Calendering of polypropylene

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The most-used thermoplastic material in calendering is PVC, which has been calendered for several years with few difficulties and the process is now well established. Other important calenderable thermoplastics are some styrenic copolymers, such as ABS and ASA, polyurethane, some polyamide grades and nowadays also polyolefins [1, 2] Among polyolefins, polypropylene (PP) is one of the most interesting materials because it has a great potential to replace PVC in existing markets and to penetrate in new ones.

Recent developments in PP quality, together with some ecological credentials of the product and the process, are more and more attracting the attention of manufacturers of calendered products and machinery. The main problem in PP calendering is definitely the lack of experience [3, 4].

Calendering is a versatile processing method to manufacture polymer sheets and coatings. Calendering may be very competitive to various film extrusion techniques specially while manufacturing small batches. Advantages of calendering are, for example, less material loss due to the change of colour and grade, low residual stresses in the product and the possibility to print different three-dimensional patterns on the produced sheet or coating [2, 4].

CALENDERING PROCESS

A calendering line can be either a line for sheet manufacturing or a line for coating a carrier material. The main components of a calendering line in the case of coating are schematically shown in Figure 1. While using

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PVC, premixing of the resin with plasticizers and other components in a dry blender (turbomixer) is required before processing. With PP, there is no need for premixing since the resin (and coloured masterbatches in case of coloured products) can be dosaged directly into the melt mixer. As melt mixers, extruders (planetary or twin-screw) are mostly used. The equipment can be similar to that used with PVC but it must be optimized for each product. The purpose of a melt mixing stage in a PP calendering process is to mix the pigments and fillers into the resin and melt the material. The calender can be feeded directly by the mixing extruder or via an additional feeding device between the extruder and calender [1, 4].

A calender consists of two or more heated rolls with different configurations depending on the product to be manufactured. All different roll configurations (I, L, F, Z, etc. [2]) used for PVC can also be optimized for the processing of PP. The purpose of the heated rolls in the calender is to convert the molten material into a product that has the desired thickness. The thickness decrease is achieved by squeezing the molten plastic through the nips between the heated rolls. The differences in rotation speeds and directions of the rolls drive the molten material to pass the calender [2, 4].

During calender coating, the molten PP film that is covering the heated roll after passing through the nip has to be laminated on a carrier material by using a rubber coated roll. In the sheet manufacturing, the purpose of rubber coated roll is to serve as a take-off roll, i.e. to detach the sheet from the surface of the roll. In both cases, the molten sheet starts to solidify immediately after taking off from the roll. During this phase of the calendering line, an efficient cooling system is needed. A very common and effective cooling system consists of several small diameter rolls of high thermal exchange efficiency [1, 2, 4].