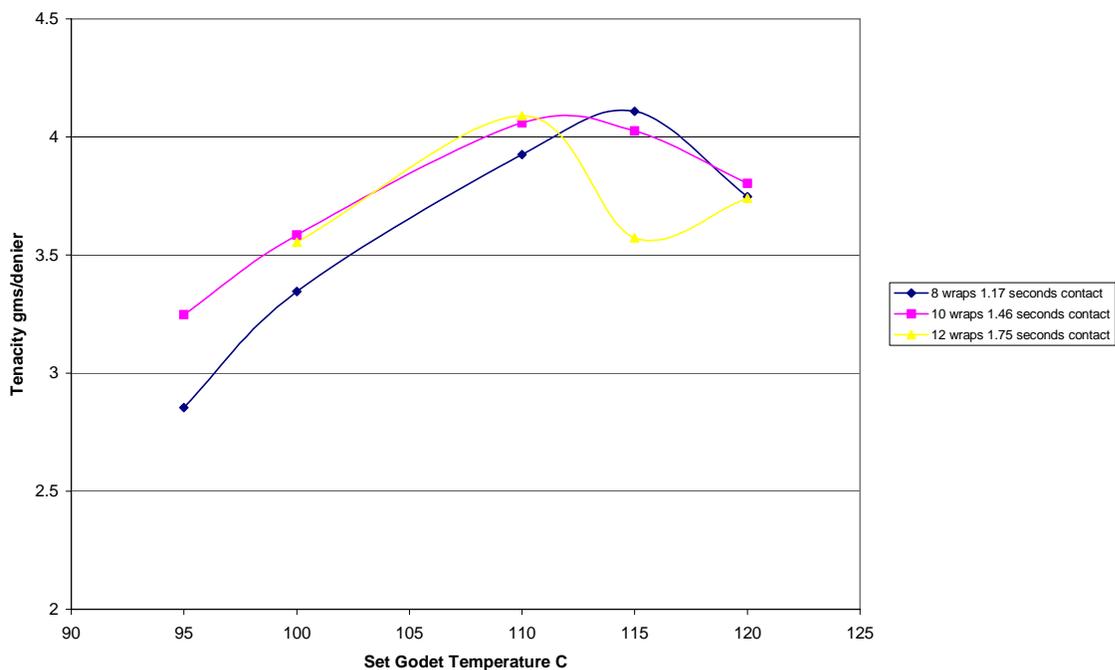
Table 1
 Pre-Draw Response Data



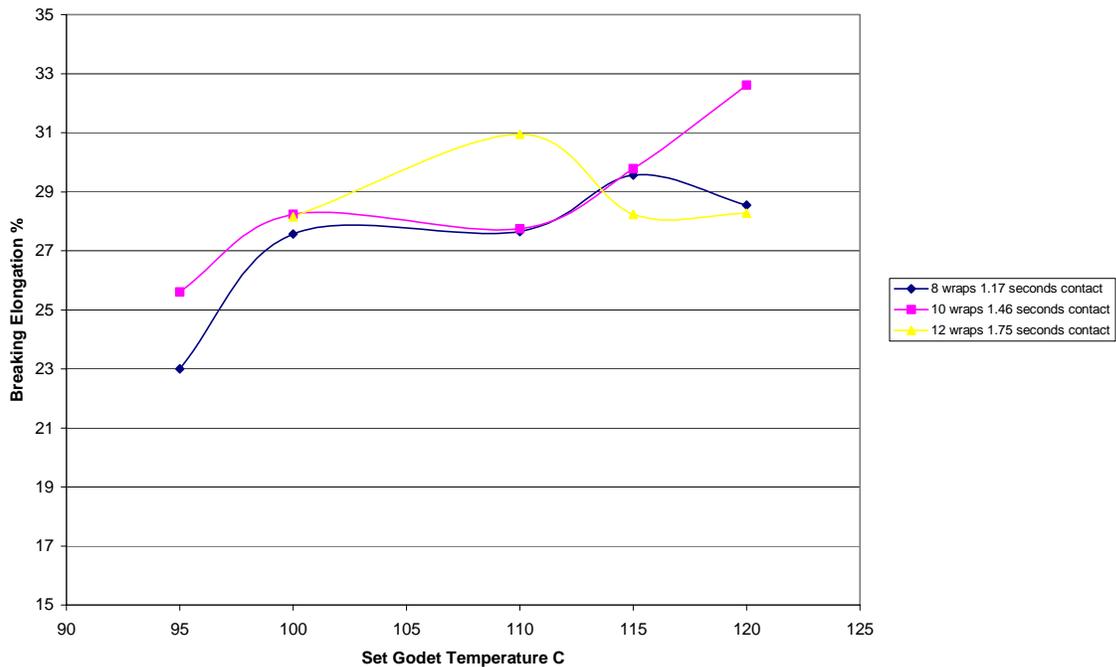


Heat Setting Experiments for Flat Yarns

Yarn Tenacity vs Temperature/Residence Time

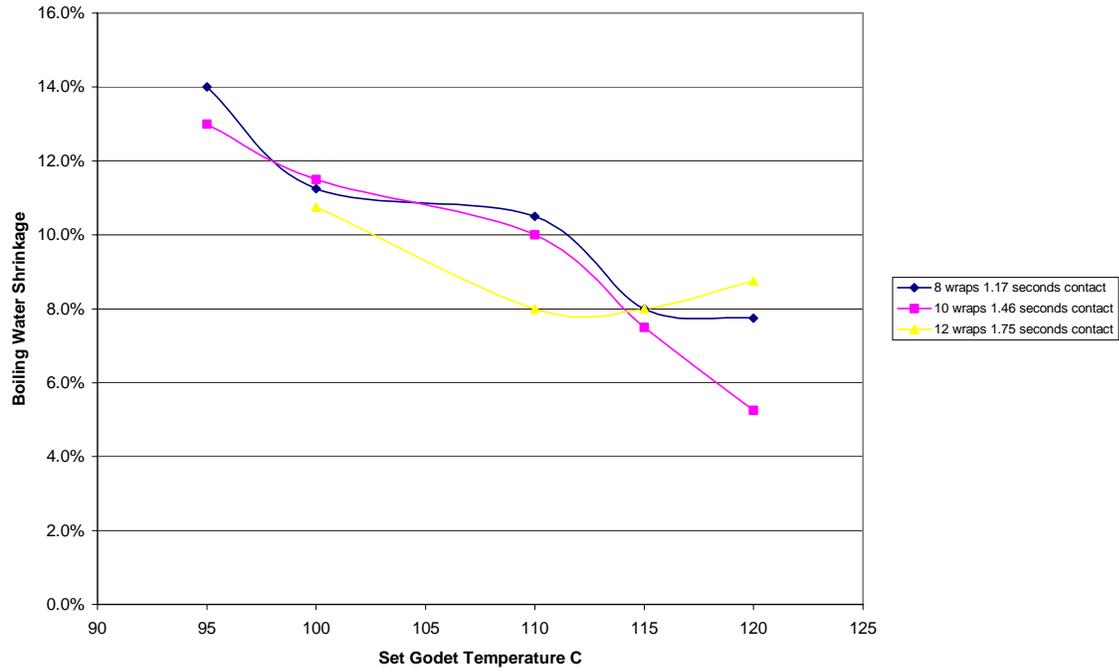


Yarn Elongation vs Temperature/Residence Time



Attachment II continued

Yarn Shrinkage vs Temperature/Residence Time



Safety and Handling Considerations

Material Safety Data (MSD) sheets for PLA polymers are available from NatureWorks LLC. MSD sheets are provided to help customers satisfy their own handling, safety, and disposal needs, and those that may be required by locally applicable health and safety regulations, such as OSHA (U.S.A.), MAK (Germany), or WHMIS (Canada). MSD sheets are updated regularly; therefore, please request and review the most current MSD sheets before handling or using any product.

The following comments apply only to PLA polymers; additives and processing aids used in fabrication and other materials used in finishing steps have their own safe-use profile and must be investigated separately.

Hazards and Handling Precautions

PLA polymers have a very low degree of toxicity and, under normal conditions of use, should pose no unusual problems from incidental ingestion, or eye and skin contact. However, caution is advised when handling, storing, using, or disposing of these resins, and good housekeeping and controlling of dusts are necessary for safe handling of product. Workers should be protected from the possibility of contact with molten resin during fabrication. Handling and fabrication of resins can result in the generation of vapors and dusts that may cause irritation to eyes and the upper respiratory tract. In dusty atmospheres, use an approved dust respirator. Pellets or beads may present a slipping hazard. Good general ventilation of the polymer processing area is recommended. At temperatures exceeding the polymer melt temperature (typically 170°C), polymer can release fumes, which may contain fragments of the polymer, creating a potential to irritate eyes and mucous membranes. Good general ventilation should be sufficient

