RECYCLING TECHNOLOGY

Starlinger

RECYCLING TECHNOLOGY FOR FIBER & NONWOVENS

for filament, fiber, yarn, spunbond, meltblown, needle punch, PP, PES, PA and multi-component material, **ultra fine filtration,** broad viscosity range (MFI 25 – 2,000, IV 0.5 – 0.9)

Increasing competitiveness & value *through recycling*

A variety of economic factors such as rising resin prices, cost reduction pressure and stronger competition have led to higher awareness concerning production costs. Production and post-consumer scrap are valuable secondary resources: Recycling is the first step into a second life cycle.

Since the late 19th century man-made fibers have widely replaced natural fibers because of definable characteristics such as greater comfort, easier dyeability, strength-to-weight properties and others.

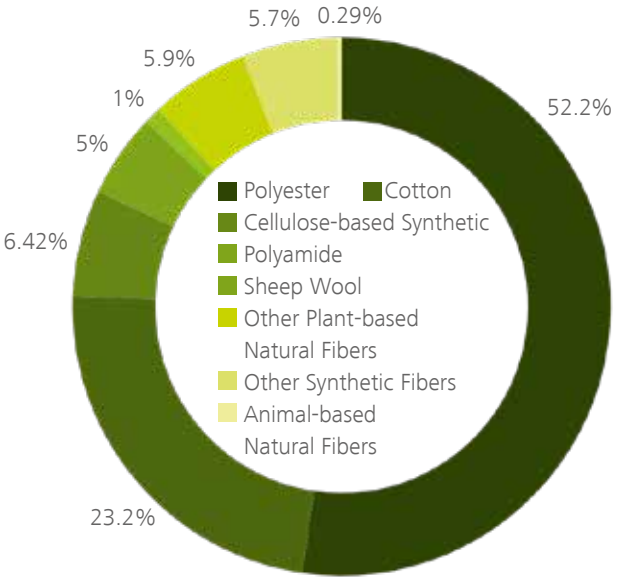
Man-made fibers find application in consumer products such as apparel, home furnishing and stuffing, as well as industrial products for the automotive, filtration, and building industries, amongst others. Nonwovens are used in hygiene products, agriculture and household, health and personal care, partially substituting other materials.

Like other industries, fiber and non-woven production is under tight competition, pushing for cost efficiency. Primary resin is a considerable cost factor. Although zero scrap in production is the goal, it is not fully achievable. Consequently, recycling of production scrap considerably contributes to competitiveness. At the same time, environmental consciousness and resource conservation call for recycling, but quality requirements in the industry are very high.

Thus, the challenge is to provide equipment that can handle a variety of in-house production scrap with different characteristics whilst ensuring that regranulate added even in high proportions does not negatively influence the production process.

Starlinger provides ongoing plastic recycling innovation, quality and state-of the-art technology as well as a full range of consulting services and optimization on site.

Global Market Share by Fiber Type



Source: Von Faser zu Faser. Recycling Magazin, October 2024 issue

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Nonwovens recycling: *transforming production scrap into a secondary resource*

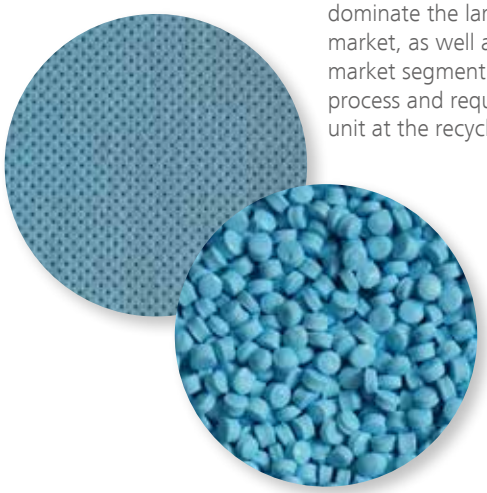
Production scrap accrues throughout the process chain, from start-up scrap to off-spec material and conversion scrap. During material handling and storage, the scrap can get wet and contaminated. Also, the nonwoven can be one type of plastic or a mixture of materials and may have different viscosities. Due to the fact that nonwoven production waste comes in different shapes it is necessary to recycle it into pellets to make it suitable for reuse. For this, high quality is decisive: A production stop caused by less than perfect regranulate is costly and jeopardizes the economic benefits of processing and reusing the production scrap. In this case, in-house recycling provides an opportunity for complete quality control.

