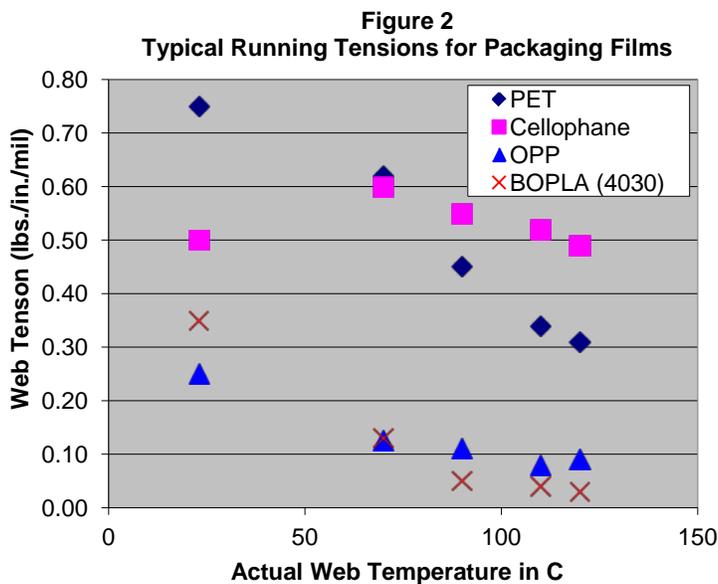
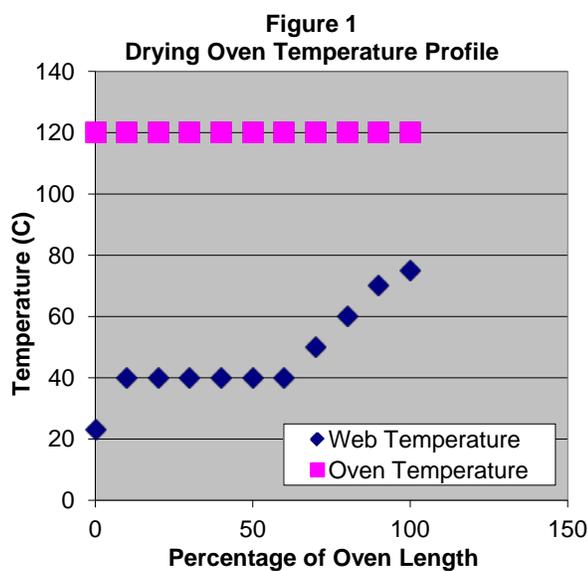


Many secondary converting processes require a polymeric packaging film to pass through a drying unit such as an oven or a bank of IR heaters to remove volatile components from inks, coatings, or adhesives. Good heat management during these various secondary converting processes is critical to insuring the production of good quality converted polymeric film with regard to proper print repeat lengths and predictable web widths. Variation in impression repeat lengths caused by excessively high web temperatures during printing, coating or adhesive laminating can adversely affect the packager using the converted film thus leading to off registered packaging. Variation in web widths can adversely effect the secondary converter, often times not allowing for all lanes of print to be correctly slit out of a master roll.

