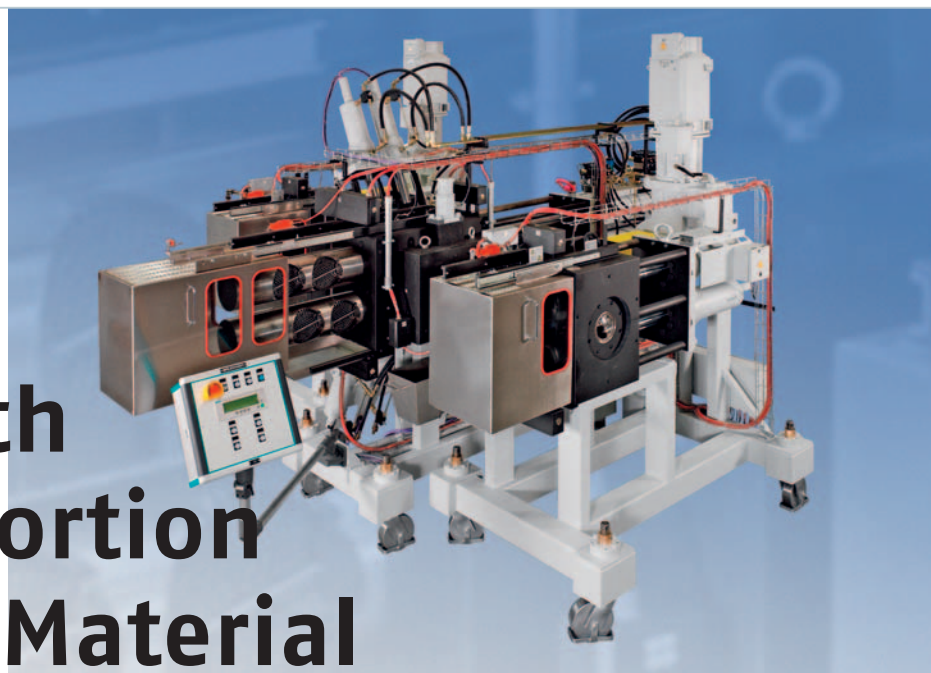


Discharge unit
with melt filter
and melt pumps



PET Film with a High Proportion of Recycled Material

Without Preliminary Drying. The combination of high-performance extrusion equipment with innovative filtration technology results in an overall concept that makes it possible to economically produce PET film with a high proportion of recycled material.

**UWE JEBSEN
STEFAN WÖSTMANN**

The amount of rigid packaging made from PET continues to grow. Form-fill-seal (FFS) applications in particular are driving the demand for PET film at an above-average rate. Form-sill-seal machines produce, fill and seal PET film packaging in a single operation. An increasing number of film manufacturers are replacing virgin PET resin with reclaimed material from bottle flakes (PET-R). Use of PET-R lowers product costs considerably. Growing environmental awareness, improved availability of reclaimed PET material from bottles as well as innovative solutions regarding processing are accompanying this development. As a result, use of reclaimed PET in film production has increased significantly in the past four years (Figs. 1+2).

Given this market trend, manufacturers of plastic-processing machinery face the challenge of developing new system concepts to permit direct extrusion of bottle regrind into high-quality products. These high-performance cast film lines process both virgin resin (PET-A) as well

as reclaim (PET-R) into PET film productively and flexibly. By way of example, Table 1 summarises the material specifications for reclaim from beverage bottles for processing on a cast film line. Fig. 3 shows an example of the layout of such a high-performance extrusion system with its components.

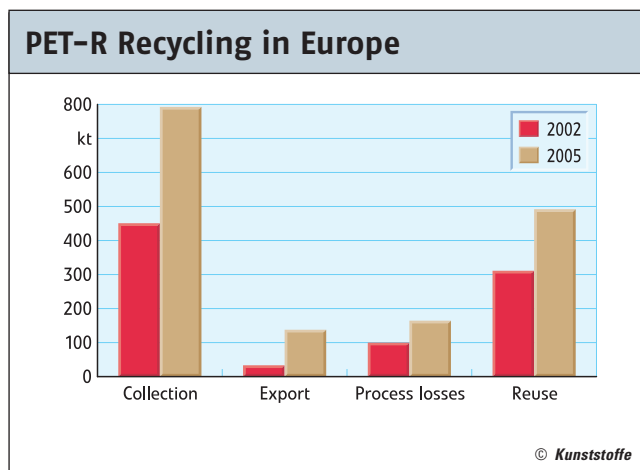
Working together, Brückner Formtec GmbH (BFT) and Kreyenberg GmbH have developed an innovative overall concept to master the technical challenges associated with creating a high-performance system to produce cast film from PET-A and PET-R. This joint effort com-

bined the competencies of BFT in the field of PET-A cast film lines without predrying and the know-how of Kreyenberg in the field of melt control and filtration systems for PET-R cast film lines.

