A Jump Reaction

Quick and Cost-Effective Processing of PET Industrial Wastes

Although extruders can process high volumes of contaminated PET industrial wastes from the fiber, nonwovens or film production, they generally cannot return the residues directly to the production process. The PET melt achieves the necessary viscosity particularly cost-effectively thanks to a new and compact unit.

During the production of intermediates such as fibers, nonwovens and films, wastes are created along the whole process chain. Waste volumes of 1 to 2% are not unusual. On a fiber line with a production capacity of 500 t per day, for example, the waste volume totals 5 t.

Particularly in the fiber industry these wastes are frequently contaminated with the preparation oils used to ensure a good spinning result. Furthermore, wastes resulting from a broken fiber or a filter change at the spinneret are very high-volume wastes with a low density between 20 and 100 g/l. While the intrinsic viscosity (IV) of these ready spun PET fibers lies in the order of 0.6-0.65 dl/g, the start-up and headwaste lumps from industrial lines show far lower IV values, in extreme cases of only 0.4 dl/g. An overall concept is therefore required that can process both inhomogeneous and contaminated PET wastes.

The overall process for treating such industrial wastes developed by Gneuss Kunststofftechnik GmbH, Bad Oeynhausen, Germany, comprises two main steps which change the IV value of the PET melt: After melting and cleaning, it must first be homogenized and then raised to the level required for the particular application. The first step can take place in a Gneuss Processing Unit (GPU) comprising MRS Extruder (Multi-Rotation System), rotating melt filter and Online Viscometer VIS with viscosity monitoring and control. After this processing, the PET melt has until now first had to be transformed into pellets before the chain length of the polymers, and hence the IV value, was subsequently raised in a solid state polymerization phase (SSP). A faster and more cost-effective alternative here is offered by the Jump Reactor from Gneuss that can be flanged directly to the extrusion unit to increase the viscosity of the PET melt by up to 0.3 dl/g. As the melt does not have to be reheated, the compact unit saves energy. Furthermore, the reaction speed in the melt phase is considerably higher than in the solid phase, thus also contributing greater cost-effectiveness.

Throughput between 100 and 2000 kg/h: The Jump Reactor is available in various sizes and can recycle not only industrial wastes but also post-consumer PET bottles to films, fibers, packaging tapes or new PET bottles (© Gneuss)

The Process in Detail

Shredders or granulators – depending on the quality – first bring the industrial wastes to a meterable size. In order that the high-volume fiber residues can be fed into the MRS extruder, they either have to be compacted in a further process step or fed into the extruder using stuffing screws. The first important step – the melt cleaning – now takes place in »

Online Viscometer: VIS can not only monitor but also control the viscosity of the melt

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the extruder. The Multi-Rotation System extruder employed has a high decontamination and degassing performance so that even heavily contaminated and damp wastes can be directly charged without further processing. In the multi-rotation drum, several individual screws provide a large melt surface area and a high surface renewal rate so that a good result can be obtained here even with conventional vacuum pumps, and volatile foreign matter such as water and spinning oils can be reliably removed. Solid contaminants are subsequently removed in a rotating melt filter. Rotary filters operate continuously in a constant process and, if required, automatically. Their filtration screens with mesh sizes down to below 20 µm remove particles from the melt.

Precise Setting of the Viscosity

An important role in the complete line is played by the Online Viscometer VIS that not only measures but also controls the viscosity of the melt in the MRS extruder. With materials having varying residual moisture contents and starting qualities it is possible in this way to keep the melt viscosity – and hence the IV value of the finished product – within close tolerances.

Depending on the application it can be expedient to partially degrade the polymer through a selective addition of glycol or water in order to set an IV value of, for example, 0.3 or 0.5 dl/g. The Online Viscometer thereby ensures an adequate dwell time of the melt in the extruder and adapts the level of the applied vacuum. A melt pump subsequently feeds the cleaned and homogenized melt into the Jump unit where the second important step in the overall process takes place. Here again, the size of the melt surface area and the dwell time of the melt in the reactor play crucial roles.

Constant Surface Renewal

The melt passes through several slowly rotating elements so that a polymer film is formed whose surface is constantly renewed. The reactor is under a vacuum that removes glycol and other volatile constituents from the melt. Via the process parameters dwell time in the reactor (10 to 100 min), applied vacuum and rotational frequency of the installed elements it is possible to selectively influence the polycondensation reaction within wide limits and to increase the IV value of the PET melt by up to 0.3 dl/g.

Thanks to the design of the system, the intake of oxygen is ruled out, effectively preventing any yellowing of the PET melt. After passing through a settling section, a delivery pump feeds the melt directly into the production process or a pelletizing line.

The complete line of Gneuss Processing Unit with MRS Extruder and Jump Reactor is very compact and operates efficiently, as no renewed heat input is necessary. It allows industrial wastes to be converted into a high quality and immediately chargeable melt within a minimum of time. Thanks to the flexibility of the line, it can also produce different PET grades. It is thus a compact, cost-effective and fast variant to conventional SSP lines and allows the wastes to be directly returned to the production process. ■

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