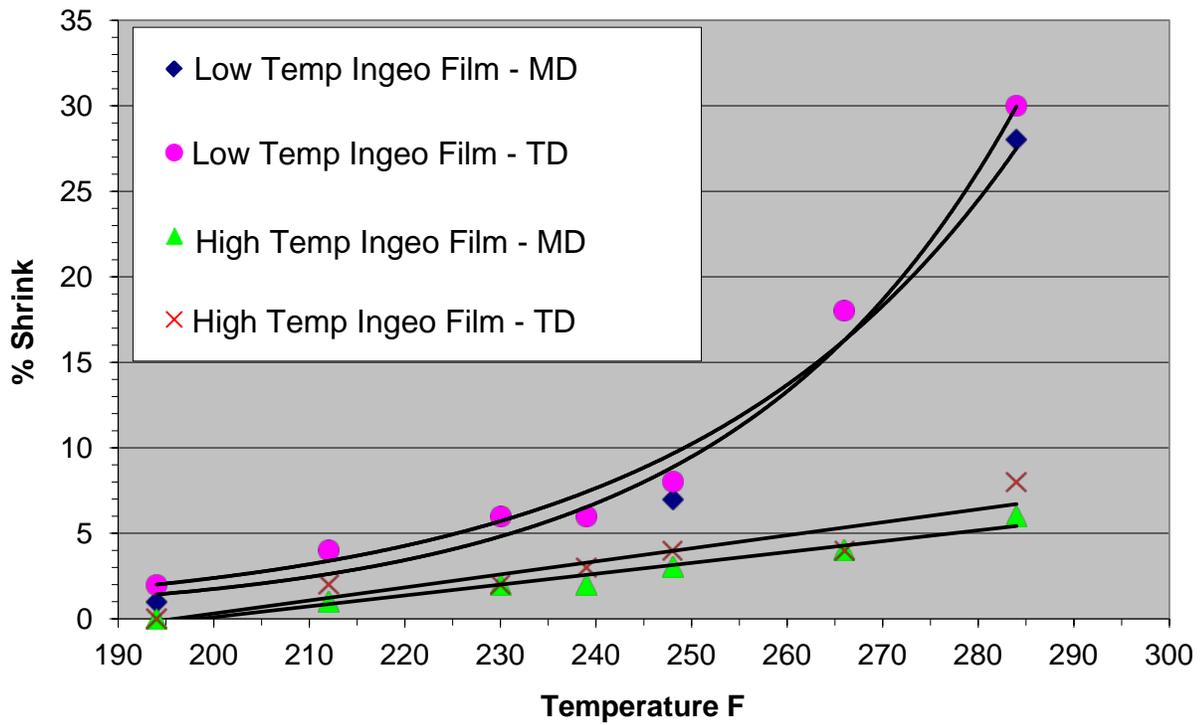
In addition, a film may need to pass over heated rollers as in dry bond laminating or extrusion laminating as a means of introducing heat to the film while nipping a second web onto the first web forming a lamination. This often requires the primary web to have the greatest allowable profile wrap around the heated roll both before and after the nip point. If the temperature of the heated roller is high enough to distort the film, wrinkles, creases and or edge curl may occur. These negative effects lead to an increase in film waste. Whether a secondary converter is printing, coating, or laminating films, there is a critical need for managing the heat that a film is exposed to during the converting process.

As an example, effective drying of a coating in a high airflow oven is just as dependent on heat as it is on air circulation throughout the oven. When looking at the web temperature as a function of position in a drying oven, the web temperature should start to increase as it is exiting the oven. Figure 1 shows the ideal web temperature of a packaging film and oven temperature as it is related to position in a drying oven. This type of web temperature profile inside a drying oven indicates that near the end of the oven the “cooling” effect from the evaporation of volatiles has stopped and the web is beginning to absorb the heat from the airflow of the oven. If the web temperature can be kept below the distortion temperature for the polymeric film as it exits the oven it is considered to be good heat management. Figure 2 shows some typical web tensions for various packaging films as they relate to actual web temperature. This data was generated by comparing the yield stress of known polymeric packaging films at various temperatures and recommended web tension values for these films. It should be noted that for cellophane, which is considered a thermoset polymer, the web tension is not directly related to the web temperature. The yield values for cellophane were very consistent across a range of temperatures tested.



Biaxially oriented Ingeo film also has limitations to the amount of heat that it can be exposed to before the film will shrink and or begin to distort under tension. Figure 3 shows the shrink curves for oriented Ingeo film made from both 4032D and 4043D resin. These data were obtained using a standard film shrink testing unit. The film tested was 20 microns thick and oriented on a sequential orientation line. The figure shows that provided the web temperature for the high temperature Ingeo film made with 4032D resin is kept below 120°C (248°F), film shrinkage is not an issue.

Figure 3
Shrinkage Plot for Ingeo Film



Safety and Handling Considerations

Material Safety Data (MSD) sheets for Ingeo biopolymers 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 Ingeo biopolymers; 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

Ingeo biopolymers 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 Ingeo biopolymers. Use gloves with insulation for thermal protection when exposure to the melt is localized.

Combustibility

Ingeo biopolymers 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.

Product Stewardship

NatureWorks LLC has a fundamental duty to all those that make and use our products, and for the environment in which we live. This duty is the basis for our Product Stewardship philosophy, by which we assess the health and environmental information on our products and their intended use, then take appropriate steps to protect the environment and the health of our employees and the public.

Customer Notice

NatureWorks LLC encourages its customers and potential users of its products to review their applications for such products from the standpoint of human health and environmental quality. To help ensure our products are not used in ways for which they were not intended or tested, our personnel will assist customers in dealing with ecological and product safety considerations. Your sales representative can arrange the proper contacts. NatureWorks LLC literature, including Material Safety Data sheets, should be consulted prior to the use of the company's products. These are available from your NatureWorks LLC representative.

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