Metering and Extrusion

Metering of the individual components takes place via separate gravimetric weight feeders. Reliable metering of PET flakes with their low bulk density receives special attention. Two twin-screw extruders with specially designed processing sections permit high extrusion rates.

Fig. 1. Reprocessing of PET bottle reclaim
(source: Petcore)



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polishing stack

For an overall extrusion rate of up to 2,000 kg/h, extruders with screw diameters of 105 mm and 60 mm are used. With screw diameters of 120 mm and 75 mm, an overall extrusion rate of up to 3,000 kg/h can be attained. The L/D ratio in all machines is 34:1.

A high vacuum is achieved through use of a two-stage, dry-running modular vacuum system with process air cooling and a process air filter. The modular concept permits connection of several units in parallel to provide the necessary suction volume. The primary extruder and the coextruder are usually served by independent vacuum systems. In this way, the vacuum can be adjusted individually to process requirements.

Melt Filtration

Based on the tried-and-true basic principle employed in the piston screen changer, Kreyenberg developed a novel, patented filtration concept with which even

highly contaminated melts can be filtered effectively and at constant pressure in sensitive extrusion processes. The filter elements can be cleaned via backflushing during ongoing production with minimal pressure fluctuation in the process. The discharge unit consists of a pump protection filter with attached pressure build-up pump, a backflushing filter with a downstream microfiltration stage as well as a second melt pump, which fulfils the function of

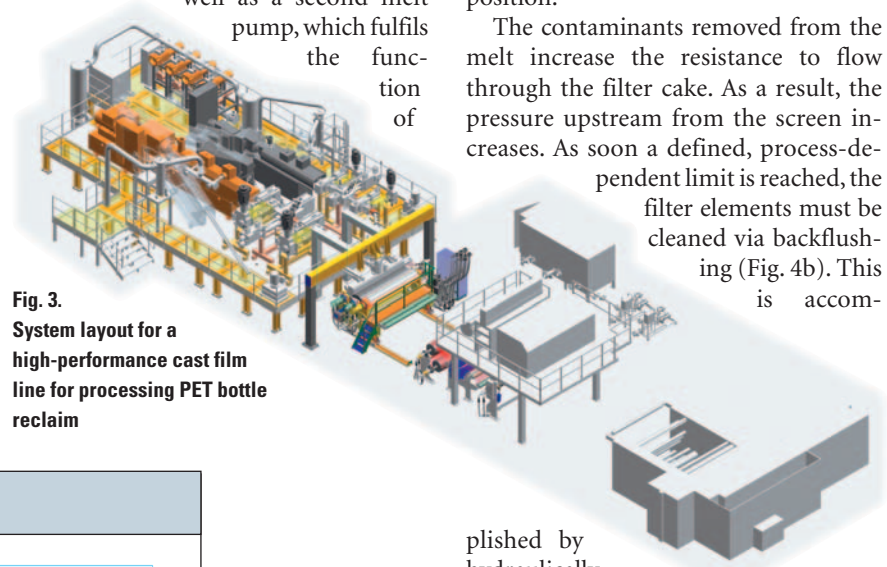


Fig. 3. System layout for a high-performance cast film line for processing PET bottle reclaim

a spinning pump. These two melt pumps define the controlling system limits for filtration and guarantee a constant volume flow at the die.

Melt is taken from the process as back-flushing material to clean the screens. Large filter areas are needed especially with highly contaminated polymer melts. This results in an unfavourable ratio of flushing material to overall throughput. The novel filtration concept combines the requirements for a large filter area, controlled removal of material from the extrusion process and effective backflushing. In this way, the requirements for processing bottle reclaim are met.

In the K-SWE-4K-V-RS screen changer (Fig. 4a) the melt passes through four screens. The heated steel housing holds two sliding screen support pistons (arranged transverse to the melt flow) each of which has two filter units. At the material inlet, the melt stream is split into four channels that feed into one screen cavity each. After filtration in the screen support piston, these partial melt streams are recombined in the housing. The outlet channel from each screen cavity has a backflushing piston which forms a smooth flow channel with no protruding edges when retracted to the production position.