Selecting the right recycling equipment

The input material and intended use of the regranulate are important factors for choosing the right recycling equipment. The modular design of Starlinger recycling solutions for processing nonwoven production scrap ensures the required flexibility for handling the full variety of materials, no matter their type or characteristics. The recoSTAR dynamic recycling line densifies and preheats the material before extrusion, allowing a higher moisture content of the input material. The recoSTAR universal recycling line facilitates the processing of hard-to-grind materials like fiber bales without pre-cutting. To separate the components of polymer mixtures such as PES/PE or polymer/cellulose compounds, special filtration is applied.

An optimized recycling process makes it possible to use 100 % regranulate in nonwovens production with no noticeable difference in ease of processing, and no loss of quality in the final product.

PP spunbond (SB) nonwovens dominate the large hygiene market, as well as the building market segment. They are easy to process and require no degassing unit at the recycling line.



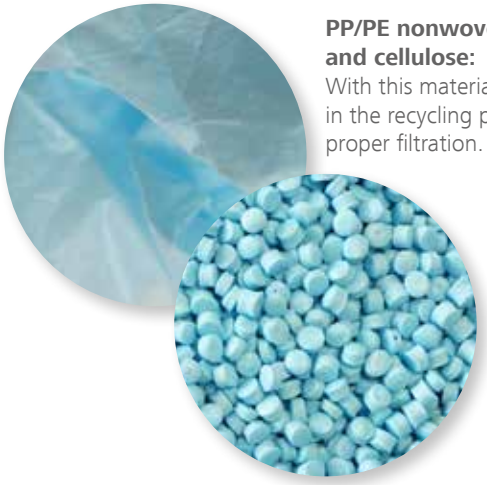
PP SMS nonwovens, a combination of two layers spunbond with one layer melt-blown nonwovens inside (spunbond-meltblown-spunbond), require a degassing unit and an underwater pelletizer in case the MFI is > 80 g/10 min.

PP meltblown nonwovens are made of fibers that are smaller in denier than those found in other nonwovens. Due to the high MFI, an automatic strand pelletising unit is required.

PE/PP bicomponent spunbond nonwovens: The sheath (outside) is PE for softness, the core (inside) is PP for strength. A special screw geometry is required for the recycling process.

PET nonwovens are best recycled on the recoSTAR dynamic recycling line with high vacuum degassing. If the IV is increased in the SSP afterwards, a higher reuse percentage is possible.

PP/PE nonwovens with paper and cellulose:
With this material, the challenge in the recycling process lies in the proper filtration.



Filament & fiber recycling: *high-tech solutions for a variety of applications*

More and more fiber producers and plastics recyclers have started to recycle fiber and fabric scrap from industrial production and post-consumer collection.

Many brand owners integrate recycled plastics in their products as part of their sustainability strategy, following increasing demand from consumers for "green" products. Also, the use of recycled granulate helps to reduce material costs significantly, creating an additional incentive for both producers and recyclers.

Selecting the right recycling equipment

The input material and intended use of the regranulate are important factors for choosing the right recycling equipment. For PES fiber recycling applications Starlinger recycling technoloy provides special machine features such as drying before extrusion, high-vacuum degassing and fine melt filtration. Also, solid stating for IV increase in the produced pellets can be supplied if necessary to achieve the characteristics required for reuse.

One challenge of using post-consumer material in fiber and filament production is the required filtration fineness. By cascade filtration, coarse contaminants are filtered out in the first melt filter. After a melt pump, fine filtration down to 15 µm is possible in the second melt filter. To separate polymers of composites, e.g. PES/PE or cellulose, melt filtration with power backflush or continuous melt filtration is provided.

All recoSTAR lines can be equipped with dosing units for additives in pellet, powder or liquid form to change the characteristics of the regranulate. Consequently, the end product matches the requirements of the customer exactly.

PP staple fibers are easily recycled on the recoSTAR universal recycling line with ACTIVE shredder for optimal pre-cutting before extrusion.

PA 6 fibers need drying before extrusion due to their hydrolytical properties. Optional air flushing during material preparation is available for both, recoSTAR dynamic and universal lines.

PET staple fibers can contain up to 30 % moisture. The Starlinger recycling solution provides an additional drying step in the ACTIVE shredder with subsequent drying and processing on the recoSTAR dynamic recycling line.

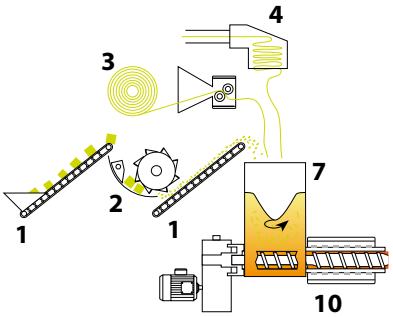
PA 6.6 fibers need to be prepared and dried before extrusion. Air-flushing during cutting and feeding is recommended. The extruder is equipped with advanced degassing sections and an automatic strand pelletising unit.

