Calcium Carbonate Improves Blown Film Properties

Direct Extrusion with Mineral Fillers

The addition of calcium carbonate into the blown film process is the most effective way to boost productivity and output, and to improve the mechanical properties of the film. Thanks to a newly developed technology, direct dosing of $CaCO_3$ powder is now possible.

Evolution 3-layer Ultra Fusion Line producing yellow/black film with high amount of $CaCO_3$ powder for soil packing bags (figure: Reifenhäuser)

State-of-the-art blown film extrusion lines can process the most diverse raw materials: polyolefins, barrier and tie resins, as well as various additives, masterbatches and bio polymers. Generally, all these resins are available as pellets, produced within the reactor or compounded with additives in a second step before they are delivered to the converters. Film producers combine these resins, additives and masterbatches to produce miscellaneous blown films of up to 11 layers. Mineral modifiers offer the opportunity for more economic film production. At the same time mechanical properties of polyolefin films are improved which enables significant down-gauging. Here calcium carbonate ($CaCO_3$) represents the most popular mineral modifier.

Usually, $CaCO_3$ is added to polyolefins in form of masterbatches. However, some specific production lines allow direct dosage of $CaCO_3$ powder into pipes and polypropylene sheets.

With the Evolution Ultra Fusion Technology recently developed by Reifenhäuser Blown Film GmbH, Worms, Germany, it is now possible to directly add $CaCO_3$ powder to a blown film converting line. These lines working with the Ultra Fusion Technology are equipped with a special co-rotating twin-screw extruder, REItruder type (**Fig. 1**), and are designed as mono – or more advantageously – as 3-layer lines with two standard extruders for thin skin layers (**Title figure**).

A high-precision powder dosing system and the adapted mixing screw elements in the REItruder ensure the optimum filler distribution in the polymer melt (**Fig. 2**). Furthermore, an efficient vacuum degassing system is used for the removal of moisture in the raw material.

$CaCO_3$: a Natural Product

$CaCO_3$ represents the most significant mineral within the plastics industry and is unequivocally the most consumed, as it is used in numerous applications. From the most simple to the most demanding ap-

plications, $CaCO_3$ can be added to a variety of polymers, ranging from polyolefins to PVC, together with biopolymers, polystyrenes and polyurethanes.

$CaCO_3$ is a mineral frequently found as around 4% of the continental earth crust consists of it, for example in the form of chalk, limestone and marble. Rocks are extracted at a quarry and transformed into powder by milling, are strained and surface-treated. After these steps it is ready for its numerous uses in plastics applications. Due to the large number of $CaCO_3$ deposits, this mineral can be considered as a virtually inextinguishable raw material source.

It must be noted, however, that the selection of the right $CaCO_3$ powder type, i.e., the right specific particle size distribution, high purity and optimized surface treatment, is a prerequisite to obtain an outstanding performance in plastics applications.

Why Is $CaCO_3$ Used in Blown Film?

Apart from anti-blocking properties, calcium carbonate offers a wide variety of performances contributions, such as higher mechanical values and enhanced optical properties, or other specific features that are always combined with a high cost savings potential.

In addition, it modifies the physical properties within the polymer melt. Compared to unfilled polyolefins $CaCO_3$ has a substantially higher density, thermal conductivity and lower heat capacity and it remains in solid form during the extrusion process. Hence, the main features resulting from this are:

- Increase of the extruder output,
- reduction of the melt pressure and extruder torque,
- more efficient and as a result faster cooling of the film bubble,
- melt homogenization effect.

Summarizing, the addition of $CaCO_3$ in a blown film line is a simple and efficient way to increase productivity and output rates.

