

À la Carte Input

Producing Sheet from Different Input Materials

Despite fluctuations in the quality of input materials, end products are expected to meet high quality standards, especially in the food sector. The wide range of products available on the fast-paced global PET packaging market calls for a high degree of versatility on the part of plastics converters. For this reason, it is necessary to have lines which have a short process chain capable of producing good quality and which can respond rapidly to different requirements.



Food-grade compliant and more: Post-consumer input material of variable quality and widely fluctuating moisture content is converted into FDA- and EFSA-compliant sheet

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In terms of sheet-surface area, the European market for plastic sheet is set to grow by 2.4% in the years ahead. This is the view of the GVM Gesellschaft für Verpackungsmarktforschung mbH in Mainz, Germany, in its current study "Flexible Plastic Packaging Market in Germany and Europe" which also discusses other trends and outlooks through to 2021. But it is not only the European sheet market which is growing. Plastic packaging for food and non-food products is gaining ground worldwide. After all, it offers very good product protection at a low weight. Aside from PE and PP sheet, PET sheet is in high demand because it not only is crystal-clear, but also has excellent mechanical properties and barrier values and is easy to process.

Regardless of whether the PET sheet is used for crystal-clear, transparent packaging for food and non-food articles, for blister packs, for thermoformed trays for biscuits, e.g., or as trays for fruit and vegetables, fresh fish or meat, it is always important to take the specific characteristics of the material into account. Many con-

verters produce a wide range of PET packaging based on sheet of all sizes, mono- and coextruded sheet, and sheet made from different polymer combinations and with a variable content of recycled material. Despite fluctuations in the quality of input materials, end products are expected to meet high quality standards, especially in the food sector, where products must be approved by the FDA (Food and Drug Administration), the EFSA (European Food Safety Authority) and others (**Title figure**).

Changing Requirements

PET extrusion lines from Gneuss too can cope with the variable requirements relating to input material and the intended end product (**see box on p. 78**). The thermoforming sheet lines are based on the GPU (Gneuss processing unit), which comprises an MRS extruder, rotary filtration system and viscometer (**Fig. 1**). This can process almost any input material without the need for pre-drying or crystallizing and without any modification work. The

range extends from food-safe monoextruded sheet made from 100% post-consumer bottle flakes to coextruded sheet, to liquid-coated and laminated sheet. Typical applications operate at 350 to 2000 kg/h and produce sheet widths of up to 2m and thicknesses of usually between 0.15 and 1.2mm. In addition to bottle flakes and pellets, regrind from skeletal waste and edge trim obtained from PET, coextruded PET-G/rPET/PET-G and PET-PE laminated sheet can serve as feedstock (**Fig. 2**). The main reason why this is possible is that all the individual components are matched to each other and to requirements. Processing is direct and gentle (no pre-drying, crystallizing or introduction of frictional heat), making it possible to directly process materials and blends with all kinds of melt temperatures, such as PET/PE or PET/PET-G (glycol-modified polyethylene terephthalate).

The Multi Rotation System

The Multi Rotation System (MRS) extruder consists of a drum containing eight screws embedded in barrels parallel to the main screw axis. These are driven by a ring gear which rotates them in the opposite direction to the extruder drum and constantly renews the already large melt surface area. The system is thus capable of delivering a high devolatilization and decontamination performance. Thanks to the rapid surface area renewal, a vacuum of around 25 mbar is enough to remove all moisture from the material. The processing unit can thus handle input materials economically as they need neither pre-drying nor crystallizing. This applies as much to virgin material as to post-consumer bottle flakes with input moisture contents of more than 1% and to mixtures of different materials such as PET and PE or PET and PET-G. Even sheet made solely from recycled material can achieve FDA or EFSA approval as a result and may be re-used in the food industry. The gentle melt homogenization also benefits the optical properties of sheet made from recycled material.

A wide range of materials can be used. For example, many sheet manufacturers not only use different PET grades and re-generated material from different material streams, they also incorporate edge trim from the production of PET/PE laminating sheet. They are able to do so because the MRS extruder does not require materials to be pre-treated. In contrast, conventional drying systems suffer from the fact that PE has a lower softening temperature than PET and so are prone sticking or blocking, which hampers processing. Other sheet raw materials such as PP, PS and PLA can also be processed.

Complemented by Filters and Viscometer

Melt purification is carried out not only in the MRS extruder, but also in the rotating melt filter downstream of the extruder. The lines typically have an RSFgenius filter with filtration finenesses of 40, 56 and up to 160 μm , depending on requirements, which produces a clean melt devoid of foreign bodies and specks, as this is essential for using recycled material and producing transparent



Fig. 1. An integral component of a sheet line: the Gneuss Processing Unit (GPU) with MRS 200, RSFgenius 200 and VIS © Gneuss

sheet. Another component is the online viscometer whose control system ensures that the viscosity of the melt corresponds to the set target value. The control variable is the vacuum in the extruder. This means that different viscosities can also be set for different end applications, a feature that satisfies the demand for high line versatility. Thermoforming applications require a melt with a narrow molecular weight distribution as that yields sheet with high toughness, high strength and low brittleness. Precisely this is delivered by the MRS through its combination of large melt surface area, good homogenization and constant melt surface area renewal under vacuum.