PET continuous filament is processed on the recoSTAR universal recycling line for perfect colour, or on the recoSTAR dynamic recycling line for a higher IV, depending on the intended reuse.

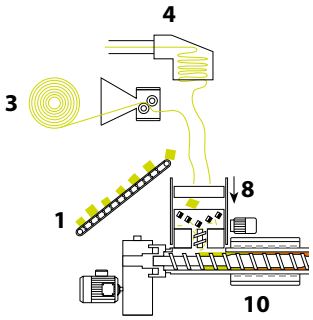
Sheared-off carpet face yarns are post-consumer BCF fibers that can be made from PP, PA or PES. Apart from the polymer-specific processing conditions a special focus has to be put on melt filtration to remove solid contaminants.

Flexibility through modular design: Three different types of lines are available to recycle fiber or non-woven scrap or even post-consumer PET bottles flakes. Depending on the properties of the input material and its requirements, the pre-treatment and down-stream equipment is chosen. Optionally, a vacuum SSP reactor provides adjustable IV increase and removes released spin finish.

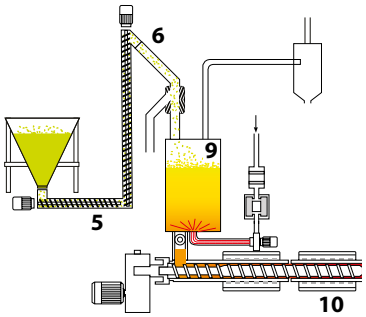
recoSTAR dynamic

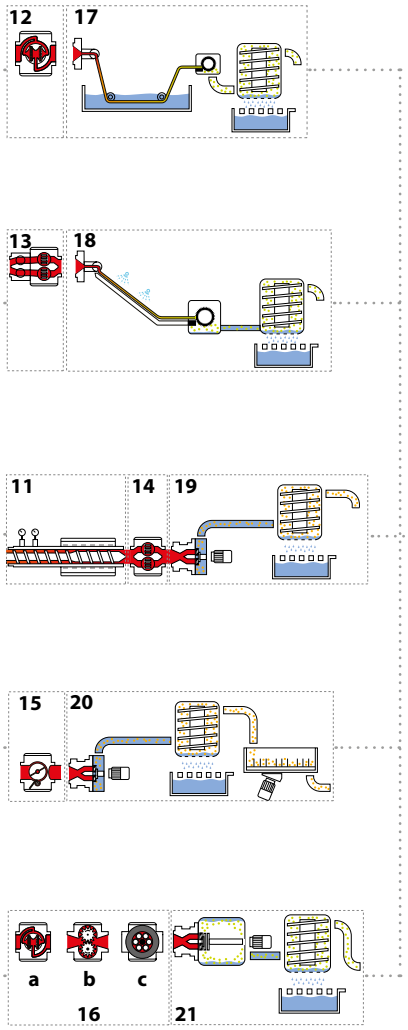


recoSTAR universal

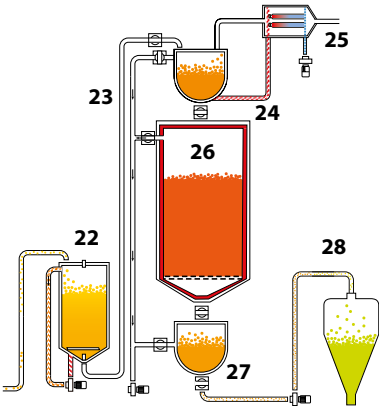


recoSTAR PET





recoSTAR SSP



1. Conveyor belt with metal detector
2. Single-shaft cutter, stand-alone
3. Nip roll feeder
4. Edge trim cyclone
5. Feeding screw
6. Metal separator
7. SMART feeder
8. ACTIVE shredder with dosing screw
9. Combined drying unit
10. Extruder
11. Degassing extruder
12. Power backflush filter
13. (14.) Melt filter with(out) backflush
15. Continuous melt filter
16. Cascade filtration:
a) Melt filter with power backflush
b) Melt pump
c) Sleeve filter
17. (18.) (Automatic) strand pelletizer
19. Underwater pelletizer (UWP)
20. UWP with inline crystallisation
21. Water ring pelletizer
22. Post-crystallization unit
23. Separate vacuum feeding system
24. SSP preheater
25. Heat exchanger for preheater
26. SSP reactor
27. Discharge unit
28. Storage silo

Recycling into pellets with excellent flow characteristics

is necessary as production scrap comes in different shapes. After having analysed the characteristics of the input material, both the right choice of equipment as well as process know-how ensure the production of high-value regranulate, improving cost efficiency and stability of the primary production process.