The contaminants removed from the melt increase the resistance to flow through the filter cake. As a result, the pressure upstream from the screen increases. As soon a defined, process-dependent limit is reached, the filter elements must be cleaned via backflushing (Fig. 4b). This is accom-

plished by hydraulically pushing the back-flushing piston into the forward position at an adjustable speed to flush the contaminants to the outside through the flushing channel and flushing valve. Corresponding controls ensure that the melt flowing towards the die is not affected by this operation. The amount flushed always remains constant, so that the contaminants are reliably removed from the screen cavity. Fig. 5 shows the contaminants that were flushed from one screen

Reuse of PET-R in Europe

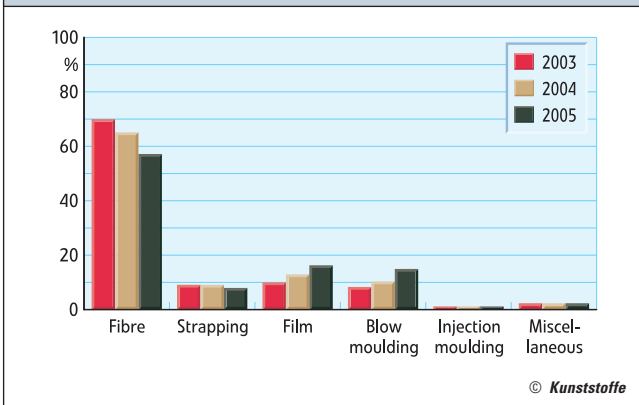
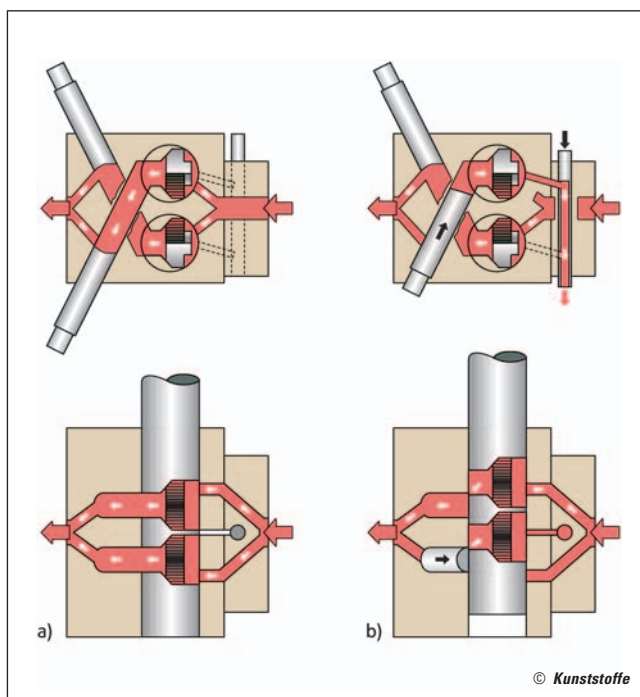


Fig. 2. Use of PET bottle reclaim (source: Petcore)

Fig. 4. Schematic representation of how the Model K-SWE-4K-V/RS screen changer functions



cavity. The aluminium particles and burned organic matter are clearly recognizable in the PET melt.

Following flushing, the screen support piston is returned to the production position, while the flushing piston is pushed back to the retracted position by the melt pressure with some hydraulic assistance. Removal of material from the process, which causes pressure fluctuations, is thus extended over a long, adjustable period of time. An intervention limit is incorpo-

rated into the control loop, so that the equipment operator can define a maximum deviation from the pressure that is to be held constant. This means that the amount of material being diverted into the discharge channel, which leads to a pressure drop, is reduced as soon as the intervention limit is reached. Propagation of these slight pressure deviations to the die is prevented by the second melt pump (spinning pump), which functions as a limit on the system.

Film Die and Polishing Stack

The melt is distributed in a high-precision T-die that is optionally available with adjustable internal decking to provide different final film widths. The die bolt control system features a self-optimising control algorithm and reduces thickness variations in the profile to a minimum.

The horizontal 3-roll polishing stack has been specially designed to provide a high cooling capacity and features a polishing roll with adjustable crowning (Jubo technology, Fig. 6). The lineal force in the polishing nip is thus kept constant over the entire working width. This results in uniform distribution of the melt. By pressurising a closed internal hydraulic chamber, the crowning of the polishing roll is preset under defined conditions. This permits complete compensation for polishing roll and chill roll deflection. If production conditions change, the preset crowning of the polishing roll can be adjusted by making a slight change to the water temperature in the outer cooling channel. In conjunction with any additional chill rolls that may be necessary, the post-cooling roll in the polishing stack ensures a uniform temperature over the film cross-section.

