

Process Notes for making NuPlastiQ /LLDPE films using BiologiQ's NuPlastiQ Resins

BiologiQ's NuPlastiQ based film resins and Masterbatches can be used to make monolayer film or layers of a co-ex film with NuPlastiQ content from 15% to 35% on most standard LDPE blown film equipment. This Process Note highlights key procedures and information that we use to make quality film.

NuPlastiQ Masterbatch and Mixing Details

Film that is blown with BiologiQ's NuPlastiQ and LLDPE is typically made from an NuPlastiQ Masterbatch that is further down blended during the film blowing stage. The Masterbatch typically contains:

50%	BiologiQ NuPlastiQ GP
50%	LLDPE (mLLDPE, Octene, or Hexene) (including compatibilizer)

This Masterbatch is then further down blended for the monolayer film or co-ex layer during film blowing as follows to arrive at the indicated final NuPlastiQ GP to LLDPE ratios in the film or co-ex layer:

<u>Final Film Layer Ratio</u>	<u>Masterbatch</u>	<u>Additional LLDPE</u>
15% NuPlastiQ GP / 85% LLDPE	30% MB	70% LLDPE
25% NuPlastiQ GP / 75% LLDPE	50% MB	50% LLDPE
35% NuPlastiQ GP / 65% LLDPE	70% MB	30% LLDPE

Notes:

- 1) The Final Film Layer Ratio above represents the percentage of NuPlastiQ GP in a monolayer film, or in the layer containing NuPlastiQ in a co-ex film.
- 2) If a fully diluted resin is used in lieu of a Masterbatch (ie 25% NuPlastiQ / 75% LLDPE), no further down blending is required during film blowing.

Machine Configuration & Setup

Most standard LDPE film blowing equipment can be used to blow film from resin containing NuPlastiQ. BiologiQ has successful direct experience with monolayer equipment that has the following characteristics:

Screw Diameter	55 – 80 mm (strong mixing elements preferred but not required)
L/D Ratio	38 – 45
Die Gap	1.0 mm – 1.2 mm
Die Diameter	130/150 mm – 300 mm
Typical Blow Up Ratio	2.5 – 2.8
Screen Pack	100 mesh
Chilled Air	Highly recommended
Extruder Degassing	Not required

Notes:

- 1) Films made with NuPlastiQ are slightly more sensitive to process conditions (such as die gap and blow up ratio) than are traditional PE films. While we find a BUR of approx. 2.5 is optimum, the best ratio for your equipment can be determined by ensuring the MD and TD strengths are essentially equivalent.
- 2) NuPlastiQ®+ (L)LDPE or other carrier resin as the Masterbatch (produced in BioLogiQ's Ecco-Alloy® process) is sometimes made with resins selected from our customer that are based on their end-use formulation. These resins may or may not contain enough slip and anti-block additives to achieve the final COF required after blooming is completed. Therefore, dependent upon the customer formulation and final slip level required after blooming, additional slip may be required in the formulation phase of the design. Slip tends to bloom somewhat slowly when NuPlastiQ is present. We recommend measuring the COF per normal protocol and after 72 hours. Please contact us if questions arise.
- 3) It is normal for our bio-based NuPlastiQ resin to outgas (smoke with a slight smell) during processing. This does not affect the final film quality or performance. Note: starch based films will typically have a slight odor if starch is contained in the outer layers.

Startup Procedure

- 1) Clean or replace the Screen Packs before starting. NuPlastiQ based resins will act as a purge agent when introduced to the equipment, so gels and other defects might be experienced if the screen packs are not clean when NuPlastiQ is introduced.
- 2) Initial settings for the Film Extruder Process Temperature profile may be set as follows – adjustments to the profile may be needed depending on process equipment and base resins (all temperatures °C):

Zone	C1	C2	C3	C4	C5	AD	D1	D2
Set Temperature	130	140	150	160	170	170	175	175

- 3) Start with 100% LLDPE (eg Octene) and establish a stable bubble.
- 4) Introduce the required blend of Masterbatch and Base Resin to the extruder to obtain a film with the desired NuPlastiQ GP content (eg for 25% NuPlastiQ GP– use 50% MB + 50% additional LLDPE).
- 5) After the initial introduction of the resin blend, and during the transition, adjust the extruder RPM, the Line Speed, Take up Reel Speed, Winder Speed (and any other typical parameters) to obtain the bubble stability, width and film thickness desired.
- 6) Start and maintain the film winder as normal.
- 7) On shutdown, it is recommended to purge the film extruder with 100% LDPE. Leaving any starch based resin (like NuPlastiQ) in the extruder during shutdown and startup may cause it to burn and delay normal startup on the next use.

Resin Storage

- 1) BiologiQ LLDPE BioBlends containing NuPlastiQ will absorb moisture from the environment. They should be stored in a cool dry environment until ready for use.
- 2) The material must be kept sealed until directly before processing.

- 3) Any leftover material should be re-sealed as soon as possible to prevent moisture absorption.
- 4) If left in an open container, pellets should be dried to less than 0.5% moisture as measured by the following test conditions:

Measure with an infrared moisture analyzer at 105°C for 10 minutes.

- 5) Drying of pellets can be performed by introducing warm, dry air at 80°C for 1-4 hours.