Practical Examples of Turn-Key Plants

In recent years, Gneuss has installed a series of thermoforming sheet lines worldwide for FDA-compliant food packaging made with up to 100% PET bottle flakes. The lines vary in size from 400 to 2000 kg/h PET and can handle sheet widths ranging from 450 to 1950 mm and thicknesses of 150 to 1600 μm .

A regular customer in Florida, USA, operates five MRS 130 and MRS 160 PET sheet extrusion lines that produce clamshell packaging for fruit, vegetables and eggs from bottle flakes and in-house sheet regrind. This customer values the fact that the MRS extruder has FDA approval for

monosheet, as this renders co-extrusion for the purpose of embedding the recycling material superfluous; the sheet is then treated in a silicone bath which produces an antiblocking coating on the outer layer. The lines are less complex and easier to operate as a result.

A compact MRS 200 was supplied to a further Gneuss customer in California, as a customer-specific solution for installation into a sheet line. Due to the limited space, it was necessary to realize an extrusion part as short as possible. This MRS 200 provides a throughput rate of 2000 kg/h and is used for the manufacture of PET sheet rolls for thermoformed food packaging. This customer, too, typically employs rPET in the form of bottle flakes and sheet regrind of variable quality.

Another US converter who processes rPET into a large number of product variants such as cups, dessert bowls and containers with different compartments and configurations opted for an MRS 130 mono-extrusion line capable of 1000 kg/h. The direct processing capability supports fast changes of formulation, material and color and saves on input material.

Countless Product Variants and Different Input Materials

An Eastern European user produces a wide range of PET sheet for thermoforming applications from rPET, as well as laminated PET/PE sheet and laminated »

Company Profile

Gneuss Kunststofftechnik GmbH, Bad Oeynhausen, Germany, has been offering technologies, systems and components for plastics processing for over 30 years. The company has established itself in the sheet extrusion sector in recent years, supplying more than 20 tailor-made sheet lines which will operate flexibly with both virgin and recycled material to produce packaging sheet intended primarily for food contact. The machinery company can furnish an entire line with upstream and downstream equipment – from material metering to sheet die, to polishing stack to wind-up – tailored to the wishes of the sheet manufacturer.

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PET/EVOH/PE sheet – this diversity places high demands on the sheet extrusion line from extrusion section to winder. The sheet line has a total capacity of 1750 kg/h and produces sheet across the thickness spectrum from 150 to 1200 µm in widths 450 to 1800 mm. For this purpose, both the sheet die and the slitting and winding station have a versatile design: the sheet die features an automatic lip adjustment system which operates in a control loop with the thickness gauge system to ensure narrow sheet tolerances. Thanks to an internal deckling system, the useful width of the sheet can be deckled by up to 300 mm per side, with the deckle blades adjustable from the outside by means of a spindle system. The sheet die and the downstream 3-roll polishing stack are matched to each other. The melt enters the lower polishing nip tangentially at an angle of 40°; this configuration has proven to be particularly advantageous for producing low-tension, high-quality PET sheet that can be easily thermoformed.

Furthermore, the entire line is equipped with an inline laminating station, in which, e.g., a PE sealing layer can be laminated onto the PET sheet, further expanding the range of sheet that can be produced. Laminating, peel and barrier sheet can also be produced. The slitting and winding system also provides the desired level of versatility. High precision rotary knives ensure clean edge and reel

slitting free from burrs. Up to four different webs can be wound. The winder works with four winding stations because the system is equipped with split, bilaterally driven winding shafts. This makes it possible to wind two reels on one winding shaft under a defined, constant tension without the need for friction-winding shafts.

Upstream of the line is a short crystallizing section for homogenizing the bulk densities of both the large quantities of PET bottle flakes and the regrind. This sheet manufacturer benefits especially from the fact that he can process laminated PET/PE sheet regrind directly and, in particular, can blend PET and PE very homogeneously. Consequently, instead of having to dispose of this material, he can use it to produce colored products or egg boxes, for which transparency is not essential.

Specific Uses of the Technology

Plastics converters exploit the advantages of this technology in very specific ways, with each sheet line meeting individual requirements. For example, a German customer uses an MRS 130 system specifically to process mixtures of different polymer regrind of a particular composition. As the softening temperatures are all different, this formulation can only be processed directly, i.e. without any pre-treatment, and so conventional systems are ruled out.