Fig. 1. REItruder (special co-rotating twin-screw extruder) installed in an Evolution 3-layer Blown Film Line (figure: Reifenhäuser)

Improved Film Properties

The addition of fine and surface-treated $CaCO_3$ into a semi-crystalline polymer matrix modifies the properties of a blown film, such as:

- Increase of stiffness,
- higher dart drop impact resistance,
- anti-blocking effect,
- higher tear propagation resistance (Elmendorf),
- improved barrier properties,
- slight increase in surface tension,
- non-stretched: rise of film density,
- stretched: reduction of the density and if desired with a permeation function.

The magnitude of the above mentioned changes in polymer properties strongly depends on the film formulation, film thickness, the mineral content, but also on the $CaCO_3$ type.

Prominent examples of blown film applications where $CaCO_3$ is successfully added include shopping bags, t-shirt bags, garbage bags, paper-like films, agricultural films, heavy-duty bags, and backsheet films.

Lower Formulation Cost

As the addition of $CaCO_3$ increases the film density, it is necessary to reduce the film thickness in order to keep a constant film weight, the so-called down-gauging. It must be noted that this increase is not in linear correlation with the mineral content. For example, with 30% $CaCO_3$ content, the required down-gauging will "only" be at a level of 20% to keep the film weight constant.

Increased Sustainability

Over the whole process chain there are additional energy savings. The Ultra Fusion Technology provides higher sustainability by admixing $CaCO_3$ powders. The process saves heat energy during extrusion, because these minerals have significant lower specific heat than polymers. From this results a smaller product carbon footprint and a significantly reduced environmental impact.

Advantages of Direct Dosage

The direct dosage of $CaCO_3$ allows substantial savings in raw material costs. The cost saving potential is »

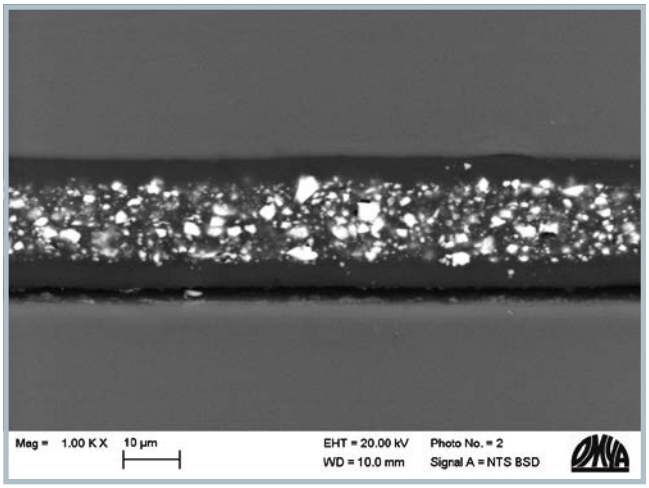

Fig. 2. SEM of blown film produced with the Ultra Fusion Technology and containing 35% of $CaCO_3$ (in this case with Omyafilm 707-AV from Omya International AG, Oftringen, Switzerland) in the middle layer (figure: Omya)