for most conditions. Local exhaust ventilation is recommended for melt operations. Use safety glasses if there is a potential for exposure to particles which could cause mechanical injury to the eye. If vapor exposure causes eye discomfort, use a full-face respirator. No other precautions other than clean, body-covering clothing should be needed for handling PLA polymers. Use gloves with insulation for thermal protection when exposure to the melt is localized.

Combustibility

PLA polymers will burn. Clear to white smoke is produced when product burns. Toxic fumes are released under conditions of incomplete combustion. Do not permit dust to accumulate. Dust layers can be ignited by spontaneous combustion or other ignition sources. When suspended in air, dust can pose an explosion hazard. Firefighters should wear positive-pressure, self-contained breathing apparatuses and full protective equipment. Water or water fog is the preferred extinguishing medium. Foam, alcohol-resistant foam, carbon dioxide or dry chemicals may also be used. Soak thoroughly with water to cool and prevent re-ignition.

Disposal

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. For unused or uncontaminated material, the preferred options include recycling into the process or sending to an industrial composting facility, if available; otherwise, send to an incinerator or other thermal destruction device. For used or contaminated material, the disposal options remain the same, although additional evaluation is required. (For example, in the U.S.A., see 40 CFR, Part 261, "Identification and Listing of Hazardous Waste.") All disposal methods must be in compliance with Federal, State/Provincial, and local laws and regulations.

Environmental Concerns

Generally speaking, lost pellets are not a problem in the environment except under unusual circumstances when they enter the marine environment. They are benign in terms of their physical environmental impact, but if ingested by waterfowl or aquatic life, they may mechanically cause adverse effects. Spills should be minimized, and they should be cleaned up when they happen. Plastics should not be discarded into the ocean or any other body of water.

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