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Oriented polypropylene film technologies

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Abstract

Today consumers expect product to have good protection. Flexible packaging materials play a great role in many industries. BOPP film is one of the most popular materials that is in demand in almost any field where flexible packaging is required. Most oriented plastic films have a biaxial orientation, the characteristics of which perfectly correspond to the requirements of modern flexible packaging. General improved barrier properties are achieved due to the orientation of the chains of molecules. Tension in the longitudinal direction is usually performed using the machine direction orientation (MDO) through the rollers with increasing speed. For all transversely oriented films, the stretching process occurs using a transverse directional orientation (TDO), where the film is fixed at both ends and, after passing through the oven at different temperatures and it is stretched in the transverse direction.

Keywords: Orientation technology, multilayer, packaging, BOPP;

1. Introduction

Today oriented plastic films are commercialized in large quantities. Most of them are biaxially oriented, that is, the films are stretched in both directions and it gives the improvement in performance. The characteristics achieved using biaxially oriented films ideally meet the requirements of modern flexible packaging [2].

Flexible packaging should have the protective function and the design of the product should be consistent in economic and environmental aspects. The required protection of the packaging product is achieved due to its excellent protective properties against gases (water vapor, oxygen, etc.). The appearance of the product is achieved thanks to the glossy and transparent thin packaging film, as well as excellent printing. Requirements for popular economical packaging are met by good material use and by satisfying the demand for high-speed packaging lines.

This paper discusses orientation technology and provides examples of the most common type of films (biaxially oriented polypropylene (BOPP). Particular attention is paid to improving the mechanical, optical and permeability characteristics by selectively orienting the chains of molecules. While single-layer biaxial stretching is the most suitable for certain applications, many applications use a multilayer film. It can be explain by the fact that a variety of specific films is usually required, and a single layer film cannot satisfy these requirements. They can be found only with the various combinations possible in the multilayer structure. The multilayer film uses the advantages of various additives to achieve the desired mechanical properties and sliding, seal and barrier properties [1].

2. Technology of the polypropylene film production process

The film consists of five layers. The main extruder forms the central layer where the raw material and finely divided film parts are arrived. Two auxiliary satellite coextruders form intermediate layers and are used to give films additional appearance properties. Two satellite extruders form the extreme layers. The chief technologist gives the formula for the preparation of the produced film. The operator enters the film formula into the computer of the automated process control system (APCS). The percentage of components in the mixture depends on the type and thickness of the film, the quality of raw materials. In the production of a mono-film, a homopolymer (polypropylene) is sent into the satellite extruders of the outer layers of the film, while in the production of a coextruded film with heat-sealable layers, a polypropylene copolymer is sent.

Reusable material (regranulate) is fed into the silo through a pneumatic conveying system from the NGR film waste regranulation unit. There is also a system for loading regranulate in big bags and a system for unloading them into storage silos.

The homopolymer and regranulate from storage silos are fed through a pressure line for pneumatic conveying to the main and auxiliary extruders.

The copolymer from storage silos through the suction pipe of pneumatic transport (vacuum loaders) is fed to the metering unit [4].

The co-extrusion process is the most common method for producing multilayer films, because it combines all the advantages in terms of the greatest flexibility in combining layers and maximum profitability / operational efficiency. Figure 1 shows a typical extruder configuration for a five-layer BOPP film production line.

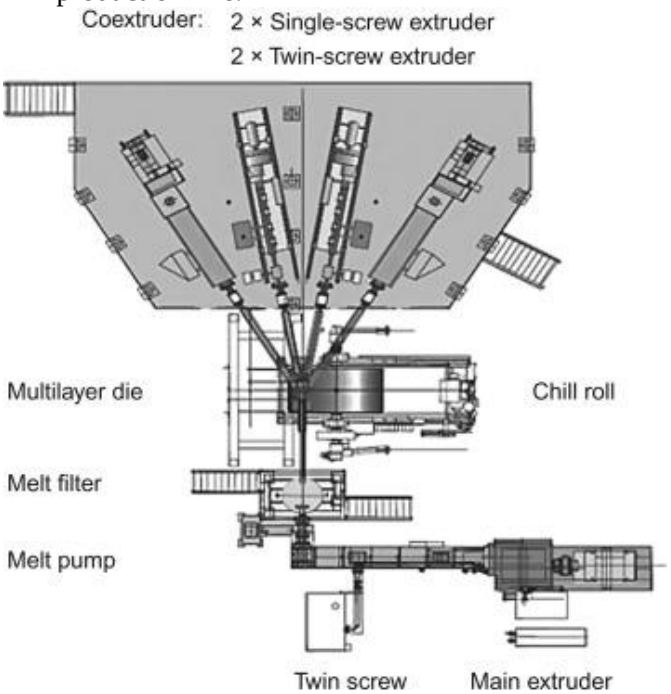

Figure 1. A five-layer extruder configuration.

