

## WHAT IS FLAT-DIE EXTRUSION?

Argotec's flat-die extrusion process begins with computerized mixing of virgin resin with additives to control film process and properties, along with carefully controlled rates of regrind, if necessary, to reduce customer cost. Any regrind used is generated in-house to ensure quality.

The blend of materials is melted and conveyed through the extruder. The heated material is then forced, under pressure, through a flat, horizontal die slit.

The gauge of the film is controlled by adjustments made at regular intervals across the width of the die. The film cools at the die exit as it passes through the chilled nip rolls. It is trimmed to the specified width prior to being wound onto corrugated or plastic cores, wrapped and packaged for shipment.

Depending on the secondary fabrication requirements, physical properties or end-use of the film, interleaves such as polyester film, single or double polyethylene film (DPE), or paper may be inserted prior to final winding to assist in handling or to prevent blocking.

## HOW DOES CAST-ON-CARRIER DIFFER FROM FLAT-DIE EXTRUSION?

Cast-on-carrier extrusion is a variation of the flat-die process that is used when:

- Film is so thin it requires support to handle.
- Secondary fabrication requires the use of a carrier.
- The surface finish of the film needs to be preserved.

The initial phases of the cast-on-carrier process are identical to flat-die extrusion. The process differs because the carrier is introduced at the die instead of at wind up. Since the film is warm at the die exit, it takes on the surface finish of the carrier. Typical carriers are polyester film, polyethylene film and paper.

The film-on-carrier is then conveyed through chilled rollers, slitting and winding, as with the flat-die process.

## WHY FLAT DIE AND CAST-ON-CARRIER EXTRUSION IS SUPERIOR TO BLOWN FILM EXTRUSION

Films produced via flat-die and cast-on-carrier extrusion technologies are considered higher quality than product manufactured using blown film extrusion because:

- They contain less gel. Gel can be unmelted resin or resin particles with slightly different melt properties.



Raw resin



Film traveling over cooling rolls

Gel can effect mechanical and aesthetic properties.

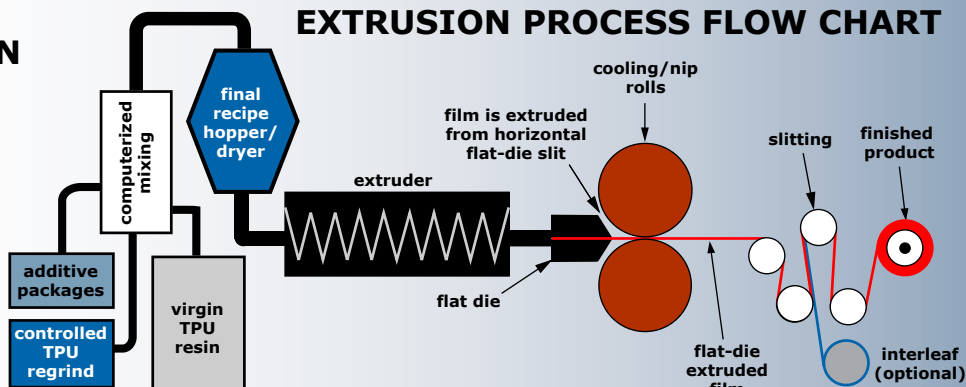
- No processing aids or lubricants are required. These processing aids can affect adhesive wet-out. Lubricants can interfere with downstream processing, such as lamination or printing.
- Gauge can be adjusted in-line.
- Surface finish can be controlled.
- Extremely thin films can be extruded using the cast-on-carrier option, to thicknesses as low as 0.2 mil.
- Thick films up to 125 mils can be produced.
- One or more interleaves/carriers may be used for cleanliness or other reasons.

When run in Argotec's hard wall, clean room manufacturing facilities, flat-die extrusion reduces virtually all contaminants, air-borne and otherwise, for the cleanest possible film.