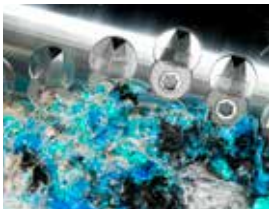
	Materials	Humidity	Fiber & Filament	Fabric & Nonwoven	PET Flakes	SSP
recoSTAR dynamic	PES / PET, PA, PP	up to 20 %	preground	preground	yes	optionally

recoSTAR dynamic is the perfect choice for hygroscopic and humid materials due to the cutting and preheating in the SMART feeder. The frictional process dries the homogenized material before it is fed into the extruder. The dynamic automation package regulates the ideal operation point. Automatic speed adjustment of the rotating disc and positioning of the load-controlled intake slider leads to increased output. Higher levels of humidity can be processed.

In the SMART feeder the material is cut and densified by the knives of the rotating disc at the bottom. Material temperature detection enables stable production conditions.

	Materials	Humidity	Fiber & Filament	Fabric & Non-woven	PET Flakes	SSP
recoSTAR universal	PES / PET, PA, PP	up to 2 %	preportioned	preportioned	yes	optionally

recoSTAR universal allows processing of fibers, filaments and nonwovens without pre-cutting; only preportioning to fit conveyor belt dimensions is required. This material preparation in combination with the sophisticated software and the dosing screw allows processing of materials with different bulk densities and even flakes. Material temperature is controlled by rotor cooling or heating. Efficient material preparation and the dosing screw system ensure perfect process stability.



The hydraulic pusher in the ACTIVE shredder presses the material against a water-cooled or heated rotating shaft and thus provides efficient crushing. Continuous feeding of the extruder is controlled by the dosing screw.

	Materials	Humidity	Fiber & Filament	Fabric & Non-woven	PET Flakes	SSP
recoSTAR PET	PET	up to 1 %	no	no	yes	optionally

The recoSTAR PET process allows the use of PET post-consumer bottle flakes as an alternative, cost-effective input material. Flakes are dried in a FIFO (first-in/first-out) dryer. Feeding to the extruder via dosing screw is controlled by the extruder motor load. Due to constant feeding into the extruder, exact feeding of liquid additives is possible. If required, the viscosity (IV dl/g) can be adjusted automatically within a defined range. Very fine filtration of 25 µm or even less requires special filtration systems, e.g. cascade filtration.

PET bottle flakes are fed into the pre-drying unit on top of the extruder. The material is dried, heated and crystallised by hot (desiccant) air. Natural gas can be used as a cost-effective alternative for heating.

Recycling plus up-cycling:

Finest melt filtration and high machine uptime

The patented and unique candle filter efficiently removes solid contaminants during the recycling process and is suitable for processing PET bottle flakes and continuous filaments. Due to the quick-release technology the filters can be changed easily during the continuous production process.

Candle filter with special features:

- Depending on the throughput the candle filter has two or more canisters which consist of 6 filter elements with one support pipe and sleeve each.
- The filter sleeves are designed with quick-release technology for a high uptime and low melt loss.
- All sleeves can be changed easily "on the fly" during production instead of changing the whole canister and/or shutting down of the line.
- Finest 3-D melt filtration down to 15 µm is guaranteed with a special nonwoven fiber felt filter medium.
- Increased efficiency by using contact-free infrared heating – it enables easy and quick access and saves energy.

an economically and ecologically winning formula

Increase the IV to enable higher regranulate content

Due to IV loss in PET/PES during every thermal process, regranulate usually can only be used at a lower level than virgin resin. Increasing the viscosity of the material during the recycling process to the level of virgin resin allows the use of up to 100 % regranulate, or upcycling for special applications such as high tenacity fibers.

recoSTAR lines with SSP technology feature the following advantages:

- IV is adjustable and consistent due to FIFO principle (variation rate similar to virgin resin).
- Increased efficiency by using gas, steam or the residual heat of previous process steps to optimise electrical energy consumption.
- The pre-fabricated SSP units have a small footprint, a convenient height and can be quickly installed on standard industrial floors.
- The modular system allows simply adding another SSP unit in case a higher IV is needed or the IV of the input material decreases over time.
- After SSP treatment, rPET pellets enable converters to replace virgin material without having to change their production process or materials handling.

We reserve the right to technical modifications. Published 06/2025. DPR-23831

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