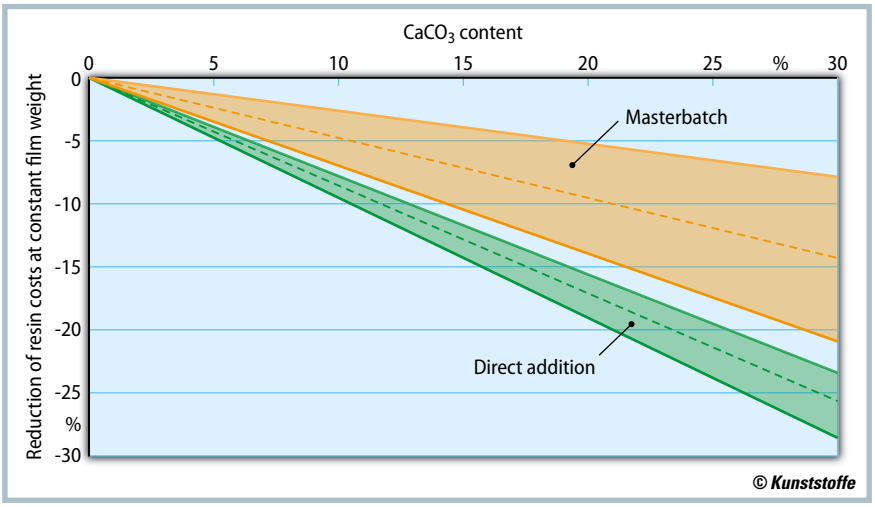

Fig. 3. Estimation of cost saving potential by adding $CaCO_3$ in blown film by keeping the film weight constant (for further information, please read the paragraph 4) (figure: Reifenhäuser)

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clearly illustrated in **Figure 3**. A polymer price of approximately 1,100 EUR/t was taken as a basis.

In the orange area the figure shows the savings potential by using a masterbatch with regard to a masterbatch price between 550 and 900 EUR/t.

The figure also illustrates, in green, the additional savings potential on material cost by using directly $CaCO_3$ powder via direct extrusion by using the Evolution Ultra Fusion Technology. This technology is very profitable, especially when the filler level needs to be high and the extrusion line output is of importance.

A further advantage of a direct extrusion solution is the opportunity to add directly other minerals such as TiO_2, making cost savings perhaps even more significant.

Also in cases where down-gauging is technically not feasible, direct extrusion of $CaCO_3$ will nevertheless offer potential cost savings together with improved mechanical properties through the reinforcement effect of the mineral.

Conclusion

The Evolution Ultra Fusion Technology offers the opportunity to successfully incorporate high amounts of $CaCO_3$ powder into blown films. This leads to significant cost savings due to the substitution of more expensive polymer resins. The positive effect of $CaCO_3$ on film properties enables significant film down-gauging, and in addition, the product carbon footprint of the film can be reduced. ■

Single Needle Valve Gate Nozzle with Minimum Process Risk

Ready-to-Install Complete Solution

Needle valve nozzles located centrally in the mold are always particularly challenging, since, due to the central melt feed, the drive cylinder cannot be positioned axially behind the valve. Now, a new single needle valve gate nozzle (type: SNV-06, SNV-12) with corresponding melt deflection is offered by **Hasco Hasenclever GmbH + Co. KG**, Lüdenscheid, Germany, as a ready-to-install unit with either hydraulic or pneumatic drive, including flange-mounted nozzle. The unit is particularly service friendly thanks to the use of standard and interchangeable components and identical installation spaces for both models.

The aforementioned single needle gate die is designed for use in nozzles of the TechniShot Z33 series. The pressure losses are low thanks to needle diameters from 2 to 6 mm and needle strokes of 8 and 12 mm respectively. Melt guidance, analogous to multi-cavity manifold systems, permits results from single-cavity molds to be applied directly to multicavity molds. The new heating concept with improved temperature distribution extends the range of applications to include engineering plastics, too. A uniform temperature profile right through to the gate is always ensured. Users benefit from easy installation and maintenance in the mold. The installation and process risks, and not least the time required to produce a mold, are therefore kept to a minimum.

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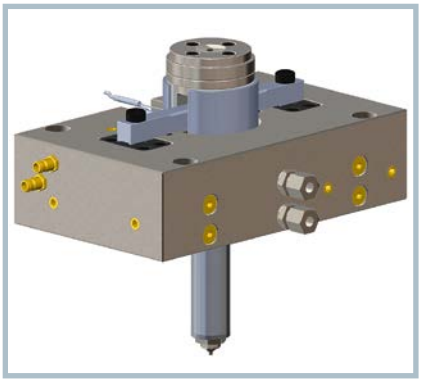

Fig. 1. The single needle gate valve nozzle is available as a ready-to-install unit with either hydraulic or pneumatic drive (figure: Hasco)

To the manufacturer's product presentation:
www.kunststoffe-international.com/976436