## WHEN TO USE BLOWN FILM

In certain cases, there may be advantages to using blown film extrusion. For example:

- When cost is a factor. Blown film is the most economical method for producing films from 1-10 mils.
- When a carrier or interleaf is not required.
- When a smooth surface is acceptable.
- Gloss or matte finish is not required.
- When even roll put-up is critical. The rotating die on a blown film extruder distributes any gauge variations evenly across the width of the roll.





Flat-die extrusion in Argotec's hard-wall cleanroom production facility



Flat horizontal die slit



Beta-gauge measurement



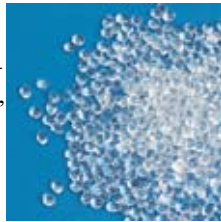
Insertion of interleaf

- In some applications, the high-slip attribute of the processing aid is desirable.
- However, when these factors do not exist, flat-die or cast-on-carrier will typically be the preferred extrusion method.

## WHAT GOES INTO A SUCCESSFUL FLAT-DIE EXTRUSION PROGRAM

A successful flat-die or cast-on-carrier extrusion program involves much more than just having equipment. Up to five key factors must be included:

1. **Recipe Control** – the fixed ratio of ingredients that go into the film. Argotec uses up-front engineering to eliminate mid-run recipe changes to fix problems or increase yield. Three basic components are custom designed to meet the specific needs of the application:
  - Virgin TPU (or other polymeric) resin, straight out of the box from the resin supplier.
  - Chemical additives which can impart flame resistance, UV resistance, antibacterial (odor) control, infection control, antifungal, antistatic, lubricant or antiblock properties.
  - Regrind, the recycling of edge trim or other films of the same chemistry previously produced by Argotec. Use of regrind is carefully controlled and limited to the same resin type, color and additives. Cleanness of the regrind is strictly monitored. Argotec does not buy regrind on the open market unless instructed by the customer.
2. **Process Control** – standard operating conditions and procedures are used to ensure consistent film quality, lot-to-lot, roll-to-roll. The conditions and procedures include:
  - Temperature & pressure used to pump the melted recipe through the die.
  - Running speed effects product quality. Running film at low temperatures and high speeds can result in poor dimensional stability in the end use. This is because the resin tends to orient in the machine direction. When exposed to ambient or secondary processing heat, the polymer will attempt to reorient, causing the film to



Virgin TPU resin (top) and regrind



change dimension, typically becoming narrow or longer. Argotec maintains the optimum temperature and through-put rate for consistent dimensional stability.

- Measurement of critical film properties to assure consistently high product standards. Argotec utilizes beta gauge systems to maintain consistent sheet thickness and a camera inspection system for gel and defect detection. Three of Argotec's flat-die extrusion lines are housed in hard-wall, clean-room facilities.
3. **Packaging** – Argotec will package in a variety of configurations to meet customer requirements, including:
    - Sheeted and stacked per customer specification.
    - Individually boxed rolls, horizontally suspended with end plates.
    - Vertical bulk pack, rolls stacked on end.
    - Horizontal bulk pack, rolls suspended in cradles.
  4. **Labeling** – Argotec will package, label and ship in a manner that will support customer objectives:
    - Standard Argotec labels and drop shipment.
    - Private labeling, with shipping and labels customized to specific customer requirements.
  5. **Secondary Processing** – Argotec can refer you to a variety of secondary processing operations through industry partners who meet rigorous quality standards, including:
    - Slitting
    - Die cutting
    - Sealing
    - Adhesive coating
    - Textile lamination
    - Glass lamination
    - Perforation

Argotec's control of carefully engineered recipes, tight process and measurement of film properties, packaging and labeling options, and industry partners, provides a complete TPU film and sheet program.

## ARGOTEC PRODUCT OPTIONS

In addition to flat-die and cast-on-carrier extrusion, Argotec has expertise in blown film, extrusion coating and multi-layer constructions. Material options include aliphatic and aromatic polyester and polyether polyurethanes, copolyesters, copolyamides, ether-amides, specialty TPE's and TPO's, and other difficult-to-extrude polymers. Carefully engineered additive packages for flame and UV resistance, antibacterial, antifungal, antistatic, antiblocking, as well as specialty lubricant packages are also available.



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