Thickness Measurement, Take-off and Winding

Film thickness gauging is fully integrated into the process control and visualisation

| Material | PET bottle reclaim for producing spun fibre via direct extrusion | PET bottle reclaim for producing cast film via direct extrusion | PET-A pellets for producing cast film via direct extrusion |
|------------------------------------|--|---|--|
| Physical condition | amorphous flake 1–20 mm | amorphous flake 1–20 mm | amorph or crystalline pellets 2.5 mm |
| Origin | post-consumer PET beverage bottles | post-consumer PET beverage bottles | virgin resin |
| Amount in recipe [%] | 0–100 | 0–100 | 0–100 |
| Viscosity – IV [dl/g] | 0.7–0.9 | 0.7–0.9 | 0.75–0.81 |
| Bulk density [kg/dm ³] | 0.25–0.5 | 0.25–0.5 | 0.75–0.85 |
| Residual moisture, undried [ppm] | 3,000–5,000 | 3,000–5,000 | < 3,000 |
| Dust [%] | ≤ 1 | ≤ 1 | ≤ 1 |
| Contaminant – PE; PP [%] | ≤ 6 | ≤ 6 | |
| Contaminant – PVC [ppm] | ≤ 300 | ≤ 10 | |
| Contaminant – metal [ppm] | ≤ 100 | ≤ 20 | |
| Contaminant – paper [ppm] | ≤ 100 | ≤ 10 | |
| Contaminant – other polymers [ppm] | ≤ 50 | ≤ 50 | |
| Contaminant – adhesive [ppm] | ≤ 20 | ≤ 20 | |
| Contaminant – other polymers [ppm] | ≤ 50 | ≤ 50 | |

Table 1. Material specification for PET

system. In accordance with customer specifications, conventional thickness gauges with radionuclide sources, capacitive or inductive systems are used for thickness measurement. An intermediate take-off acts to isolate the tension between the polishing stack and the winder. The polishing process is thus not adversely affected by the winding process. The film winder must be designed for small roll diameters in order to permit short cycle times. An automatic turret winder with multiple slitting and fully automatic roll handling is the correct approach here.

The entire cast film line is operated by the process control and visualisation system (IPC). It offers freely configurable trend displays, lock indicators for the op-



Fig. 5. Organic contaminants and aluminium particles in the backflushed material from processing PET bottle reclaim

erator as well as maintenance and service support via integrated electrical schematics. Additional software modules allow the process and product data to be linked to external enterprise resource planning (ERP) systems. It is thus possible to incorporate the high-performance cast film line more efficiently into overall production planning.

Summary

High-performance systems for producing PET-A and PET-R film meet the requirements for an attractive price/performance ratio. The filtration concept permits use of up to 100 % PET bottle reclaim for high system throughput at a high quality level. The integrated process control and visualisation system helps the operator to reliably adjust all components of the high-performance system to the conditions needed for cast film production. Stored recipes and machine settings are retrievable for further additional or

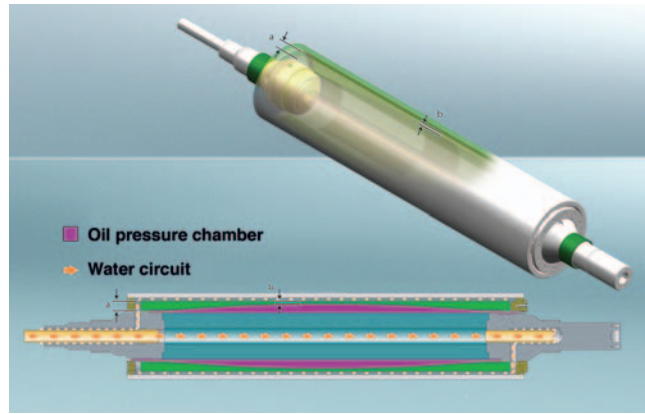


Fig. 6. Schematic illustration of a Jubo polishing roll

similar product requirements. The flexibility and productivity of this system concept thus puts PET film manufacturers in a position to satisfy the changing requirements resulting from global competition. ■

REFERENCES

- 1 Wöstmann, S.: Stable and Cost-effective Filtration. *Kunststoffe international* 95 (2005) 2, Document Number PE103189
- 2 Wöstmann, S.: Melt Filtration at Constant

- Pressure. *Kunststoffe international* 95 (2005) 8, Document Number PE103325
- 3 Thiele, U.: High Performance Products from PET Bottles Flakes, *PRF Forum* 10/2006

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Melt filtration with screen changers and pumps from Kreyenberg

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