The main extruder has a twin screw additive dispenser, a melt pump and a melt filter. This particular configuration has two single screw and two twin screw coextruders. The plant can also use melt pumps to ensure an accurate flow of thin coextruded layers. Twin screw extruders ensure that additives, recyclable material and edge processing are well homogenized. In addition, the specific energy consumption is reduced, better degassing is achieved and, due to self-cleaning, a shorter product switching time is provided. Given these advantages over the past 10 years, many tensile lines have twin screw extruders.

During the last process, the extruder has an extrusion coating device. The formation of curing film is formed on an injection machine. The combined melt stream emerging from the die is fed to the irrigation drum in the form of an endless belt. Then there is cooling of a continuous ribbon of polymer melt and its crystallization. To obtain a homogeneous crystalline material, the melt must be cooled constantly under the same conditions over the entire width of the drum. The ingress of air between the melt and the drum should be eliminated. Otherwise, it will not be possible to obtain the final product with a smooth shiny uniform surface [5].

3. Orienting technologies

In orienting technologies, as a rule, one can distinguish between the orientation direction and the corresponding stretching process. The necessary tensile machines vary by process. Sequential stretching first in the machine direction, and then in the transverse direction with MDO and TDO is the most common process used today. The MAO machine includes a shaft system with drives and instrumentation (Figure 2). The longitudinally oriented film is fed through the guide rolls and the filling device to the transverse orientation of the TDO, where special clamps capture the edges of the film. With the help of clamps, the film is passed through the TDO installation, where it is heated with hot air, stretched in the transverse direction, thermostabilized under reduced tension and cooled, passing the following functional and temperature zones.

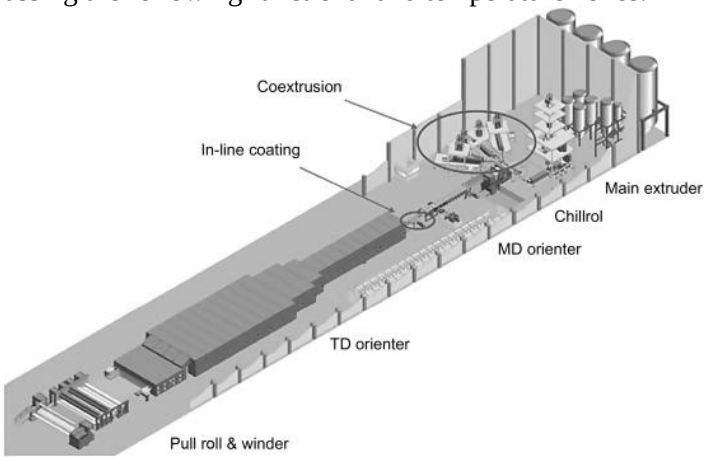

Figure 2. Multilayer structures in biaxially orienting lines

In a sequential orientation, the stretching process has two stages, and there is a relatively small technological window in terms of temperatures and tensile coefficients. However, with simultaneous stretching, the applicable stretching factors are much larger. For example, in the longitudinal and transverse directions, the same tensile coefficients can be set, or even a higher tensile coefficient in the longitudinal direction can be realized in order to achieve improved mechanical properties in the longitudinal direction. Another advantage is the possibility of relaxation while simultaneous orientation, by reducing the distance between the clamps not only in the longitudinal but also in the transverse directions. In addition, it can be emphasized that, as

a non-contact process, simultaneous orientation avoids the restrictions of stretching using rollers [3, 6].

4. Conclusion

In fact, oriented films are best suited to meet trends in the packaging sector as determined by politics, society and industry. The packaging rules force the industry to consider not only the costs of materials and production, but also the costs of disposal. This leads to the achievement of minimum packaging material and maximum protection with packaging. These goals can be achieved only with the help of high-strength materials to reduce thickness, as well as perform protective and barrier functions, as well as operational properties that provide high speed packaging. With complex orienting processes, a significant increase in the strength of all plastics can be achieved.

The packaging material should satisfy the basic needs of consumers, as they should be easy to open and, if possible, re-close. Therefore, there is a need for multilayer composites with low tensile strength and reusability. Consumer requirements to see the contents of the package and have a long shelf life require transparent barrier films. Coextruded oriented films with corresponding barrier layers ideally achieve these film characteristics. This applies in particular to a transparent cover film for products, such as sausages and cheese, in deep trays that provide the required shelf life.

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