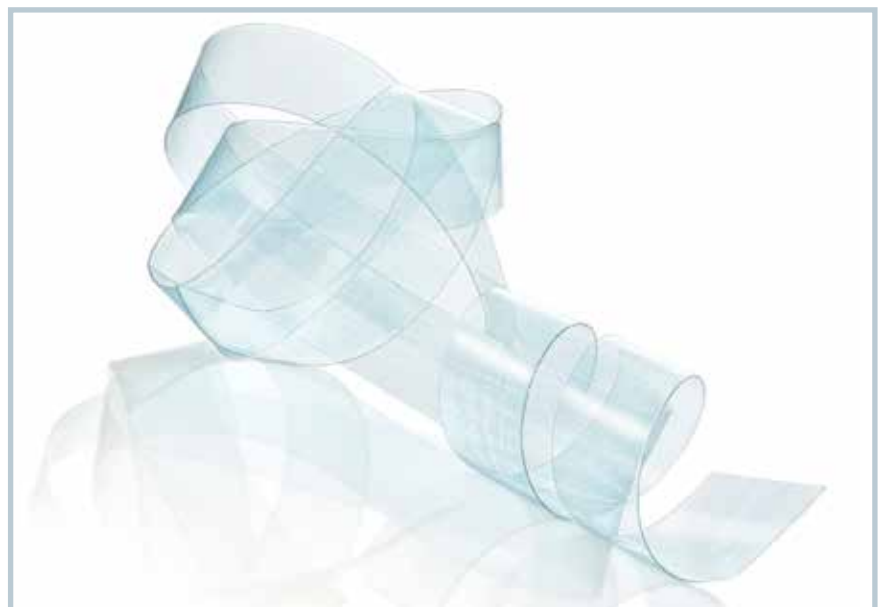


Fig. 2. Edge trim: In addition to bottle flakes and pellets, many converters also want to process regrind from skeletal waste and edge trim direct (© Gneuss)

A customer in the United Kingdom achieved a certain level of flexibility over input material by combining a new GPU comprising two MRS coextruders with equipment of an existing downstream section (Fig. 3). The high devolatilization and decontamination performance of the MRS extruders enables post-consumer input material of variable quality and widely fluctuating moisture levels to be processed and converted into food-grade FDA- and EFSA-compliant sheet. The sheet line mainly co-extrudes 3-layer sheet, with recycled material capable of being used in all layers. The coextruded outer layers provide functionality and color (e.g. antiblocking function). The main extruder is an MRS 130 (1000 kg/h) while the coextruder is an MRS 90 (400 kg/h); the processing unit has a total capacity of 1400 kg/h. Both extrusion systems are equipped with a rotary melt filtration system with backflushing function to allow for consistent processing of recycled material.

A large number of Gneuss sheet customers are located in South America, where they are taking advantage of the MRS extruder's capability to produce FDA-approved sheet and packaging with just a monolayer structure. Typically, they use MRS 90, 110 and 130 machines capable of 400, 600 and 1000 kg/h. However, every customer has individual requirements. Thus, a customer in Argentina uses an MRS 110 sheet line to manufacture not only packaging made of recycled APET for catering purposes, but also CPET products that can be used in microwave ovens. Other customers have sorting and washing facilities and produce their own bottle flakes which are converted directly into sheet and packaging. For example, a Brazilian processor uses in-house rPET to produce sheet on an MRS 130 line and then thermoforms the sheet in-house into packaging for bakery products, fruit and sushi. Again, a customer in Colombia processes not only rPET but also PP on his MRS 130 line. Materials are changed on the fly, without the need for any modifications at all. This means that it is possible to make products which possess very different properties on a single machine. Similarly, another packaging manufacturer from Colombia uses an MRS 90 sheet line to convert rPET, PP, and PS into sheet for packaging cakes, salads and fruit bowls. A Brazilian customer uses the gentle direct



Fig. 3. Integration of a coextrusion line into an existing sheet downstream section (© Gneuss)

processing method without pre-drying, crystallization or use of frictional heat to process PET/PET-G and PET/PE regrind on an MRS 130 line.

Switching from Compact Sheet to Foam Sheet

Even sheet extrusion lines can be quickly switched to producing physically foamed sheet. Thanks to the extremely good mixing properties of the MRS extruder, the nucleating and blowing agents are dissolved and distributed homogeneously in the melt. After extrusion and filtration, the melt is conditioned until it has the right viscosity and strength. This ensures that, as the polymer emerges from the die, it foams with the required density reduction. The MRS foam module can convert 100% post-consumer material, regrind, virgin material and combinations of these into foam sheet with a density reduction of more than 50%, while maintaining the same mechanical properties. PET foam sheet can be used for economically manufacturing such diverse products for the food industry as packaging, cups, plates and lids. The effect of foaming sheet is to reduce the density and hence the raw material costs compared with rigid sheet. As required, the density reduction can serve to increase the linear sheet output rate or reduce material input or permit a thicker sheet to be made from the same amount of material.

Conclusion

Manufacturers of plastic sheet and packaging are engaged in stiff competition and margins are low. Complete lines featuring MRS extruders offer sheet manufacturers high flexibility in terms of both the raw material inputs and the sheet product. Especially in view of fluctuating raw material prices, uncertain availability of material streams and variable regrind quality, it is essential for a sheet processing line to be versatile. The same applies to the changing demands which the market imposes on the sheet products themselves: even in the highly competitive packaging market, the ability to respond rapidly offers a chance to participate in long-term market growth with food-grade and nonfood-grade sheet. ■